GOODMAN RESEARCH GROUP, INC.
Program Evaluation ❖ Consultation ❖ Market Research

FINAL REPORT OF THE WOMEN'S EXPERIENCES IN COLLEGE ENGINEERING (WECE) PROJECT

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Executive Summary

The Women's Experiences in College Engineering (WECE) project is the first cross-institutional, longitudinal examination of undergraduate women's experiences and retention/persistence in engineering majors programs. The study was funded by both the National Science Foundation and the Alfred P. Sloan Foundation and conducted by Goodman Research Group, Inc. (GRG), a research company specializing in program evaluation. This executive summary presents the methods, findings, and conclusions from the WECE study.

The WECE project was driven by the increased funding and attention given to support activities for women in undergraduate engineering programs. Over the past decade, the consistently low representation of women in undergraduate engineering and in the engineering workforce has continued to challenge educators, researchers, and policymakers as they search for a clearer understanding of what contributes to these low numbers. While women make up 56.8% of the total U.S. workforce, only 8.5% of the country's engineers are women. On average, women compose only 20% of enrollment in engineering schools and are both less likely to choose an engineering major and more likely to switch out of one than are men.

In response to such statistics, over the past 15 years, a number of formal Women in Engineering (WIE) programs have been developed at universities across the country to assist in recruiting and retaining women in engineering majors. These programs offer academic and social support for female engineering undergraduates: mentoring, study and laboratory skills workshops, career exploration, social opportunities and support, outreach activities, scholarships and awards, and newsletters.

Numerous studies have explored issues related to the low representation of women in science and engineering, but until WECE no research design had ever included a national cross-institutional study of the experiences of women that could ***statistically*** assess the relationship between women's persistence in undergraduate engineering programs and their participation in support activities, as well as the relationship between persistence and departmental, institutional, and personal factors.

WECE Research Questions

The WECE project's chief goal was to identify aspects of women's educational experiences that are critical to their retention in engineering. The major research questions of this study were:
What roles do student and institutional factors play in women's persistence in engineering?
What is the relationship between women students' persistence in engineering and their participation in support activities and use of engineering resources?
What makes resources and support services for undergraduate women engineering students successful?

Although the study began as an evaluation of WIE programs, the WECE project's focus broadened early on, when it became clear that we needed to explore the range of activities and supports for undergraduate women in engineering across all the institutions, both with and without WIE programs.

Institutional and Student Samples

Fifty-three institutions with undergraduate engineering schools participated in the WECE project. Of these, 26 schools had formal Women in Engineering (WIE) programs. These were matched with a stratified random sample of 27 schools that did not have such programs. The schools were selected to represent a range of geographic regions, sizes of engineering programs, Carnegie classifications, and levels of selectivity.

For each of three years, all undergraduate women at the 53 participating institutions who were majoring in engineering, or who were known to have once considered or pursued a major in engineering (including computer science), were selected to participate in the WECE study. (This number ranged from 21,000 to almost 25,000 per year). Response rates to the annual questionnaire were 33% (n=6,926) in 1999, 41% (n=9,231) in 2000, and 36% (n=8,999) in 2001. The vast majority of the sample (96% in 1999 and 92% in both 2000 and 2001) consisted of women continuing in the major, hereafter referred to as *stayers*. Those who left the major are referred to as *leavers*. (The percentage of leavers in our sample was well below the national average because we had to rely on lists from the schools—lists that were not always available or complete—and because many leavers thought they were not eligible to participate, despite our requests for their responses.) Across all three years, the sample was fairly evenly divided across freshmen, sophomores, juniors, and seniors. In 2000 and 2001, 8–9% of the sample consisted of fifth-year students.

A sizable number participated in our study multiple years: 66% of the women who completed the survey during 1999 and who were eligible to complete it in 2000 did so, 59% who participated in 2000 and were eligible to do so in 2001 completed the survey both times, and 16% who were eligible to participate all three years did so.

Methods and Procedures

We collected data from a variety of sources at the 53 institutions, using the following instruments:

Student Online Questionnaire: In each of the three years, students were invited to complete a 30–40 minute, 220-question, online questionnaire about their backgrounds, their experiences in and perceptions of engineering, and their participation in engineering support activities. The annual surveys were based on students' prior responses; stayers and leavers saw closely related, but slightly different, survey instruments that were tailored to reflect their current status in engineering.

WIE Program Director Semi-Structured Interviews and Online Surveys: Data were gathered by interview in fall 1999 and by online survey in fall 2000 from directors at all 26 WIE schools. Topics covered were: how to develop and manage support programs, the history of their WIE program and its activities, their relationships with engineering faculty and administrators, their advice to new directors, the future plans of their WIE program, and how they raised funds.

Engineering Dean Online Questionnaire: In fall 2000, the deans at 51 of the 53 engineering schools (96%) completed a short online questionnaire about their background in engineering, goals and challenges for their school of engineering, and their initiatives and support for programs for women in engineering.

Engineering Faculty Online Questionnaire: In fall 1999, 7,421 engineering faculty at the 53 schools were invited to complete an online questionnaire about their fields of interest, their advising responsibilities, the courses they taught, and their beliefs about engineering education. We have 1,385 responses (19% response rate).

Site Visits: We conducted site visits in spring and autumn 2000 in 11 geographically diverse schools with the largest percentages of female engineering undergraduates reporting (on the student online questionnaire) high levels of contentment in engineering, confidence in engineering, and commitment to their major. Each visit consisted of female student focus groups (123 students in 21 focus groups across all schools) and interviews with the engineering dean, other key administrators (e.g., provosts, other deans), the WIE director, other engineering student support staff, and engineering faculty.

Institutional Database: We constructed an institution-level database with information about the 53 institutions (e.g., school size, selectivity, percentage of women in engineering), using sources such as ASEE engineering directories and *Peterson's Guide to Four-Year Colleges 1998.* We then used the data to run the statistical models to investigate whether institutional characteristics affected women's persistence.

Nonrespondent Bias Survey: In spring 2000, we contacted 125 nonrespondents; 82 students (66%) responded to the survey. The nonrespondent sample had a greater percentage of leavers and of fifth-year students than did the respondent sample. However, after considering the differences in leaver status and year in school, on all significant areas of interest, the respondent and the nonrespondent samples were essentially identical.

Data Analysis

The WECE project employed both quantitative and qualitative data analysis techniques. We used two longitudinal multivariate strategies for analyzing student data: hierarchical linear modeling (HLM) and global-survival (event history) analysis. HLM allows both the differences among institutions and the differences among students grouped within institutions to be incorporated into one model. Event history analysis enables researchers to examine persistence issues by constructing hazard models to determine the particular points when undergraduate women are most at risk for leaving engineering.

Statistical analyses produced eight scales related to student perceptions and student participation, which were then used in the multivariate models. Each scale consisted of questions that centered around one concept; combining questions into scales increased the power of our analyses.

The four scales regarding perception were:

(1) Engineering Department Environment (6-item composite re: how encouraged or discouraged they were by teaching, school size, overall department atmosphere, faculty, peers, their advisor)
(2) Engineering Classroom Environment (4-item composite re: how encouraged or discouraged they were by grades, time required for coursework, classroom competition, pace)
(3) Contentment in the engineering major (3-item composite re: interest in engineering and happiness with choice of engineering major)
(4) Change in Self-confidence (4-item composite re: self-rated changes in confidence related to SME and overall academic abilities)

The four participation scales were:
(1) Participation in Social Enrichment activities (4-item composite re: field trips, guest speakers, engineering social events, and engineering society events)
(2) Participation in Get Help activities (4-item composite re: getting help via tutoring, peer mentoring, career mentoring, email mentoring)
(3) Participation in Give Help activities (2-item composite re: giving help via mentoring and tutoring)
(4) Overall Participation (Sum of Get Help, Give Help, and Social Enrichment scales)

In addition to these scales, the variables "Participation in Study Group" and "Participation in Internship/Research Experience" were used in analyses.

For the qualitative data, we took extensive notes during our site visit observations, interviews, and focus groups, and then integrated the multiple data sources and developed themes from the selected group of schools. The themes arising in the focus group discussions during site visits corroborated the quantitative findings from the large-scale student questionnaires.

Findings From the Student Questionnaire and Focus Groups

Student Background and Pre-College Experiences

- The average woman in our study was a U.S. citizen, white, a graduate of a suburban, public, co-ed high school, and of traditional college age.
- Almost half took an advanced placement course in calculus, one-quarter took AP chemistry, and one-fifth took AP physics. Ten percent took an engineering course in high school, and 15% took a science or math course at a local college.
- At the high school level, almost half belonged to SME afterschool clubs, one-third had entered SME competitions, one-quarter took summer SME programs and/or special programs or workshops, and one-fifth volunteered, interned, or taught SME.

Reasons Women Enter Engineering

Students' reasons for choosing engineering included:

- Early interest and abilities in math, science, engineering, and technology

- Attraction to the kind of work engineers do, especially particular applications—for instance, helping people and society, building and designing, improving the environment, and exploring outer space
- Experiences in high school that piqued their interest, such as clubs, classes, and workshops
- Job opportunities
- Value of an engineering degree for entering business, law, medicine, or other fields

Nearly one-third of students who attended schools with WIE programs said their decision to attend that school was influenced by the presence of a women's engineering support program.

Staying with or Leaving the Engineering Major

Students' explanations about when and why they had considered leaving or had left the engineering major included:

- About two-fifths of student participants in all years of college reported that they had considered leaving engineering at some point during college. Sophomore year was most frequently mentioned as a year when they considered leaving engineering: about one-third of all sophomore and more advanced student respondents reported that they had seriously considered leaving engineering during sophomore year.
- Freshman and particularly sophomore year were, in fact, the years women were most likely to actually leave engineering.
- Leavers were about three times more likely than stayers to have considered leaving in a prior year.
- Half of all leavers cited dissatisfaction with their school's program (e.g., grades, teaching, workload, pace) as a reason to leave; another one-third mentioned negative aspects of their school's climate: competition, lack of support, and discouraging faculty and peers. One-half said they left because they found they were not interested in engineering. One-third said they were attracted to another discipline.
- Regardless of whether they had considered leaving or had left engineering, the vast majority in our sample would still either *definitely* or *probably* encourage other women to major in the subject. Only a very small percentage said they *definitely would not* encourage others.
- Eighty percent of senior and fifth-year students expected to be working in the engineering field in seven years.

Grades

Both in the focus group discussions and in the questionnaire, students reported their grades and their feelings about their grades and the grading process at their schools.

- Stayers, on average, received higher grades than did leavers in engineering-related courses; chi-square tests indicate that the differences were significant. However, almost 45% of leavers had A or B averages in their engineering-related courses, and two-thirds had had A or B averages in a previous year. This suggests that many students capable of the academic work are still choosing to leave engineering.
- Leavers generally were more discouraged by their grades than stayers were—but even women doing very well academically were often discouraged by their grades.

Most Significant Sources of Encouragement and Discouragement
Students were both encouraged and discouraged to pursue an engineering degree by influential people and other factors.

- Parents were the most encouraging people overall; father, mother, and interest in the subject matter were most commonly cited sources of encouragement in every year of college. In later years, students also cited employment opportunities, salary potential, and internships/research experiences.
- The most significant sources of discouragement were grades and amount of time required for engineering coursework, followed by uneven teaching quality and lack of interest in the subject matter. Also discouraging were the heavy workload, having no time for other activities, a restrictive curriculum, the practice of grading on the curve, and lack of female faculty.
- Competition in engineering classes was considered discouraging most often in women's first two years; later on it was the engineering department environment, class environments, and college faculty members.

Being Female in Engineering
On the questionnaire, women were asked to compare themselves to their male peers.

- Students compared themselves more negatively to male peers than to female peers in understanding engineering concepts, solving engineering problems, commitment to engineering, and confidence in their engineering abilities.
- A majority of women felt that they worked better with other people than did their male peers. They also felt they spent more time and effort on their class work than did males.
- Most women felt they had no advantage or disadvantage compared to male peers in working with faculty and advisors or in finding a mentor.

Perceptions and Persistence

- Women's assessments of their Change in Self-Confidence, the Department Environment, and the Classroom Environment were all related to their persistence in the major. More negative perceptions in any of these areas were significantly associated with an increased risk of leaving engineering in every undergraduate year.
- Stayers tended to have a more positive Change in Self-Confidence, and they had more positive perceptions than did leavers of both the engineering Classroom Environment and the Department Environment. Furthermore, leavers often listed disenchantment with their classes and with the department atmosphere as reasons for leaving.
- We cannot say whether more positive perceptions are due to environment, student personality, or both, but it is clear that more positive perceptions were significantly associated with staying in engineering.

Participation in Support Activities as Related to Perceptions of the Engineering Environment
Participation in support activities was clearly related to students' perceptions of the engineering environment.

- Stayers were more likely to participate in all types of support activities than were leavers. A stayer's level of participation in Social Enrichment activities was significantly associated with more positive perceptions of the Department and Classroom Environments and with positive Change in Self-Confidence. The higher the level of participation, the more positive the perceptions. In contrast, for leavers, greater participation in Social Enrichment activities was associated with negative perceptions of the Classroom Environment, and not significantly associated with other perceptions.
- A woman's level of participation in Get Help activities was positively associated with positive Change in Self-Confidence and with positive perceptions of the Department Environment. However, stayers who participated more frequently in Get Help activities tended to have more negative views of the engineering Classroom Environment. It is possible that poor teaching necessitates seeking more help, or that receiving good help makes the classroom environment look worse in comparison.
- Leavers, like stayers, perceived the engineering Classroom Environment more negatively if they participated more in Get Help activities. Unlike stayers, however, greater participation by leavers in Get Help activities was also related to negative Change in Self-Confidence.
- For leavers, participation in support activities seems to have a very different impact on their perceptions of the environment than it does for stayers.

Participation in Support Activities as Related to Persistence
Students participated in a variety of support activities and used resources during their undergraduate years in engineering. WIE programs, where they were present, frequently were sponsors of mentoring programs, newsletters, engineering society activities, engineering speakers, social events, and outreach to pre-college students. Level of participation in certain types of support activities and resources was related to persistence.

- Juniors, seniors, and fifth-year students were much more likely to participate in various support activities than were freshmen or sophomores. Most prevalent among the wide range of reasons for participating were "learning about opportunities in engineering" and "socializing with others in engineering."
- The vast majority of women who had previously participated in support activities indicated that they would *definitely* or *probably* participate in the activity again.
- Students who were leavers in a subsequent year participated in significantly fewer support activities (of all kinds) overall, and especially in fewer Social Enrichment activities, than those who remained in engineering during our study.
- Conversely, students who participated more frequently in support activities—particularly students who participated in Social Enrichment activities—were less likely to leave engineering than were those who did not participate or who participated less frequently. Social Enrichment activity participation was significantly associated with staying in engineering, even after taking into account Change in Self-Confidence or perception of Department Environment. This suggests that there is a unique quality of Social Enrichment activity participation that makes women want to stay in engineering.

- Students seem to attach importance to giving help to others. Getting help is also important to them and satisfies many of their needs. However, levels of participation in both Give Help activities and in Get Help activities were not related to persistence.
- From freshman year onward, students who stayed in engineering had been participating in study groups more frequently than those who left the major. Similarly, first-year students in study groups were significantly more likely to persist in engineering later.
- A higher percentage of stayers had held a research or internship position than had those who subsequently left engineering, though this difference was not statistically significant. Nevertheless, internships seem to play an important role in students' education, one valued by students who have had the experience and even by those who haven't.

Relationship of Institutional Variables to Graduation Rates and to Participation
Neither the institutional variables nor the scale variables (averaged by school) bore any relationship to women's participation in engineering support programs or to graduation rate. The only exception was that the higher the proportion of engineering students to the entire student body population, the higher the graduation rate in engineering. Whether a school had a formal WIE program or not bore no relationship to women engineering students' frequency of participation in Social Enrichment, Give Help, or Get Help activities. Many non-WIE schools offer a range of support resources and activities for women engineering students that are similar to those offered by WIE schools.

Findings related to WIE Program Directors, Deans, and Faculty

WIE Directors
WIE programs seek to support students academically, socially, and psychologically. To do this, WIE directors believe they must have the support of engineering administration and faculty.

- WIE directors have a range of responsibilities: recruiting, retention efforts, fundraising, and advising students. The director must decide how to allocate limited funds to the various activities the WIE program offers, using her own experiences and input from others to decide which activities to offer.
- WIE directors surveyed felt that mentoring programs were the most effective way to retain female engineering students. Other activities valued by directors included research internships, orientations, career days, speakers, and various social activities.

Engineering Deans
Deans of engineering make many decisions that directly affect the quality of the undergraduate experience of women engineering students: decisions regarding funding, program offerings, course offerings, and the hiring of faculty.

- Some top priorities listed by the engineering school deans we surveyed included improving the quality of research, meeting the demands of growth in industry, bringing technology into the curriculum, and continuing and expanding K-12 outreach activities.

- Challenges faced by deans include raising funds, building faculty development initiatives, recruiting and retaining female and minority faculty, and recruiting more students.
- In site-visit interviews, all deans expressed support of the WIE program, yet levels of enthusiasm and knowledge about the successes and challenges of the program varied across institutions.

Faculty

The faculty questionnaire respondents were predominantly male, white, tenured, and 50 years of age or older. Female engineering faculty were substantially overrepresented in our sample (14%).

- The majority of faculty (of both genders) advocated actively recruiting female students into engineering programs, but there was less consensus on whether more ought to be done to retain women once they were there, and there was no consensus at all on the desirability of support programs for women students.
- Faculty generally believed that female students' academic skills were comparable to those of male students, except a majority felt male students had better laboratory skills, while females had better study habits. Female engineering faculty were more likely than male faculty to say that the engineering academic climate favored male students, and they reported hearing more complaints of unfair treatment of females.
- Female faculty generally perceived conditions in the engineering workplace as more difficult for females than did male faculty.
- During site-visit interviews, female faculty members gave accounts of gender-specific pressures in their own faculty careers: extra demands to serve on committees, being sought as advisors to female students, and needing to prove themselves as women engineers.

Conclusions and Recommendations

We believe that the findings from the WECE project can inform the planning processes of WIE and other program administrators and can help senior administrators in universities to better understand how campus support activities, resources, and other factors can be used to maximize the retention of women in engineering. Below we describe conclusions drawn from the results and offer some recommendations upon which various stakeholders may act.

Pre-college exposure encourages students to pursue an engineering major.

Both individuals (particularly parents) and organizations play an important role in encouraging young women to pursue college engineering majors. The vast majority of student respondents knew they were going to be engineering majors before they entered college, even if they were not exactly sure what engineers do. For those without parental encouragement, other means of becoming aware of engineering and of selecting engineering as an "informed consumer" need to be made widely available.

Possible ways to expose young women to engineering concepts, what engineers do, and necessary skills, include:

- Expanding enrichment activities in pre-college informal education settings and exposing girls to engineering at the elementary and middle school level.
- Greater implementation of universities' outreach initiatives that teach girls and their teachers and school guidance counselors about engineering. A number of WIE programs already carry out pre-college outreach. These efforts, particularly if conducted in concert with elementary, middle, and high schools, can introduce girls to women who are majoring in engineering and to women in engineering careers.
- Continuing to mount and expand outreach initiatives within the engineering profession (e.g., National Engineering Week, Introduce a Girl to Engineering Day).
- Sponsorship by foundations and other organizations of an ongoing media campaign (via newspapers, television, radio, billboards, etc.) over the next decade to help the public better understand what engineers do.

Women are most likely to leave engineering majors in their freshman or sophomore years.
Female engineering students are most vulnerable to leaving the major during their first two years. Yet most colleges and universities, with the exception of technical institutes, do not accept women into a field-specific engineering major until their junior year. Thus, WIE programs and other support entities play a particularly important role during these first two years.

Ways to prevent students from leaving and provide them with support during the first two years include:

- Stepping up the efforts of engineering departments or schools to educate and encourage *all* incoming students about the benefits of using support resources, be they WIE programs, minority engineering programs, study groups, professional engineering societies, or student chapters of the Society of Women Engineers.
- Offering engineering classes for freshmen and sophomores and matching up prospective engineering majors with advisors in students' general fields of study.
- Departmental orientation and monitoring of students.
- Talks, forums, social activities, and other department-sponsored activities and events that involve students from the time they begin college.

Women are not leaving engineering because they can't make the grade.
Many young women leave not because they can't do the work (a misperception that has been common among engineering faculty), but for reasons other than academic ability. These reasons can include their negatively interpreting grades that may actually be quite good, diminished self-confidence, or reluctance to spend all of their waking hours "doing engineering." For some students, the investment necessary to earn grades of A or B may be too much of a sacrifice and "not worth it."

Possible ways of ameliorating students' sense of discouragement include:

- Developing grading rubrics
- Explaining the grading system (pointing out how grading in engineering is different from grading in other disciplines, if that is the case)
- Setting clear goals and expectations for classes
- Designing tests that mirror the goals of a class

- Basing grades on how well students meet educational goals
- Generally reviewing and improving pedagogical strategies

Women's self-confidence must be recognized as a major factor in persistence.
The decline in young women's self-confidence—even the confidence of very talented students who are succeeding in what they do—is a societal problem that extends far beyond undergraduate engineering departments, and a tough one to solve. A student's self-confidence increases when she feels that someone believes in her engineering abilities, cares about her, and wants her to be part of a community.

Possible ways of building awareness of this issue include:

- Increasing faculty, advisors', and mentors' sensitivity to students' self-confidence
- Educating faculty and staff about topics such as gender equity and creating more inclusive environments
- Providing more opportunities for women to meet with other students and professionals from the field who might provide additional support and encouragement

The climate in college engineering affects whether women persist.
A student's perception of the quality of support in her classes and department is related to whether she persists in engineering. Students whose views of the engineering department and engineering classroom environments were the most positive were most likely to stay in engineering. Women were discouraged the most by their grades, the amount of time required for their coursework, the quality of teaching by faculty, their own lack of interest, and the atmosphere of the engineering department and courses. The ones who were most discouraged were more likely to leave the major. Several of these factors are related to the climate and thus warrant examination by engineering administrators and faculty, whose decisions can directly affect the quality of the day-to-day experience of engineering students.

Examples of what institutions can do (and what some are already doing) include:

- Recognizing that a major reason many women choose engineering is because of an altruistic bent (and the knowledge that engineering does, in fact, help society and people)
- Making room for students to pursue and develop other interests and skills: making freshman year courses pass-fail, not requiring as many "grunt" courses in the first two years, and mandating some electives
- Nourishing students' interest by using examples in class that highlight applications and problem solving and that demonstrate how engineering has led to improvements in society and the quality of people's lives
- Providing advisors—especially at the outset—who can make the climate more welcoming and supportive by providing adequate time, information, and encouragement

Women undergraduates in engineering need community.
Our findings strongly indicate that participation in support activities is vital to many women undergraduates, who need to feel they are part of a larger community in engineering. Community allows students to build networks and to feel that their presence in engineering is important to others. Networking can counteract the isolation that women experience—providing them with information, support, and the knowledge that they're not alone in the challenges they face.

Possible ways for the engineering administration to build support for students and draw them into the engineering community include:

- Providing opportunities to socialize and learn with other students, through study groups and a variety of other support activities, through internships, and through interactions with older students, mentors, peers, faculty, and administrators
- Involving students in the planning of community-building activities
- Allowing students more time and resources—by revisiting and possibly revising the engineering curriculum, course requirements, and grading system—to develop a sense of community that might in turn help them feel better about the environment in engineering

WIE programs are beneficial, and they are challenging to administer.
WIE programs meet many needs of female engineering students. They provide advocacy for women, meeting places (both literal and figurative) for students seeking contact with one another, and mentors, internships, and social and academic activities and resources for women across the board. In our research, many women enumerated the challenges specific to being female in engineering; WIE programs exist to help students with these extra challenges. The WIE directors are well versed in women's issues in engineering and work to provide female students with awareness, understanding, and support to help them navigate the engineering path.

One of the biggest challenges to the existence of WIE programs is not whether the programs can do what they set out to do, but how the programs are perceived by some individuals (e.g., providing remedial or "hand-holding" services to students who would not otherwise succeed). To counteract this perception, some WIE programs make their services available to all students, although they continue to focus on providing activities tailored specifically to women's needs. Other programs underplay their sponsorship of activities, instead working "in the background" through SWE or other organizations.

Possible ways to accentuate the positives of the WIE program and to bring its true purpose into clearer focus include:

- Continuing to advocate for women's often-overlooked perspectives and providing networking centers, mentoring, engineering applications lectures and classes, and community-building, but under the umbrella of engineering student affairs—as part of an organization that manages student community/life for all students
- Developing and implementing "public relations" campaigns on campus that inform engineering students (male or female), faculty members, and others about the function of the WIE program
- Recognizing and acknowledging on the institutional level that WIE program administrators serve as important resources for students and administrators.

Schools can benefit from close institutional data keeping and analysis.
Early on, we found that institutions do not track individual students throughout their college careers, and that reliable institutional figures for graduation rates are quite rare. Each year of our study, we provided deans of engineering and WIE directors with the results of the annual student survey for their institution (compared to the total sample of 53 institutions). The deans and WIE directors met the reports with great interest, telling us they were eager to know the perceptions and attitudes of their female students. Clearly institutions are in need of and are interested in more consistent collection and use of student data.

Data collection and analysis approaches that could benefit engineering institutions and their students include:

- Administering brief questionnaires to engineering students—for instance, incorporating a mini-WECE questionnaire into online registration—that would periodically give administrators a snapshot of students' perceptions about the department, their courses, the instruction, and their self-confidence.
- Longitudinally tracking individual students in engineering departments from the time they enter until they graduate or otherwise leave the major, collecting data on who leaves, how long students take to complete their degrees, and which majors have the highest attrition rates and the lowest number of women and other minorities.
- Integrating data keeping with monitoring/mentoring of all students, particularly younger undergraduates. A program such as WIE, which exists to help support and build the engineering community, can work with the college or school administration to carry this out. Data on the tracked students' engineering coursework could be analyzed to determine whether the courses they take or the sequence in which they take them is related to whether they persist. To complete the picture, schools could conduct exit interviews with students who leave the engineering major.
- Devising better ways to glean more reliable figures for graduation rates.

Looking Ahead

The WECE study has provided a first quantitative glimpse into the factors affecting women's persistence in undergraduate engineering, answering the questions we outlined back in 1995. We realize, however, that the study was by no means definitive, and, as with much research, it has raised many more questions. One perplexing question arising from our results is why we found no statistically significant differences in persistence between women at schools with WIE programs and women at non-WIE institutions. One possible explanation suggested by our research is that many schools without WIE programs offer similar types of programs that are run by other organizations (such as SWE)—and other institutions run WIE programs but did not exactly meet our criteria to be included as a WIE school.

The distinction between a formal WIE program and some other entity (non-WIE) may be somewhat artificial. What ***is*** important to young women's persistence in engineering is to provide them with access to a range of support activities throughout their college years, especially in the first two years when they are most vulnerable to dropping out. As engineering institutions navigate the next few decades, the search for the optimal balance of activities and supports, curricular improvements, and positive attitudes toward women in this field must continue.

Chapter 1: Introduction

The low representation of women in engineering is well known. Virtually every federal funding agency, professional society, and foundation involved with engineering has issued studies and reports documenting the dearth of women in the field and the possible barriers that have contributed to this shortage. In response, many universities, as well as industries, corporations, and foundations, have mounted Women in Engineering (WIE) programs or contributed funds toward the development or expansion of such programs. The mission of WIE programs is supported by such organizations as the American Association for the Advancement of Science, the National Science Foundation, and the U.S. Department of Education

These specially designed WIE programs are a significant part of a general national movement to increase female presence in the sciences. WIE programs are interventions specifically aimed at increasing the number of women who graduate with engineering degrees and pursue careers in engineering.

THE GENESIS OF THE WOMEN'S EXPERIENCES IN COLLEGE ENGINEERING PROJECT

Planning for the project that is reported here – named the Women's Experiences in College Engineering (WECE) Project – began nearly eight years ago. In summer 1994, Ted Greenwood, a program officer of the Alfred P. Sloan Foundation, discussed with Irene F. Goodman, the Principal Investigator of this study, whether Goodman Research Group, Inc. (GRG) would be interested in writing a proposal to the foundation to conduct an evaluation of WIE programs. The Sloan Foundation was particularly interested in an evaluation of WIE programs because they had been funding several of these programs over a ten-year period and wanted to know if they were effective. Effectiveness, as defined by the foundation's staff, was whether programs had contributed to the increase in retention of women in engineering majors.

Early discussions made it clear that it would be prudent to study not just Sloan-funded programs but also the burgeoning number of programs funded by the National Science Foundation, other foundations, and institutional funds. The impact of WIE programs had scarcely been studied at all, let alone examined on a national basis. The groundwork for the current WECE project was laid during those early discussions, which centered on the need to better understand the variables affecting recruitment and retention of women undergraduates in engineering.

Goodman and her colleagues, Colleen F. Manning and Robert T. Brennan, wrote a concept paper and a planning grant proposal to the Sloan Foundation, and in June 1995, GRG received a six-month planning grant from Sloan to investigate the feasibility of conducting a large-scale, cross-institutional research study by:

(1) reviewing relevant literature and consulting with current researchers;
(2) exploring the WIE programs' objectives and implementation, and classifying them according to program features and school types;
(3) ascertaining appropriate methods for a full-scale evaluation, including strategies for sampling, instrument development, and analytic techniques; and

(4) meeting with and obtaining commitments from WIE program administrators to cooperate in an evaluation, and selecting the institutions that would participate in the full-scale evaluation.

A literature review, interviews with 15 WIE directors, formal site visits to three institutions, and interviews with registrars and other administrators revealed that there was no clear consensus from the field as to what constituted a formal WIE program. All programs emphasized increased enrollment and retention of women in engineering and science, but the types of activities and the rate of student participation in WIE programs differed widely.

Because WIE programs are not solely responsible for the outcomes desired by program managers and funding agencies, GRG explored other variables that could affect women's presence in engineering; we decided we would ask about these variables in a large-scale survey were a study eventually funded.

After completion of the planning study and final report, the Sloan Foundation requested a full proposal for a large-scale study. This required additional research and proposal revision beyond the planning grant period, as well as many lively discussions about goals, data collection methods, and sample. For instance, some of the discussions with the Sloan Foundation program staff and WIE advocates in the field revolved around whether to include men in the sample. Some in the field felt that without also surveying men one would not obtain a complete picture of the conditions and successes, while others felt that including men would distort the aims of the study, which was to examine WIE programs. In the end, it was decided not to include men, because even though the theoretical constructs upon which WIE programs are based are related to gender issues, we were proposing to study the influences of programs and activities aimed at providing support to women.

The Sloan Foundation agreed to partially fund the large-scale study (contingent on our receiving the remainder of funds elsewhere). In 1997, we recruited Christine Cunningham to join our research team (pending funding) as the Co-P.I. and Project Director. With an additional grant from the National Science Foundation, in April 1998, the Women's Experiences in College Engineering (WECE) Project was launched. The WECE project team was completed with the hiring of Cathy Lachapelle as project manager and Meredith Thompson and Katherine Bittinger as research assistants.

STUDY GOALS AND MAJOR RESEARCH QUESTIONS

We believe that the study reported here is the first multi-site study to systematically, rigorously, and objectively assess the contribution of undergraduate WIE programs in the U.S. Generalizability, perhaps the single most important element of this evaluation, sets this study apart from all other studies of WIE programs. Other studies thoughtfully examining the success of WIE programs have typically been conducted at single institutions or at a few "hand-picked" institutions, and although these studies have often been of tremendous use to the participating institution and of general interest to others in the field, their findings have not been generalizable.

The chief goal of the WECE project has been to collect and analyze quantitative data from female engineering students at a range of engineering institutions in order to identify aspects of women's educational experiences that are critical to their retention and success in engineering. The major research questions of the study were:

- What are the relative roles of institutional and student factors in women's persistence in engineering?
- What is the relationship between students' persistence and their participation in support activities and use of engineering resources?
- What makes resources or support services for undergraduate women successful?

In addition to answering these research questions, our study set out to:

- build a knowledge base about the practices of WIE programs and their impact;
- identify successful WIE program practices to create a foundation on which to build future programmatic interventions;
- guide the development of policy within institutions; and
- assist stakeholders in making critical funding decisions.

Knowledge Base

Our evaluation has established a *national* knowledge base about WIE program activities and supports, as well as other factors that impact recruitment and retention of women in engineering. This study is the first of its kind to include cross-institutional qualitative and quantitative data using comparison institutions and a national sample. Our data set has already been used by several other researchers studying women in engineering.

Program Practices

Our study examined what practices programs actually employ to recruit and retain women in engineering. Several previous studies highlighted factors common to engineering intervention programs that are regarded as effective (Brainard, 1992; Matyas, 1992), including solid support from faculty and administration; a designated director of the program; a sufficient budget; fund-raising capabilities; well-defined program goals; outreach and follow-up with students, teachers, and parents; multi-year involvement; the participation of members of diverse racial/ethnic groups; student involvement in planning; and program evaluation. Our study's large sample size and quantitative measures support many of the findings from these earlier studies of program practices.

Program and Institutional Policy Implications

Our results have policy implications at the program and institutional levels. At the program level, if departments of engineering know what kinds of program activities and supports are successful at retaining students, as well as the particular points in time in students' careers when they are more likely to leave the major, departments can refine and enhance existing efforts.

At institutions, policy-makers want to know how to retain students toward successful completion of engineering degrees. We expected the WECE study to demonstrate the importance of establishing institutional systems to track the retention of women in quantitative fields. Institutions have a vested interest in assuring the success of all their students; tracking "at-risk" students, such as women in quantitative fields, helps identify points and means of intervention. Similarly, the study aimed to identify critical campus climate issues that have indirect but strong effects on the retention of women in quantitative fields. Senior officers can use these results to inform their decisions regarding avenues of budget and reward structures.

Assist Stakeholders Making Funding Decisions

Finally, this study provides current and potential funders with quantitative evidence of how activities and supports for women, as well as other variables, influence female retention in engineering. Our results go beyond the more general statistics cited by advocates espousing the benefits of intervention programs. At the national level, we believe that stakeholders such as federal agencies who award funding to institutions for programs and for research (e.g., NSF, AAAS, U.S. Department of Education, engineering organizations) can use the results of the study to best guide deployment of funds in the effort to retain women in engineering.

OVERVIEW OF THE WECE FINAL REPORT

This report consists of 11 chapters. The remainder of this report is divided into the following chapters:
Chapter 2 provides a review of the literature informing the study.
Chapter 3 describes WIE programs, followed by the methods used to select the institutional sample and a description of that sample.
Chapter 4 discusses the methods and procedures used for the various components of the study.
Chapter 5 describes the student sample and response rate, then the descriptive statistics from the student questionnaire.
Chapter 6 presents analysis of the student questionnaire data using multivariate models.
Chapter 7 provides results of focus groups with student informants.
Chapters 8, 9, and 10 present results from our other informants: WIE directors, engineering deans, and engineering faculty, respectively.
Chapter 11 presents a summary and conclusions.

Chapter 2: Literature Review

Over the past few decades, researchers have called attention to the paucity of women in science and engineering and have begun to examine reasons underlying this phenomenon. Scholars have generated a number of hypotheses, theories, and conceptual frameworks to explain why so many capable women are not attracted to, or retained in, science and engineering fields. The WECE research team drew heavily upon existing literature in this area to develop our theoretical framework and create survey instruments. In designing the study, particularly the student questionnaire, we strove to craft instruments that would allow previous theories to be examined using our quantitative data.

This chapter situates the WECE study in the larger landscape of research about women in engineering. We discuss the need for a study such as WECE and outline existing research by describing major factors that have been posited to explain the dearth of women in engineering. We conclude by reviewing research that has assessed the impact of women in engineering (WIE) programs[1] on recruiting and retaining women in engineering.

THE NEED FOR THE WECE STUDY

Scholars have been examining why women do not stay in science, math, and engineering fields since the 1960s. These studies have proven useful in grasping the nature and scope of women's attrition from engineering, but many have significant limitations, including a general research focus on pre-college experiences; the treatment of engineering as part of a larger science, math, engineering, and technology (SMET) conglomerate; and small sample sizes that include only qualitative data, data taken at one point in time, or data collected from one or a few selected institutions. The WECE study addresses these limitations.

Many researchers have chosen to focus on students' pre-college experiences to identify women's reasons for attrition (e.g., Bennet, 1996; Cannon & Lupart, 2001; Martinez, 1992). Although studying the recruitment and retention of women in the early stages of the "pipeline"[2] helps to understand their overall representation, this approach ignores many variables unique to women's experiences in college engineering. Higher-education researchers such as Sheila Tobias have argued that, by focusing on why women leave engineering before college, researchers contribute to universities' slow progress on improving college retention (Tobias, 1992).

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[1] The WECE project and the Women in Engineering Programs and Advocates Network (WEPAN) have specific requirements of what constitutes a formal WIE program. This section refers to support programs for women in engineering in a broad sense, including both formal WIE programs and less structured support programs for recruiting and retaining women in engineering.

[2] The "pipeline" is a common metaphor used to describe the path students take in pursuing a career in science, math, engineering, or technology (SMET). In this model, students are funneled into the pipeline early in their secondary school years, continuing through postsecondary programs to careers in SMET fields. Much early literature uses the "pipeline" language (e.g., Alper, 1993; Hilton & Lee, 1988; Oakes, 1990).

In working to understand the low numbers of women in the engineering workforce, one logical place to begin is an examination of why women who enter college with an interest in engineering don't follow through on this interest. Recent statistics show a 20 percentage point gap between women and men in their rate of completion of undergraduate engineering programs; while 62% of men earn their engineering degree, only 42% of women do (Adelman, 1998).

A second limitation of previous research is that many studies have examined undergraduate engineering students only within the context of the SMET pipeline (e.g., Ethington & Wolfle, 1988; Leslie, McLure, & Oaxaca, 1998; Manis & et al., 1989). By lumping women engineering students with women in other underrepresented fields, researchers have failed to take into account the uniqueness of engineering education – namely, its professional orientation and its absence from the national K-12 curriculum. In addition, the percentage of women engineering majors is even smaller than the percentage in most science majors.

Research studies that focus exclusively on experiences in college *engineering* are scarce; many of the reasons for attrition outlined below are drawn from the more prevalent work on women in science or women in science and engineering. Underlying the translation from women in science to women in engineering is an assumption that women in the two disciplines face identical challenges. While multidisciplinary studies largely bolster this supposition, experiences unique to students of engineering bear further examination.

Researchers' analyses and conclusions have also been constrained by the qualitative nature and the amount of the data collected on women in engineering, especially that related to evaluation of programs for women in engineering (e.g., Anderson, 1995; Bennet, 1996; Seymour & Hewitt, 1997). This valuable work has generated data and theories about the unique experiences of women in underrepresented fields. Yet for making broad-based policy decisions, engineering administrators – especially those trained in quantitative fields – often prefer quantitative large-scale studies that offer the advantages of powerful statistics and generalizability to complement qualitative findings.

The WECE study's cross-institutional sample stands out among previous research on student attrition, much of which has focused on a single institution (e.g., Brainard & Carlin, 2001; Gardner & Jackson, 1989; Nauta, Epperson, & Waggoner, 1999). Not only does the number of institutions in the sample increase the generalizability of the results, but sample diversity in terms of size, geographic location, size of engineering program, and Carnegie classification yields a more complex portrait of women in engineering across the nation.

Longitudinal data are invaluable in explaining women's persistence in or attrition from engineering, but most studies of women in engineering collect data at only one point during women's college experience (e.g., Ross, Volkwein, & Vogt, 1995; Schaefers, Epperson, & Nauta, 1997; Strenta, Elliot, Adair, Scott, & Matier, 1994). The WECE study tracks individual students' experiences, and these longitudinal data enable the creation of more accurate models of the college career trajectories of women students.

To date, WECE is the largest quantitative study that examines issues related to women in undergraduate engineering. Other large-scale studies such as Cooperative Institution Research Program (CIRP) have collected some data pertinent to studying the experiences of women in engineering, but these studies addressed numerous facets of students' college experiences, and their data on specific influences on engineering is limited. The WECE project was created explicitly to research women in engineering. The study and its instruments were designed to probe factors identified in previous research as key reasons why women leave engineering.

REASONS WOMEN MAY LEAVE ENGINEERING

The majority of theories developed by sociologists, psychologists, educators, gender theorists, and scientists studying the underrepresentation of women in engineering have focused on both personal and institutional factors and have been grounded in a belief that women's educational experiences are strongly influenced by their gender and that engineering education institutions have not traditionally been sympathetic to or aware of women's unique experiences. (Others countering these claims have said that women engineering students are no different than other engineering students and that engineering schools are designed to educate the best and brightest: in other words, those who can "cut it." (e.g., Cole, 1979)).

To craft its research instruments, the WECE team drew upon previous research, namely, five primary themes that researchers have developed to explain the lack of women in engineering:

- Lack of self confidence and engineering self-efficacy
- Lack of pre-college experience and knowledge in engineering
- Curricular focus, pedagogy, and climate in engineering
- Lack of female peers and role models
- Gender and societal issues

Lack of Self Confidence and Engineering Self-Efficacy

Traditionally, women have reported lower levels of self confidence than men in their math and science abilities – a factor that researchers have identified as important for success in engineering. Lack of confidence in math and science ability inhibits many women from pursuing a major in engineering before they even enter college, but the confidence gap between the sexes may also deter women from completing an undergraduate engineering degree. While some have argued that women's confidence levels decline as a result of doing poorly in these fields, evidence suggests that women's confidence lags men's even when their grades in engineering courses are similar.

Studies of college students have shown that, in general, women have lower-levels of self confidence in college than men. Karen Arnold's (1993) widely cited longitudinal examination of high school valedictorians in Illinois found that women's perceptions of their academic and intellectual abilities dropped dramatically once they entered college, while male students' did not. Studies of engineering students have also shown that women rate their abilities lower than men, despite higher GPAs (Jackson, Gardner, & Sullivan, 1993).

Confidence in their engineering-related abilities has been shown to be a crucial variable in determining students' persistence in engineering. Students (both male and female) leaving engineering lack the requisite confidence needed to persist in the competitive environment of engineering schools (Einarson & Santiago, 1996; Felder, Felder, Mauney, Charles E. Hamrin, & Dietz, 1995; Schaefers et al., 1997). Some researchers have found that the lack of self confidence among female engineering students stems partly from their lack of technological experience and expertise, qualities deemed especially important in the engineering "culture of technical know-how" (McIlwee & Robinson, 1992, p.49).

Another construct related to self confidence is self-efficacy. Researchers have defined engineering self-efficacy as an engineering student's belief that she is capable of succeeding in an engineering degree program. Zeldin and Parajes (2000) have discussed psychologist Albert Bandura's theory of self-efficacy in studies of women in math, science, and technology careers. Bandura argued that self-efficacy, one's judgment of one's ability to produce designated levels of performance, is formed primarily from one's "mastery experiences," secondly from "vicarious experiences," and additionally from "verbal persuasions" and "physical and emotional states."

In research related to self-efficacy and persistence in math, science, and engineering-related fields, scholars have found that women are more susceptible to attrition because of lower levels of self confidence in their abilities, lack of hands-on experience, and their perception that these fields lack relevance for everyday social and personal issues. Zeldin and Parajes suggested that social cues can also easily discredit women and dissuade them from pursuing a degree in a field where they are underrepresented (Zeldin & Pajares, 2000).

Other theories have been derived from women's sense of self confidence and self-efficacy. The "imposter syndrome" describes high-achieving women's tendency to attribute their successes to luck or charm, and internalize their failures as a symptom of their perceived incompetence (Young, 1986). Women students in engineering may perceive that their previous successes in math and science were flukes and they are only "imposters" in the field of engineering. Another construct commonly used to explain women's discomfort in engineering has been "math anxiety," a profound fear of mathematics and the belief that only white men succeed in math (Tobias, 2000).

Lack of Pre-College Experience and Knowledge in Engineering

Most of the public, and indeed many engineering students, have only a vague concept of what engineers do. This is partly due to the absence of engineering from the K-12 curriculum – the vast majority of students don't study or do engineering projects in school, and thus many students do not consider it a potential field when they are considering college majors or careers or when they are choosing what courses they will take in high school.

Some scholars have argued that women are less likely to major in engineering because they lack the requisite high school courses in advanced math and physics. Yet the gap in secondary school math and science coursetaking between women and men is closing (National Science Foundation, 1996), and researchers have also found that high school preparation does not entirely explain the different numbers of men and women in college engineering (Frehill, 1997). After accounting for the smaller proportion of women taking physics and higher-level math courses in high school, Frehill still found a significant difference between the percentages of men and women who majored in engineering.

Despite similar high school coursework, women still lag behind men in extracurricular engineering experiences. Some have speculated that pre-college "tinkering" with machines and technology leads to more comfort and success in engineering programs and industry. In their study of male and female computer science majors, Margolis and Fisher discovered that men entered college computer science programs with more programming experience and described more of a "self-initiated" interest in exploring computers than did women (Margolis & Fisher, 2002). Women tended to explain their interest in computer science as an extension of their proclivity in math and science.

Some researchers have argued that for women engineering is less a "natural" career path than an "academic" one – that a woman will enter engineering more often due to encouragement from a family member, teacher, or parent on the basis of her strong math and science ability in high school rather than from her own intrinsic interest (Anderson, 1995; Seymour & Hewitt, 1997). Although some high school teachers counsel female students with good grades in math and science to pursue a college degree in engineering, women's lack of hands-on engineering experience may be a hindrance to their persistence in the field.

Lack of experience "tinkering" with machines may not only set women apart from men in engineering but could also place them at a disadvantage in engineering programs and in industry jobs. As scholars McIlwee and Robinson have written: "Engineering is a profession imbued with a culture of technical know-how. Even engineers who do nothing more mechanical than tapping keys on a computer keyboard share in the culture of 'the tinkerer'" (McIlwee & Robinson, 1992, p.49). Despite possessing the same theoretical foundation as men (i.e., high school math and science courses), most women do not have and may not have expressed interest in tinkering. This discrepancy in experiences further undermines women's confidence in their ability to "cut it" as an engineer.

Studies have also shown that women who enter engineering hold its extrinsic (i.e., social) value in higher regard than men do (Frehill, 1997). Margolis et al. reported that female computer science majors wanted to use computers for a purpose, as aids to help people and in connection with other social sectors such as medicine and education (Margolis, Fisher, & Miller, n.d.). Seymour and Hewitt found that over 90% of women (and minorities) cited altruistic reasons for choosing a major in science, math, or engineering (Seymour & Hewitt, 1997, p.69). These studies indicated that women's choice of major was closely aligned to the value they place on social contributions.

Thus, if undergraduate science and engineering curricula fail to present their disciplines in the larger context of benefit to humanity, they may lose women. Using a national sample of men and women interested in science, Sax concluded that “placing a higher priority on helping others in need is negatively associated with science career persistence for women” (Sax, 1994, p.54). Sax argued that a stereotype persists that science is not a field where one can exercise connections with others. Other research has shown that women may not think a career in science and engineering is compatible with family and personal life (Ware & Lee, 1988).

Curricular Focus, Pedagogy, and Climate in Engineering

Researchers investigating the underrepresentation of women in engineering have scrutinized the focus, structure, and climate of engineering institutions and courses. In general, they have criticized engineering educators for not encouraging a diversity of ideas and for promoting the concept that engineering is a rigorous, competitive, and exclusive environment. Engineering education reformers have argued that the interests, socialization, and experiences of women (and other underrepresented groups) are often at odds with traditional engineering structures. These populations tend to flourish, on the other hand, in settings that emphasize hands-on, contextual, and cooperative learning.

Many engineering students, including women, report feeling pressured by the rigid structure of undergraduate engineering education. The fast-paced, sequential nature of engineering courses is considered detrimental to many students in the field (Seymour & Hewitt, 1997). Students who complain about the workload in engineering argue that they are not given enough time to grasp concepts sufficiently. The heavy workload discourages many students from continuing in an engineering major (Adelman, 1998).

The focus of most engineering programs remains extremely subject-oriented, with little contextual or societal explanation. Introductory courses in physics and engineering are especially likely to examine their subjects in isolation, leaving out the intellectual and sociopolitical histories of these fields (Nair & Majetich, 1995). The prevailing approach to teaching the sciences and engineering is the reduction of the complex to the simple (Ginorio, 1999). A reductionistic approach that strips academic material from its larger context has been identified as a factor that discourages women from scientific fields (Adelman, 1998; Bleier, 1991). Women tend to choose majors and careers that they perceive have a high level of interaction with other people and whose benefit to society is apparent (O'Hara, 1995; Sax, 1994). Courses that neglect these interpersonal facets of engineering fail to contradict societal stereotypes and can contribute to the flight of female students.

The single-minded focus of engineering promotes an absolute devotion to the major, which many professors and administrators also sustain, reformers have said. Sheila Tobias noted that professors expect students to concentrate solely on engineering work, and do not encourage outside interests (Tobias, 2000). Researchers have found that women who “exhibit a diverse set of personality traits” are less likely to persist in science (Sax, 1994). Many women in engineering find their peers’ single-minded devotion to engineering and computer science frightening and at odds with their desire to maintain a variety of hobbies and interests and live a balanced life (Margolis & Fisher, 2002).

The climate of engineering for women has been raised as one important aspect of women's experiences. Nearly two decades ago, Roberta M. Hall and Bernice R. Sandler published a landmark study of the overt and subtle ways women are discriminated against in higher education and discouraged from their academic and career aspirations (Hall & Sandler, 1982). Several studies following Hall and Sandler have further explored or challenged their claim that women's educational experiences differ significantly from those of their male peers (e.g., Constantinople, Cornelius, & Gray, 1988; Crawford & MacLeod, 1990; Foster & et al., 1994; Heller, Puff, & Mills, 1985). While the level of comfort women feel in their environment is difficult to measure, Hall and Sandler's study has instigated debate and discussion over climate concerns for women in higher education.

Many reformers have argued that schools of engineering foster a competitive culture. Faculty and administrators often subscribe to a "weed-out" philosophy and promote the idea that engineering is an academically difficult discipline, reserved for the truly gifted. A competitive climate in engineering has been identified as a factor that causes many talented, bright individuals to leave engineering (Lipson & Tobias, 1991; Rosser, 1993). Professors often expect the best students to "rise to the top" due to students' "intrinsic interest in the subject matter," perhaps even despite the instructor's teaching method (Tobias, 1990, p.10).

Sue V. Rosser, who has written extensively on reforming science education, has argued that a competitive climate is a strong deterrent for women (Rosser, 1993). Sheila Tobias has also lobbied for changing the nature of science education and postulated that many students, including women, reject "the culture of competition," which they say often takes precedence over competence (Lipson & Tobias, 1991). Some women's discomfort with competition in science and engineering may relate to their "academic" orientation and their desire to be judged solely by their academic merits.

A large majority of the students in the Seymour and Hewitt study cited poor teaching by science, math, and engineering faculty as a strong consideration for leaving their major (Seymour & Hewitt, 1997). Students perceived that faculty value research much more than teaching. Students indicate that engineering professors dismiss their questions about course material or delegate their students' concerns to teaching assistants (Seymour & Hewitt, 1997). Large lecture classes have also been cited as encouraging student passivity (Nair & Majetich, 1995). Intellectual curiosity about science may be squelched in introductory courses, where the emphasis is more on the "how" than on "why" (Tobias, 1990). Some researchers have argued that many engineering faculty fail to understand and incorporate into their teaching how students learn and why the students are interested in engineering.

Women view their professors as advisors and role models (Seymour & Hewitt, 1997) and look to them to help them understand engineering. But instructors in introductory engineering courses usually teach to the first tier of students – whom they define as those who have an intrinsic interest in engineering and who knew they would major in engineering before they even entered college – and these professors assume that students will understand the material after a brief in-class explanation and reading the textbook. According to Tobias, the typical science or engineering professor's beliefs about how his students learn reflects his professional solipsism, where one's "ideas [are] constrained by [the] practitioner's own experiences" (Tobias, 1990, p.10). Solipsist professors contribute to the exclusive climate in science and engineering.

Failing to take into account women's motivations and backgrounds in engineering, engineering professors may also not seriously consider women as engineers. Engineering reform advocate Karen Tonso has argued that in engineering, women have been traditionally absent from the cultural identity of the school (Tonso, 1998). Professors are less likely to cite examples of notable achievements by women in engineering and are more likely to make or tolerate comments and jokes that are offensive to women in the classroom or laboratory. Although less prevalent than in the past, women still tell stories of how some professors treat their presence with subtle or overt hostility or condescension (Seymour & Hewitt, 1997).

Lack of Female Peers and Role Models

A "chilly" climate and unreceptive professors are even more discouraging for women in engineering if there are not significant numbers of female peers and engineering faculty. Some researchers have speculated that a "critical mass" of women in engineering is needed before women will feel completely comfortable in the environment. Others argue that proportionate representation does not always lead to institutional change.

The idea of "critical mass" may have originated with a 1986 study, by M. Elizabeth Tidball, of students in the natural sciences. Tidball found that institutions with a greater number of women (students and faculty) produce a greater proportion of the women who become doctoral scientists (Tidball, 1986). Others have since studied the influence of the proportion of women in a particular discipline on women's persistence in that field (Ivey, 1988; Meihnholdt & Murray, 1999; Sharpe & Sonnert, 1999). Some have found that institutional proportionality (a large percentage of women in faculty and administrative positions) may have a greater effect on women's persistence in a major than peer group proportionality (a large percentage of female peers) (Sax, 1996). Women in positions of authority would provide role models for their female students, another element critical to persistence in engineering.

Other researchers challenging the theory of critical mass have shown that more women in a certain discipline do not always lead to structural changes in that field for long-term retention (Etzkowitz, Kemelgor, Neuschatz, Uzzi, & Alonzo, 1994). For example, Schiebinger noted that many women who enter science and engineering do not want to "rock the boat" and that they work hard to become members of the "old boy" network to gain respectability (Schiebinger, 1999). Although women may gain positions of power in engineering schools, if they fail to enact systemic change at their institutions, their numbers alone may not significantly affect retention.

Gender and Social Issues

Another important consideration for scholars examining the underrepresentation of women in engineering has been the conflict between the social definitions of women and of engineering. Some feminist and gender theorists have argued that women are socialized in ways that discourage them from pursuing engineering: social pressures may discourage a girl from tinkering and reward her for desiring to help others. White male engineers were the principal developers of science, math, engineering, and technology norms, and the structures that currently exist reflect their background and values. Feminist scholars of science hope that the inclusion of underrepresented groups will result in an environment that is more hospitable for women.

At the heart of this discussion has been a challenge to the sciences and engineering as purveyors of absolute truth. Critic Evelyn Fox Keller described her position: “Science is neither a mirror of nature, not simply a reflection of culture, [but] the name we give to a set of practices and a body of knowledge delineated by a community – constrained although certainly not contained by the exigencies of logical proof and experimental verification” (Keller, 1992, p.47). Other feminist scholars of science have agreed, saying that the characterization of science (and, by extension, engineering) as value-neutral truth is preposterous; our knowledge about the world cannot be stripped from the context in which we live (i.e., our race, class, and gender) (e.g., Hubbard, 1989).

By failing to recognize the context of the supposed value-free, neutral science of engineering, feminist scholars have argued, the engineering community continues to subordinate women and other minority groups (Rosser, 1995; Tonso, 1998). As long as white, upper-class men define engineering and engineering institutions, they create a system where their own values are equated with power and prestige (Tonso, 1998). This ideology inhibits change, as engineering institutions look for evidence of gender equality only in terms of “equal opportunities to learn, equal treatment by professors, and equal grading practices” (Tonso, 1998, p.41). Tonso noted that engineering’s supposed “equality” does not include equal access to the engineering community.

For some scholars, doing science as a feminist, rather than “feminist science,” means changing the practice of science and engineering from one of hierarchy to one of collectivity, where many voices are welcomed (Longino, 1989). Feminist scholars of science have argued that science should not be viewed as “aperspectival”; their work underscores the biases in science (Ginorio, 1999). Many women dislike the term “feminist science” because of its implicit assumption that “feminist science” is less rigorous and hard than traditional science (Longino, 1989). What needs to be articulated, feminists have said, is that different perspectives collectively examining science strengthens the science’s objectivity (Ginorio, 1999). These same philosophies can be translated to engineering.

The feminist critique has asked engineering educators to reexamine their purpose and mission. By reflecting on how engineering as a discipline is shaped, scholars can articulate “why women have not participated fully in scientific communities and why many still feel unwelcome when they do” and “[articulate] the reasons why it is advantageous to science that there be a diversity of people and perspectives in the scientific community” (Ginorio, 1999, p.3). According to Ginorio, feminists challenge engineering and science administrators to do more than just place “token” females in engineering schools and to concentrate their efforts on changing the content of their curricula.

Feminists have challenged engineering practitioners’ historical denial of group access to the power and prestige associated with the field of engineering and have discussed the importance of women’s influence in male-gendered institutions such as engineering. For example, while many male engineers like to discuss machines and technology in abstract terms, women often wish to include the human perspective within a concrete reality (Hacker, 1990). Yet by being excluded from male “camaraderie” in engineering, women’s voices and their perspective remain subordinate to or ignored by the male establishment (Seymour & Hewitt, 1994; Tonso, 1998, p.32)

Research on why women leave engineering has focused on either large, societal factors that have an impact on women and the engineering culture, or on women's experiences as individuals in the engineering milieu. However, these theories are interrelated: the societal factors that shape women's concepts and expectations of themselves in engineering affect engineering schools, including faculty and administrators. The "gendered" nature of science and engineering affects the individual, her self confidence, her preparation in high school, her experience with machines and technology, and her concept of engineering, as well as the institution, its curriculum, its pedagogy, and its theories of engineering.

PROGRAMS DESIGNED TO RECRUIT AND RETAIN WOMEN IN ENGINEERING

In this section we present literature regarding the programs that have been created to improve the retention and success of women who major in engineering. We begin with a discussion of WIE initiatives, followed by evaluations of such programs, and weaknesses found in some such engineering support programs.

Women in Engineering (WIE) Initiatives

Most literature on WIE programs has been designed to inform colleagues, describing the programs' activities as well as their challenges and successes – information useful for others in the field interested in increasing the number of women in engineering. Jane Daniels, founder and former director of the WIE program at Purdue University, identified several key areas for increasing the enrollment of women in engineering, including personal contact, use of role models, high school recruitment, and variety and continuity of programs (Daniels, 1988).

Activities typically offered by WIE programs fall into three categories: social groups and living communities, research internships, and mentoring programs. Providing a network of women studying science and engineering was the impetus behind Rutgers University's special dorm for women engineering and science majors (Stinson, 1990). Carol Muller described the research internships for first-year students in Dartmouth College's Women in Science Project as offering hands-on experience in the field, the chance to realize how "failure" is an important part of learning, and the opportunity to work on a more personal basis with a faculty member (Muller, 1992). For the Women in Science and Engineering Program at the University of Iowa, women college students mentor both their peers and pre-college students in service learning projects (Ocif & Marshall-Goodell, 1996).

Evaluation of WIE Programs

While information about activities at one institution is useful, descriptions alone do not explain exactly how WIE programs affect women's presence and persistence in engineering. Given that few student support services have conducted evaluations of their programs, educators have generally agreed that there is a need for more published evaluations to better determine the effects of programmatic interventions (Brainard, 1992; Davis & Rosser, 1996). This is true for support programs in general as well as those specifically targeted toward women in postsecondary engineering schools (e.g., Darby & Bland, 1994).

While the introduction of WIE programs has coincided with a general increase in the number of women majoring in engineering, the exact role WIE programs have had in creating that outcome, and the ways WIE programs can further increase women's representation, have yet to be determined. Support programs for women in engineering that publish studies of their outcomes can only report success in meeting their objectives in a limited context. Most evaluations of WIE programs have been done internally at one institution (Brainard & Carlin, 2001; Wadsworth, 1996) or have focused on one programmatic activity (Single, Muller, Cunningham, & Single, 2000; Sondgeroth & Stough, 1992). Many WIE support program proponents have argued that their program has contributed to an increase in the number of women studying engineering at their school (e.g., Brainard, 1992). However, despite an increase in the number of women, the effects of WIE programming at even one institution are difficult to measure without adequate controls. Moreover, studies that have used control groups have often relied on dubious comparisons. For example, the women in Caitilyn Allen's Women in Science and Engineering-Residential Program at the University of Wisconsin chose to participate in the program and thus evaluations of this residential program that compare this group and the general student population are biased by students' self-selection (Allen, 1999).

Assumptions Underlying Strategies of WIE Programs

Recent independent research into the effectiveness of WIE programs has revealed one difficulty in determining the success of a WIE program: different institutions have different ideas about why women are underrepresented in engineering, and these assumptions shape their programs' strategies. For example, the assumption that women in engineering need additional academic assistance to help them succeed in engineering seeds a group of programs that might be very different in nature from those growing out of the assumption that women are underrepresented because the field lacks female role models and mentors. Catherine Cronin and Angela Roger, who observed women in science, engineering, and technology initiatives in Scottish higher education, noted that these programs' recruitment activities assume that SMET fields are "good places for women to be" (Cronin & Roger, 1999). Cronin and Roger found that many of the initiatives are built on the assumption that "women require and deserve extra attention to persist" in SMET areas, and that other efforts to change SMET curricular and teaching practices wanted to change "the culture of SMET itself to attract more women" (Cronin & Roger, 1999, p.646). British feminist theorist Flis Henwood has also argued that WIE initiatives in the U.K. developed from "assumptions" concerning the underrepresentation of women in these fields; she criticizes an approach that aims only to open opportunities for women in engineering without first examining the field of engineering itself (Henwood, 1996).

In the United States, many WIE programs developed an approach to improving women's representation in engineering that encompass a variety of approaches to retaining women. Jane Daniels, founder of the nation's first WIE program, at Purdue, noted that the impetus for Purdue's WIE program arose after administrators looked at the obstacles that might have accounted for women's lower retention rates (Daniels, 1992). The overall focus was on creating a supportive environment for this underrepresented population. Other WIE initiatives modeled themselves after the Purdue program and its underlying assumptions. In a recent study of the University of Wisconsin's WIE program, Allen outlined four factors, on which she based the program's strategies, that she believes contribute to women's low representation in engineering: isolation, lack of female role models, chilly classroom climate, and low self confidence (Allen, 1999).

Limitations of WIE Programs

Some support program directors have discussed what they see as weaknesses in their approach to increasing the numbers of women in engineering. Alice Miller and Catherine B. Silver identified several factors that challenged a support program for women interested in math and science at Brooklyn College (Miller & Silver, 1992): students' backgrounds, including their low level of interest in science and math, and their lack of interest in women's issues. Miller and Silver wrote that their program seemed to benefit those women with "academic, social, or psychological advantages" who were confident and engaged in the intellectual community (Miller & Silver, 1992, p.26).

Additional research has supported the importance of student background and motivation in terms of increased level of participation and benefit from support programs (e.g., Muraskin, 1997). Miller and Silver found that programmatic emphasis on women's issues might alienate those who don't consider themselves feminists (Miller & Silver, 1992). Other program directors have written about the difficulty of helping women engineering students who feel isolated yet are reluctant to participate in "women's" programs (Davis, 1989). Most WIE directors are well aware that their programs are not panaceas for women in engineering, and some recognize their school's program may not meet the needs of all women at their institution equally.

Some researchers have gone beyond saying that WIE programs may not work for all students to suggest that some current WIE initiatives do not adequately address issues in engineering education contributing to women's underrepresentation. For instance, Cronin and Roger found that in Scotland, despite numerous programmatic efforts to increase the number of women in SET disciplines, the proportion of women in these fields had not significantly increased (Cronin & Roger, 1999, p.642). British WIE programs researcher Henwood argued that WIE programs fail to recognize that women choose engineering because it holds higher status than traditional women's work (Henwood, 1998).

Formal efforts to evaluate WIE programs have been largely inconsistent and sparse. Without evaluation and longitudinal data, it is difficult to address systematically how effective WIE programs actually are in achieving their goals – and precisely how achieving these goals ultimately benefits students in concrete, measurable ways. Institutional climate is not a factor easily changed by support programs. The WECE project seeks to provide engineering deans with solid quantitative data upon which to base their activities to maximize their programs' effectiveness. We hope that future guidelines for engineering education will incorporate our data on women students' experiences.

Chapter 3: WIE Programs and Institutional Sample Selection

The WECE study was initially designed as an evaluation of the effectiveness of Women in Engineering (WIE) programs. Therefore, the first step in selecting our institutional sample was determining which of the institutions of higher education with undergraduate engineering majors had such support programs. Half of the study sample consists of those institutions with WIE programs that agreed to participate in this research and the other half of the sample consists of institutions without formal WIE programs, each matched on several criteria.

To give the reader a context for understanding the study's results, this chapter begins with a general description of the types of activities and supports that WIE programs may offer. It is followed by a description of the methods used to select the institutions and a description of the institutional sample. Table 4-1 at the end of the next chapter displays all of the data sources used in the WECE project.

WOMEN IN ENGINEERING (WIE) PROGRAMS

Half of the schools (n=26) in the WECE project have WIE programs. In the late 1980s, programmatic efforts for women in engineering were sparse, with only about 10 colleges or universities having formal WIE programs. In 1990, the formation of the Women in Engineering Program & Advocates Network (WEPAN) helped launch the beginning of an intensive effort across the United States to bring more organized support and encouragement to women in engineering programs. This, along with increased national awareness and government funding, helped the number of WIE programs to grow from 10 in 1990 to over 50 in 1999 (Anderson-Rowland et al., 1999). The establishment of new WIE programs and the expansion of existing programs continue today.

Types of Activities Offered by WIE Programs

The size and focus of WIE programs vary. In general, programs offer academic and social support for female engineering undergraduates. However, program directors may also recruit women to apply to the engineering school, conduct outreach to students in grades K-12, and provide support for graduate students and faculty women in engineering. WIE program directors have created a wide range of activities and resources to encourage and support women who are considering or pursuing an engineering major. Activities and resources cluster in seven major categories: (1) mentoring, (2) study and laboratory skills, (3) career exploration, (4) social opportunities and support, (5) outreach activities, (6) scholarships and awards, and (7) publicity. Following are more detailed descriptions of each of these categories.

Mentoring

Navigating through college life, engineering sequences, and expectations; learning to balance coursework and a social life; filtering out what is important for a career in engineering and how to prepare for the work world; and having someone with more experience to ask questions – these are all facilitated by a mentor. Mentoring can help both the mentor and the protégé; the protégé obtains information and support while the mentor often gains confidence as she recognizes what she has learned and helps others.

In general, mentoring programs take one of two forms: 1) programs that pair a student with a professional in an engineering workplace, and 2) programs in which a student who is more advanced in her studies provides advice to one who is less advanced. For example, some schools pair incoming first-year women engineering students with engineering upperclasswomen who serve as their "buddies" or "big sisters." Interactions may occur in groups or in one-on-one sessions (either face-to-face or via the telephone or Internet).

Study and Laboratory Skills

College courses, especially engineering courses, often require a set of study skills and habits that differ from those used by students in high school. For example, problem sets are often designed with the expectation that students will work together to solve them. Thus, some WIE activities focus on helping students to develop new study skills and provide extra academic support. These include study groups, academic tutoring, and study skills workshops. At some institutions, WIE programs have also sponsored sessions that discuss issues specific to women in science, mathematics, and engineering (SME) majors. In response to research suggesting female students are less confident in their laboratory skills, some programs offer students an opportunity to disassemble computers, tinker under the hood of an automobile, or build robots.

Career Exploration

While some WIE activities are geared toward the undergraduate college experience, others focus on careers and life after college. Thus, career workshops, career advising, and career resource centers are among the resources offered by schools. Some WIE programs organize opportunities for students to network with people in industry, visit industry workplaces, and take on internships. The rationale is that facilitating women's awareness of, contact with, and experience in academic and industry settings can increase women's commitment to pursuing an engineering major. For example, one school has a series of workshops about applying to graduate school. These workshops include information on how to apply for graduate school, discussions of what to expect from graduate school, and assistance in identifying faculty mentors and research experiences that can help students prepare for graduate school.

Social Opportunities and Support

Many WIE programs sponsor opportunities for women engineering students to socialize with one another. Social gatherings are designed to 1) help women build community and become acquainted with others in engineering, 2) provide opportunities for women in engineering to spend time relaxing with one another, 3) encourage communication that helps women realize that they are not alone in the work and the challenges they face in engineering, and 4) provide a place where women are in the majority.

Examples of social opportunities are orientations for new students, retreats, outings, and gatherings at designated meeting or lunch spaces. Interacting with others who have, or will have, similar experiences often helps students to develop rewarding friendships and support structures. For instance, one program offers an extended orientation in which first-year students can meet upperclass students before classes begin and meet them again on a variety of occasions throughout the year.

Some WIE programs offer residential clustering for women in their engineering programs, WIE focus groups and discussions, class clustering (clustering women in some sections of SME courses in order to increase the numbers of women), or counseling. Increasing the relative percentage of women in engineering courses can lessen feelings of being “on display,” and encouraging women to discuss issues or challenges they face can help them recognize that they are not alone in their struggles and triumphs. A few universities offer programs for first-year students that involve them in workshops on study skills and coping skills, lunches, and evening activities.

Outreach Activities

In addition to serving college students on their campuses, most WIE programs conduct outreach activities to pre-college students, from kindergarten through 12th grade. Objectives for this type of outreach include increasing awareness among students about the field of engineering and planting seeds for recruiting prospective engineering students.

Examples of outreach programs include holding Girl Scout badge workshops and summer science camps, inviting students or staff to serve as judges for science fairs, putting on “career days” to introduce girls to careers in engineering, and visiting local high schools to recruit for the engineering school or WIE program. These activities provide enjoyable opportunities for female engineering students to organize and lead outreach activities with K-12 students. An added benefit is the boost to their self confidence as they share their enthusiasm, as well as what they have learned about engineering, with younger students.

Scholarships and Awards

Some WIE programs administer or provide scholarships for female students. These scholarships tend to be sponsored either by the school or by outside companies. Some programs offer money for students to attend conferences to present research or to join professional societies such as SWE (the Society of Women Engineers). Another form of recognition involves cash or other awards for academic achievement in engineering during an awards banquet.

Publicity

Publicity about WIE programs takes several different forms, including WIE-sponsored newsletters, email/enewsletters, and web pages. All are designed to keep women apprised of WIE activities and resources, programs, jobs, or lectures at the college or elsewhere, and they often contain other interesting or useful information. For example, a number of WIE programs send a newsletter to women in engineering featuring information, updates, and human interest stories, such as an interview with a female faculty member in engineering about her background and current research.

SELECTION OF INSTITUTIONAL SAMPLE

Our sampling strategy selected institutions with WIE programs as treatment institutions and those institutions without such programs as control group institutions. Because there was no comprehensive database of all schools of engineering in the United States, we began by contacting the dean at every school of engineering in the U.S. that offers undergraduate degrees in engineering to collect baseline data about the engineering program and whether the school had a WIE program. (Since databases are generally constructed from surveys that are filled out by deans or their assistants, it is rare for 100% of the population to respond.)

We developed our population of treatment institutions from two main sources: the Profiles of Engineering & Engineering Technology Colleges (American Society for Engineering Education, 1996) and the Integrated Postecondary Education Data System (IPEDS) from the National Center for Educational Statistics (1995). After querying 305 institutions, we determined that from the initial list of 77 institutions with WIE programs, 45 were eligible for participation as treatment institutions in our study.

Our four criteria for inclusion as a WIE school in the sample were: (1) the WIE program had institutional funding, with an administrator whose position is paid (outside of a faculty position), (2) the WIE administrator devoted 25% or more time to the program, (3) the WIE program had a focus on undergraduate students and outreach activities (college recruitment and retention activities), and (4) the WIE program had been in existence for at least three years. The first three criteria had been developed by WEPAN in 1995 to determine the number of WIE programs in the U.S. We added the fourth criterion because the WIE program needed to have been available to all students at that institution, including seniors, who had been students there for three years.

Our original goal was to recruit 20 treatment schools. Because of possible attrition, we decided to include all institutions with WIE programs that agreed to participate. We wrote to all WIE directors to introduce the project and to ask for their participation, and WECE staff subsequently spoke by phone to all WIE directors to provide more detailed information about the project, answer questions, and determine whether the institution was interested in participating. Twenty-seven ultimately agreed to participate after they received permission from their institution's administration. We decided to use all 27 as treatment schools.

We then matched each of the 27 WIE schools with a randomly selected school that did not offer a WIE program but was similar in other ways. We stratified the sample of 27 using the following strata: geographic region of country, Carnegie classification (Research or Doctoral levels), selectivity, and size of engineering department relative to university size. The size of the institution was not used in selection, but was considered in the selection of the comparison schools, as was the institution's funding source (public or private university).

One of the WIE schools subsequently dropped out of the study, leaving a total of 53 institutions in our sample. All 53 schools (26 WIE schools and 27 non-WIE schools) agreed to be listed as participants in our study. The list of participating institutions is in Appendix A-1. It should be noted that schools will be not be named in results of this report, nor will any institutional data be linked to specific schools.

Strata Used in Sample Selection

The following descriptions provide information about the criteria used to match schools from the WIE sample to schools from the potential non-WIE sample. Much of the data come from the Integrated Postsecondary Education Data System (IPEDS). Established as the core postsecondary education data collection program for the National Center for Education Statistics, IPEDS is a single, comprehensive system designed to encompass all institutions and educational organizations whose primary purpose is to provide postsecondary education. Table 3-1 displays the institutional sample, broken down by the five classifications. Appendix A-2 provides additional definitions and other detailed information about the strata used in our sample selection.

Region
The IPEDS database classifies postsecondary educational institutions into eight geographic regions of the United States. For the purpose of our selection process, we combined the IPEDS classification codes into four regions: Northeast, Midwest, South, and West. In the Northeast region there are 13 schools (7 WIE and 6 non-WIE), in the Midwest region 14 schools (8 WIE and 6 non-WIE), in the South region 11 schools (5 WIE and 6 non-WIE), and in the Western region there are 15 schools (6 WIE and 9 non-WIE).

Carnegie Classification
A school's Carnegie Classification describes both its diversity of programs and degrees offered, and in the case of a doctorate-granting institution, its emphasis on research. There are six categories in the Carnegie classification system, as specified in the IPEDS database. We converted the six classifications represented by our sample into three classification codes: Master's, Doctoral, and Research. Almost three-quarters of the institutions in our sample (39 schools: 20 WIE and 19 non-WIE), are in the Research institution category – the highest in the Carnegie system-8 schools are in the Doctoral category (3 WIE and 5 non-WIE) and 6 schools are in the Master's category (3 WIE and 3 non-WIE).

Selectivity
We used classifications from *Peterson's Guide to Four-Year Colleges* to define institutional selectivity. Selectivity is based on the high-school standing and SAT and/or ACT scores of the accepted students, as well as the percentage of applicants accepted. We combined Peterson's original classification codes into two revised codes: selective and moderately selective. A total of 19 schools were in the selective category (10 WIE and 9 non-WIE). In the moderately selective category, there were six institutions (3 WIE and 3 non-WIE).

Size of Engineering Program
Some schools in our sample had a relatively large proportion of their students in engineering – the technical schools all had more than a third of their students in engineering majors. Other schools had a comparatively small proportion of engineering students. To determine the size of the engineering program, we considered the percentage of graduating seniors receiving a degree in engineering, and we categorized schools into three proportions of engineering degrees: low, medium, and high. This information was also calculated from the IPEDS database. In over half the schools in our sample (n=30), engineering was a medium percentage of the total student population (15 WIE and 15 non-WIE), while 17 schools had a low percentage of students in engineering, relative to the total school population (8 WIE and 9 non-WIE). Six institutions were primarily technical/engineering institutions (3 WIE and 3 non-WIE) and categorized as having a high proportion of engineering degrees.

Size of School
We also considered the size of the undergraduate student population, as indicated in the IPEDS database. Schools were not categorized by size: instead, once a selection of non-WIE schools was found that matched a WIE school on the first four criteria, the non-WIE school closest in size was chosen as the final match.

For each WIE school, we generated a list of non-WIE universities matching on the first four criteria (or, if no match was available, one matching on three of four criteria). We invited the non-WIE school on that list closest in size (criterion five) to the WIE school to participate in the study. The total number of eligible student subjects from WIE schools far exceeded that from non-WIE schools, mostly because WIE schools tended to be the largest as well as the most prominent engineering schools in the nation.

Other Characteristics
Every school in our sample has a school of engineering. In most schools, students apply directly to the school of engineering. Some apply to a school of engineering but are not admitted until their junior year.

Institutions are funded either publicly or privately. Just over two-thirds of the institutions (n=36) were publicly funded, 20 of them WIE and 16 non-WIE. The other 17 were privately funded institutions, 15 of which were non-religious and two of which were funded by religious entities.

Table 3-1
Institutional Sample by Classification Types

CARNEGIE →		Research		Doctoral		Master's	
SELECTIVITY →		Selective	Mod. Sel.	Selective	Mod. Sel.	Selective	Mod. Sel.
REGION ↓	**% in Eng. ↓**						
Northeast	Low		**1** / *1*				
	Med	**3** / *3*		**1** / *0*			**1** / *1*
	High	**1** / *0*		**0** / *1*			
Midwest	Low		**2** / *1*				
	Med	**0** / *1*	**4** / *2*				**1** / *1*
	High			**1** / *0*	**0** / *1*		
South	Low				**1** / *1*		
	Med	**1** / *1*	**2** / *3*				
	High	**1** / *0*			**0** / *1*		
West	Low	**1** / *2*	**3** / *4*				
	Med	**1** / *1*			**0** / *1*		**1** / *1*
	High						

Note: The first number (in bold) is the count of WIE schools, the second (in italics) is the count of non-WIE schools.

Though the WIE schools are geographically diverse, the majority of the WIE schools in our sample are moderately selective research universities with a medium percentage of engineering students in the student body. Since the WIE schools were matched to non-WIE schools during sample selection, this trend is also reflected in the larger WECE sample.

Once the WECE team selected a non-WIE counterpart to each WIE institution, we needed to obtain an agreement to participate from the institutional administrator. For each of the 53 institutions in our study, we drew up a memorandum of agreement (MOA) that outlined the project's responsibilities and the institution's responsibilities. One stipulated responsibility was that each school in our sample provide us with the names and contact information of all undergraduate women in their engineering schools or departments. Chapter 4 describes the WECE student sample that resulted from the lists from the 53 institutions.

Chapter 4: Methods and Procedures

The WECE study strove to understand the factors that influence undergraduate women's pursuit of or departure from an engineering major. The principal source of data was a web-based student survey. To help situate student data in its larger institutional context, we also collected background information about each school and its engineering program, conducted web-based surveys of engineering faculty and of engineering deans, interviewed WIE program directors, and conducted site visits to 11 institutions. Table 4-1 at the end of this chapter outlines the WECE data sources. Each of the data collection methods is described below.

STUDENT QUESTIONNAIRE

The WECE student questionnaire was developed after a comprehensive literature review was undertaken to identify factors that had previously been posited as discouraging or encouraging to women in science and engineering. Additionally, previous surveys of women in engineering and science (Astin & Astin, 1992; Carroll, North, & Marshall, 1992; Davis & et al., 1987; Grandy, 1994; Pathways Project, 1991; Sondgeroth & Stough, 1992) were reviewed and relevant questions were noted. The WECE survey was drafted and pilot-tested, first in paper form, to solicit students' feedback about the content and wording of questions. After the survey was revised and shortened it was programmed and tested online for format and functionality.

The questionnaire asked students about their backgrounds, their perceptions of and experiences in engineering, and their interactions with support programs. It included approximately 220 questions and took 30-40 minutes to complete. (See Appendix B-1 for a copy of the student survey.) To permit longitudinal analyses, the content of the questionnaire remained extremely constant throughout the study. Minor text modifications were made from year to year based on preliminary analysis of the data and student comments.

When the WECE proposal was first written, the student data were to be collected using a paper and pencil survey. However, once NSF and Sloan Foundation grants had been awarded we realized that our sample population of undergraduate engineering majors provided a unique opportunity to employ a new research and evaluation technology for our study – a web-based survey. We believe that WECE was the first large educational research project to use web-adaptive surveys that followed social science principles with regard to sampling, response, and measurement. Employing an on-line, web-based survey method presented the project with a series of opportunities and challenges, each of which is described below. These included: survey customization, user identification, legal aspects, costs, verification of email addresses, follow-up, completing the survey in more than one sitting, minimizing skipping of questions, and providing incentives.

Survey Customization

Web technologies permit survey instruments to be dynamically generated. Our surveys were "computer-adaptive"– that is, the questions that students were asked were contingent upon their prior responses and the characteristics of their school's engineering program. The treeing WECE survey was generated based on: (a) whether the student had completed the WECE survey in a previous year, (b) whether the student was still planning to major in engineering or had left an engineering major, (c) a student's year in school (first year, sophomore, junior, senior, 5th year), and (d) whether the student attended a school with a formal WIE program or not.

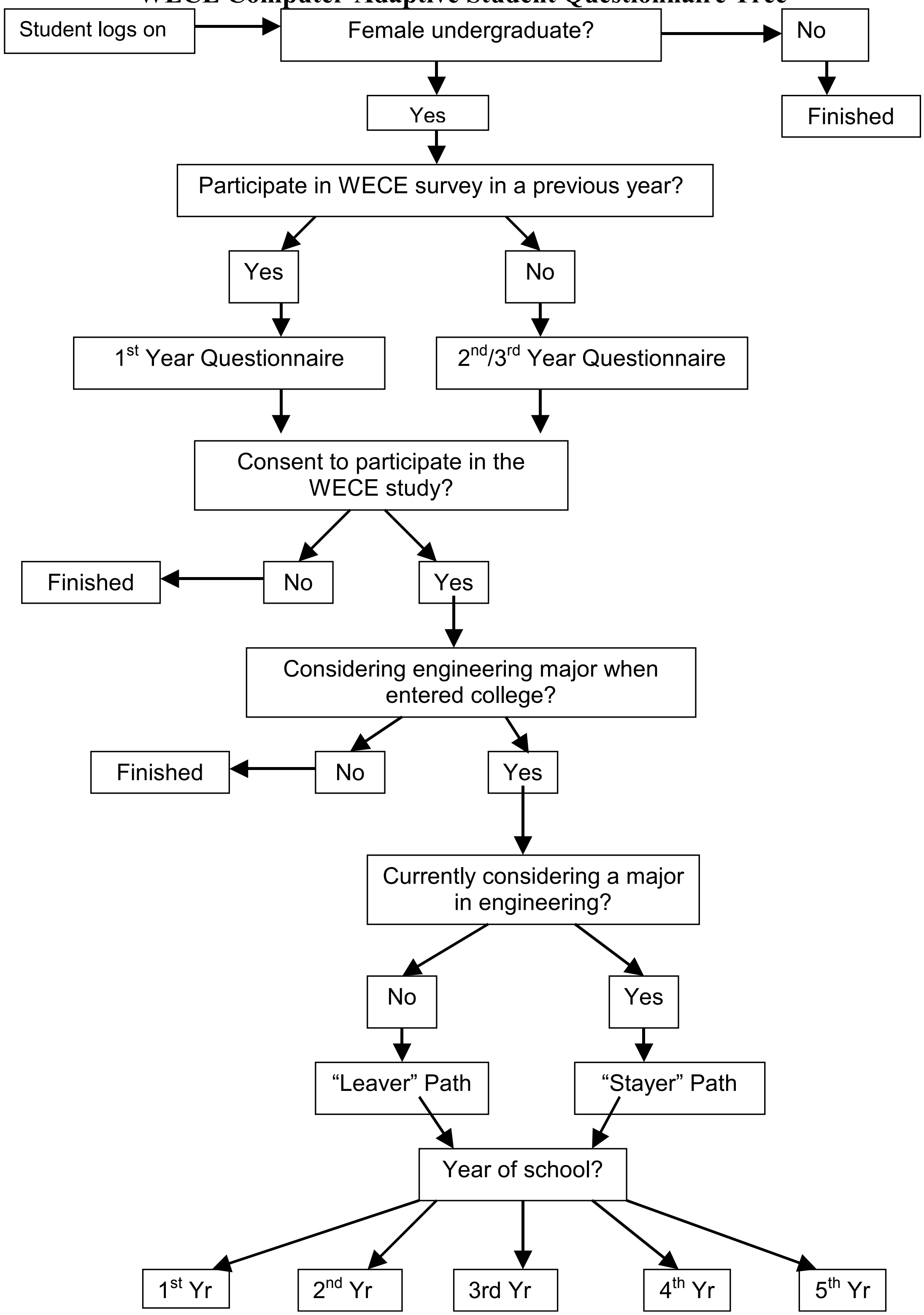
Figure 4-1 provides an overview of the treeing structure of the WECE student questionnaire. The ability to reference earlier responses in order to customize the survey allowed us to eliminate complex skip patterns that would have been necessary in a paper survey. Additionally, students who participated in our study for multiple years received a shortened survey after the first year.

User Identification

Collecting data via the World Wide Web presented challenges that are not associated with other survey methods, namely, that the web is a more public medium than postal mail or telephone. One concern that we needed to consider was how to limit access to the instrument so that only members of the sample population would be allowed to provide data (Hewson, Laurent, & Vogel, 1996; Kaye & Johnson, 1999; Schmidt, 1997). A second related concern for the WECE project was matching each student respondent with her entry in the master database: because the database contained information about the student's school that was necessary to render the questionnaire, because respondents needed to be identified so they would not receive reminder messages after completing the survey, and so a longitudinal analysis would be possible. From the experiences of the first year of the project, the WECE staff developed strategies to more efficiently structure and maintain respondent identification systems.

During our first year, we developed gate-keeping mechanisms to limit access to the target population. These involved "matching" the text that students type (email addresses or school names) with those stored in our database. Matching protocols can be error-laden and time consuming. However, to protect the identity of participating institutions and students, we had to reject quicker, fail-safe options, such as selecting from a pull-down menu. Our system, although functional, did present us with some challenges.

Figure 4-1
WECE Computer-Adaptive Student Questionnaire Tree



First, we only asked students to type their email address once. Quite a few students introduced a typing error into their email address – we learned to have students double-enter any information that needs to be acted upon by a database. More problematic, however, was the fact that many students had multiple email addresses. During the first year of the study, legitimate survey participants were identified by their school email address. We sent an invitational email to students' school addresses. However, many students configured their school email account so it automatically forwarded to a personal address (e. g., Yahoo or Hotmail accounts) – addresses that were not in our database. When students logged in, they were asked for a school address that was matched against a master database of addresses provided by the institution. Often, students ignored instructions to use a school address either when they logged in or when they sent the WECE staff email, thus making it difficult for us to identify them.

Due to the number of problems that the matching system presented, we revised the user identification system in the second year. (Our first round of student data collection was in 1999; in the two subsequent years we updated our methods to utilize new technologies as soon as they were developed). Capitalizing upon the ability to "click through" from a hyperlink in an email message to a web page and the ability to include bits of program code that drive active server pages in a hyperlink, in the second year of the project we assigned each student a unique numerical identification code. This code was then embedded in the URL link to the WECE survey that we sent to students in the emailed invitations.

When the students accessed the site with a customized link, their identity was instantly known by our survey program, which then customized the pages accordingly. Because not all platforms support click-through technologies yet, all students were also given the opportunity to enter the survey using a more general link where they needed to type in their identification code. The adoption of this identification system facilitated the student identification process. It also proved to be a valuable system for tracking students longitudinally – because a student identification code could indicate to the server that the respondent had completed the survey in a previous year. Thus, the program would generate a shortened survey tree for previous-year respondents that excluded background and other static information that would not change from year to year.

Legal Aspects of Conducting Research Online

The Internet space is a relatively new one, and legislation governing it continues to change and be updated. The Family Educational Rights and Privacy Act (FERPA) (1974) regulates the privacy of their educational records to protect students' rights. In the case of university students, as long as a university considers email addresses to be "directory information," they may legally provide researchers with a list of student email addresses. However, this does not guarantee that a university will release such a list.

Many universities have their own policies prohibiting the release of directory information in general, or email addresses in particular. WECE staff worked with each university to determine the policies of that institution and then secured a written memorandum signed by the dean or other university official stating that the university had agreed to participate in the study for three years (an important step due to the mobility of administrators).

The majority of the colleges participating in our study provided the WECE staff with a list of the email addresses of female undergraduate women in engineering each year. Because many schools remove from their lists students who leave engineering, WECE needed to create a master database to store longitudinal information in order to gather data from leavers as well as continuers in engineering (referred to in our study as "stayers").

In her first year of eligibility, every student in the sample was assigned a unique WECE identification number that was used to track her longitudinally through the three-year study. Each year, the new school email address lists were compared with the master list; each address that matched was paired with an existing address (continuing students), a new record was created for new engineering students, and engineering students from previous years who were not in the current school lists were carried over (potential leavers or students who graduated). Once in the database, a student was invited annually to participate in the study until she completed the leaver survey tree, she indicated that she was graduating that year, or her email address "bounced" and could no longer be found in the college directory system (an indication that she was no longer at the school).

About 20% of the schools chose not to release the email addresses of their students to the WECE study. At these schools we used a second electronic technology, known as the e-mail mailing list server, to contact women. Instead of sending WECE staff the email addresses, a university administrator created a WECE email mailing list administered by the LISTSERV program and subscribed all the women engineering students. WECE staff posted the invitation messages to the mailing list. Then, before each reminder message, the WECE staff sent the mailing list administrator a list of the students who had begun or completed the survey (the students provided their email address when they logged on). The mailing list administrator removed these students' addresses from the mailing list before WECE staff posted the next reminder message. Although this method required more work by both WECE and school staff, it served as a fairly workable alternative method for contacting students.

No federal laws regulated "unsolicited email" at the time we conducted the data collection. Five states have enacted such laws, but the constitutionality of those laws is in doubt because of the commerce clause of the U.S. Constitution. To avoid problems and complaints, we clearly stated in our email messages: (1) where the email address was obtained; (2) whose permission was obtained to conduct the study at that university; and (3) how a person who had been contacted could remove herself from the contact list.

Costs Related to Developing and Administering Web vs. Written Surveys

Web-based surveys eliminate or minimize traditional costs such as postage and data entry. However, administering instruments electronically means paying computer programming and Internet charges. For our large-scale study with extensive follow-up of non-respondents (four to five reminder notes), we estimate that we spent one-third to one-half of what a similar mail-based survey would have cost during the year that the survey was first programmed. The economic savings is a function of our sample size – in a smaller sample, the programming costs might not be offset by the savings garnered through inexpensive email messages. This is not to say that the programming costs were minor; our survey was much more expensive to program than a simpler survey because of the need to tailor it to individual institutions and because of extensive skip patterns. Nonetheless, we believe that, in the long run, the web-based method was much more cost efficient.

Verification of Email Addresses

Even though we received the lists of email addresses directly from college administrators, many addresses bounced back to us. We developed methods to verify email addresses and eliminate error messages (O'Lear, 1996; Swoboda, Muhlberger, Weitkunat, & Schneeweiss, 1997). These included visual checks and spot-checks using online directories to identify highly inaccurate lists. Even so, thousands of email messages bounced back to us. We accessed the school's online directories to check the email address for each individual. Students whose names were no longer in the directory were removed from the list; we updated the email addresses of the other women and re-contacted them.

Follow-Up

Encouraging college students to voluntarily participate in a lengthy study is extremely challenging and response rates for such studies are generally quite low. To increase response rates, we contacted students multiple times to ask them to complete the questionnaire. Using email permits sending instant, frequent, and cost-effective reminder messages to non-respondents; during our student survey we initially sent out 5 reminder messages – one every three to four days. Based on student feedback, we reorganized our reminder structure to send four reminders (one per week). Reminder notes were sent both to students who had not begun the survey and to those who had begun, but not yet completed, the survey.

Completing the Survey in More Than One Sitting

Another method we used to boost response rate for our lengthy survey was to provide students the opportunity to begin the survey and return to complete it at a later time. All survey responses were automatically saved on the main server. When a student returned, she resumed the questionnaire where she last left off. Approximately half of the students who began the WECE survey but did not complete the survey in the first sitting returned to complete it. If a participant did not return to finish the survey, the data from partially finished surveys could still be used in data analysis.

Minimizing Skipping of Questions

The WECE survey employed technologies to review students' responses, check if all survey questions had been completed, and, if not, prompt students to finish the unanswered ones. This is particularly important because, given the length of the survey, it was not uncommon for a student to inadvertently skip a question. When a respondent pressed the "Next Page" button at the conclusion of each Web page, the responses were automatically scanned to check for any blank items. If the program found any, the computer generated a new web page that listed the unanswered questions and invited students to complete them. To protect students' right not to complete a question, a respondent could override the prompt by pressing a "Proceed Anyway" button, which allowed them to continue without completing the blank questions.

Technical Issues – Sending Bulk Email

Contacting students via email, the WECE office sent out thousands of email messages a day. Such large volumes of email are often automatically identified as "spam" by automatic filters used by Internet service providers (ISPs). During our first year, we needed to negotiate release of our emails by our ISP, despite the automatic filters. During the second year of our study, we found an ISP that would allow us to send and maintain control of our bulk emailings. Many of the companies that permit bulk mailing are set up as commercial bulk emailers and require that a client provide them with the list of email addresses, the content of the messages, and the delivery schedule so they can assume responsibility for the mailings. Not only would the release of email addresses to an outside agency violate confidentiality agreements, but the complexities of our launch and the coordination with the 53 schools required WECE staff to maintain control of when and which email messages were sent.

Communication Between Survey Population and Staff

Both email messages and the web site invited students to contact project staff via email if they had questions. A small percentage of the surveyed population chose to email the staff to request additional information, report a problem accessing the questionnaire, or express an opinion. Internet technology allowed the staff to respond quickly to these students.

Incentives

Because some of our funding was from non-governmental sources, we were able to offer incentives as an enticement to participate in our study. As the WECE project is based entirely on the Internet, it was logical to have the incentives delivered in this medium as well. At the conclusion of the questionnaire, we offered students the opportunity to enter themselves into a drawing for over 500 gift certificates. These gift certificates were all from electronic commerce companies (Amazon.com, Borders.com); thus we could award them via email and students could redeem them via the Web – an important consideration when the survey respondents were situated in 53 locations across the country. We believe that these incentives increased our study's response rate. At the request of one participant school, students there were not offered an incentive.

NON-RESPONDENT BIAS STUDENT QUESTIONNAIRE SURVEY

As in all social science research, response rate is a critical factor in the credibility of the findings. Unfortunately, the reality in higher education is that response rates tend to be low; response rates below 50% are typical of even the most highly regarded data collection efforts. Despite the length of the WECE survey, our response rates exceed those seen in some of the highest profile, multi-campus studies; for instance, CIRP (Cooperative Institutional Research Program), which is administered to first-year students in institutions across the country, has an overall response rate of 20%. However, merely having a response rate as high as or higher than key studies within higher education does not ensure that the WECE results are valid. We took several critical steps to examine the trustworthiness of the WECE data. Chief among these efforts was recruiting a random sample of non-respondents to complete the survey in spring 2000 in order to test for differences between respondents and non-respondents. Results from the non-respondent bias survey are described in Chapter 5.

ENGINEERING DEAN QUESTIONNAIRE

We also administered a web-based survey to the engineering deans at each of the 53 schools. The nine-question survey took 5–10 minutes to complete and asked about deans perceptions of the challenges that their engineering departments faced, the future of engineering, and the resources offered for undergraduate women in engineering. Deans were initially invited via email to complete the survey online. Two electronic reminders were sent to non-respondents and then a paper copy of the survey was sent to deans who had not responded. A copy of the administrator questionnaire can be found in Appendix B-2; Chapter 9 contains results of the survey and interviews.

ENGINEERING FACULTY QUESTIONNAIRE

The web-based faculty survey was designed to gather additional information about schools' climates, student-faculty interactions, and faculty perceptions of engineering education and the engineering workplace. The survey drew upon a review of previous faculty surveys including Simpson(1984), Jones(1984), and Linksz(1990). In fall 1999, each of the 53 participating institutions provided the WECE staff with a list of email addresses of all tenure and non-tenure track engineering faculty and instructors. We contacted the 7,421 individuals via email and invited them to complete the online survey; non-respondents were contacted weekly for two weeks and reminded to complete the questionnaire. The computer-adaptive survey contained 50 multiple choice and two open-ended questions, and took 10-15 minutes to complete. Results are described in Chapter 10; a copy of the faculty questionnaire can be found in Appendix B-3.

WIE DIRECTOR INTERVIEW AND QUESTIONNAIRE

Throughout the project, we drew heavily upon the expertise of WIE directors. At the inception of the study, each director was interviewed to understand how the WIE program was structured at her institution and to compile a list of the types of programmatic activities that were offered nationwide. Such data informed the development of the student questionnaire. It also functioned as a springboard for later data collection from WIE directors.

A more in-depth, semi-structured telephone interview was conducted with each WIE director between August and September of 1999. Data were gathered from a total of 28 WIE directors from 26 universities,[1] yielding a 100% response rate. The hour-long interview included questions about five main topics: the director's personal background, the history of the WIE program, faculty and administrative support, information about programs, and advice and future plans. The directors' responses were transcribed into an Access database.

Regular contact with the WIE directors throughout the study permitted school information to be updated; a more systematic review of each school's data in the form of a short written survey was administered to all WIE directors in winter of 2001. This was designed to fill in some data gaps and provide standardized information across all WIE schools in our sample. The survey included a detailed breakdown of the program's funding sources and budget and more information on specific programmatic efforts. Appendix B-4 contains the WIE director interview protocol, and the written survey can be found in Appendix B-5. Chapter 8 presents the results.

SITE VISITS

The WECE data are highly quantitative in nature and span a broad range of schools. To obtain a more comprehensive understanding of engineering education and the role of Women in Engineering programs, we conducted site visits at eleven institutions in the spring and fall of 2000. The institutions were chosen based on an analysis of student survey results from the first and second years of data collection. In particular, scales related to students' satisfaction with their engineering majors and data about the percentage of student survey respondents who had participated in WIE activities were reviewed. The WIE schools with high rankings in these categories were identified and the group reviewed to ensure that they represented a wide range of schools and geographic locations.

During the 2- or 3-day site visit, WECE staff interviewed the WIE director and other support staff (such as Minority in Engineering directors), engineering deans, and a handful of faculty. We also conducted focus groups with female engineering students in general, and female students who had participated in WIE activities. More information on the site visit selection process can be found in Appendix B-6; Appendix B-7 contains the focus group protocol. Results are described in Chapter 7.

[1] Two institutions had both a WIE and WISE director, and we interviewed both directors at those schools.

INSTITUTIONAL DATABASE

The WECE study aimed to investigate whether institution-level variables (such as school size, selectivity, and the percentage of women in engineering) affected women's persistence in engineering. To run the statistical models necessary to analyze such influences, we needed to construct an institution-level database. Information that is standardized across institutions can be difficult to obtain and time-consuming to collect; therefore, for this project we chose to glean such data from existing sources. Throughout the project, we used the 1998 Directory of Undergraduate Engineering Statistics (American Society for Engineering Education, 1999a) and the 1998 Profiles of Engineering & Engineering Technology Colleges (American Society for Engineering Education, 1999b) compiled by the American Society of Engineering Education as well as Peterson's 1998 Guide to Four-Year Colleges (1997) to gather numerical data about school variables. Institutional results are described in Chapter 6.

Table 4-1
WECE Data Sources

Data Source	When Administered	Sample Invited	Sample Participating	Primary Topics
Student web questionnaire	Spring 1999, 2000, 2001	All women engineering undergraduates at 53 schools; also all women who left engineering within the time of the study (n˜21,000/year)	Year 1: 6,921 (33%) Year 2: 9,074 (41%) Year 3: 8,999 (37%)	• Background data: - Demographic information - Pre-college experiences • Experiences in and perceptions of engineering: - Attitudes about engineering - Campus climate indicators - Experiences in and outside of the classroom in eng. - Sources of encouragement and discouragement • Support resources in engineering: - Participation history in support activities - Reasons for participation
Faculty web questionnaire	Autumn 1999	All engineering faculty and instructors at 53 schools (n=7,421)	1,385 (19%)	• Teaching and advising responsibilities • Beliefs about engineering education • Beliefs about engineering profession
Administrator web questionnaire	Autumn 2000	Deans of engineering (n=53)	53 respondents from 51 schools (96%)	• Challenges facing engineering schools • Future of engineering • Relationship with support programs
Interviews with WIE directors	Summer 1999	Directors of WIE programs (n=28)	28 respondents from the 26 WIE institutions (100%)	• History of WIE program • Relationship with faculty and administration • WIE activities • Advice and future plans
WIE director questionnaire	Winter 2000	Directors of WIE programs (n=28)	28 (100%)	• Detailed budget information • Program philosophy • Activities offered
Site visits	Spring 2000, Autumn 2000	11 selected schools	11	• Interviews with administrators • Interviews with support program directors • Interviews with faculty • Focus groups with engineering students

Chapter 5: Results of Student Questionnaire – Descriptive Statistics

The cornerstone of our study is the web-based student questionnaire that was administered in three waves, once each year in 1999, 2000, and 2001. This chapter provides information about the student questionnaire response rate, presents descriptive statistics about our student sample, and describes the results from our non-respondent bias survey.

STUDENT QUESTIONNAIRE RESPONSE RATE

The WECE study administered a web-based questionnaire to students in each of the years 1999, 2000, and 2001. In 1999, 21,000 students were invited via email to participate in the study, and 6,926 of those students completed the questionnaire that first year, a 33% response rate.

Each successive year, a crop of incoming students became eligible to participate in the study for the first time, while others became ineligible to participate. Students were not eligible to participate in the study for a second or third year once they graduated or left the engineering program. If a woman indicated she had left engineering, she completed a leaver survey that year and then was removed from our database of eligible participants.

In 2000, the second year of the study, the WECE study invited 22,516 students to participate, and 9,231 (41%) of this group eventually completed the questionnaire that year. In 2001, the third and final year of the study, 24,809 students were invited to participate, and 8,999 of these students completed the questionnaire, a 36% response rate.

Fifty-nine percent of students invited to participate in 2000 who had completed the 1999 survey participated again in 2000 (n=3,127). In 2001, 57% of students invited to participate who had completed the survey in 2000 participated again. A total of 8,285 students were invited to participate every year for all three years. Of the 21,000 students invited to participate in the study in 1999, 1,302 (16%) responded all three years. Of those who participated in both 1999 and 2000, 66% went on to participate for a third year.

Table 5-1a presents the response rates each year and the rates of returning participants and percentages in the sample who stayed and those who left. Table 5-1b details the intersection of two sets – those who were invited to participate and those who actually participated – and gives percentages for the intersections of invited and participated for the three years.

Table 5-1a
WECE Student Survey Response Across the Three Waves

Year	Invited	Responded	Response rate	Stayers	Leavers	Completed 2 of the 3 years	Completed all 3 years
1999	21,000	6,926	33%	96%	4%		
2000	22,516	9,231	41%	92%	8%	3,127	
2001	24,809	8,999	36%	92%	8%	3,769	1,302

Table 5-1b
Eligibility and Participation

Eligibility	# students	**Participation**	%
Eligible in both 1999 and 2000	13,193	% who completed the survey in both years	24%
…. and completed 1999 survey	5,334	% who completed the survey in both years	59%
Eligible in both 2000 and 2001	15,437	% who completed the survey in both years	24%
…. and completed 2000 survey	6,631	% who completed the survey in both years	57%
Eligible to participate all three years	8,285	% who completed the survey in all years	16%
….. and completed first two years	1,982	% who completed the survey in all years	66%

Three-fifths of the women who were eligible to complete a second survey during the second round of data collection chose to participate for a second year. A similar number of those who completed the survey in 2000 and were eligible to complete the survey in 2001 chose to participate both times. Two-thirds of the women who were eligible for all three years and participated twice went on to participate all three times. As the tables above indicate, if a woman responded once to the questionnaire, she was more likely to complete it the second or third time than if she did not participate the first year of her eligibility.

The percentage of leavers responding to our survey does not reflect the national average, for two main reasons:

1) Each year, the schools could only provide us with the email addresses of students who were *currently* majoring in engineering – institutions do not keep lists of students who have left the major or the school. Thus, this number represents students who had left engineering since we received email lists for each year. As our study lasted 3 years, we eventually kept our own lists of students in engineering and retained the names of all students from year to year until they graduated or indicated that they had left the major.
2) Despite every effort to make it clear to leavers that we were very interested in their responses, students who had left engineering often assumed they were not eligible for the study.

BACKGROUND CHARACTERISTICS AND PRE-COLLEGE EXPERIENCES OF STUDENTS

This section describes the entire sample of students who responded to the survey at least once during the three-year duration of the study. It presents descriptive statistics on the background variables of our student sample. Note that any descriptive statistics that are not split between students who left engineering and those who stayed will be biased toward the average stayer response because leavers are underrepresented in our sample.

Student Profile

The first time a student filled out the WECE questionnaire, she was asked to provide some background data about herself, including ethnicity; type, size, and location of high school; date of birth; citizenship; and, if a U.S. citizen, what region of the country she was from (Table 5-2).

A majority of students (73.3%) reported their ethnicity as white. Consistent with national averages, 14.0% of students indicated that they were fully or partly of Central/Southeast/East Asian descent. Students most frequently came from high schools that were public (84.3%), co-ed (94.3%), and suburban (57.8%). One-quarter came from urban high schools, and one-fifth from rural schools. Two-thirds of students attended medium-sized schools, with 101–500 students in their senior class. Nearly all respondents were born in the period 1977–1981; one-tenth were older and one-tenth were younger. Nearly all respondents (92.5%) were U.S. citizens, hailing predominantly from the Great Lakes states, the Southeast, and the Mid Eastern states.

Table 5-2
Student Profile

(N)*	Question	%**
Undergraduate Year, 1999 (6,926)	Freshman	23.7%
	Sophomore	23.4
	Junior	24.3
	Senior or 5th Year	28.6
Undergraduate Year, 2000 (9,231)	Freshman	24.1%
	Sophomore	23.0
	Junior	22.8
	Senior	21.0
	5th Year	9.0
Undergraduate Year, 2001 (8,999)	Freshman	24.1%
	Sophomore	23.5
	Junior	23.6
	Senior	20.8
	5th Year	8.0
Ethnicity*** (15,125)	Black/African-American/African	5.5%
	Central/Southeast/East Asian (e.g., Chinese, Taiwanese, Vietnamese, Korean)	14.0
	Hispanic/Latino(a)	5.0
	Indian Asian (e.g., Indian, Pakistani)	3.2
	Native American, American Indian, Alaskan Native, or First Nation	1.5
	White	73.3
	Other	3.3
H.S. Sector (15,351)	Public High School	84.3%
	Private High School	9.7
	Parochial/Religious High School	5.9
	Home-schooled	0.2
H.S. Type (15,279)	Single-Sex High School	5.7%
	Co-ed High School	94.3
H.S. Region (15,244)	Urban High School	24.2%
	Suburban High School	57.8
	Rural High School	18.0
Size of H.S. Senior Class (15,315)	0-50 Students in High School Senior class	5.4%
	51-100 Students in High School Senior class	10.4
	101-500 Students in High School Senior class	66.9
	501-1000 Students in High School Senior class	15.3
	More than 1000 Students in High School Senior class	2.0

Year Born (15,227)	Born before 1975	4.6%
	Born in 1975	1.5
	Born in 1976	4.6
	Born in 1977	10.4
	Born in 1978	14.2
	Born in 1979	17.8
	Born in 1980	19.7
	Born in 1981	17.0
	Born in 1982	9.6
	Born after 1982	0.7
Citizenship (14,977)	United States citizenship	92.5%
	Canadian citizenship	0.4
	Other foreign citizenship	7.1
Geographic Region: U.S. Citizens (14,434)	U.S. citizen from New England (CT, ME, MA, NH, RI, VT)	4.5%
	U.S. citizen from Mid East (DE, DC, MD, NJ, NY, PA)	14.8
	U.S. citizen from Great Lakes (IL, IN, MI, OH, WI)	23.6
	U.S. citizen from Plains (IA, KS, MN, MO, NE, ND, SD)	8.0
	U.S. citizen from Southeast (AL, AR, FL, GA, KY, LA, MS, NC, SC, TN, VA, WV)	18.6
	U.S. citizen from Southwest (AZ, NM, OK, TX)	8.8
	U.S. citizen from Rocky Mountains (CO, ID, MT, UT, WY)	2.9
	U.S. citizen from Far West (AK, CA, HI, NV, OR, WA)	10.9
	U.S. citizen from outlying areas (AS, CM, GU, PR, TT, VI)	0.3

* N of the population responding varies because respondents were allowed to skip questions.
** Percentages may not add up to 100 due to rounding.
*** Respondents were asked to indicate all options that applied, so percentages do not add up to 100.

Pre-College Coursework

Respondents reported the types of courses they took and experiences they had in science, math, and engineering prior to attending college. Not surprisingly, women engineering students reported taking multiple mathematics and science courses in high school (n=15,235):

- A majority of students (85.2%) took calculus during high school
- Nearly every student took classes in biology (97.6%) and in chemistry (98.4%), and a large majority took physics (91.4%)
- Approximately half of the students took earth science (51.1%) or computer science (43.4%)
- Some students took environmental science classes (22.6%) and about a third of the students took classes in a science other than those listed above (32.5%)

In addition to standard high school science and math courses, women in the WECE study participated in a wide range of other science, math, and engineering-related courses and experiences during high school (Table 5-3). Nearly half took an AP Calculus AB course; nearly half participated in SME after-school clubs. A third participated in contests or competitions. About a quarter of all students took a class in AP Chemistry, participated in non-club SME programs over the summer or other out-of school programs. About a fifth took a class in AP Calculus BC and/or Physics, did an internship or volunteer work in SME, or taught SME classes in high school.

Table 5-3
Science, Mathematics, and Engineering Classes and Experiences during High School

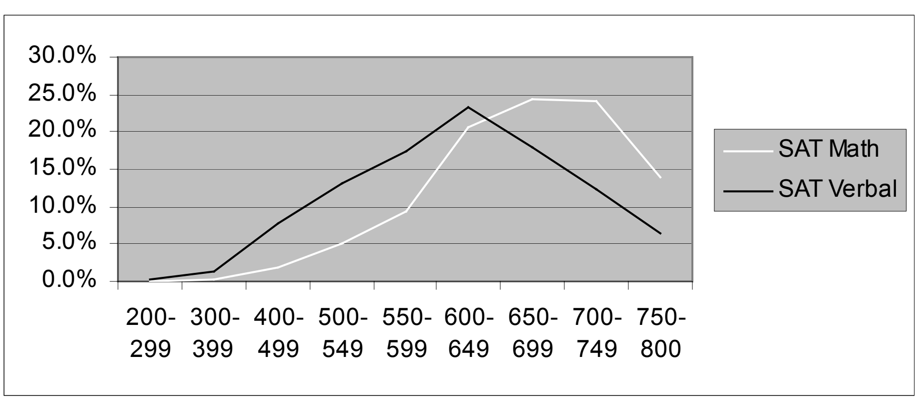
Classes and Experiences in SME	Categories	%
AP Course (n=15,164)	Calculus AB	**48.4%**
	Calculus BC	**18.0**
	Physics	**21.9**
	Biology	**16.1**
	Chemistry	**24.3**
	Environmental science	**0.9**
SME Course (n=15,283)	Engineering course	**10.3**
	Independent science research course	**6.4**
	A science or math course at a local college	**15.0**
SME Experience (n=15,220)	Summer science, math, or engineering programs	**27.0%**
	Competitions or contests (e.g., Westinghouse)	**35.3**
	After-school clubs	**48.8**
	Special programs or workshops (on weekends, after-school)	**25.0**
	Teaching science, math, or engineering	**19.4**
	Research experience	**11.7**
	Paid work experience in science, math, or engineering	**9.2**
	Volunteer work experience or internship	**19.6**

Scores on National Standardized Tests

Students' reported SAT and ACT scores tended to be higher than the national average. The College Board reported that in 2000–2001 the national average SAT math score was 514, and the average SAT verbal was 506 (College Entrance Examination Board, 2001). In comparison, the average SAT math score range reported by our respondents was 650–699, and the average SAT verbal was 600–649.

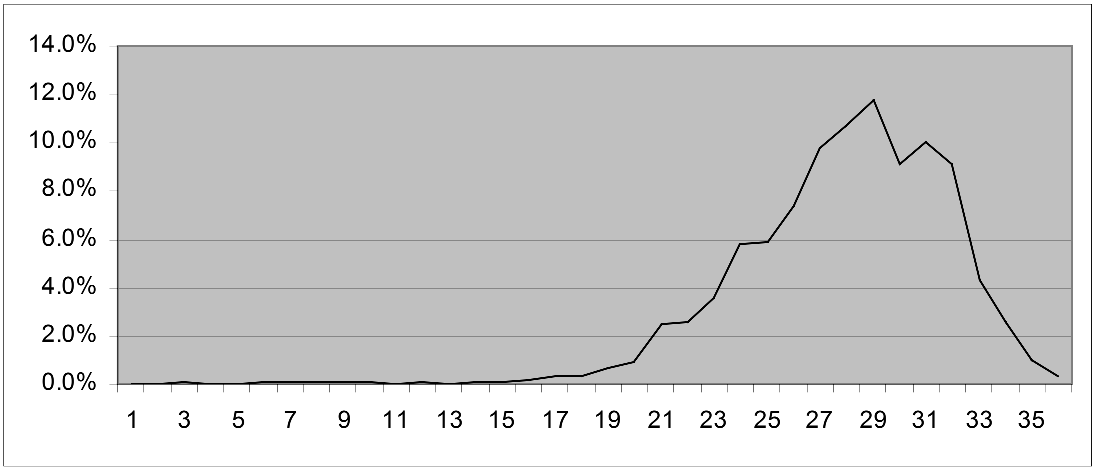
The ACT company reported a national average composite score of 21.0 on the ACT in 2000–2001 (ACT Inc., 2001); our respondents reported an average ACT score of 27.9. The scores of our respondents are reported in Figures 5-1 and 5-2.

Figure 5-1
SAT Scores



SAT Math score (n=12,914). SAT Verbal score (n=12,909).

Figure 5-2
ACT Scores



ACT score n=7,644.

People Most Influencing the Decision to Major in Engineering

Women in our study were asked to identify the most influential and the second-most influential people in their decision to major in engineering. Participants most commonly cited a mother and/or father as the most or second-most influential. As Table 5-4 shows, over 70% of women identified a mother and/or father as most influential. After parents, teacher (13%) and spouse/partner (10%) were most often cited as one of the two most influential.

Table 5-4
The Two People Most Influential on Students' Decisions to Major in Engineering

	Most influential n=15,022	2nd most influential n=14,884	Chosen either most or 2nd most influential*
Mother	**41.4%**	**33.5%**	**74.9%**
Father	**39.6**	**32.1**	**71.7**
Teacher	**4.8**	**8.3**	**13.1**
Spouse/Partner	**4.4**	**6.0**	**10.4**
Another relative	**2.4**	**5.8**	**8.2**
Female sibling	**2.2**	**3.5**	**5.7**
Male sibling	**2.0**	**3.1**	**5.1**
A peer	**1.3**	**3.4**	**4.7**
A non-related adult	**1.1**	**2.4**	**3.5**
Guidance counselor	**0.5**	**1.3**	**1.8**
An employer	**0.3**	**0.7**	**1.0**

*Combined percentage of the prior two columns.

Women were asked what the highest educational level of the two most influential people they chose was. If respondents had chosen someone other than their parents as the most or second-most influential person, they were asked to provide information about their mother and/or father's educational level as well. About four-fifths of all parents of respondents had at least some college education (Table 5-5).

Table 5-5
Educational Level of Most Influential People

	Mother n=15,131	Father n=15,104	Other most influential n=6,397*	Other most influential:2 n=1,553**
Up to high school diploma or equivalent	**21.1%**	**16.9%**	**8.9%**	**11.6%**
Some college up to 4 year college or equivalent degree	**53.0**	**44.9**	**44.9**	**44.3**
Graduate school up to master's degree or equivalent	**19.8**	**20.7**	**25.3**	**21.2**
Doctorate or professional degree	**5.7**	**16.0**	**14.4**	**15.8**
Not sure	**0.6**	**1.4**	**6.5**	**7.0**

* Asked only if at least one of the most influential people chosen was not a parent.
** Asked only if neither of the most influential people chosen was a parent.

Engineers may beget engineers. A large percentage of students reported having a parent who was an engineer: nearly one-third of the women in our sample had a father who was an engineer. However, only 3% of students' mothers were engineers (Table 5-6). Nearly half of respondents' mothers, and more than half of fathers, work or worked at some point in a science, math, engineering, or technology field.

When a respondent cited a non-parent as most influential, that person was likely to be an engineer – about one-third of all non-parents mentioned were engineers. Influential non-parents who were not engineers were most likely to be math or science teachers.

Table 5-6
Fields of Work of Most Influential People

	Mother (n=14,168)	Father (n=14,666)	Other most influential (n=6,224)*	Other most influential:2 (n=1,528)**
Engineer	**3.0%**	**29.8%**	**37.8%**	**32.5%**
Scientist, lab technician	**4.8**	**7.4**	**16.3**	**13.4**
Computer scientist, system administrator, programmer, technician	**5.9**	**13.0**	**15.5**	**13.8**
Medical professional – including doctor, veterinarian, dentist, medical technician, nurse, physician assistant	**16.9**	**5.4**	**7.6**	**7.7**
Mathematician, statistician, actuary	**2.4**	**3.6**	**8.1**	**8.1**
Accountant, auditor, budget analyst, cost estimator, financial manager	**13.6**	**10.9**	**6.5**	**6.7**
Architect, surveyor, drafter	**0.8**	**5.4**	**5.1**	**5.3**
Math or science teacher	**9.3**	**6.0**	**21.8**	**18.6**
Another field related to math, science, technology, or engineering, but not listed above	**3.6**	**11.7**	**9.1**	**9.2**
A field other than those listed above	**57.5**	**40.9**	**25.7**	**27.4**
Not sure	**2.6**	**2.8**	**2.8**	**6.4**

* Asked only if at least one of the most influential people chosen was not a parent.
** Asked only if neither of the most influential people chosen was a parent.

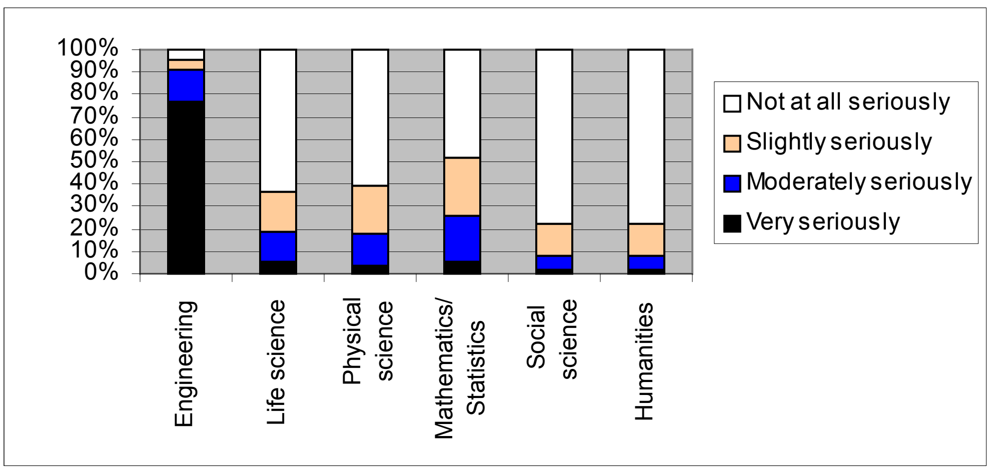
College Experiences and Perceptions

Decide to Major in or Leave Engineering

Engineering students make their decisions about majoring in engineering early on; in fact, over three quarters of survey respondents reported that they made their decision to major in engineering prior to entering college (Figure 5-3). A similar number reported that they were very seriously considering a major in engineering when they entered college.

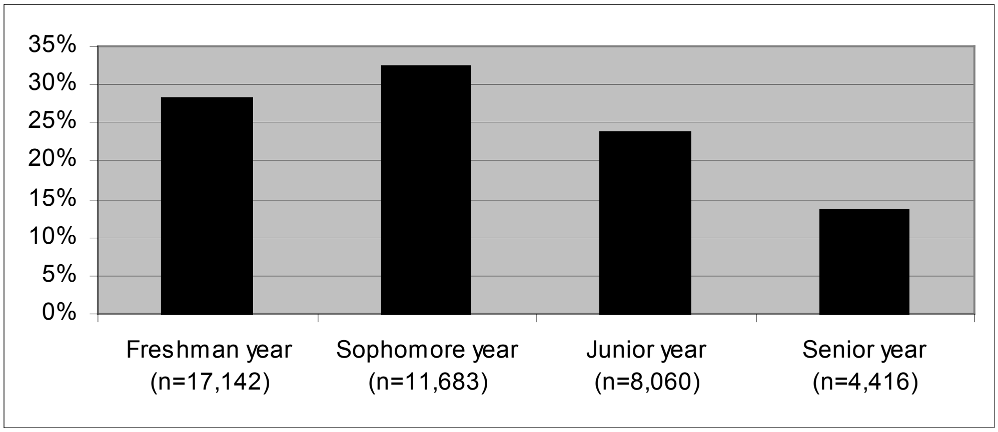
- 64.3% of junior, senior, and fifth-year respondents decided to major in engineering before entering college (n=16,586). Another 16.1% decided in their freshman year, with almost all of the remaining upperclasswomen (15.1%) deciding in their sophomore year.
- 76.7% "very seriously" considered majoring in engineering when they began college. Another 14.9% considered an engineering major "moderately seriously."
- 5.6% of students or fewer considered a non-engineering major "very seriously."

Figure 5-3
Majors Considered on Entering College (n=17,740)



About two-fifths of student participants in all years of college (44.1%) reported that they had considered leaving engineering at some point during college (Figure 5-4). Of seniors and fifth-year students only – students unlikely to leave engineering by that point in their career – 48.1% reported that they had considered leaving engineering at some point during college. Sophomore year is most frequently mentioned as a year when students considered leaving engineering: about one-third of all sophomore and more advanced student respondents reported that they seriously considered leaving engineering during sophomore year.

Figure 5-4
Students Report They Seriously Considered Leaving Engineering...*

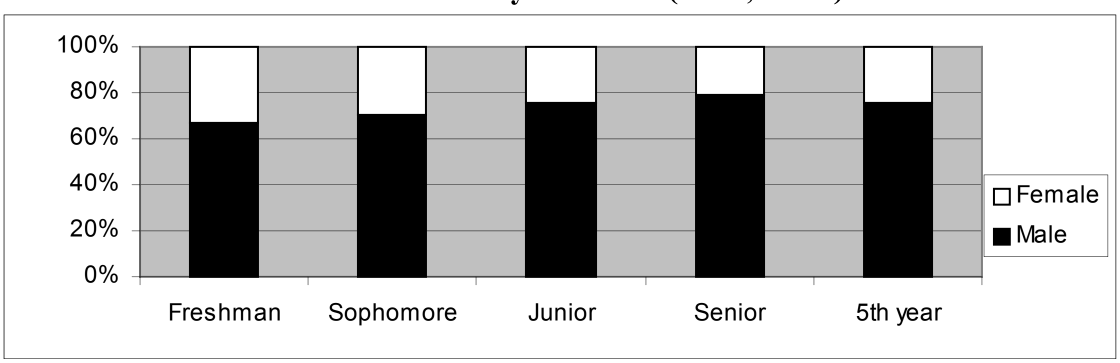


*Students were asked about their own year and prior years.

Advisors, Mentors, and Faculty

About 87% of students in each college year reported that they had a faculty advisor in engineering. First-year students were more likely to report having a female advisor than students in any other year (Figure 5-5): possibly because older students are more likely to be assigned to more senior faculty, who are more likely to be male. Still, the percentage assigned to or choosing a female faculty as their advisor is much larger than would be expected given women make up only about 8% of the engineering faculty nationwide. This suggests that female students are actively being assigned to or choosing female advisors.

Figure 5-5
Gender of Faculty Advisor* (n=25,025)**

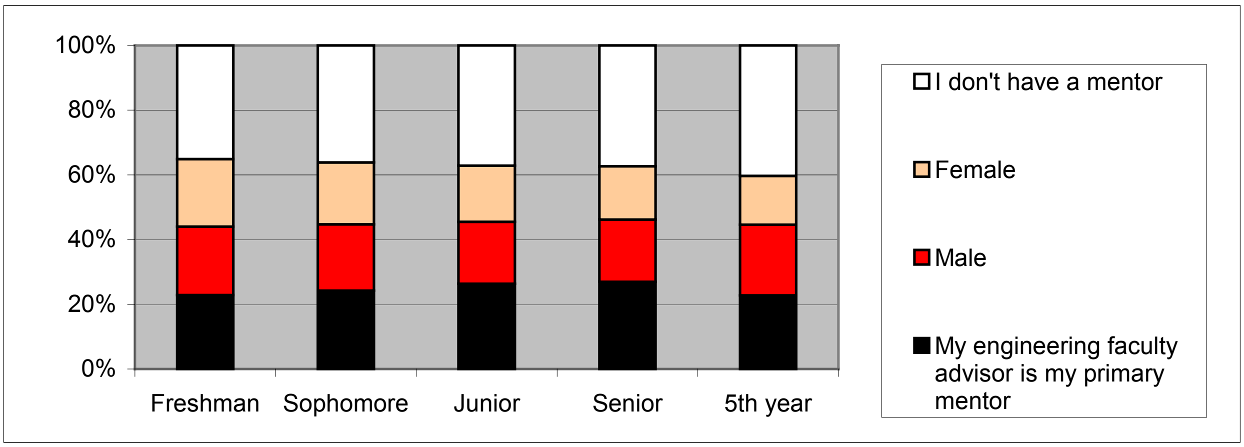


* Only asked of students who reported having a faculty advisor.
** Students were asked this question each year that they completed the questionnaire.

Each year we also asked students about their primary mentor in engineering. We defined a mentor as someone with more experience in engineering, to whom the student turns for advice or support about educational or professional decisions. Figure 5-6 presents the gender of their primary mentor.

- Thirty to forty percent of students in each undergraduate year said they did not have a mentor.
- Each year, about a quarter of student respondents said their faculty advisor was their primary mentor.
- Between 15% and 21% of all students in each undergraduate year said their primary mentor (when not their advisor) was female; between 19% and 22% said their primary mentor (when not their advisor) was male.
- First-year students were most likely to have a non-advisor mentor who was female.

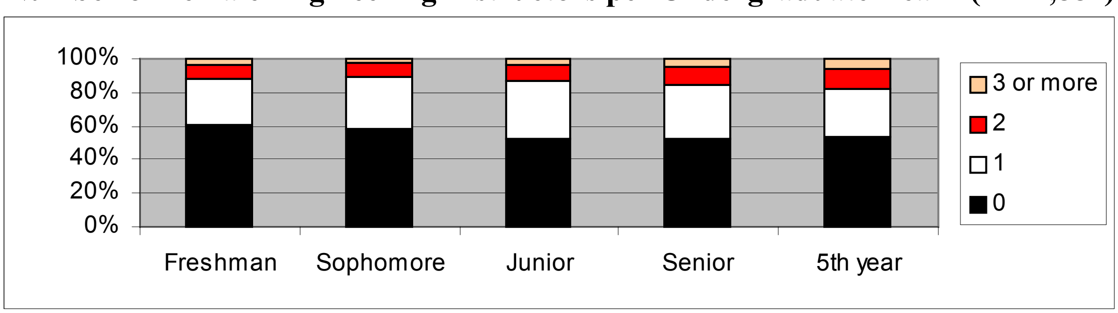
Figure 5-6
Gender of Primary Mentor (n=23,238)*



* Students were asked this question each year that they completed the questionnaire.

Students were asked each year to indicate how many of the primary instructors in their engineering courses had been women (see Figure 5-7). Each year more than half of the undergraduates indicated that they had had no female instructors in engineering in the prior year. First-year students were slightly more likely than students in other years to say they had had at least one instructor who was a woman in the prior year. Between 20% and 30% of students reported that they had had one female engineering instructor. Between 5% and 10% of women reported having more than one female engineering instructor.

Figure 5-7
Number of Female Engineering Instructors per Undergraduate Year* (n=24,882)



* Students were asked this question each year they completed the questionnaire.

Being Female in Engineering

Students were asked to compare themselves to other women in their engineering courses (Table 5-7) and to men in their courses (Table 5-8). Roughly a third of student respondents – both stayers and leavers – neither agreed nor disagreed that they spent more time on class work, understood concepts better, were better at solving problems, were more committed to engineering, worked better with others, or had more confidence than other women. Stayers tended to compare themselves positively to other women; while between a third and a majority of leavers compared themselves negatively, with the exception of "I work better with other people."

It should be kept in mind that with statements of the sort represented in Tables 5-7, 5-8, and 5-10, the difference between 'neither agree nor disagree' and disagreement is somewhat ambiguous. Disagreement may not imply belief in the opposite of the statement, while 'neither agree nor disagree' most likely represents a neutral response, a belief halfway between the statement and its opposite. Since disagreement most likely represents a more negative response than 'neither agree nor disagree' (or more positive, if the prompting statement is negative), we will discuss it as such in the rest of the section.

With two exceptions, most students – both leavers and stayers – compared themselves negatively to men in their engineering courses, and roughly a third, again, considered themselves about the same. The exceptions were about 70% of stayers who said they "work better with other people" than male students – about 60% of leavers – and another 60% of stayers and nearly 45% of leavers who said they "spend more time and effort" on class work (this may not be viewed by students as positive, of course – it could mean they feel they are having more difficulty). Leavers were uniformly more negative than stayers, including in their response to the difficult-to-interpret "I spend more time and effort on my class work." More leavers disagreed with this statement than stayers (as with all the other statements in this set of questions).

Given there are so many more men than women undergraduates in engineering, it is interesting to speculate why female students tend to say they are not as good at engineering than 'men' generally. Male students most likely represent a more visible range of ability and competence than females. Do women truly feel that men tend to do better at engineering than they do, and are more confident and committed, or is it that male 'stars' in the classroom are much more common and visible? Evidence from the focus groups (described in Chapter 7) suggests that at least some women feel that male students have an 'easier time in engineering' than females, that they come into the major knowing more.

Table 5-7
Self Comparison to Other Female Undergraduates in Engineering*

	Agree**	Neither agree nor disagree	Disagree***
I spend more time and effort on my class work.	**46.6%** / *33.8%*	**30.6%** / *34.1%*	**22.7%** / *32.2%*
I understand engineering concepts better.	**53.9** / *31.2*	**33.9** / *35.3*	**12.3** / 33.5
I am better at solving engineering problems.	**52.3** / *29.7*	**36.0** / *35.4*	**11.6** / *34.9*
I am more committed to engineering.	**46.1** / *12.3*	**36.9** / *30.6*	**17.1** / *57.1*
I work better with other people.	**59.0** / *53.1*	**30.6** / *32.0*	**10.4** / *14.9*
I have more confidence in my engineering abilities.	**48.5** / *20.0*	**36.0** / *36.4*	**15.5** / *43.7*

* Percentages for stayers answering the 2001 survey are in bold. This question was asked of stayers each year that they completed the questionnaire. Results varied little from year to year. Comparison percentages for leavers from all years are in italics.
** The sum of "Strongly agree", "Moderately agree", and "Slightly agree".
*** The sum of "Strongly disagree", "Moderately disagree", and "Slightly disagree".

Table 5-8
Self Comparison to Male Undergraduates in Engineering*

	Agree**	Neither agree nor disagree	Disagree***
I spend more time and effort on my class work.	**61.0%** / *43.8%*	**22.0%** / *26.0%*	**17.1%** / *30.2%*
I understand most engineering concepts better.	**38.0** / *18.7*	**34.9** / *33.9*	**27.0** / *47.4*
I am better at solving engineering problems.	**36.2** / *19.1*	**37.4** / *33.8*	**26.4** / *47.0*
I am more committed to engineering.	**39.8** / *12.3*	**36.3** / *27.6*	**23.8** / *60.1*
I work better with other people.	**68.6** / *59.4*	**23.8** / *28.3*	**7.5** / *12.4*
I have more confidence in my engineering abilities.	**30.8** / *11.5*	**36.2** /*31.9*	**40.3** / *56.5*

* Percentages for stayers answering the 2001 survey are in bold. This question was asked of stayers each year that they completed the questionnaire. Results varied little from year to year. Comparison percentages for leavers from all years are in italics.
** The sum of "Strongly agree", "Moderately agree", and "Slightly agree".
*** The sum of "Strongly disagree", "Moderately disagree", and "Slightly disagree".

The majority of students – nearly two-thirds of stayers, and slightly fewer leavers – felt they had no advantage or disadvantage compared to their male peers in dealing with faculty and advisors and with finding a mentor (Table 5-9). Of those remaining, a somewhat larger percentage of stayers tended to feel they had an advantage, except in the case of 'relating to [their] advisor'. About 10% more leavers – roughly a quarter of those who felt either advantaged or disadvantaged – felt they were at a disadvantage for every case about which we asked.

Table 5-9
Advantages and Disadvantages Compared to Male Students in Engineering*

	Advantage**	Neither advantage nor disadvantage	Disadvantage***
Interacting with faculty	**25.4%** / *16.0%*	**57.2%** / *56.1%*	**17.5%** / *27.8%*
Relating to advisor	**16.8** / *15.8*	**63.2** / *57.0*	**20.1** / *27.0*
Finding a mentor	**18.7** / *12.7*	**66.0** / *65.5*	**15.4** / *21.6*
Getting support from engineering faculty	**22.1 / 16.3**	**62.8** / *56.3*	**15.5** / *27.4*

* Percentages for stayers answering the 2001 survey are in bold. This question was asked of stayers each year that they completed the questionnaire. Results varied little from year to year. Comparison percentages for leavers from all years are in italics.
** The sum of "Great advantage", "Moderate advantage", and "Slight advantage".
*** The sum of " Great disadvantage", "Moderate disadvantage", and "Slight disadvantage ".

Roughly a fifth to a quarter of all students neither agreed nor disagreed with the statements presented in Table 5-10. The two exceptions were “The content of my engineering courses was less relevant to women than men” and “I believe women in engineering are generally offered higher-paying jobs than men”, to which 42% and about a third of women respectively gave a neutral response.

To many of the questions, a majority of students gave a response that was a positive assessment of engineering conditions at school. A minority of students (about 12%) agreed that their courses ‘were less relevant to women than men’ or that their ‘instructors made comments that demeaned women’, and few disagreed with the proposition ‘My engineering department was supportive of women students’ in the past academic year. Approximately equal numbers of the three-quarters of students who were not neutral in saying they ‘felt stigmatized by students outside engineering’ agreed and disagreed with that statement. More than half of students disagreed that they felt more comfortable in non-engineering classes; a quarter of students agreed with that statement. A small majority of non-neutral students disagreed that ‘the competitive climate in engineering favored male students’; about a third of students agreed with this statement.

Students tended to be more ambivalent about the engineering workplace. More than half agreed that ‘it is easier for women to go into some fields of engineering than other fields’ and that ‘it is more difficult for a woman to balance a career and family in engineering than in most other fields’; almost a quarter either disagreed or were neutral in answering each of these statements. Roughly 60% agreed that ‘being a woman improves my prospects of finding a job in engineering’ and disagreed that ‘women in engineering are generally offered higher-paying jobs than men’: statements that are difficult to interpret as either negative or positive assessments of engineering, depending on the students’ sense of fairness versus their desire for advantage.

About 40% of students agreed that ‘engineering departments should have special programs to address women’s needs.’ A third of students disagreed; the remaining quarter were neutral.

Table 5-10
Beliefs and Perceptions About Conditions for Women in Engineering*

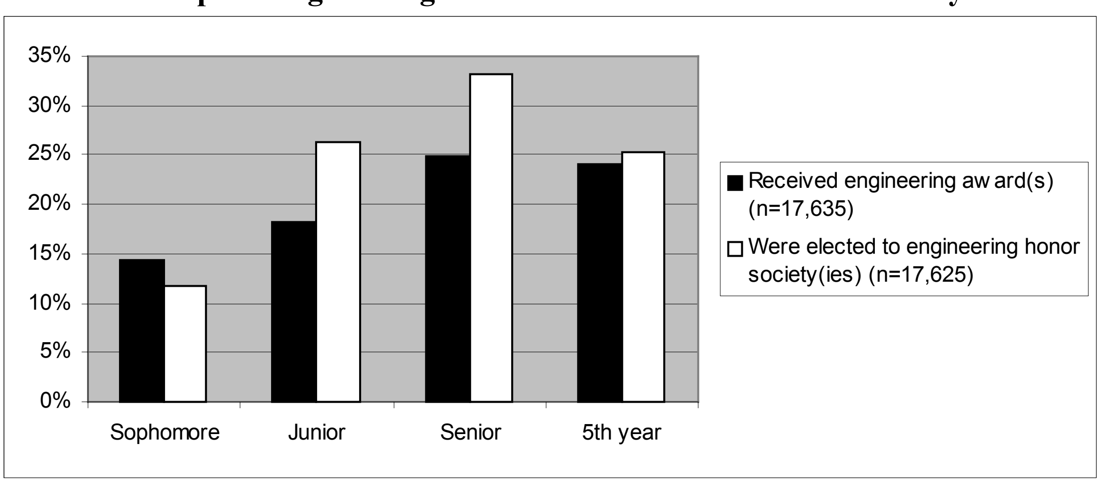
	Agree**	Neither agree nor disagree	Disagree ***
The content of my engineering courses was less relevant to women than men.	**11.4%**	**42.0%**	**46.6%**
In my eng. lectures, my instructors made comments that demeaned women.	**12.8**	**20.6**	**66.7**
As an engineering student, I felt stigmatized by students outside engineering.	**36.7**	**26.0**	**37.5**
My engineering department was supportive of women students.	**69.2**	**22.3**	**8.5**
I felt more comfortable in my classes in departments outside of engineering than in my engineering classes.	**26.7**	**21.8**	**51.5**
The competitive climate in engineering favored male students.	**32.9**	**24.1**	**43.1**
I believe that engineering departments should have special programs to address women's needs.	**40.1**	**24.4**	**35.5**
I believe it is easier for women to go into some fields of eng. than other fields.	**54.2**	**22.7**	**23.2**
Being a woman improves my prospects of finding a job in engineering.	**58.9**	**24.2**	**16.8**
I believe women in eng. are generally offered higher-paying jobs than men.	**8.2**	**31.6**	**60.3**
It is more difficult for a woman to balance a career and family in engineering than in most other fields.	**52.2**	**24.6**	**23.2**

* Percentages are for the 2001survey only. Results varied little between years. May not sum to 100% due to rounding.
**The sum of "Strongly agree", "Moderately agree", and "Slightly agree".
*** The sum of "Strongly disagree", "Moderately disagree", and "Slightly disagree".

Engineering Awards

Students reported whether they had received an engineering award or been elected to an engineering honor society (Figure 5-8). As might be expected, seniors most frequently reported having been elected to an engineering honor society during the past academic year. About one-quarter of all seniors and fifth-year student respondents reported having received an engineering award, and a slightly higher percentage reported having been elected to an engineering honor society.

Figure 5-8
Receipt of Engineering Awards in the Year Before the Survey*



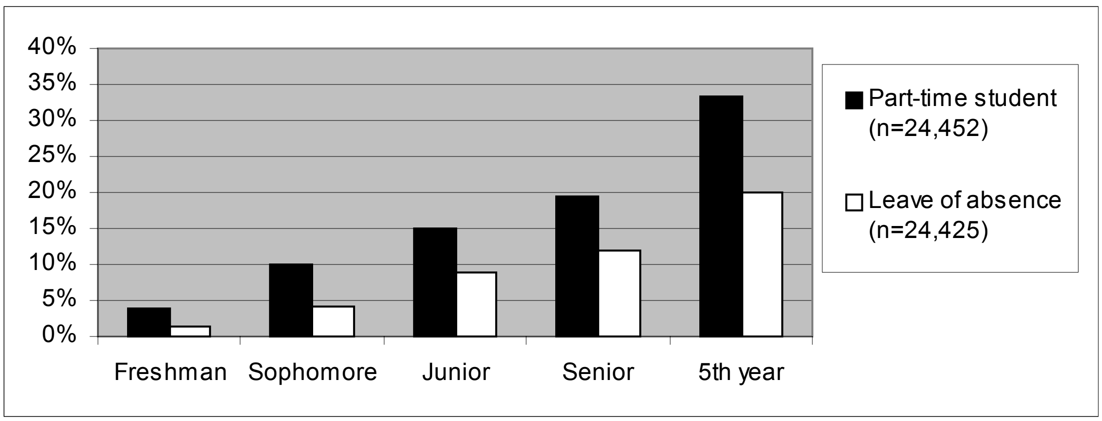
*Question was not asked of first-year students. All other students were asked this question each year they completed the questionnaire.

Attendance Patterns

The past decade has seen an increase in the percentage of students who take time off during their college careers, and engineering students are no exception. About 20% of seniors in our sample reported having been a part-time student at some point during their college career, and 12% reported having taken a leave of absence. Those students who answered the questionnaire during their fifth year of engineering education were, not surprisingly, much more likely to have taken time off (20.0%) or been a part-time student (about 33%) (Figure 5-9).

Respondents most often took a leave of absence between sophomore and junior years (4.6%), and most commonly attended college part-time between freshman and sophomore years (6.0%).

Figure 5-9
Has student ever taken time off from school?*



* Students were asked this question each year that they completed the questionnaire.

Work and Financial Aid

More than 90% of students in our sample used family and/or personal funds to pay for college. About 80% of students used scholarship or grant money, with older students using this source more often than younger students. Many students also worked during the school year to help fund their college education; students who were more advanced in their college careers were more likely to use funds from their school-year employment to finance their education than students in the earlier years of their engineering majors. Funding sources by year in school are displayed in Table 5-11.

Table 5-11
Sources of Funding for College

Funding Source (n)	Freshman	Sophomore	Junior	Senior	Fifth-year
Family support/personal funds/savings (21,647)	**92.4%**	**92.3%**	**91.6%**	**91.3%**	**90.3%**
Scholarships/grants (21,635)	**77.7%**	**77.5%**	**77.8%**	**79.6%**	**80.5%**
Loans (21,607)	**43.9%**	**47.7%**	**49.1%**	**53.1%**	**63.0%**
Employment during the school year (21,598)	**29.8%**	**44.7%**	**58.2%**	**67.0%**	**77.6%**
Summer or other employment (21,621)	**64.9%**	**74.0%**	**80.3%**	**83.8%**	**87.0%**

More than one-quarter of first-year students reported being employed during the school year. The older the student, the more likely she was to work during the academic year – more than three-quarters of fifth-year students reported such employment. Similarly, the percentage of students reporting using summer employment to pay for college increased every year, from two-thirds of first-year students to almost nine-tenths of fifth-year students. The more advanced students also tended to work more hours than beginning students, as shown in Table 5-12.

Table 5-12
Hours Worked per Week During the Academic Year

Hours (n=21,721)	Freshman	Sophomore	Junior	Senior	Fifth-year
0	**46.6%**	**32.2%**	**24.5%**	**19.0%**	**22.5%**
1–10	**38.1%**	**41.0%**	**38.2%**	**39.1%**	**25.4%**
11–20	**11.6%**	**20.4%**	**27.3%**	**31.8%**	**35.0%**
21–30	**2.5%**	**3.7%**	**6.2%**	**7.0%**	**11.5%**
31–40	**3.5%**	**5.9%**	**9.3%**	**9.7%**	**15.7%**
More than 40	**0.2%**	**0.5%**	**0.6%**	**0.5%**	**1.4%**

Encouragement and Discouragement

Most students reported that they had been encouraged to pursue a degree in engineering by influential people in their lives (see Table 5-13). Parents were the most encouraging; more than half of students said their parents gave them "a great deal of encouragement," less than one-tenth reported no influence either way, and only a small percentage reported that their parents discouraged them: 6.5% of mothers and 4% of fathers.

Most discouraging, when applicable, were high school guidance counselors. Yet only 7.5% reported that their counselors discouraged them, while two-fifths said their counselors were encouraging. The other influential people we asked about were reported to have encouraged students to pursue a degree in engineering more than half the time.

Table 5-13
Level of Encouragement or Discouragement from Influential People for Pursuing a Degree in Engineering

People who discouraged (disc) or encouraged (enc)	Great deal of disc*	Moderate disc	A little disc	Neither enc/disc	A little enc*	Moderate enc	Great deal of enc	N/A
Mother (n=16,398)	**1.3%**	**1.3%**	**2.9%**	**10.0%**	**8.1%**	**20.1%**	**54.8%**	**1.6%**
Father (n=16,397)	**1.3**	**1.0**	**1.7**	**8.6**	**6.2**	**16.4**	**59.7**	**5.1**
Most influential sibling(s) (n=16,391)	**0.6**	**0.7**	**1.7**	**30.4**	**10.2**	**14.8**	**24.4**	**17.4**
Most influential high school peers (n=16,384)	**0.9**	**1.4**	**4.1**	**26.7**	**16.6**	**20.9**	**20.1**	**9.3**
Most influential teacher (n=16,385)	**0.8**	**1.0**	**2.0**	**18.7**	**12.0**	**20.9**	**34.4**	**10.2**
High school guidance counselor (n=16,383)	**2.2**	**2.0**	**3.3**	**32.9**	**10.2**	**12.8**	**18.2**	**18.4**

Someone who works in a SME field (n=16,389)	**0.8**	**0.7**	**1.3**	**11.5**	**10.2**	**20.2**	**38.8**	**16.6**

In addition to probing the influences of various people, each year the WECE study asked women to indicate the level of encouragement or discouragement provided by approximately 25 influences in the past academic year (the number varied due to refinements each year). Table 5-14 compares the responses of "stayers" (students who remained in engineering majors) and "leavers" (students who left engineering majors) to these questions. Stayers were more likely than leavers in all cases to find a particular influence encouraging, and except for "employment opportunities" and "salary potential," stayers were less likely to find a particular influence discouraging. Leavers were more likely to say an influence was not applicable (N/A) to them, except for "spouse/partner."

Table 5-14
Encouragement and Discouragement for Pursuing an Engineering Major from Various Sources in the Past Academic Year* (n=8,681)

	A great deal of disc	Moderate disc	A little disc	Neither enc/disc	A little enc	Moderate enc	A great deal of enc	N/A
Most influential college engineering faculty member	**1.2%** / *3.7%*	**1.2%** / *3.1%*	**2.3%** / *6.2%*	**23.9%** / *30.8%*	**12.5%** / *10.4%*	**20.2%** / *12.2%*	**25.6%** / *10.0%*	**13.1%** / *23.6%*
College advisor	**1.3** / *4.0*	**1.7** / *3.6*	**2.8** / *6.7*	**28.8** / *30.8*	**13.5** / *12.8*	**18.8** / *13.7*	**20.8** / *12.0*	**12.3** / *16.4*
Most influential graduate student or teaching assistant	**0.8** / *1.8*	**0.9** / *2.2*	**1.8** / *4.4*	**28.3** / *36.4*	**13.1** / *9.8*	**16.2** / *7.3*	**15.1** / *4.6*	**23.8** / *33.5*
Most influential peers in engineering	**1.1** / *3.3*	**1.3** / *4.6*	**3.5** / *8.3*	**14.7** / *24.4*	**16.7** / *18.4*	**27.6** / *17.0*	**29.8** / *10.4*	**5.2** / *13.6*
Employment opportunities	**1.0**/ *1.9*	**1.8** / *1.7*	**5.3** / *3.2*	**9.6** / *16.6*	**12.4** / *14.5*	**28.1** / *21.4*	**39.2** / *30.8*	**2.5** / *10.0*
Salary potential	**0.4** / *0.6*	**0.7** / *0.5*	**1.9** / *0.9*	**11.0** / *15.7*	**16.5** / *13.9*	**30.4** / *23.5*	**37.2** / *36.6*	**1.8** / *8.4*
Interest in the subject matter in engineering	**1.3** / *17.0*	**2.1** / *14.7*	**6.0** / *14.1*	**5.1** / *7.0*	**17.6** / *17.5*	**34.1** / *15.0*	**33.1** / *7.7*	**0.7** / *7.0*
Quality of teaching by instructors in engineering	**3.4** / *12.0*	**5.6** / *14.3*	**16.3** / *20.0*	**19.2** / *23.1*	**21.9** / *10.5*	**21.7** / *7.7*	**10.3** / *2.6*	**1.6** / *9.8*
Mentor	**0.4** / *2.6*	**0.6** / *1.7*	**1.3** / *3.9*	**25.4** / *27.3*	**13.1** / *7.7*	**14.4** / *4.7*	**13.3** / *2.4*	**31.6** / *49.7*
Study group	**0.5** / *1.4*	**0.7** / *2.6*	**2.6** / *6.0*	**25.7** / *31.4*	**19.3** / *13.6*	**19.3** / *6.2*	**10.8** / *2.6*	**21.0** / *36.2*
Grades	**5.3** / *25.9*	**8.1** / *16.1*	**21.9** / *19.0*	**11.0** / *12.5*	**17.0** / *8.0*	**22.3** / *6.5*	**13.4** / *3.7*	**1.0** / *8.3*
Spouse/partner	**0.4** / *1.1*	**0.4** / *2.2*	**1.5** / *4.5*	**12.0** / *22.6*	**6.4** / *7.5*	**9.7** / *6.8*	**17.3** / *5.9*	**52.2** / *49.3*
Peers	**0.4** / *1.7*	**1.1** / *4.5*	**4.6** / *12.6*	**17.8** / *31.0*	**23.2** / *21.3*	**29.9** / *11.8*	**19.3** / *5.0*	**3.6** / *12.1*
Internship/research experience	**1.2** / *3.2*	**1.7** / *4.1*	**4.7** / *3.1*	**9.3** / *16.9*	**10.4** / *6.5*	**16.1** / *5.8*	**23.1** / *4.8*	**33.5** / *55.5*
Amount of time required for engineering coursework	**5.3** / *16.7*	**11.7** / *20.6*	**39.0** / *27.6*	**27.2** / *21.5*	**7.6** / *2.4*	**5.6** / *1.5*	**2.2** / *0.4*	**1.5** / *9.2*
Competition in engineering classes	**3.5** / *13.0*	**7.7** / *16.2*	**24.2** / *22.3*	**36.3** / *31.2*	**13.8** / *4.6*	**8.1** / *1.8*	**3.2** / *0.6*	**3.1** / *10.3*
Pace of engineering courses	**3.2** / *12.3*	**6.9** / *15.8*	**28.2** / *24.6*	**36.7** / *31.8*	**13.1** / *3.9*	**7.9** / *1.4*	**2.7** / *0.7*	**1.4** / *9.4*
Number of women in the major	**2.5** / *7.6*	**4.0** / *6.1*	**10.8** / *12.5*	**46.0** / *45.8*	**13.2** / *9.0*	**11.8** / *5.6*	**10.3** / *4.6*	**1.3** / *8.8*
Number of women faculty in engineering	**4.3** / *8.6*	**5.8** / *7.6*	**13.5** / *12.9*	**57.8** / *55.1*	**6.0** / *3.1*	**4.8** / *1.8*	**4.7** / *1.2*	**3.1** / *9.8*
Class size in engineering	**1.4** / *4.5*	**3.0** / *6.5*	**9.4** / *11.6*	**52.9** / *52.6*	**14.7** / *9.6*	**10.9** / *4.1*	**5.7** / *1.4*	**1.9** / *9.6*
Atmosphere of engineering dept/courses	**3.0** / *16.7*	**5.1** / *14.8*	**16.2** / *21.2*	**29.5** / *24.6*	**19.4** / *7.6*	**15.7** / *4.6*	**9.5** / *1.5*	**1.5** / *9.0*

* Percentages for stayers answering the survey in 2001 are in bold. This question was asked of stayers each year that they completed the questionnaire. Results varied little from year to year. Comparison percentages for leavers from all years are in italics.

After ranking each variable, engineering women were asked to identify the single most significant source of encouragement and the single most significant source of discouragement they had experienced during the past academic year. The most commonly chosen sources are listed in Tables 5-15 and 5-16 below.

"Father," "Mother," and "Interest in the subject matter of engineering" were most commonly cited as the most significant sources of encouragement by respondents in every year of college. People are particularly influential; four of the seven most commonly cited factors are people, including "College peers," "Spouse/partner," and, for first-year students, "Precollege teacher." "Employment opportunities" and "salary potential" also highly encourage students, and once students become involved in internships or research experiences, in the junior, senior, and fifth year, women cite them as significantly encouraging.

Table 5-15
Most Significant Sources of Encouragement, by Undergraduate Year*

	Freshmen (n=5,714)	Sophomores (n=5,558)	Juniors (n=5,613)	Seniors (n=5,525)	Fifth-years (n=1,467)
Interest in the subject matter of engineering	Third (15.1%)	First (15.3%)	First (14.8%)	First (14.6%)	Fourth (10.3%)
Father	First (18.4%)	Second (15.2%)	Second (13.3%)	Second (11.4%)	Second (15.5%)
Mother	Second (15.8%)	Third (13.7%)	Third (12.5%)	Third (11.0%)	First (17.6%)
Employment opportunities	Fourth (8.6%)	Fourth (9.4%)	Fourth (9.9%)	Fourth (10.5%)	Fifth (8.2%)
College Peers	Sixth (5.1%)	Fifth (7.5%)	Fifth (6.8%)	Sixth (6.6%)	Seventh (6.5%)
Internship/research experience			Sixth (6.4%)	Fifth (7.5%)	Sixth (7.2%)
Salary potential	Fifth (5.3%)	Sixth (5.5%)			
Spouse/partner		Seventh (5.2%)	Seventh (4.0%)	Seventh (6.4%)	Third (11.5%)
Precollege teacher	Seventh (3.6%)				

* Students were asked this question each year that they completed the questionnaire.

"Grades" and "Amount of time required for engineering coursework" topped the list of the most significant sources of discouragement for students in every year; about 20% of respondents chose each of these. "Quality of teaching by instructors in engineering" and "Interest in the subject matter of engineering" also were cited frequently. During their first two years of college, women indicated that competition in engineering classes was discouraging; in the last three years they found the atmosphere of the engineering department and courses to be significantly discouraging. Finally, from sophomore year onward, the women engineers found college faculty members to be a discouraging influence.

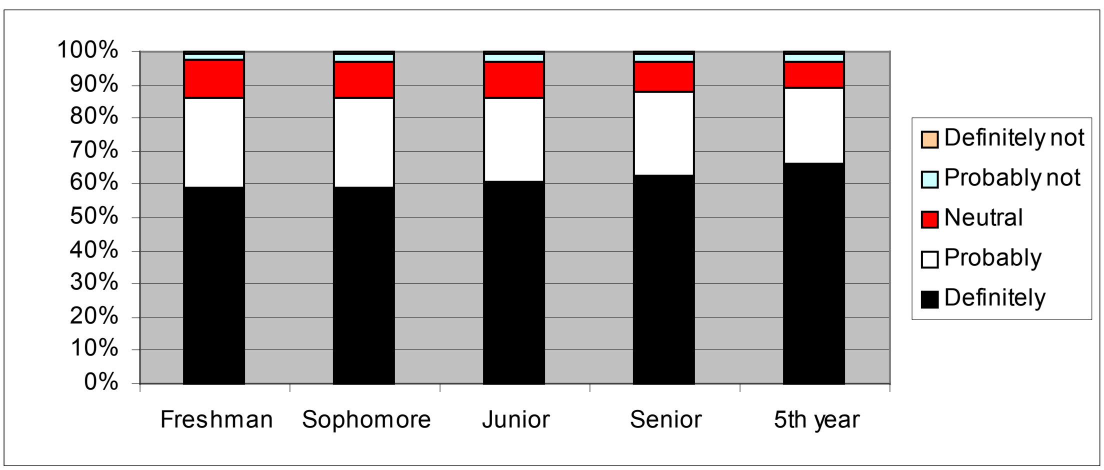
Table 5-16
Most Significant Sources of Discouragement, by Undergraduate Year*

	Freshmen (n=5,560)	Sophomores (n=5,462)	Juniors (n=5,519)	Seniors (n=5,424)	Fifth-years (n=1,436)
Grades	First (23.5%)	First (25.2%)	First (22.0%)	Second (17.7%)	First (21.2%)
Amount of time required for engineering coursework	Second (21.3%)	Second (20.0%)	Second (20.9%)	First (19.0%)	Second (17.1%)
Quality of teaching by instructors in engineering	Fourth (4.8%)	Third (7.1%)	Third (9.2%)	Third (10.0%)	Fourth (7.8%)
Interest in the subject matter in engineering	Third (4.9%)	Fourth (6.4%)	Fourth (5.9%)	Fourth (6.4%)	Fifth (7.2%)
College faculty member		Fifth (4.9%)	Fifth (5.3%)	Fifth (5.8%)	Third (12.0%)
Outside interest	Sixth (4.0%)			Sixth (4.3%)	
Atmosphere of engineering department/courses			Sixth (3.8%)		Sixth (6.5%)
Competition in engineering classes	Fifth (4.3%)	Sixth (3.7%)			

* Students were asked this question each year that they completed the questionnaire.

For the most part, women engineering students indicated they would encourage women to major in engineering (Figure 5-10); three-fifths said they would “definitely” encourage other women, and another one-quarter said they would “probably” do so. About one-tenth said they were “neutral” on the question. Only a small percentage said they would not encourage other women to major in engineering.

Figure 5-10
Would Encourage Other Women to Major in Engineering* (n=23,790)

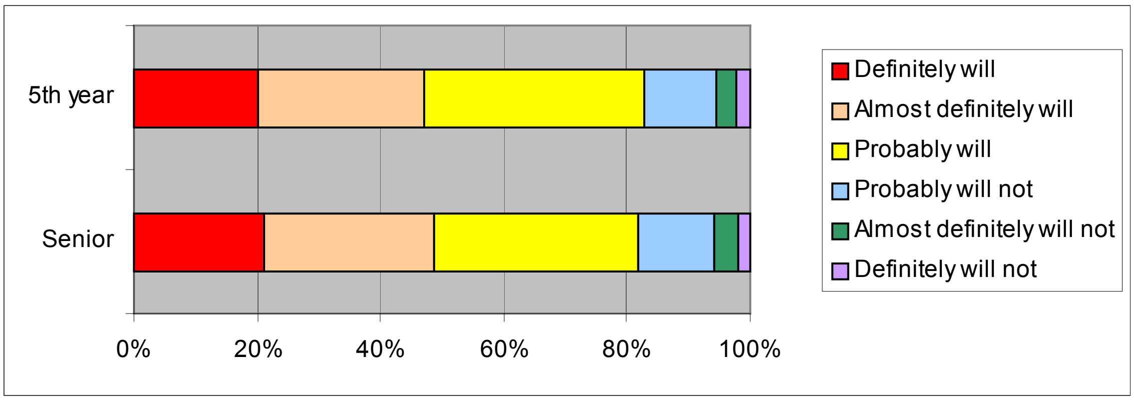


*Asked each year of all “stayer” students.

Future Plans in Engineering

Students were asked the likelihood that they would be working in an engineering field in seven years (Figure 5-11). More than 80% of senior and fifth-year students expected they would be working in engineering seven years hence. About one-third of these said they "probably will" be working in engineering, about one-quarter said they "almost definitely will" and about one-fifth said they "definitely will." Of those students who said they would more likely not be working in engineering, most – about 12% – said they "probably will not."

Figure 5-11
Expectation That Student Will be Working in an Engineering Field in 7 Years* (n=6,592)



*Question asked of seniors and fifth-year stayers only.

Participation in Support Resources and Activities

Students participated in a variety of activities and support resources during their undergraduate years. The proportion of students participating in a particular kind of activity almost always varied by undergraduate year, as displayed in Table 5-17. The exception to this rule was academic advising: slightly more than four-fifths of all students made use of this resource (possibly because it was required at many schools).

Students later in their program were more likely to participate than underclass students in most engineering support activities:

- Study and support groups in engineering: though always frequented by a large majority of students, participation increased by about 4% each year through senior year
- Reading an engineering newsletter
- Internship/research, in which participation increased dramatically from freshman (less than a fifth) to senior/fifth years (more than two-thirds)
- Engineering society, increasing from half to three-quarters of students
- Social events: participation increased from two-fifths to two-thirds
- Engineering speaker, increasing from a third to nearly twice as many
- Career counseling
- Field trips to industry, tripling from a fifth in freshman year

- Being a tutor or a mentor to a younger student
- Working with high school students: more than doubling from a tenth to a quarter

A few programs were more likely to be used by beginning students.
- Nearly half of freshman received tutoring; the number decreased to a third by senior year
- A third of frosh had peer mentors; a quarter of students did in other years

Table 5-17
Participation in Activities by Undergraduate Year*

Activity	Year				
	Freshman (n=15,932)	Sophomore (n=12,541)	Junior (n=9,281)	Senior (n=5,156)	5th Year (n=1,390)
Received academic advising	**83.2**	**83.9**	**83.7**	**85.4**	**84.8**
Study or support group	**71.9%**	**75.5%**	**78.9%**	**83.9%**	**83.5%**
Read engineering newsletter or listserv	**53.6**	**61.6**	**71.5**	**78.9**	**77.5**
Internship/ Research experience	**17.6**	**37.6**	**57.8**	**70.3**	**68.1**
Engineering society activities (e.g., IEEE, ASME, SWE)	**48.2**	**57.1**	**68.4**	**76.4**	**73.9**
Engineering social event	**40.4**	**46.1**	**59.3**	**68.8**	**66.5**
Engineering speaker	**33.2**	**38.5**	**48.6**	**58.0**	**60.4**
Received tutoring	**47.2**	**43.3**	**34.5**	**33.1**	**28.0**
Received career counseling	**28.0**	**32.8**	**40.4**	**46.9**	**47.6**
Field trip to industry site	**18.7**	**27.5**	**42.2**	**55.7**	**57.4**
Been a tutor	**18.0**	**25.1**	**29.4**	**34.8**	**31.7**
Been a mentor or "buddy"	**11.1**	**19.7**	**25.7**	**30.8**	**28.4**
Received peer mentoring	**31.7**	**24.9**	**23.9**	**26.6**	**24.7**
Worked with outreach to high school students	**11.3**	**16.4**	**20.3**	**25.4**	**24.7**
Participated in online mentoring with a professional engineer	**6.5**	**7.0**	**8.0**	**9.5**	**6.5**

* A student's survey completed in the first year asked for reports of participation in prior years. Every survey asked for current year participation.

For each activity in which they had participated during the year prior to the survey, students were asked the reasons they participated. The most frequently cited reasons – those selected by 33% or more of student participants – are highlighted below. (The full results are listed in Appendix C-1.)

The most common reasons cited for 'Get Help' activities (Table 5-18) were reasons specific to the kind of help, learning about opportunities in engineering, and socializing with other women.

- 'Learning about opportunities in engineering' was chosen by nearly half of students as their reason to receive career counseling, and by more than a third of those receiving peer mentoring and participating in online mentoring with an engineer.
- More than a third of participants receiving peer mentoring and online mentoring with an engineer said they did so to socialize with other women in engineering.

Table 5-18
'Get Help' Activities

	Received tutoring (n=13,180)	Received career counseling (n=12,002)	Received peer mentoring (n=9,532)	Participated in online mentoring with a professional engineer (n=4,862)
Getting help with engineering coursework	First (58.2%)			
Getting career counseling or information		First(50.0%)		
Learning about opportunities in engineering*		Second (n=8325) (46.3%)	Second (n=6569) (34.9%)	First (n=4227) (37.8%)
Socializing with other women in engineering			First (35.0%)	Second (36.0%)

* 'Learning about opportunities in engineering' was offered as a choice on the 1999 and 2000 questionnaires only.

Students who participated in 'giving help' activities overwhelmingly said they did so to help others: two-thirds to three-quarters of students chose this reason (Table 5-19). About two-fifths of students who acted as a mentor or 'buddy' to newer students also said they did so in order to socialize with other women in engineering.

Table 5-19
'Give Help' Activities

	Been a mentor or "buddy" (n=6495)	Been a tutor (n=6405)
Helping others*	First (n=2040) (70.5%)	First (n=2551)* (76.9%)
Socializing with other women in engineering	Second (42.4%)	

* 'Helping others' was offered as a choice on the 2001 questionnaire only.

Students participated in engineering society activities, in particular, for many different reasons (Table 5-20). This is not surprising, since the mission of such organizations is to serve a variety of needs of engineering undergraduates.

- Students participated in engineering society activities and engineering social events in order to socialize with other women in engineering (two-thirds to three-quarters of students) and to socialize with men in engineering (almost half to two-thirds).
- 'Learning about opportunities in engineering' was an important reason for more than half of students participating in engineering society activities, listening to an engineering speaker, or taking a field trip to an industry site.
- Two-fifths of students indicated that they participated in engineering society activities in order to be in a supportive atmosphere.
- Students participated in society activities, went on field trips, and listened to engineering speakers so they could learn about an engineering topic of interest and also learn more about specific fields in engineering (two-fifths to three-fifths of survey participants).
- A third of participating students indicated that they attended talks by engineering speakers and went to engineering society activities in order to talk about issues of concern in engineering.

Table 5-20
Social and Enrichment Activities

	Engineering society activities (e.g., IEEE, ASME, SWE) (n=12,453)	Engineering speaker (n=9035)	Field trip to industry site (n=6853)	Engineering social event (n=10,165)
Socializing with other women in engineering	First (67.4%)			First (74.0%)
Socializing with men in engineering	Third (45.7%)			Second (66.4%)
Learning about opportunities in engineering*	Second (n=6632) (55.0%)	First (n=4414)* (59.7%)	First (n=3682) (56.7%)	
Learning about a topic of interest related to engineering	Fifth (39.2%)	Second (58.9%)	Third (50.7%)	
Learning more about specific fields in engineering	Sixth (37.0%)	Third (54.7%)	Second (55.8%)	
Being in a supportive atmosphere	Fourth (41.6%)			
Talking about issues of concern in engineering	Seventh (35.2%)	Fourth(33.2%)		

* 'Learning about opportunities in engineering' was offered as a choice on the 1999 and 2000 questionnaires only.

There were a number of other types of activities in which students participated, and various reasons for doing so. Students participated in a study or support group, for the most part, in order to get help with engineering coursework (more than three-quarters of students cited this reason). They also said they participated in order to be in a supportive atmosphere (nearly half), in order to socialize with other women and with men in engineering (more than a third), and in order to help others (about two-fifths).

Study or support group (n=19,629)

1. Getting help with engineering coursework (78.8%)
2. Being in a supportive atmosphere (46.2%)
3. Socializing with other women in engineering (39.3%)
4. Helping others (n=6,910)* (38.1%)
5. Socializing with men in engineering (36.0%)

* 'Helping others' was offered as a choice on the 2001 questionnaire only.

About half of students chose each of the reasons 'earning money,' 'learning more about specific fields in engineering,' and 'learning about opportunities in engineering' as why they participated in an internship. Somewhat fewer said they did so in order to learn about an engineering-related topic of interest.

Internship/ Research experience (n=14,034)

1. Earning money (53.8%)
2. Learning more about specific fields in engineering (51.5%)
3. Learning about opportunities in engineering (n=10,317)* (48.1%)
4. Learning about a topic of interest related to engineering(42.5%)

* 'Learning about opportunities in engineering' was offered as a choice on the 1999 and 2000 questionnaires only.

'Learning about opportunities in engineering' and 'learning about a topic of interest related to engineering' were both cited by more than half of students who said they read an engineering newsletter. Nearly half said that they did so to learn more about specific fields in engineering.

Read engineering newsletter or listserv (n=13,191)

1. Learning about opportunities in engineering (n=7004)* (57.5%)
2. Learning about a topic of interest related to engineering (55.8%)
3. Learning more about specific fields in engineering (47.3%)

* 'Learning about opportunities in engineering' was offered as a choice on the 1999 and 2000 questionnaires only.

Nearly half of students said they received academic advising in order to get advice about engineering. 'Getting career counseling or information' and 'learning about opportunities in engineering' were each cited by more than a third of students.

Received academic advising (n=19,541)

1. Getting advice or mentoring about engineering (45.5%)
2. Getting career counseling or information (35.7%)
3. Learning about opportunities in engineering (n=12,095)* (35.6%)

* 'Learning about opportunities in engineering' was offered as a choice on the 1999 and 2000 questionnaires only.

Students who worked with outreach to high school students overwhelmingly said they did so in order to help others (more than three quarters of participants cited this reason).

Worked with outreach to high school students (n=3,444)

1. Helping others (n=1,803)* (78.6%)

* 'Helping others' was offered as a choice on the 2001 questionnaire only.

Many students participated in SWE-sponsored programs, or in programs sponsored by the Women In Engineering program at their school, if one existed (Table 5-21). About half of students who participated in an engineering society were participating in the Society for Women Engineers (SWE). About a third of students who read an engineering newsletter, heard an engineering speaker, went to a social event, or worked with outreach to high school students were participating in SWE-sponsored activities.

Students cited the school WIE program as a common sponsor of online mentoring with an engineer (25%). WIE programs were also said to have sponsored between a tenth and a fifth of the peer mentoring (both for mentor and mentored), engineering newsletters, engineering society activities, engineering speakers, social events, and high school outreach. All of these programs were also often indicated by students to have been sponsored by SWE, at universities with or without a WIE program. Other programs like tutoring, internships and study groups, career counseling and academic advising – all activities that are often sponsored by the university, department, or classroom, or else individually arranged – still had a number of students saying that their participation was sponsored by the WIE program and/or by SWE.

Table 5-21
Engineering Activity Sponsors

Activity**	Sponsored by?*		
	WIE***	SWE	Neither or Don't know
Study or support group (WIE n=4665; else n=6906)	6.0%	6.7%	86.0%
Internship/ Research experience (WIE n=2548; else n=3717)	4.0	4.0	88.8
Received tutoring (WIE n=2775; else n=4135)	7.5	5.2	85.0
Received academic advising (WIE n=5008; else n=7444)	5.1	4.4	88.0
Received career counseling (WIE n=2404; else n=3677)	7.3	8.8	82.8
Received peer mentoring (WIE n=2014; else n=2960)	13.9	12.9	74.6
Participated in online mentoring with a professional engineer (WIE n=491; else n=635)	24.4	17.0	61.6
Been a mentor or "buddy" (WIE n=1367; else n=2038)	18.7	16.3	68.7
Been a tutor (WIE n=1639; else n=2551)	3.2	4.5	88.2
Read engineering newsletter or listserv (WIE n=4205; else n=6182)	12.6	34.6	63.4
Engineering society activities (e.g., IEEE, ASME, SWE) (WIE n=3930; else n=5815)	11.3	47.6	52.8
Engineering speaker (WIE n=3153; else n=4621)	12.6	32.9	63.6
Field trip to industry site (WIE n=2181; else n=3167)	3.7	10.3	83.9
Engineering social event (WIE n=3414; else n=5044)	15.5	40.6	58.7
Worked with outreach to high school students (WIE n=1315; else n=1805)	13.8	34.9	58.8

*Students could check more than one answer; percentages will not sum to 100%. Data reported for the 2001 questionnaire.
**Asked of and reported for only those students who participated in a given activity.
***Only asked at schools with a WIE program; percentage reported only of students from those schools. Question individualized with school's WIE program name and acronym.

To assess the value that students place on various support activities, we asked "If it were available, would you participate or participate in any of the following activities?" (Leavers were asked, "If you were still in engineering, would you participate, or participate again in any of the following activities if they were offered at your university?") As Table 5-22 shows, students who had participated in the activities previously, were much more likely to indicate that they would "definitely" or "probably" participate again in the activity than those who had not participated. For 11 of the 18 activities over 90% of the prior participants responded that they would "definitely" or "probably" participate again. The remaining 7 activities were also viewed positively by their participants – for 5 activities 80-90% responded favorably, and the last two garnered support by 70-80% of students who had participated previously. Especially worth noting is the extremely positive response to the internship/research experience.

Table 5-22
Likelihood of Participating or Participating Again in Activities by Previous Participation (n=5,725)*

Activity	Definitely		Probably		Probably not		Definitely not	
	Partici-pated	Didn't part.	Partici-pated	Didn't part.	Partici-pated	Didn't part.	Partici-pated	Didn't part.
Study or support group	67.1%	11.1%	26.7%	42.9%	5.5%	38.5%	0.6%	7.5%
Internship/ Research experience	87.2	63.4	11.0	30.8	1.3	4.5	.6	1.3
Received tutoring	51.2	10.3	38.8	39.2	9.4	44.7	.7	5.9
Received academic advising	52.9	15.7	39.8	48.8	6.1	29.2	1.2	6.3
Received career counseling	56.5	32.1	37.0	47.3	5.6	17.7	.9	2.9
Received peer mentoring	45.0	16.3	41.5	36.9	11.8	40.3	1.7	6.5
Participated in email mentoring	35.0	8.7	42.7	32.7	20.0	48.3	2.3	10.2
Been a mentor or "buddy"	43.4	43.5	45.7	46.2	9.4	34.0	1.5	6.4
Been a tutor	44.1	10.0	45.6	40.1	8.9	41.8	1.4	8.2
Read engineering newsletter or listserv	40.9	8.1	50.1	39.7	8.0	42.9	1.0	9.4
Engineering society activities (e.g., IEEE, ASME, SWE)	60.8	18.2	33.4	48.9	5.2	28.0	.6	5.0
Engineering speaker	41.7	11.8	50.1	43.1	7.6	36.9	.5	8.1
Field trip to industry site	58.5	30.2	35.5	48.8	5.7	18.3	.3	2.7
Engineering social event	45.2	13.5	45.9	43.9	7.9	35.7	1.0	6.9
Participated in engineering orientation	33.7	13.4	48.1	45.0	15.8	35.8	2.4	5.9
Worked with outreach to high school students	52.8	18.2	41.8	47.2	4.9	29.9	.5	4.7
Lived in engineering dorm	45.7	6.0	27.1	15.7	16.8	41.4	10.3	36.9
Engineering retreat	46.5	9.6	40.6	33.9	10.8	39.7	2.0	16.8

* Data collected from the 1999 survey.

Considering the many influences on students' decision about which college to attend, a surprising number – nearly a third – of students who attended schools with WIE programs said they were influenced in their decision by the presence of support programs for women in engineering on campus (Table 5-23).

Table 5-23
Extent to which Students' Decisions to Attend their College were Influenced by the Presence of Support Programs for Women in Engineering (n=15,464)

Highly influenced	**4.2%**
Moderately influenced	**10.7**
Slightly influence	**15.4**
Not at all influenced	**69.7**

Reasons Students Enter or Leave Engineering

On the web based survey, participants continuing in engineering were asked to explain their three most important reasons for wanting to become an engineer and those who were leaving were asked the three most important reasons for leaving engineering. This question was one of only two open-ended questions on the survey. Using constant comparative analysis, a coding scheme was developed to categorize each response into one of nine response categories, and from there into one of up to ten sub-categories. The range of responses for students continuing in engineering is summarized in Table 5-24 below. 'Percent of students choosing' represents the percentage of students who mentioned a given reason category at least once in the their three reasons. 'Percent of responses' shows the number of responses (each of the three reasons per student counting once) that were coded as a given reason for choosing engineering as a major.

Table 5-24
Reasons Given by Women Students for Wanting to Become an Engineer*

Reason	Percent of students choosing (n=9,071)	Percent of responses (n=26,566)
Future job characteristics	**68.4%**	**31.4%**
To get a good salary	44.6	15.2
There are plenty of job opportunities	24.8	8.5
Overall a good job/career/salary	9.6	3.3
To have job security	5.2	1.8
To prepare myself for a specific job / goal	1.9	0.6
I like the engineering work environment	1.5	0.5
It's an honest / respectable profession	1.3	0.4
Women / minorities have good opportunities	1.2	0.4
I like engineers / like to work with engineers	1.1	0.4
I can do the work while raising a family	0.8	0.3
Interest in engineering content / process	**57.7%**	**23.6%**
It interests me	26.1	8.9
I like math / science / technology	17.2	5.9
I like problem-solving / analyzing	7.4	2.5
I like my specific major / field	5.6	1.9
I like hands-on work / building / design	5.0	1.7
I like to know / figure out how things work	2.5	0.9
I like practical applications	2.1	0.7
I like computers	2.0	0.7
I like working on a team	1.3	0.4

Personal fulfillment	**46.0%**	**18.6%**
It challenges me	20.4	7.0
I enjoy it / it is self-fulfilling	11.4	3.9
I am good at it	7.8	2.7
I'm good at math and / or science	6.3	2.2
Engineering is exciting / always developing	2.8	1.0
Satisfies my diverse interests / not boring	2.2	0.7
I want / have always wanted to be an engineer	1.6	0.6
I'm constantly developing new skills/ learning	1.2	0.4
My skills will be useful in many ways	0.6	0.2
I'm good at working with others	0.1	0.0
Work that the student wants to do	**20.2%**	**7.8%**
To help people / contribute to society	6.6	2.3
To do engineering work	5.2	1.8
To do work that is important	2.6	0.9
To design things / build things	2.0	0.7
To work on the space program	1.6	0.5
To help the environment	1.5	0.5
To do research / be at the cutting edge	1.3	0.4
To work with / develop technology	1.1	0.4
To do work that is real / concrete	0.8	0.3
To improve some aspect of engineering	0.2	0.1
Pride and achievement	**16.4%**	**6.1%**
To be respected for my achievements	5.2	1.8
To prove that I can do engineering	2.8	1.0
To achieve something worthwhile	2.3	0.8
To be a role model for women	1.5	0.5
To be different from other women	1.3	0.4
To prove that women are as good as men	1.1	0.4
To be successful	1.2	0.4
To be one of few women in engineering	1.0	0.4
The challenge of succeeding as a minority	0.7	0.2
I'll have many opportunities for advancement	0.5	0.2
Reasons external to engineering	**13.3%**	**4.9%**
This degree will be helpful in many careers	7.2	2.5
To help me get into grad school / med school / business / patent law	2.3	0.8
Nothing else interested me	2.1	0.7
I don't like / not good at other majors / fields	1.5	0.5
It's too late to quit now	0.6	0.2
Other external reason	0.2	0.1
The major I'm really interested in is too risky	0.1	0.0
I was accepted into the department	0.1	0.0
No reason not to	0.0	0.0

The influence of others	**10.1%**	**3.6%**
My parent(s) / family influenced me	3.8	1.3
Other people encourage me	2.0	0.7
My parent is an engineer	2.0	0.7
I know other engineers	1.0	0.3
To make my parents / family proud	0.7	0.2
A pre-college experience influenced me	0.4	0.1
Want to be with engineering friends	0.3	0.1
I was told I should be an engineer	0.3	0.1
Religious reasons	0.1	0.0
School program	**8.7%**	**3.1%**
I like the training / education I'm getting	5.0	1.7
I like my engineering classes	1.6	0.5
I have scholarships / other financial incentive	0.7	0.2
I had a good work / co-op experience	0.7	0.2
My school has an excellent program	0.5	0.2
A good / practical major: less time in school	0.4	0.1
A good overall experience in school	0.3	0.1
School climate	**2.3%**	**0.8%**
I like the competition	0.9	0.3
I enjoy working with men	0.5	0.2
I like the community in my department	0.5	0.2
I like the atmosphere of my department	0.2	0.1
I like the faculty & staff in engineering	0.1	0.0
I'm supported by my department / professors	0.1	0.0
My department supports women / minorities	0.0	0.0

* The total number of responses is larger than the number of students responding because each student could give up to three responses, but it is not three times larger because students sometimes gave fewer than three responses. This also means that the number of students choosing a reason in each one of the nine categories is fewer than the number of responses in that category.

- Students most often cited characteristics of an engineering job as a reason for entering engineering.
  "It pays well. I will be able to make enough money to support my family and me."
  "Jobs are plentiful." "Engineers are in high demand."
  "Good pay/benefits/regular hours for a job I will enjoy."
- Well over half of the responding students said they wanted to become an engineer because of their interest in some aspect of engineering.
  "[I] find the field very interesting." "I am interested in the subject matter."
  "I like science and math. I think they are interesting subjects."
  "I like to solve problems and think through practical situations."
  "I like to take things apart and put them back together."
- Almost half of respondents mentioned that they found engineering somehow personally fulfilling: that they found it enjoyable or satisfying, or they believed they had skill in or talent for engineering.
  "I love a challenge." "It requires more thought and less memorization and will keep me mentally challenged for the rest of my life."
  "I get great sense of satisfaction and pride from the work I do." "I think engineering is fun." "I enjoy it." "It is a rewarding field."
  "[I] wanted to use some of my talents." "I am good at it." "I believe I can make a contribution in this field."

- A fifth of students wrote that they wanted to become engineers because they wanted to do engineering work.
  "To solve difficult problems that will benefit people, or just one person even."
  "The work is exciting to me." "I'll have fun in this career." "The work that I'm doing in the engineering field fascinates me."
  "I want to make a difference in the world around me." "I want to do something important."
  "I want to be involved with designing/building of a bridge." "I want to make things."
  "I want to work for NASA." "I want to be an astronaut." "To build on the moon."
  "I want to help the environment." "Making the water and sewer systems of this country better."
- About a sixth of students wrote about wanting to be successful, to prove themselves, be a role model, or prove that women are capable of being engineers.
  "Engineers get respect." "Credibility." "I like the prestige."
  "To prove to myself that I can do it." "To prove that I can to people who don't believe that I can."
  "I want to be able to accomplish something as great as making it through engineering."
  "To help more women have a better chance in the field." "[To] encourage others, i.e. be a role model."
  "Prove to myself and others that women can do the jobs that men can do."
- Reasons external to engineering itself were cited by more than a tenth of students. Most of these students mentioned they liked how the engineering degree would be useful for entering almost any field; some mentioned they were specifically using engineering to help them in their planned medical, business, or law degree. Still others said they didn't like other fields, or didn't know what else to do.
  "Great educational background for nearly any career." "Can go from engineering to other fields, but not vice versa."
  "Good undergrad degree for law school (patent law)." "[It] will be easier to get into medical school with an engineering major."
  "[My] dislike for liberal arts." "I love not having to read novels and write research papers."
  "I don't know what else I want to do."
- A tenth of respondents mentioned that others encouraged them to become engineers, or that they know engineers.
  "My parents encouraged me." "Father says it is the smartest thing to do."
  "Adult friends encouraged me."
  "I want to be able to work with my dad." "My parents are both engineers."
  "I want to follow my uncle's footsteps."
- The school's program or school climate were mentioned by about a tenth of students. Students mentioned their satisfaction with their education, enjoyment of classes, enjoyment of competition in the department, scholarships, student community, and other reasons pertaining to their school.
  "I want to learn the thinking process of an engineer." "To get a well rounded education."
  "Because I enjoy the classes." "The courses interest me."
  "The competitve atmosphere of engineering drives me to work harder." "I enjoy the competitiveness."
  "Scholarships." "The engineering department offered me a lot of money."

"I love how my peers are so supportive of each other 'cause we all know how hard the engineering curriculum is." "I like the people in the major."
"I have had positive experiences in my summer internships."
"I love working in a male dominated environment. I relate to men easily."

Students who indicated they were leaving engineering were asked to cite the three most important reasons for why they had decided to leave engineering. A different coding scheme was developed for leavers' answers than for stayers', though many questions & categories were similar. Leavers' responses are summarized below (Table 5-25). Leavers were more likely to cite lack of interest and problems with school as reasons to leave, as well as external interests, where stayers tended to cite job, work, self-fulfillment, and interest as reasons to stay.

Table 5-25
Reasons Given by Women Undergraduates for Leaving Engineering as a Major*

Reason	Percent of students choosing (n=839)	Percent of responses (n=2417)
Lack of interest in engineering content / process	**53.9%**	**21.3%**
It doesn't interest me (any more)	44.9	15.6
I'm not interested in math / science work	6.0	2.1
I want to do something more people-centered	5.8	2.0
Engineering is not like I thought it would be	1.9	0.7
I prefer more creative / artistic thinking / work	1.2	0.4
I didn't like my specific major	1.0	0.3
Too narrow	0.5	0.2
School program	**49.8%**	**22.4%**
Takes too much time / energy to become an engineer	15.5	5.4
I was overwhelmed by the workload	11.9	4.1
Classes are too hard / pace too fast / easier in other field	10.8	3.8
I didn't enjoy my classes / poor class atmosphere	7.9	2.7
Poor teaching	6.0	2.1
I didn't like my curriculum / education	5.0	1.7
Problems with / bad experience in a specific class	2.6	0.9
Classes irrelevant to major / too much memorization	2.3	0.8
Bad overall experience in school / engineering program	1.7	0.6
Bad / uninteresting co-op experience	0.8	0.3
Reasons external to engineering	**37.2%**	**14.5%**
I like another major / field better	34.7	12.0
Other external reason	3.8	1.3
Doesn't suit / wont help my post-college goals	1.9	0.7
I'm better in non-technical fields	1.3	0.5

School climate	**30.8%**	**13.0%**
Major too competitive / too stressful	9.4	3.3
I didn't feel supported by my department	6.1	2.1
The faculty & staff in my department were unhelpful / discouraging	4.9	1.7
I didn't like my engineering department environment / atmosphere	3.9	1.4
I didn't like my peers / lack of community	3.5	1.2
Bad experience with / discouraged by a specific faculty member	3.5	1.2
Major too impersonal / didn't feel like I belonged	2.9	1.0
I dislike the lack of women peers / faculty	1.5	0.5
I was discriminated against / singled out as a woman / harassed	1.5	0.5
I was sexually harassed at my co-op	0.2	0.1
Personal fulfillment	**27.3%**	**10.6%**
I didn't enjoy it / no longer passionate about it	15.4	5.3
I'm not good at it / feeling I'm not smart enough	8.5	2.9
Took away from my other interests	5.7	2.0
It made me unhappy	0.8	0.3
Pride and achievement	**26.9%**	**10.2%**
Bad grades	20.7	7.2
Difficulty with the mathematics	3.3	1.2
I'm not well prepared	2.4	0.8
Difficulty with non-engineering science	1.4	0.5
My poor grades didn't reflect my knowledge / skills / effort	1.3	0.5
My achievement went unacknowledged / unappreciated	0.2	0.1
Future job characteristics	**17.9%**	**6.8%**
I don't like it as a career	12.3	4.3
I wanted a less demanding career / time for family	2.9	1.0
I don’t like the engineering work environment	1.4	0.5
Poor job options / hard to get a good job	1.3	0.5
I don’t like engineers	0.7	0.2
Money / other compensation not good enough reason to stay	0.6	0.2
Salary would not be what I hoped	0.4	0.1
Working mothers don't get fair treatment in engineering	0.1	0.0
The influence of others	**2.9%**	**1.1%**
I was discouraged by others	1.0	0.3
Too much pressure to succeed / my parents were pressuring me	0.7	0.2
Others encouraged me to switch	0.7	0.2
No one encouraged me	0.5	0.2
Discouraging attitudes towards women	0.2	0.1
Work that the student wants to do	**0.6%**	**0.2%**
Couldn't see how what I was doing would be useful	0.2	0.1
I don’t approve of what engineers do	0.4	0.1

* The total number of responses is larger than the number of students responding because each student could give up to three responses, but sometimes gave fewer than three. This also means that the number of students choosing a reason in each one of the nine categories will be fewer than the number of responses in that category.

- More than half of students said their lack of interest in the content or processes of engineering led them to leave engineering.

  "Lack of interest in engineering topics." "No longer an interest to me."
  "Physics and calculus classes were boring." "I no longer enjoy math and science courses."

"[I] wanted to help people." "It isn't a very social job (not the type of self gratifying work that I'm looking for)."

- Half of students cited issues with the school program as reasons for leaving.
  "The classes were very time consuming." " No Life – Too much homework."
  "Instead of being challenged, I was overwhelmed by the amount I had to not only learn, but understand in my classes."
  "Too many hard classes." "I was discouraged by the pace of the coursework."
  "Staleness of topic/classes." "Don't get enough personal attention in the classes."
  "Poor teaching quality of the faculty." "Teachers were boring." "Non-English speaking teachers."
  "Too many requirements." "Lack of basic courses, variety of courses."
- More than a third of respondents mentioned reasons external to engineering; most of these said that they had found another major they preferred over engineering.
  "I found another major that I prefer." "Decided I like economics a lot better."
- The school climate was a reason to leave for almost a third of respondents.
  "Competition was far too intense and stressful."
  "Not enough support." "Lack of tutorials."
  "Lack of support from faculty and professors." " The faculty was very impersonal."
  "Engineers are more interested in money than anything else it seems, lots of boys clubs."
  "The last professor that I had, wrote inappropriate comments on students exams (both male and female). It is harder to learn any subject when your intelligence is being insulted." "My advisor was poor and discouraging."
  "No one cares whether any student, male or female, makes it through."
- More than a quarter of students cited a lack of personal fulfillment as a reason to leave engineering.
  "I just didn't like it any more." "The teacher talked about having a passion for the subject, and I realized that I did not, so I left the major."
  "I never really knew what I was doing in my lab classes. I felt really stupid."
  "It is almost impossible to explore other educational possibilities and stay on track for the engineering program."
- About a quarter of students said they weren't achieving well enough in engineering to continue.
  "Poor grades, very discouraging." "Grades- able to get better grades in other subjects."
  "The math was too much for me."
  "Though the Engineering Projects class was fun and I earned a B+ I was very ill-prepared since I had no concept of certain things that all the males in my class seemed to understand extremely well."
- About a sixth of students said they didn't like some aspect of having a job in engineering. Most of these said they didn't want engineering careers.
  "Lack of interest in career prospects." "Working as an engineer would be too boring of a lifestyle."

NON-RESPONDENT BIAS SURVEY RESULTS

To establish whether student respondents and non-respondents differed significantly, the WECE staff conducted a non-respondent bias questionnaire. We contacted 125 non-respondents who had already received the invitational email and four reminder messages and asked them again to complete the survey. Eighty-two of those students partially or completely finished the questionnaire, yielding a 66% response rate. (Eight students wrote back that they declined to participate, while the others did not respond at all.)

The non-respondent sample was randomly chosen from the population of students who either had not started or had refused to complete the survey in 1999 or 2000. In addition, only students from schools finishing their spring semester in June were sampled, because the non-respondent sample was contacted late in the year, after the main round of data collection in the spring of 2000.

Our analysis indicates that the non-respondent sample responses mirror the population of respondents, suggesting that our conclusions based on the original sample may be trusted. Although leavers were more numerous in the non-respondent sample than in the full sample (an expected result), we found that neither the leavers nor the stayers in the non-respondent sample differed from their counterparts in the full sample on any of the variables we investigated. Students were compared on the following characteristics:

- Student Background: Race/ethnicity, high school science/math course taking, SAT/ACT scores, and after school/summer activities in high school

- High School Background: Sector (public, private, parochial, homeschooled), coed status, size, and location

- Attitudes: Considered leaving engineering, commitment to engineering as a major, self confidence change since enrollment, self-assessment of factors encouraging and discouraging the pursuit of engineering as a major, attitudes about engineering (for example gender bias), and perspectives on gender comparisons

- Participation: 'Frequency of participation in Social Enrichment' scale, 'Get Help' scale, 'Give Help' scale, study group, research/internship activities, and the number of engineering classes taken

- Other: Year in school, WIE status of college, part-time status, finish/not finish, survey, leave of absence status, and leaver status

Results of Non-respondent Survey

- A greater proportion of non-respondents (16.3%) than of respondents (8.1%) reported leaving engineering. This is not surprising given the difficulty we encountered in attracting leavers to complete the questionnaire or even read the invitational email. Even though the invitational message clearly articulated that the study was interested in the perspectives of any student who had ever considered a major in engineering, whether or not she had subsequently left engineering or was still pursuing a major, we still received a number of email messages from students who wrote that they were not eligible for the study because they had left engineering or that they "did not want to participate in a study about engineering because they were no longer in engineering." Over the course of the study we continually revised the email messages to try to encourage leavers to participate in the research, because their responses were of particular interest. However, many women, once they had left engineering, simply were no longer interested in, or willing to participate in, a study that focused on their experiences in engineering.

- First-year students are underrepresented and fifth-year students are slightly over represented in the non-respondent sample: only 7 first-year students were in the non-respondent sample (8.8%), whereas first-year students composed 24.3% of the respondent sample. Ten fifth-year students composed 12.5% of the non-respondent sample, whereas only 8.9% of the respondent sample was fifth-year students. The non-respondent sample also included 21 sophomores (26.3%), 19 juniors (23.8%), and 23 seniors (28.8%).

- On average, non-respondents had taken more engineering classes than had respondents (2.4 more classes on average). However, this is fully explained by the under representation of freshmen in the non-respondent sample.

Part-time students made up 13.2% of the respondent sample and 25.3% of the non-respondent sample.

- Non-respondents were more likely to report the teaching in engineering and their lack of interest in engineering as factors discouraging their pursuit of engineering as a major. This may be related to the overrepresentation of leavers in the non-respondent sample.

Another critical finding is that coefficients from predictive models constructed using only the non-respondent sample do not differ statistically from the coefficients estimated from the full sample, although due to the comparatively small size of the non-respondent sample (n=82), the estimates obtained are much less precise than for the vastly larger sample of original respondents. In general, other researchers have found that, while respondents and non-respondents may differ on some characteristics, relationships hold reasonably well across the samples overall.

Discussion of the Non-respondent Survey

The respondent and the non-respondent samples differ in two significant areas. First, non-respondents were more likely to have left engineering than respondents. A possible explanation is that leavers are more likely not to have responded to the survey in the first place. The second significant difference is that non-respondents were more advanced in their education than were respondents. There is a lower proportion of first-year students and a higher proportion of fifth-year students in the non-respondent sample. There is no obvious explanation for this, as the non-respondent group of students was randomly selected and all students in the population were diligently and repeatedly contacted. One possible explanation is that upperclasswomen have had more time to leave engineering and therefore are more likely to be leavers, and are therefore more likely to think they were not eligible and thus did not respond to the regular questionnaire. An alternative possible explanation is that more advanced students are not as compliant as underclasswomen and/or perhaps were not as enticed by incentives or were busier than less advanced students.

These two areas of difference are important because leaver status and year in college are related to numerous other factors. Leaver status, for example, is related to feelings of commitment and perceptions of encouragement and discouragement. The difference in part-time status is also likely related to the overrepresentation of leavers: a higher proportion of part-time students than full-time students leave the major.

Once the differences in leaver status and year in school are considered, it is safe to assume that on all significant areas of interest, the respondent and the non-respondent samples are essentially identical. Since most of our analyses separately consider stayer and leaver populations, these analyses should not be affected by the low proportion of leaver respondents.

SUMMARY

Before college, students participated in many classes, contents, summer programs, and workshops in engineering. Their SAT and ACT scores, particularly in mathematics, were higher than the national average. Many had parents, particularly fathers, who worked in engineering, or they knew an engineer who influenced their decision to choose engineering for their college major. Most students decided they wanted to major in engineering before they entered college.

Once in college, undergraduate women found that their chosen major was both challenging and time-consuming. Nearly half of the senior and fifth year respondents to our survey reported that they had seriously considered leaving engineering at some point in college. The most commonly cited discouraging factors were grades, the amount of time required for coursework, the quality of teaching in engineering, and their flagging interest. Maintained interest, parents, employment opportunities, and college peers were most encouraging to students. Despite discouragement and challenges, well over 80% of students said they would encourage other women to major in engineering. A similar number of seniors expected they would be working in engineering seven years in the future. Students entered engineering because of engineering job characteristics, interest in the content and process of engineering, personal fulfillment, the work they were interested in doing, and pride in their achievements. They most often left because of disinterest, disenchantment with their school's program including grading and workload, interest in a different major, the school climate, lack of personal fulfillment, and a poor sense of achievement.

Upperclasswomen were more likely to participate in engineering support programs than were underclasswomen; programs more likely to be used by freshmen were peer mentoring and tutoring. Students participated in support programs with various sponsors; those who attended schools with WIE programs participated in programs like mentoring, social events, and outreach that were often sponsored by the WIE program or by SWE. Students who participated in support programs almost always said they were likely to participate again, if the program were offered again. Even those who had never participated in support programs indicated that they were likely to participate if the program were available, especially in internships, career counseling, mentoring, and industry field trips. More than half showed at least some interest in participating in most of the programs we asked about.

Chapter 6: Results of Student Questionnaire - Multivariate Models

This chapter presents the results of our analysis using multivariate models with the student dataset. It begins by summarizing the definitions of the various scales and variables the WECE researchers created, describes our analysis of institutional characteristics that predict student participation in support resources and activities, then provides hierarchical linear models and event history models and discussion of their results.

CONSTRUCTION OF SCALE VARIABLES

Statistical analyses of the individual variables in the student questionnaire were conducted to determine their clustering into larger thematic units. These analyses produced seven scales: Self Confidence Change, Contentment, Perception of Classroom Environment, Perception of Department Environment, Participation in Social Enrichment Activities, Participation in Get Help Activities, and Participation in Give Help Activities. These constructed scale variables were then used in our multivariate models.

To construct scale variables we used the following procedure:
1. Identified candidate variables from the student questionnaire for constructing scales.
2. Grouped questions by theme, for example, grouped all variables that asked about self confidence. These groups were the candidate scales, constructed to have strong face validity.
3. Ran reliability analyses on all candidate scales, weeding out variables that the item-total statistics indicated did not fit and that could be reasonably construed as different from the other items in the candidate scale.
4. Compared all reliability analyses and made decisions when items were represented in multiple scales as to which scale fit the item best. This was accomplished by generating more sets of candidate scales where each item was used only once in the set.
5. Ran reliability analyses on the sets of candidate scales and decided which set to keep based on highest overall alphas and on "best fit" in terms of whether scales represented clear concepts (had strong face validity).
6. Ran principal component analysis on each of the chosen scales to further ascertain whether each scale represented a unitary concept.
7. Ran confirmatory factor analysis (RAMONA) on the groups of candidate scales (for example, all of the ability scales) and tested the scales against each other to see if they were significantly different from each other. Although our large sample size yielded highly significant differences between models the confirmatory factor analysis did provide some information about redundant indicators, which led us to discard a few candidate scales.

Table 6-1 describes the scale variables used in this analysis.

Table 6-1
Scale Variables Used in the Analysis

Name	Description
Perception of Department Environment	A 36-point composite variable consisting of six survey items that asked respondents whether certain elements of their department encouraged or discouraged their pursuit of engineering. Elements included in the composite are: teaching, school size, overall department atmosphere, faculty, peers, and their advisor.
Perception of Classroom Environment	A 24-point scale composed of four survey items that asked whether classroom-related elements of women's experience encouraged or discouraged their pursuit of engineering. This composite included questions on grades, time required for coursework, classroom competition, and pace of classes.
Contentment	An 18-point scale composed of three survey items that asked about interest in engineering and the student's happiness with her choice of an engineering major.
Self Confidence Change	A 24-point composite variable composed of four items: student-rated changes in self confidence in math abilities, science abilities, engineering abilities, and overall academic abilities.
Participation in Social Enrichment Activities	A 16-point scale composed of four survey items measuring the frequency of participation in engineering activities of a social and/or enrichment nature. Included in this scale are field trips, guest speakers, engineering social events, and engineering society events.
Participation in Get Help Activities	A 16-point scale composed of four survey items measuring frequency of participation in activities in which women received help from others through such programs as tutoring, peer mentoring, career mentoring, and email mentoring.
Participation in Give Help Activities	An 8-point scale composed of two survey items measuring frequency of participation in programs in which students helped other students – in this case mentoring and tutoring.
Overall Participation	A 40-point scale that is the sum of the Get Help, Give Help, and Social Enrichment participation scales: it includes all activities that compose the three scales.

METHODS OF MULTIVARIATE ANALYSIS

One very important characteristic of data collected from students at multiple college campuses is that students may differ in their characteristics as well as their outcomes, both as a function of who they are as individuals (e.g., math SAT scores, grades in engineering classes) and in ways that are related to their institution (e.g., selectivity). For decades, studies of education at all levels faced what was known as the "unit of analysis problem."

Specifically, when studying the effects of individual student characteristics on student outcomes, the unit of analysis was taken to be the student, while in situations where an institutional feature or policy was of interest, the school itself was treated as the unit of analysis and student data were aggregated to the institutional level. It is now well-known that both these approaches are flawed and can produce biased estimates of standard errors and can mask real effects by aggregating individual data to the institutional level (e.g., Bryk & Raudenbush, 1992; Goldstein, 1995).

For the last 15 years, the use of hierarchical, or multilevel, models has addressed these problems when subjects are grouped together within institutions (or at other levels, e.g., classrooms). Applications of such models in higher education (e.g., Civian & Brennan, 1996) have been less frequent than in studies of education at lower grades. The WECE data analysis relies primarily on hierarchical methods. In all models, the top level is the institution.

Cross-sectional Analyses

An additional advantage to the hierarchical linear model is that it allows for a multiple outcomes structure. A single outcome, such as program participation, can be modeled simultaneously for different groups. In the WECE analysis, attention was focused on differences between those who left engineering and those who persisted in engineering. In addition, differences across years of school on outcomes such as participation, self confidence, and perceptions of environment were analyzed.

Using the multiple outcomes approach it is possible to determine if and how groups differed on these measures. In the WECE analysis this method is used not only to test simple differences in the cross-sectional analysis, but in the more complex linear growth models and in the nonlinear survival models. Few other approaches allow for this kind of flexibility. With the former it is used to test whether leavers and stayers participate at different rates in support activities across years of schooling and to assess whether the impact of participation on critical outcomes such as self confidence growth varied across years. With the latter, the multiple outcomes approach is critical for establishing the difference in the hazard rates across years (Barnett, Marshall, Raudenbush, & Brennan, 1993; Brennan, Kim, Wenz-Gross, & Siperstein, 2001; Raudenbush, Brennan, & Barnett, 1995; Supovitz & Brennan, 1997).

Longitudinal Analyses

The WECE study relies on an overlapping cohort design (also known as an accelerated longitudinal design). The advantage of the overlapping cohort design is that it allows the use of all available data from multiple cohorts even though some cohorts were no longer eligible for inclusion in the sample (e.g., graduated) and other cohorts were added to the sample (e. g., frosh who entered an engineering program after the initial data collection wave). As compared with a traditional longitudinal design that follows one or more cohorts from time of entrance in a program until the time the cohort exits the study, the overlapping cohort design allows for the economical inclusion of partial cohorts.

Many threats to valid inference can be eliminated when multiple data points are collected from the same individuals over time. In particular, two longitudinal methods will be used in analyzing the data from WECE and its continuation.[1]

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[1] Neither HLM growth models nor event history models determine causality in the relationship between predictor and outcome variables. In discussing our findings and in keeping with current practice in statistics, we have adopted the terms “mediate”, “moderate”, and “predict” as terms that denote non-causal relationships of predictors and outcomes.

Growth Models

The first method, growth (curve) modeling, was employed as a means of modeling individual outcome variables (e.g., commitment to engineering) as they change over time as a function of individual and institutional predictor variables, each of which may be time-invariant (e.g., math SAT score) or time-varying (e.g., the proportion of students enrolled in engineering who are female). With three waves of data for analysis, we undertook longitudinal analysis (growth modeling) using three-level models, wherein multiple time points clustered within individuals are modeled at level one (including time-varying covariates), student characteristics that are time invariant are modeled at level two, and time invariant institutional variables are modeled at level three.

Creating a growth model in which time points are seen as being clustered within individuals at level one of a hierarchical model has several benefits over competing strategies. Most significantly, when the growth model is conceptualized as a multilevel model, the data need not be balanced with regard to the number of time points available for each subject or even the spacing of the time points (e.g., it is possible to use data from a student who responded in her first year, and then again in her junior year, skipping both sophomore and senior years). In fact, it is the availability of the hierarchical approach to growth modeling that makes the use of our overlapping cohort design practical.

Event History Models (Survival Analysis)

The second longitudinal analysis method to be used on the WECE II data is event history analysis (also referred to as "survival analysis" or proportional hazard modeling). This is a set of analytic techniques specifically developed to address the problem of censoring: where data may not be available at every time point for every subject. Event history analysis allows the use of data from cohorts with students who have not yet graduated, as well as cohorts where we have no data from freshman year. Originally used to examine clinical lifetime data (i.e., how long patients survive after treatment or diagnosis), event history analysis is now used in social science research to predict the probability of a particular event occurring.

Because WECE data are gathered in annual collection waves, they demand analysis using a discrete time model (i.e., one in which the "failure" – in our instance dropping out – has occurred between two of the data collection waves). The ability to use the data from students who have neither graduated nor dropped out of engineering without producing biased estimates means that all the WECE data can be used, thus maximizing the statistical power and producing more precise estimates. The use of multilevel modeling as an approach to event history analysis has become practical as multilevel modeling software (e.g. HLM) has been improved to handle nonlinear modeling. A Bernoulli model (analogous to logistic regression) is used to predict dropout from engineering (Reardon, Brennan, & Buka, 2000; Reardon, Brennan, & Buka, in press).

RELATIONSHIP OF INSTITUTIONAL GRADUATION RATES TO PERSISTENCE, PERCEPTIONS, AND PARTICIPATION

We wanted to see whether any of our measures were related to the institutional graduation rate. Unfortunately, we were unable to obtain consistent and reliable figures from each school on their enrollment and graduation numbers for women undergraduates in our study. Instead, we calculated the graduation rate from each school from enrollment and graduation numbers in the IPEDS database[1] (Graduation Rate = (Number of Degrees Given to Females + Number of Degrees Given to Males) / Number Enrolled).

This has two unfortunate side effects: first, the number enrolled and the number of degrees given in the IPEDS database are from the same year, and therefore they are for different cohorts of students. Second, the latest IPEDS database we had available was collected in a year before the WECE project began collecting data. We have to assume that enrollment and graduation rates remained fairly constant over the years of the study. Further research could collect longitudinal figures on enrollments, dropouts, transfers, and graduation in depth: the scope of the work required to get reliable numbers for the years of our study was beyond the reach of the WECE project.

Keeping those restrictions in mind, we tested the association between Institutional Graduation Rate and school level averages of the scales (Table 6-2): Self Confidence Change, Perception of Classroom Environment and Department Environment, Overall Participation in Support Activities, Participation in Get Help Activities, and Participation in Social Enrichment Activities. We found that graduation rate is positively associated with Perception of Department Environment – as the graduation rate rises so do perceptions of the engineering department environment. Graduation rate is negatively associated with change in self confidence. As a school's graduation rate rises, the average change in self confidence becomes more negative. These relationships do not meet the standard $p < 0.05$ level of statistical significance. However, they are at least statistically interesting at $p < 0.1$.

Table 6-2
Pearson Correlations Between Institutional Graduation Rate and School Level Measures

	Self Confidence Change	Perception of Classroom Environment	Perception of Department Environment	Overall Participation	Participation in Get Help Activities	Participation in Social Enrichmt Activities
Pearson Correlation	.277	-.036	-.260	.003	-.161	-.057
Sig. (2-tailed)	.075	.823	.096	.986	.307	.720
N[1]	42	42	42	42	42	42

[1]For six schools we had insufficient date to calculate this variable. Five schools were dropped from the analysis because their calculated graduation rates were problematic.

[1] The Integrated Postsecondary Education Data System (IPEDS) is described in Chapter 3 above.

We also tested other institutional variables. We did not find an association between an institution's graduation rate and school selectivity or size. However, in universities where engineering students comprise a larger percentage of the undergraduate population the engineering graduation rate is higher ($p<.05$). We found no graduation rate difference when testing by whether a school does or does not have a WIE program; however as some programs began quite recently they may not have had time to have any effect. Institutional Graduation Rate had no significant effect on the risk of a student leaving or staying in engineering within that school, as calculated by event history analysis.

THE EFFECTS OF INSTITUTIONAL CHARACTERISTICS ON PARTICIPATION

We conducted an institutional analysis to explore whether institutional characteristics had any effect on women's participation in support resources and activities. Analysis utilized 3-level HLM that considered participation and institutional characteristics. The models also controlled for a student's year in school.

Table 6-3 demonstrates that whether a school has a formal WIE program or not has no effect on women's frequency of participation in Social Enrichment, Give Help, or Get Help support programs and resources. Many non-WIE schools offer a complement of support resources and activities for women engineering students that is similar to those offered by WIE schools. Whether or not such activities are included under the umbrella of a formal WIE program does not appear to influence students' participation.

Neither the size of the engineering program at the college or university, nor the size of the undergraduate engineering program, nor the percentage of engineering students who are undergraduates at the college or university has any effect on women's participation in Social Enrichment, Give Help, or Get Help. This suggests that size of the engineering program does not significantly impact a woman's decision to participate in support activities. One might, for example, assume that women in bigger programs might seek out support programs as a way to establish connections in the department and avoid anonymity. On the other hand larger programs probably have more women (although not necessarily a higher percentage).

The only institutional level variable that was significantly related to women's participation in some types of support programs was institutional selectivity. In more selective schools mean participation in Social Enrichment activities is 0.75 points higher than in less selective schools and participation in Give Help activities is 0.155 points higher than in more selective schools than less selective schools. There is no difference in participation in Get Help activities between schools of different selectivity levels.

A number of variables might explain the differences in participation. For example, more selective schools may have more resources and thus be able to offer more or a wider array of programming opportunities that match students' interests. Or the students enrolled in the most selective schools may be better able to manage their time (or have more available time) and thus participate in more activities. The difference in Give Help might be linked to differing college environments as they pertain to outreach and community service.

Table 6-3
Effect of Institutional Characteristics on Participation

N=52 schools*	Social Enrichment	Give Help	Get Help
WIE Status	No Effect	No Effect	No Effect
Size of Eng	No Effect	No Effect	No Effect
Size of Undergrad Eng	No Effect	No Effect	No Effect
% of Eng Undergrad	No Effect	No Effect	No Effect
Selectivity	0.75 > mean	0.155 > mean	No Effect

* This analysis excluded one school for which data were not available.

RELATIONSHIP OF STUDENT BACKGROUND VARIABLES TO PERSISTENCE

We conducted analyses to test whether any of the student background variables were associated with staying or leaving the engineering major. None of the major variables listed below were found to be related to persistence:

- SAT/ACT Scores
- High School math and science course taking (including AP classes)
- High School experiences (including engineering programs, college classes, summer SME, competitions other SME activities)
- Source of college funding
- Mother and father: engineering and engineering related careers
- High School characteristics (sector, co-ed or single-sex, region, size)
- Personal: age, year the student finished high school, race/ethnicity

ENVIRONMENT AND PARTICIPATION BY LEAVER STATUS

Stayers persistently perceived the environment in their engineering departments as more encouraging than did leavers (Figure 6-1). They were also more likely to participate in social enrichment, give help and get help activities (Figures 6-2 to 6-4). Freshman and sophomore stayers were more likely to seek help with engineering coursework than leavers, but upperclassmen who were leavers were more likely than stayers to seek help. Overall, stayers were more likely to participate in all types of support activities than leavers (Figure 6-5).

More advanced students who stayed in engineering reported participating more frequently in Social Enrichment activities and Give Help activities than their younger counterparts. Overall, the level of participation in support activities was greater with each year in school for stayers. There was no pattern of greater or lesser participation overall across the years for students who left. In addition, from freshman to senior year, leavers were less and less likely to get help. Their perception of how encouraging they found the engineering department environment also tended to decrease in later years.

Figure 6-1
Perception of Department Environment

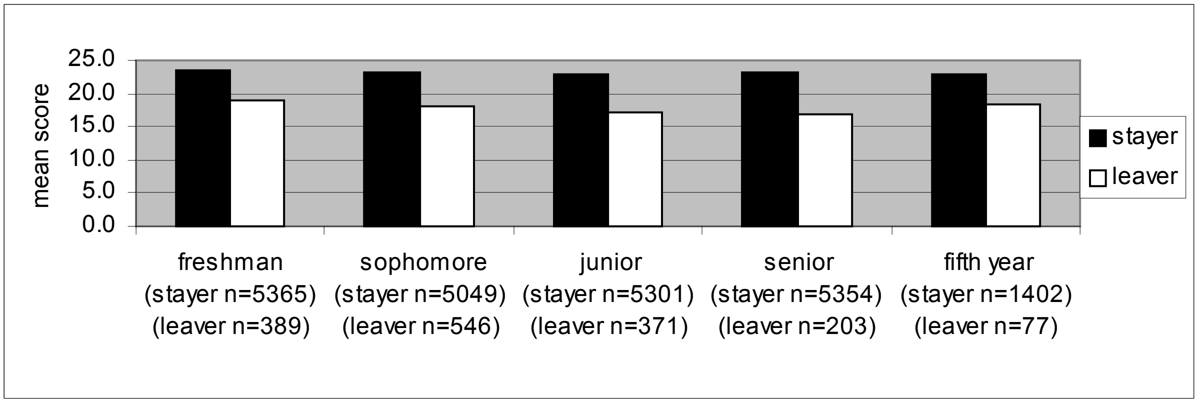


Figure 6-2
Participation in Get Help Activities

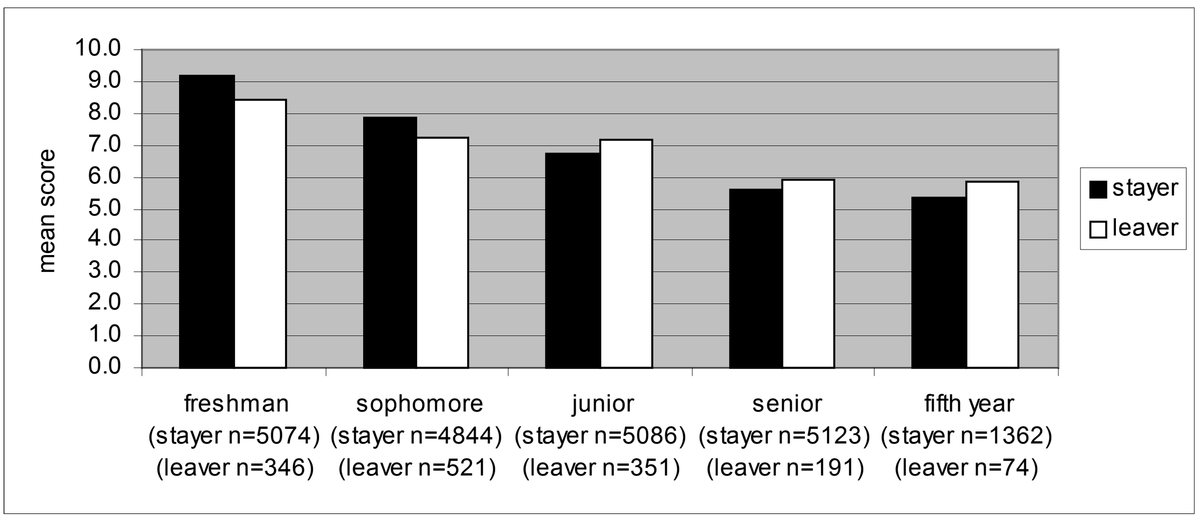


Figure 6-3
Participation in Social Enrichment Activities

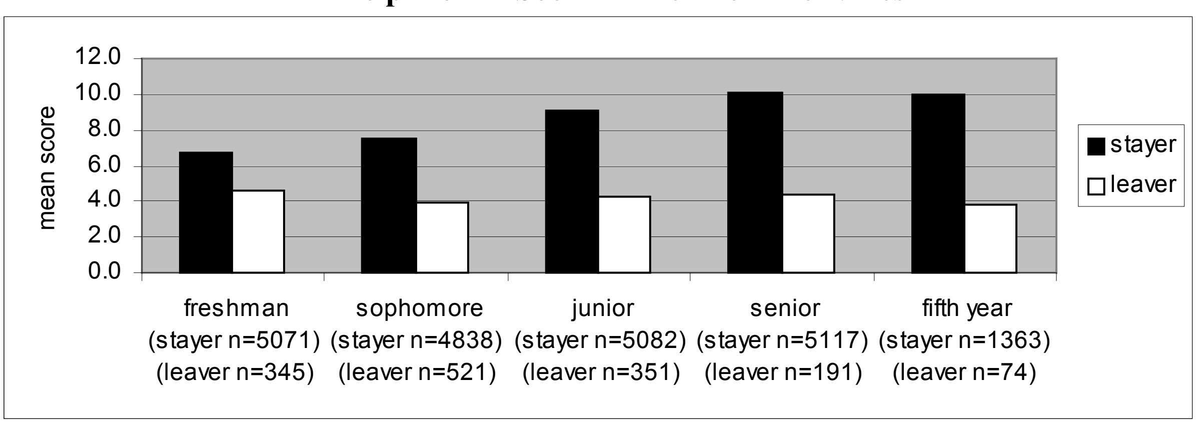


Figure 6-4
Participation in Give Help Activities

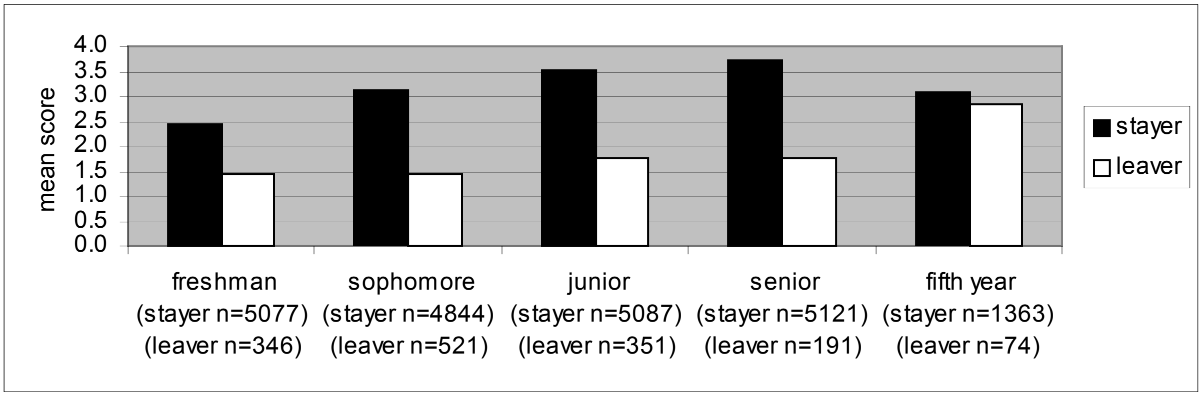
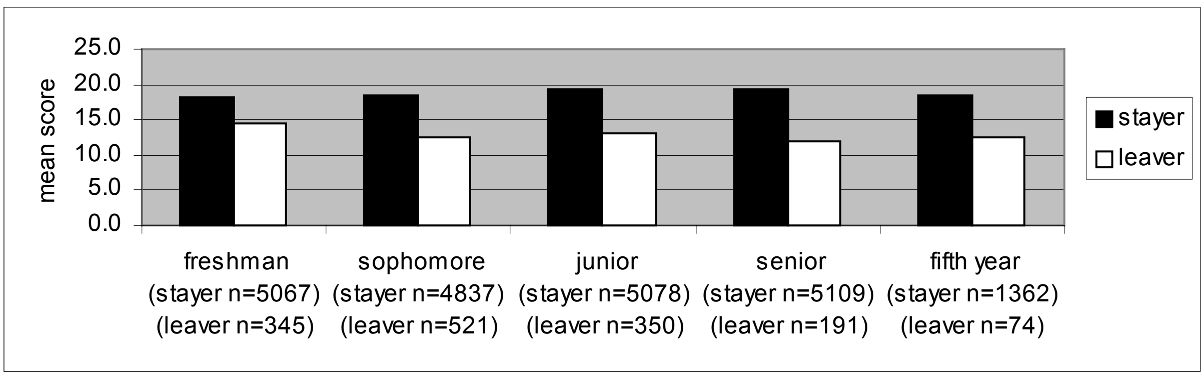


Figure 6-5
Overall Participation in Support Activities

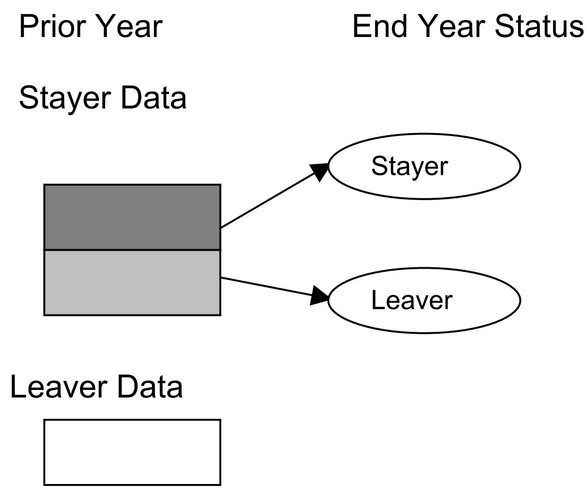


BETWEEN-YEAR STAYER/LEAVER ANALYSIS

Collecting longitudinal data for WECE permits analysis of how student perceptions and attributes are related to their subsequent decisions to persist in or depart from an engineering major. This section compares how students who completed at least two surveys and who stayed or left in a subsequent year (the End Year) responded to questions in a Prior Year. During the Prior Year (when the data were collected), all of the women indicated that they were majoring in engineering. By a following year, the End Year, some of the women had decided to leave but others remained in engineering.

We define "End Year" to be the last year that we have data for a student. "Prior Year" refers to data that were available in the year most proximal to the End Year. For analysis, the data from this Prior Year were later divided according to whether or not a student indicated that she was a leaver or stayer in the End Year; the responses of these two populations were then compared. Analyses indicate that even before women make the decision to leave engineering, their perceptions, experiences, and attributes differ from women who will continue in engineering.

Figure 6-6
Sample for Between-Year Stayer/Leaver Analysis



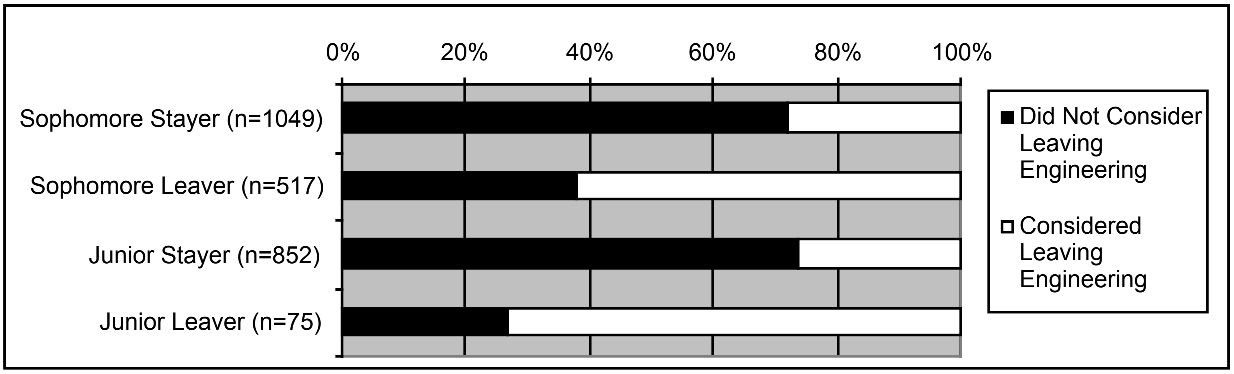
When the analyses in this section are broken down by year, we almost always report only sophomore and junior End Years (the data are from freshman and sophomore year). Investigations have revealed that seniors and 5th years who report they are leavers usually intend to graduate with a major in engineering and then leave the field of graduation after college. Therefore we have chosen not to report these data.

Consider Leaving Engineering

Not surprisingly, students who had considered leaving engineering in a Prior Year were more likely to leave in a subsequent year than students who had not considered leaving. As Figure 6-7 illustrates, 61.9% of women who left engineering during their sophomore year and 73.3% of women who left engineering during their junior year had reported during a Prior Year that they were considering leaving engineering. In contrast, 27.9% of women who remained in engineering their sophomore year and 26.4% of women who remained in engineering their junior year had reported in a Prior Year that they were considering leaving engineering.

Data used as the basis for this and all other tables in this section can be found in Appendix C-2.

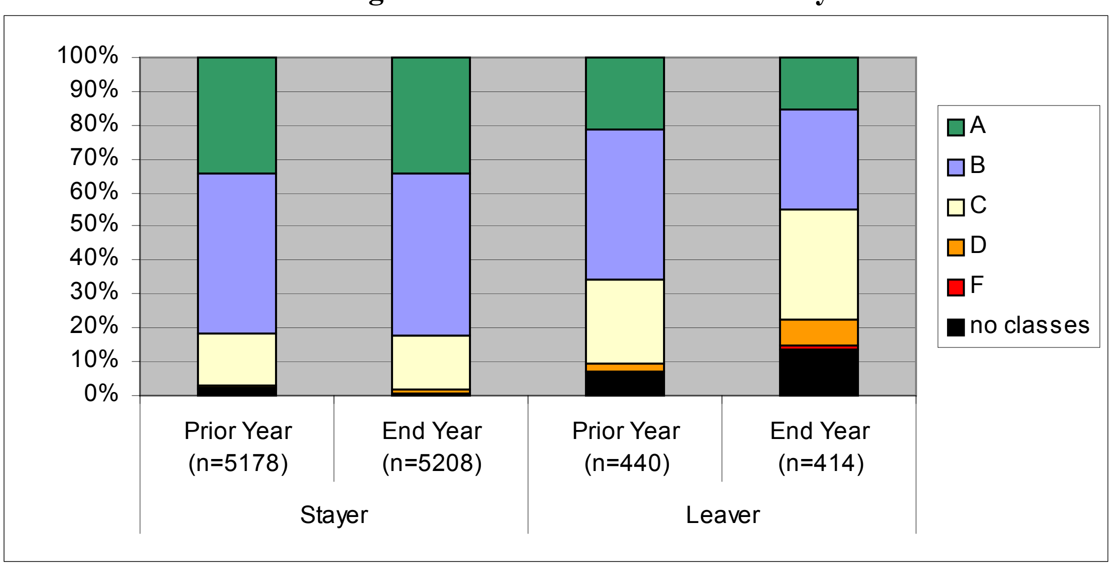
Figure 6-7
Leaver/Stayer Status by Considering Leaving in a Prior Year



Grades

One explanation for why women leave engineering majors that is commonly cited is that they could not handle the academic work. Women themselves cite grades as a factor that discourages their pursuit of an engineering major. The WECE survey asked women to report the average grade that they received in their engineering courses during that academic year. Figure 6-8 reports the average engineering grades that women received during the Prior Year and End Year by their stayer-leaver status in the End Year.

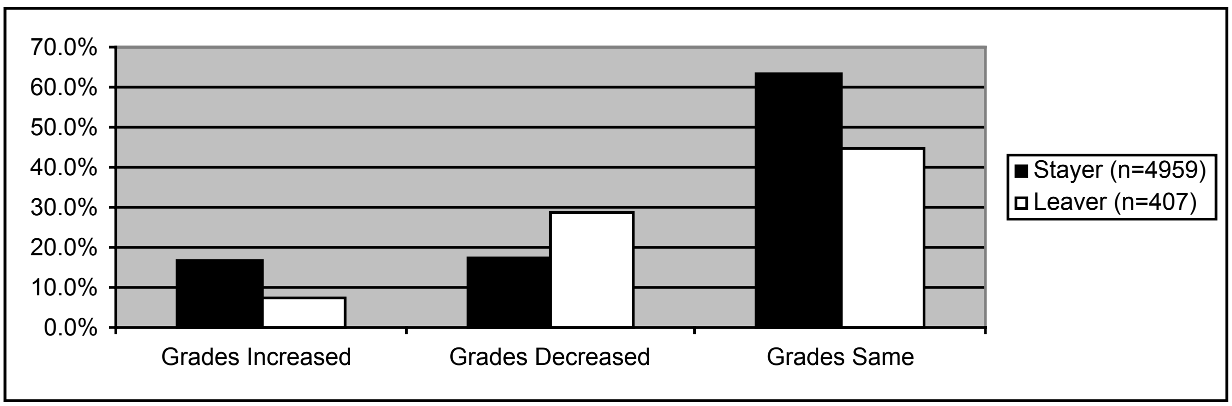
Figure 6-8
Grade Average in Prior Year and End Year by Status



The graphs illustrate that stayers, on average, did indeed receive higher grades than did leavers. Chi-Square tests indicate that the differences are significant for both sets of data. However, another important statistic is the percentage of leavers receiving As and Bs in their engineering courses who still decide to leave engineering. In the year that they left engineering (End Year), 44.7% of students were earning As or Bs in their engineering courses. During the Prior Year, 65.4% of students who would later leave engineering were earning As and Bs. This seems to suggest that many students who can do the academic work are still choosing to leave engineering.

An analysis of how students' grades changed between the Prior Year and End Year also provides some interesting data. It indicates that leavers' grades were less likely to increase and more likely to decrease than stayers', although the largest percentage of both leavers and stayers had grades that remained the same.

Figure 6-9
Change in Grades over Two Years



Some of the engineering students who responded to the questionnaire indicated that they had not taken any engineering courses that year (and thus could not provide a grade point average). Many engineering programs require students to take courses in math and science departments, especially during their first year: a student may not take an engineering course until her sophomore or junior year. In our sample, 11.5% of leavers and 0.4% of stayers reported an engineering average during the Prior Year but indicated that they had taken no engineering courses the End Year. For the reverse situation, 5.2% of leaver and 1.8% of stayers reported having no engineering classes during a Prior Year but did report an average during the End Year. Finally, 2.2% of leavers and 0.2% of stayers reported having no engineering courses in both years. These data indicate that a much higher percentage of leavers than stayers did not take an engineering course in one or both years

Students who are admitted to engineering programs have generally excelled in their math and science-related coursework during high school. They are accustomed to doing well and often report they find their college engineering grades as discouraging. Tables 6-10, 6-11, 6-12 show that leavers generally found their grades more discouraging than did stayers.

Figure 6-10
Encouraged or Discouraged by Grades in Prior Year and End Year, by Status

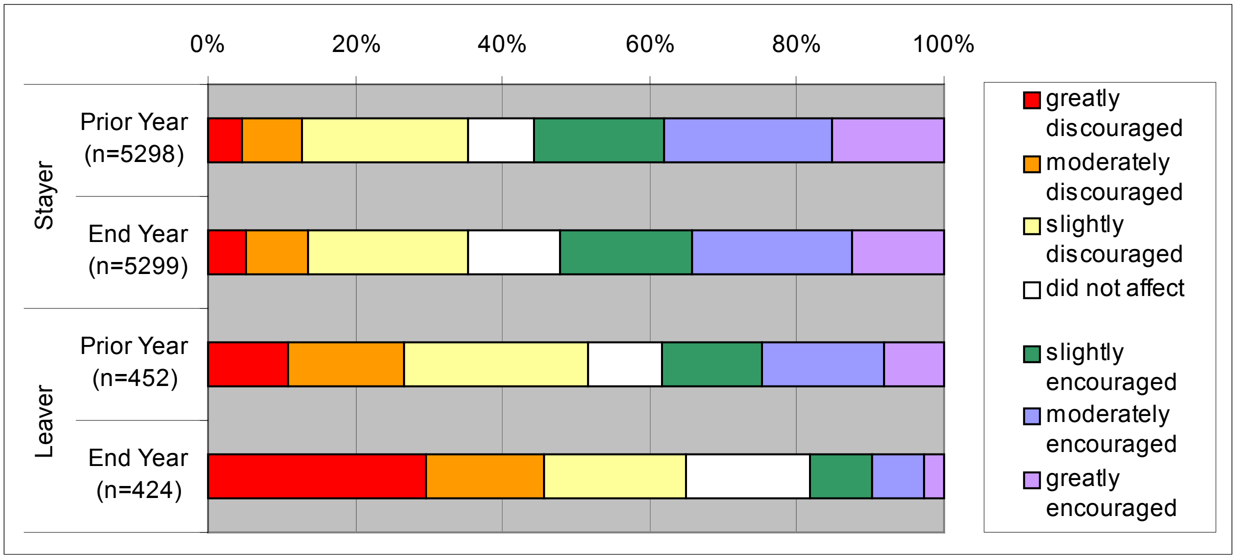
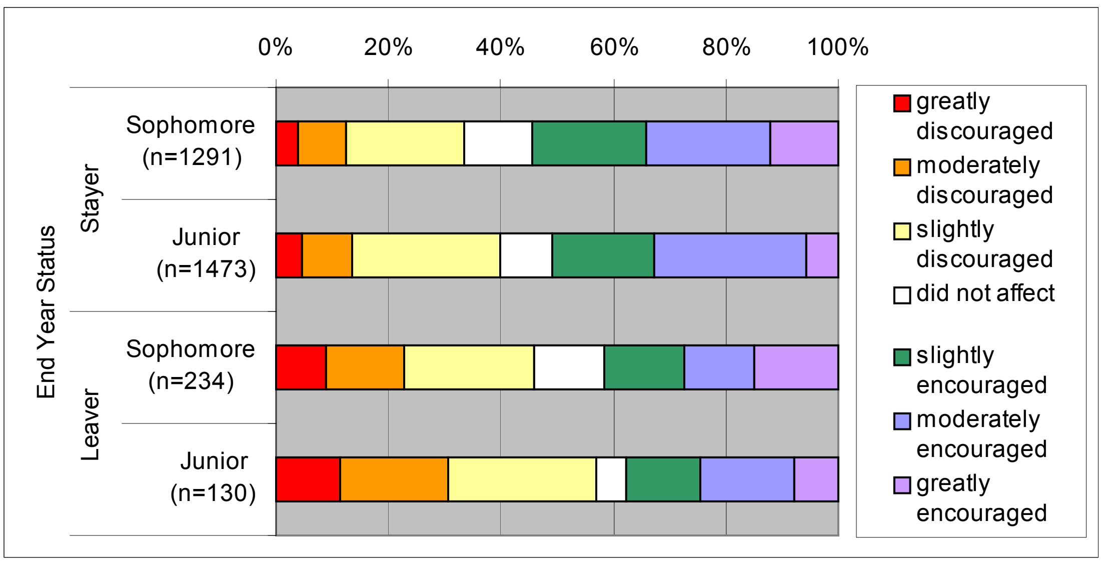
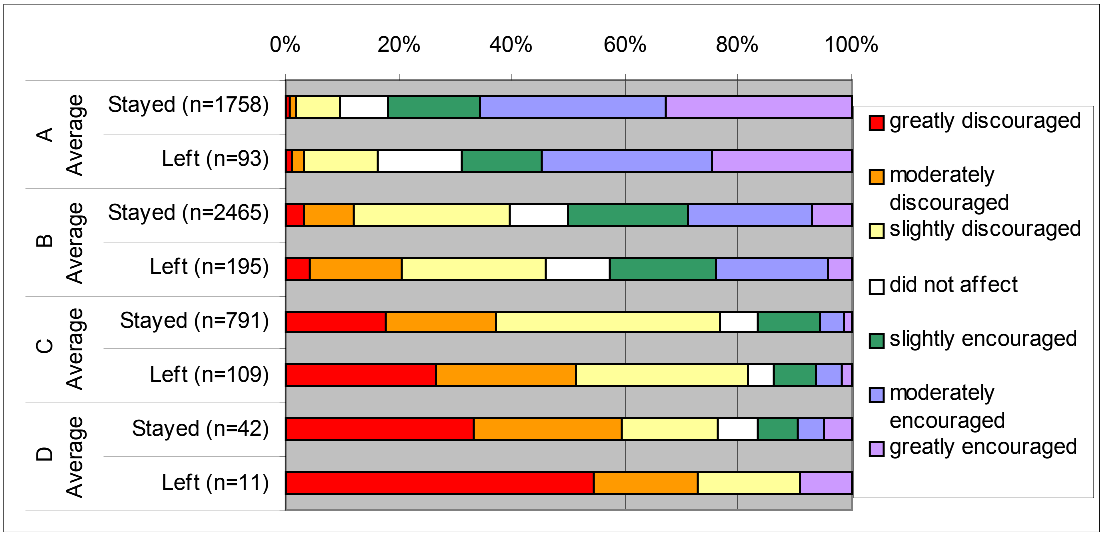


Figure 6-11
Encouraged or Discouraged by Grades in Prior Year by End Year Status



Some of the variation could be attributed to the fact that leavers receive somewhat lower grades than stayers. However, given that many of the women who are leaving have A and B averages, we must also consider other possibilities. One of these is that some women are more discouraged by what they perceive to be low grades than other women. To explore this interpretation we examined students' perceptions of how encouraging or discouraging they found their grades by what they reported those grades were. Figure 6-12 demonstrates that in the prior year students who would become leavers (but at the time classified themselves as stayers) were less likely to be encouraged and more likely to be discouraged by their grades than stayers (who remained stayers) with the same grade averages.

Figure 6-12
Encouragement/Discouragement by Grade Average and Status



These data also provide a quantitative measure of women's perceptions of their grades that supports the theory that they are discouraged even when they are doing very well. Forty-six percent of students who will leave and 39.7% of students who will stay in engineering in a subsequent year who have a B average in engineering courses reported being discouraged by these grades to some degree. For students with an A average, 16.2% of students who will leave and 9.5% of students who will remain in engineering the subsequent year reported being discouraged by their grades.

Qualitative data suggest that some of the discouragement stems from the amount of work that earning such grades requires (especially when compared to humanities). This also might explain why students with A averages reported being discouraged by their grades. However, there are also many women who believed that a "B" in a college engineering course is an indication that they are not "good at" engineering. Also it is possible that students were finding their raw grades on tests and problem sets to be discouraging: for example, when a '40%' score on a test is scaled to a grade of 'B'. Students in our focus groups spontaneously mentioned this and other grading practices as discouraging (see Chapter 7).

Participation, Self Confidence, and Environment

To probe whether there could be a relationship between students' participation in support resources and activities and their subsequent decisions to stay or leave engineering, we explored whether differences existed between stayers and leavers. We examined the difference in means of students' participation during the Prior Year in support activities by their End Year stayer/leaver status for the following variables: general level of participation in support activities and resources, Social Enrichment participation, Get Help participation, and Give Help participation. This analysis is similar to that above, displayed in Figures 6-1 to 6-5; however, instead of looking within years, it looks across years.

Table 6-4 indicates that students who would leave engineering (in a subsequent year) participated in fewer support activities overall than those who would later remain in engineering. The difference between the means of these populations is significant. Much of this difference resides in differences between women's participation in Social Enrichment activities; students who would later become leavers participated in fewer Social Enrichment activities than those who would later stay in engineering; this difference is significant. However, there are not significant differences between levels of participation in Get Help and Give Help activities as viewed by End Year status.

Table 6-4
Stayer-Leaver Comparison of Means for Participation and Perception Variables

	Estimated mean for Prior Year by:				
Scales	End Year status: Leaver	End Year status: Stayer	Chi-square statistic	Degrees of freedom	P-value
Overall participation	16.88	19.25	5.819174	1	0.015089
Social Enrichment participation	6.17	8.18	19.976462	1	0.000066
Get Help participation	8.23	7.91	0.388765	1	>.500
Give Help participation	2.66	3.15	2.259214	1	0.128721
Self confidence	10.55	8.20	80.323323	1	0.000000
Classroom environment	10.50	11.87	42.677706	1	0.000001
Department environment	22.58	23.90	25.627998	1	0.000017

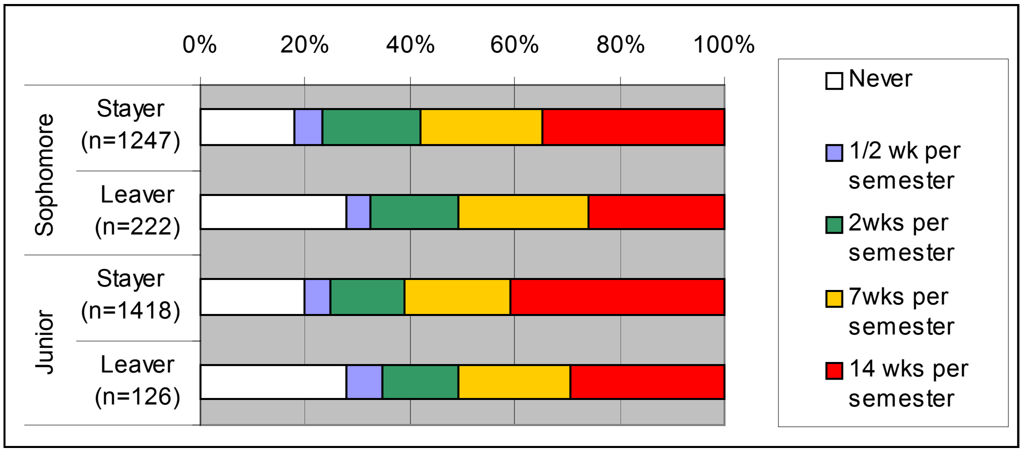
In a similar manner we investigated how future stayers' and leavers' perceptions of the change in their self confidence, classroom environment in engineering, and department environment in engineering might differ before they make the decision to stay or leave engineering. Table 6-3 shows that there is a highly significant difference ($p<.001$) between the way that students who would later stay in engineering and those who would leave engineering assess their change in self confidence, the classroom environment, and the department environment. Students who would later be stayers were consistently more positive in their perceptions in the Prior Year.

Study Groups

In college engineering, one tool that is fundamental to many students' academic survival and well-being is study groups. Unlike high school, where students are often not allowed to work together on homework, in college the difficulty of many of the math, physics, and engineering problem sets often requires that students pool their knowledge to solve them. An understanding in college that involvement in such study groups is advantageous (and often expected) may take some students a while to realize. Focus groups with students suggest that they benefit from the academic and social support that such groups offer.

Figure 6-13 displays the frequency of participation of stayers by whether they remained in or departed from engineering in a subsequent year. It is clear that from freshman year onward, students who stayed had been participating in study groups more frequently than those who left. A Chi Square test indicates that the differences for participation in freshman year (sophomore stayer-leaver status) are significant at $p=0.005$.

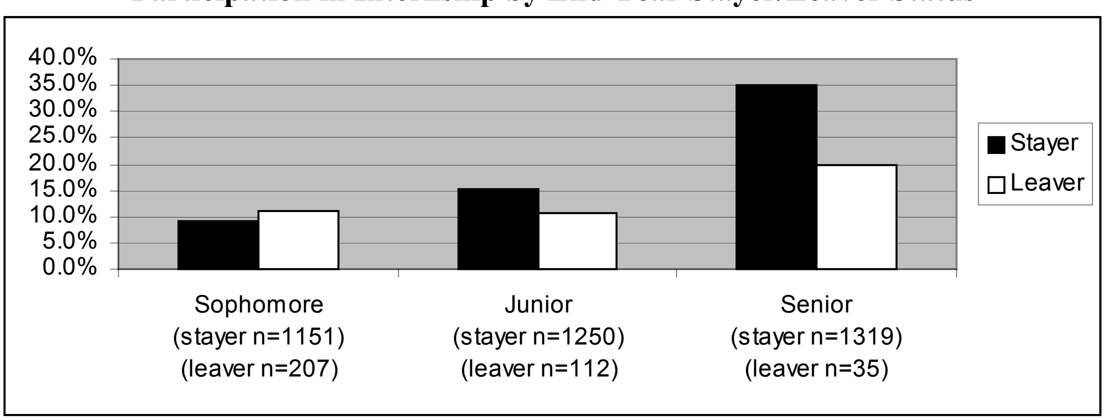
Figure 6-13
Frequency of Participation in Study Groups by End Year Stayer/Leaver Status



Research Experiences and Internships

For many students, participation in a research experience or internship is a valuable experience that provides a glimpse of what engineers do in the real world. It can serve as a positive motivator to continue in the engineering coursework they may dislike because they recognize that such coursework does not resemble what they will be doing in the work world. Not surprisingly, as students progress through college and develop more knowledge and skills about engineering content and the opportunities that are available they are more likely to have an engineering internship. Table 6-14 shows that a higher percentage of students who stay in engineering in a subsequent year have held a research or internship position than those who leave engineering. However, Chi Square tests indicate that these differences are not significant.

Figure 6-14
Participation in Internship by End Year Stayer/Leaver Status



Although these statistics do not determine causality, they do suggest that students who participate more frequently in activities, particularly Social Enrichment activities, may be more likely to remain in engineering. They also suggest that even before they have made the decision to leave engineering, students' perceptions about their self confidence and surrounding engineering environments differ between those who will continue in the major and those who will leave.

HLM GROWTH MODELS

The Effect of Participation in Support Program on Key Outcomes

In addition to examining the effects of participation in support programs on the probability of leaving engineering, we examined the relationship between participation and three key measures significantly associated with persistence in the stayer-leaver analysis above (Table 6-3): change in self confidence, perceptions of the engineering department environment, and perceptions of the engineering classroom environment.

Taking advantage of the longitudinal nature of the WECE data, we employed hierarchal linear growth models to estimate the relationship between participation and the outcome measures over time. Growth models allow for multiple records of time-varying characteristics at level one of the model, single measures of time invariant characteristics at level two, and time invariant school characteristics at level three. In addition, we used multiple outcome models to test the differences between leavers and stayers.

Table 6-5 contains the output for models showing the effect of participation on the scale Perception of Department Environment. Model 1 gives the baseline effect of time on Perception of Department Environment. A surprising finding from the models is that time is negatively associated with Perception of Department Environment, that is, as students progress through college their perception of the department environment becomes more negative. In general, participation has a small, positive relationship with Perception of Department Environment; more frequent participation is associated with more positive Perception of Department Environment.

The negative coefficients from self confidence is not surprising, because the scale Self Confidence Change is reverse coded[1]. A significant finding in this table is that participation continues to matter after considering Self Confidence Change, despite the much stronger effect of Self Confidence Change. This suggests that there is something unique to participation that is associated with Perception of Department Environment.

[1] A score of 16 refers to no change in self confidence, 0 is the largest possible positive change, and 32 is the largest possible negative Self Confidence Change

Table 6-5
Effect of Participation on Perception of Department Environment

	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7
Intercept	23.216*** (0.189)	22.090*** (0.160)	22.807*** (0.178)	21.866*** (0.137)	22.087*** (0.139)	22.623*** (0.150)	22.280*** (0.135)
Time[1]	-0.143** (0.042)	-0.163*** (0.042)	-0.081~ (0.043)	-0.187** (0.062)	-0.493*** (0.043)	-0.433*** (0.043)	-0.569*** (0.044)
Overall Participation		0.060*** (0.003)			0.049*** (0.003)		
Get Help			0.059*** (0.005)			0.054*** (0.005)	
Social Enrichment				0.113*** (0.008)			0.085*** (0.005)
Self Confidence					-0.338*** (0.008)	-0.351*** (0.009)	-0.340*** (0.009)

Note: *** p<.001 ** p< .01 * p<.05 ~ p< .1
1. The effect of time is calculated with junior year as the baseline. Therefore, the time coefficient is subtracted once for sophomore year and twice for freshman year.

For each of the seven models in Table 6-5, we calculated the estimated level of Perception of Department Environment for three different levels of participation: mean participation, participation at the 25th percentile, and that at the 75th percentile. In this chapter, only the more interesting charts are provided. The remaining charts are in Appendix C-3.

Figure 6-15 shows the estimated levels of Perception of Department Environment at three levels of Social Enrichment participation. High participation predicts the most positive perceptions: students who participate more (the 75th percentile) have a more positive view of the environment in their engineering department. The association between participation and perception is most striking at junior year. Figure 6-16 provides the same information for Participation in Get Help Activities. The relationship is similar, though more participation in get help activities predicts the most positive department perception in freshman year.

Figure 6-15
Growth Model of Effect of Participation in Social Enrichment Activities on Perception of Department Environment

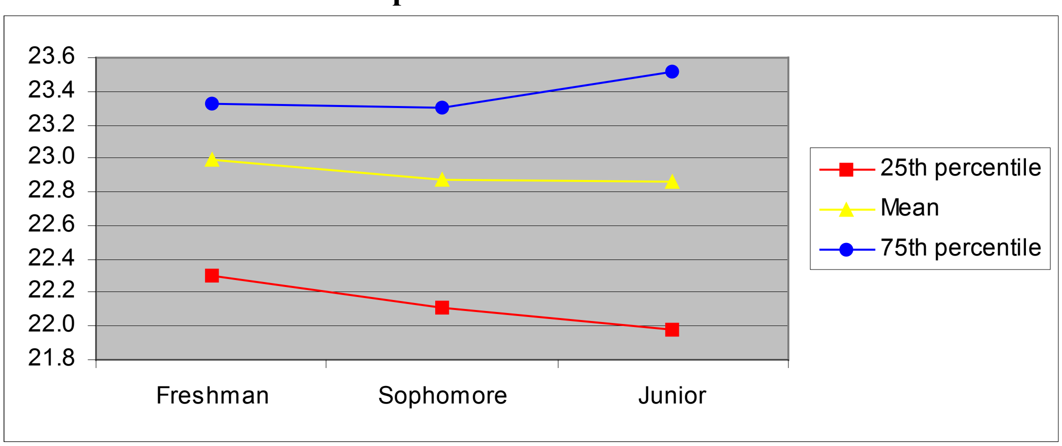
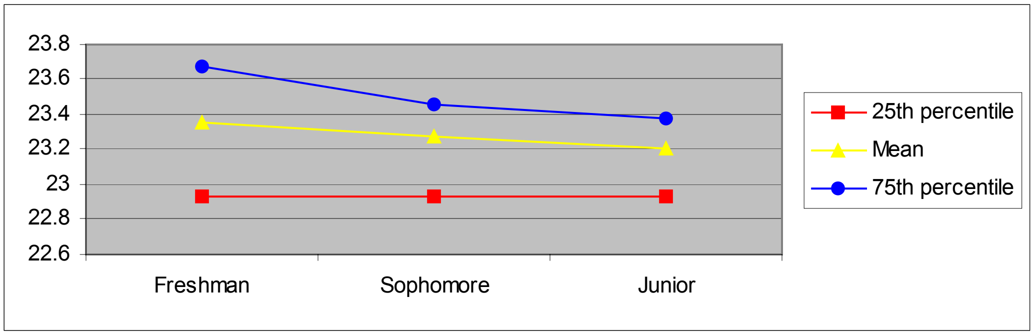


Figure 6-16
Growth Model of Effect of Participation in Get Help Activities on Perception of Department Environment



Finally, Figure 6-17 shows the estimates of Perception of Department Environment by level of Participation in Social Enrichment Activities, controlling for mean change in self confidence. The predictive power of participation in Social Enrichment activities is even more pronounced than in the other models. The gap between lower and higher perceptions of the department given low and high participation grows each year.

Figure 6-17
Growth Model of Effect of Participation in Social Enrichment Activities controlled for Mean Self Confidence Change on Perception of Department Environment

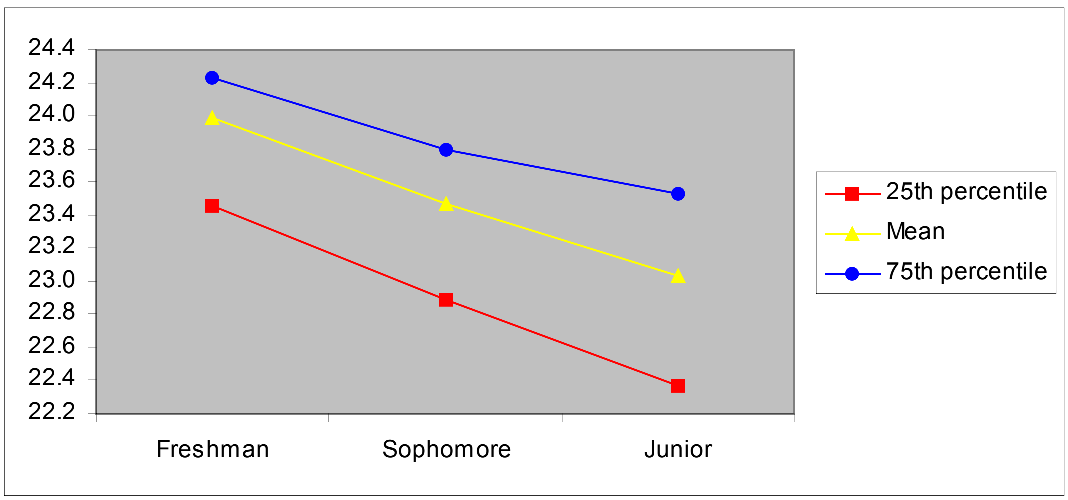


Table 6-6 is similar to Table 6-5 except the outcome for these models is the scale Perception of Classroom Environment. For the most part the relationship between participation and the Perception of Classroom Environment is positive but very small. Also in the first three models the time variable shows that Perception of Classroom Environment, unlike Perception of Department Environment, rises over time.

Table 6-6
Effect of Participation on Perception of Classroom Environment

	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
Intercept	11.695*** (0.129)	11.265*** (0.116)	11.311*** (0.120)	11.284*** (0.083)	11.245*** (0.084)	11.571*** (0.084)
Time[1]	0.113*** (0.031)	0.104** (0.031)	0.063* (0.028)	-0.264*** (0.033)	-0.286*** (0.032)	-0.282*** (0.031)
Overall Participation		0.022*** (0.002)		0.009*** (0.001)		
Social Enrichment			0.045*** (0.004)		0.025*** (0.003)	
Get Help						-0.016*** (0.002)
Self Confidence				-0.380*** (0.006)	-0.379*** (0.006)	-0.384*** (0.006)

Note: *** p<.001 ** p< .01 * p<.05 ~ p< .1
1. The effect of time is calculated with junior year as the baseline. Therefore, the time coefficient is subtracted once for sophomore year and twice for freshman year.

Figure 6-18 contains the estimated levels of Perception of Classroom Environment by different levels of Participation in Social Enrichment Activities. There is a clear positive relationship between a higher level of participation in social enrichment activity and perception of the classroom environment, though the gap between high and low participation is not large or far from the mean. The predictive power of social enrichment participation remains after controlling for Self Confidence Change (see Model 5, Table 6-6).

Figure 6-18
Growth Model of Effect of Participation in Social Enrichment Activities on Perception of Classroom Environment

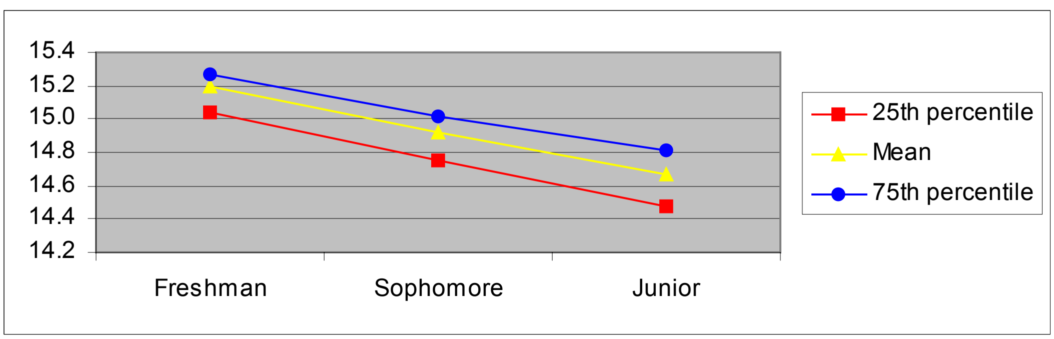


Table 6-7 is similar to the prior tables except the outcome variable is Self Confidence Change. As mentioned above this is a reverse coded scale, so a negative coefficient signifies a positive relationship in the sense that more participation is associated with a more positive change in self confidence. Self Confidence Change, though not the focus of this study, was repeatedly found to be one of the most important variables in the WECE dataset: it varied significantly with all the perceptions of environment variables, the risk of leaving, participation, academic performance, and race/ethnicity. Here it is clear that Self Confidence Change increases significantly over time and that participation in support activities is positively associated with change in self confidence.

Table 6-7
Effect of Participation on Self Confidence Change

	Model 1	Model 2	Model 3	Model4
Intercept	7.835*** (0.164)	8.465*** (0.155)	7.941*** (0.164)	8.260*** (0.160)
Time[1]	-0.979*** (0.037)	-0.969*** (0.036)	-0.996*** (0.038)	-0.925*** (0.037)
Overall Participation		-0.033*** (0.002)		
Get Help			-0.015*** (0.005)	
Social Enrichment				-0.050*** (0.003)

Note: *** p<0.001 ** p< 0.01 * p<.05 ~ p< 0.1
1. The effect of time is calculated with junior year as the baseline. Therefore, the time coefficient is subtracted once for sophomore year and twice for freshman year.

Figures 6-19 and 6-20 show the positive association of Overall Participation in Support Activities and Participation in Social Enrichment Activities with Self Confidence Change. Though the slopes are similar for all levels of participation, respondents at higher levels of participation are consistently at higher levels of change in self confidence. With social enrichment participation, the gap actually increases over time between the levels of Self Confidence Change at the two percentiles of social enrichment participation.

Figure 6-19
Growth Model of Effect of Overall Participation in Support Activities on Self Confidence Change

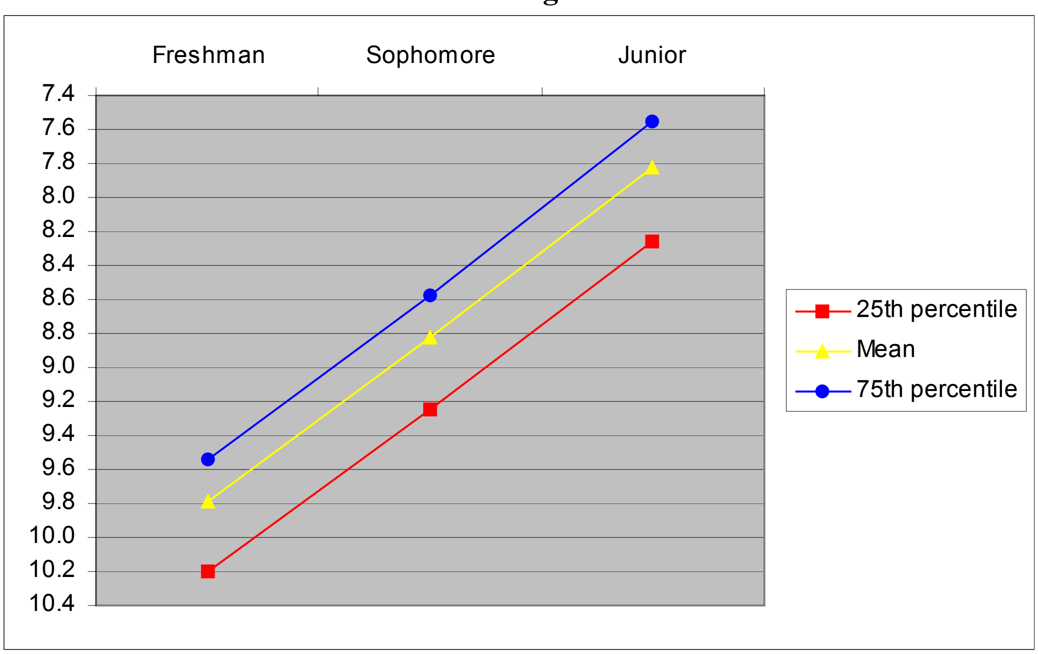
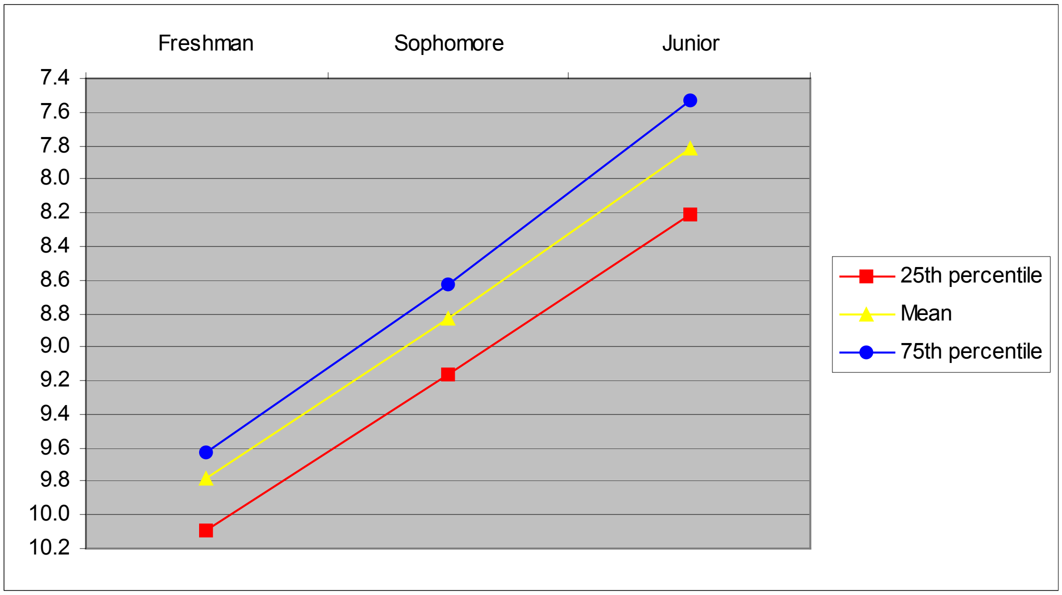


Figure 6-20
Growth Model of Effect of Participation in Social Enrichment Activities on Self Confidence Change



Differences Between Stayers and Leavers

The second part of this analysis tested whether the predictive power of participation for perceptions of environment and Self Confidence Change were statistically different between stayers and leavers. Table 6-8 contains the output from a series of multiple outcome models with Perception of Department Environment as the outcome. The multiple outcomes model produces two intercepts, in this case one for leavers and one for stayers, and two slopes for each predictor. (See, for example, Model 2 in Table 6-8.) The leaver intercept is the estimated mean level of Perception of Department Environment for a junior (because time is centered at junior year) at zero level of social enrichment participation. The stayer intercept is for a stayer at the same levels of time and participation. Further down the column are the leaver and stayer slopes for time and for social enrichment participation.

Both leavers and stayers experience that same decline in Perception of Department Environment over time first noted above (Table 6-5). However, only stayers experience a positive association between social enrichment participation and Perception of Department Environment. This is critical because Social Enrichment has repeatedly been the most significant participation variable in the analyses. Leavers' departmental environment perceptions also show no association with Overall Participation in Support Activities.

An additional advantage to the multiple outcomes models is that it allows us to test and view the differences between leavers and stayers. General hypothesis tests using a chi-square statistic were run for each of the relationships in the Table 6-8. All leaver and stayer differences in the model were found to be significant. Leavers' perceptions of their departments did not show significant positive relationships with participation in support activities as did stayers' perceptions, and the time variable shows that over time leavers' Perception of Department Environment declined more rapidly than stayers' Perception of Department Environment.

Table 6-8
Effects of Participation on Perception of Department Environment by whether a Student Stayed in or Left Engineering

	Model 1	Model 2	Model 3	Model4
Leaver Intercept	17.72*** (0.160)	17.900*** (0.221)	17.916*** (0.248)	18.170*** (0.231)
Stayer Intercept	23.16*** (0.038)	22.688*** (0.171)	22.393*** (0.168)	23.089*** (0.185)
Leaver Time[1]	-0.51*** (0.130)	-0.527*** (0.118)	-0.528*** (0.119)	-0.542*** (0.122)
Stayer Time[1]	-0.103** (0.030)	-0.197** (0.055)	-0.109* (0.05)	-0.014 (0.051)
Leaver - Overall Participation			0.002 (0.013)	
Stayer - Overall Participation			0.062*** (0.003)	
Leaver -Get Help				-0.031~ (0.017)
Stayer -Get Help				0.070*** (0.006)
Leaver -Social Enrichment		0.013 0.028)		
Stayer - Social Enrichment		0.100*** 0.007)		

Note: *** p<.001 ** p< .01 * p<.05 ~ p< .1
Coefficients are for Hierarchical Linear Growth Models. All leaver/stayer differences are statistically significant according to the hypothesis testing unless otherwise noted.
1. The effect of time is calculated with junior year as the baseline. Therefore, the time coefficient is subtracted once for sophomore year and twice for freshman year.

Because leavers' Perception of Department Environment was not predicted by their participation in support activities, growth charts in the style of Figure 6-21 are not really that interesting for leavers. Figure 6-21 shows the effect of participation on Perception of Department Environment for stayers. The relationships are about the same as shown in the Figure 6-15 (the same model for the whole sample). The main difference is that without the leavers in the model, the mean levels of perceptions of environment are higher.

Figure 6-21
Effect of Participation in Social Enrichment Activities on Perception of Department Environment for Stayers

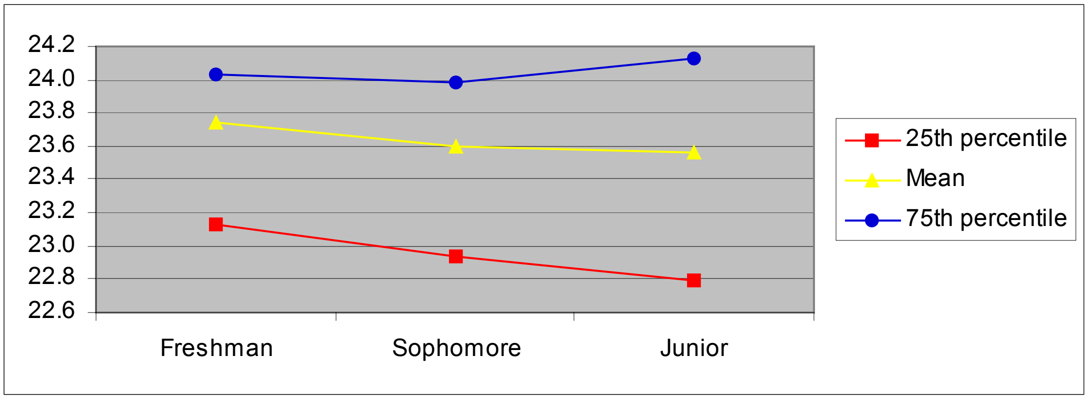


Table 6-9 contains the multiple outcomes growth models with Perception of Classroom Environment as the outcome. Once again it is clear that leavers, in general, had lower perceptions of their environment than did stayers. This relationship changes little over time. The time slopes are small and are statistically equal for leavers and stayers. The lack of significance of the leaver time slopes is likely attributable to the combination of the size of the leaver sample and of the effect size.

The surprising findings from the analysis are that leavers' participation in support activities either showed no relationship with or a negative relationship with their Perception of Classroom Environment. Only Get Help participation is in the same direction for leavers and stayers. Both have more negative Perception of Classroom Environment at higher levels of get help participation. One possible explanation is that students who need a lot of help are likely struggling in their classes and perceive a less supportive classroom environment as a result of their struggles. Another theory is that students in classes that are more poorly taught need more help, and at the same time perceive a less supportive classroom environment. However, these explanations probably do not hold for leavers' negative social enrichment slopes and overall participation slopes.

Table 6-9
Effects of Participation on Perception of Classroom Environment by whether a Student Stayed in or Left Engineering[1]

	Model 1	Model 2	Model 3	Model 4
Leaver Intercept	8.287*** (0.135)	8.666*** (0.176)	8.798*** (0.155)	8.479*** (0.153)
Stayer Intercept	11.908*** (0.132)	11.486*** (0.124)	11.982*** (0.127)	11.532*** (0.132)
Leaver Time[2]	0.031 (0.111)	0.019 (0.107)	-0.016 (0.107)	0.031 (0.108)
Stayer Time[2]	0.172*** (0.029)	0.166*** (0.030)	0.160*** (0.030)	0.127*** (0.029)
Leaver - Overall Participation		-0.030*** (0.008)		
Stayer - Overall Participation		0.022*** (0.002)		
Leaver -Get Help			-0.074*** (0.012)	
Stayer -Get Help			-0.011*** (0.004)	
Leaver -Social Enrichment				-0.047*** (0.013)
Stayer - Social Enrichment				0.043*** (0.005)

Note: *** p<.001 ** p< .01 * p<.05 ~ p< .1

1. Note that coefficient are for Hierarchical Linear Growth Models. All leaver/stayer differences are statistically significant according the hypothesis testing unless otherwise noted.
2. The effect of time is calculated with junior year as the baseline. Therefore, the time coefficient is subtracted once for sophomore year and twice for freshman year. For all four models, the time slopes are statistically equal for leavers and stayers.

Figures 6-22 and 6-23 display the different effects of overall participation on Perception of Classroom Environment for leavers and stayers. High participation consistently predicts more positive perceptions in Figure 6-22 (stayers), while high participation in Figure 6-23 (leavers) consistently predicts more negative perceptions. In addition, leaver perceptions did not change over time and leavers were at consistently lower levels of Perception of Classroom Environment than stayers. In fact, there is not even overlap in the range of estimate and percentile means for leavers and stayers.

Figure 6-22
Effect of Overall Participation on Perception of Classroom Environment for Stayers

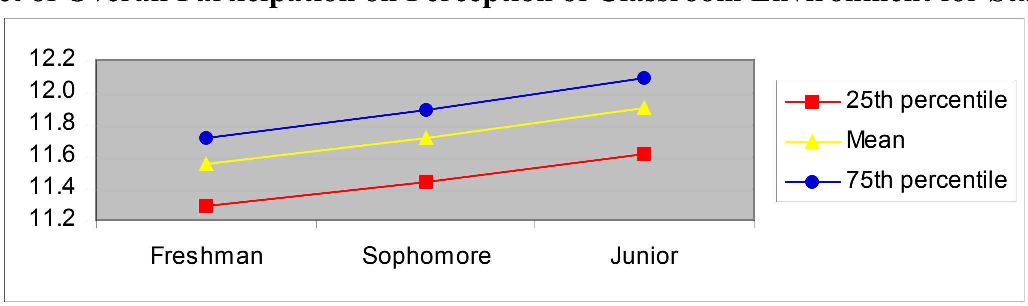
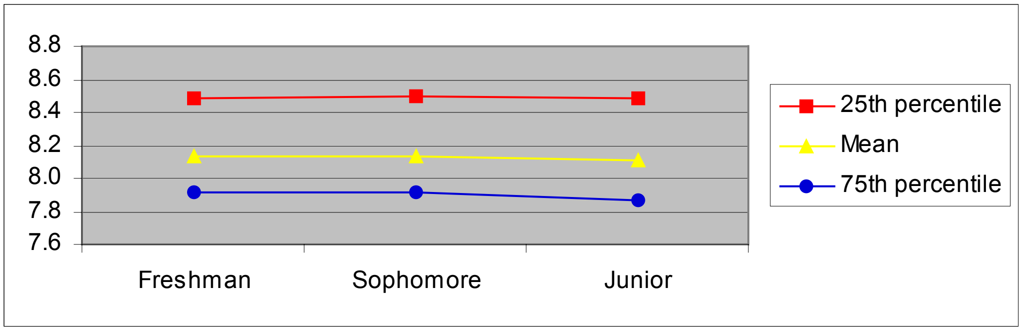


Figure 6-23
Effect of Overall Participation on Perception of Classroom Environment for Leavers



Participation in Get Help Activities had a tiny but significant negative relationship with Perception of Classroom Environment for stayers (Figure 6-24). It had a more pronounced negative association for leavers (Figure 6-25). The relationships were more pronounced for freshman students than for upperclasswomen.

Figure 6-24
Effect of Participation in Get Help Activities on Perception of Classroom Environment for Stayers

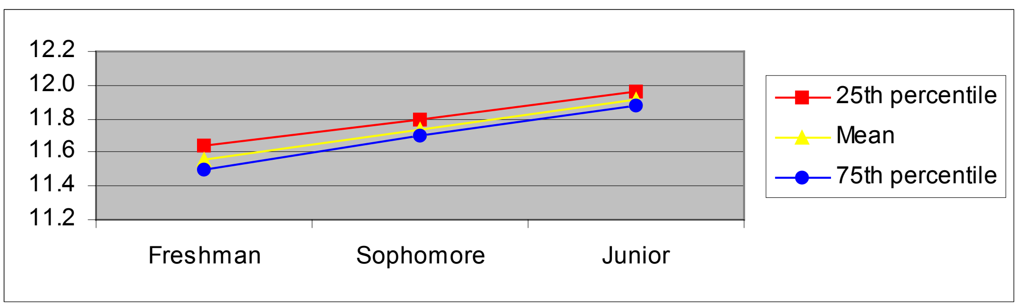


Figure 6-25
Effect of Participation in Get Help Activities on Perception of Classroom Environment for Leavers

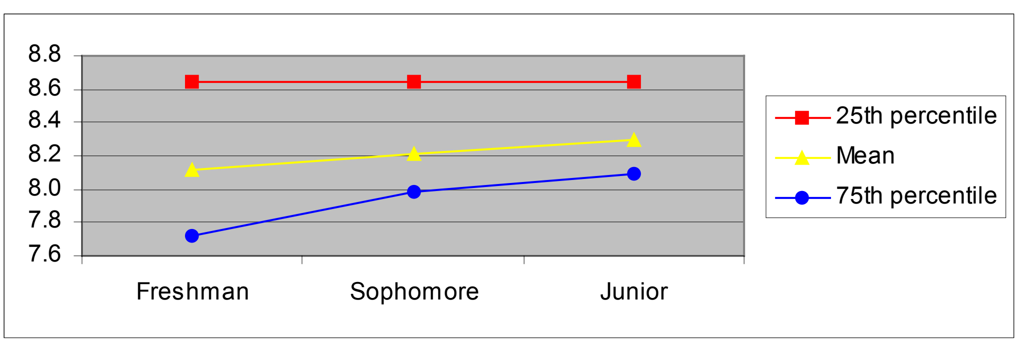


Table 6-10 contains the estimates from the multiple outcomes models with Self Confidence Change as the outcome. It is clear that leavers were consistently at lower levels of change in self confidence than were stayers. The fact that time slopes are equal for leavers and stayers suggests that leavers and stayers improved in Self Confidence Change at similar rates, but the gap between them did not shrink over time. The participation coefficients reveal that there is no relationship between Social Enrichment participation and overall participation and Self Confidence Change and a negative relationship between Get Help participation and Self Confidence Change for leavers. Remember that the positive Get Help coefficient for leavers means that leavers at a higher level of get help participation experienced a less positive change in self confidence.

Table 6-10
Effects of Participation on Self Confidence Change by whether a Student Stayed in or Left Engineering[1]

	Model 1	Model 2	Model 3	Model 4[3]
Leaver Intercept	11.921*** (0.226)	11.981*** (0.242)	11.658*** (0.260)	11.977*** (0.237)
Stayer Intercept	7.510*** (0.157)	8.137*** (0.159)	7.629*** (0.155)	7.923*** (0.161)
Leaver Time[2]	-0.901*** (0.113)	-0.904*** (0.129)	-0.876*** (0.113)	-0.900*** (0.113)
Stayer Time[2]	-1.069*** (0.042)	-1.059*** (0.029)	-1.088*** (0.043)	-1.019*** (0.041)
Leaver - Overall Participation		-0.005 (0.010)		
Stayer - Overall Participation		-0.033*** (0.002)		
Leaver -Get Help			0.039* (0.017)	
Stayer -Get Help			-0.017** (0.005)	
Leaver -Social Enrichment				-0.013 (0.018)
Stayer - Social Enrichment				-0.047*** (0.005)

Note: *** p<.001 ** p< .01 * p<.05 ~ p< .1

1. Note that all leaver/stayer differences are statistically significant except for Participation in Social Enrichment Activities. The statistical test for a difference between the leaver and stayer Participation in Social Enrichment Activities slopes does not meet the p<.05 threshold. The p-value is 0.079.
2. The effect of time is calculated with junior year as the baseline. Therefore, the time coefficient is subtracted once for sophomore year and twice for freshman year. For all four models, the time slopes are statistically equal for leavers and stayers.

Figures 6-26 for stayers and 6-27 for leavers display the different predictions of Participation in Get Help Activities for these two groups. For stayers, being at the 75th percentile for Get Help participation predicts a more positive change in self confidence than that of students at the 25th percentile. For leavers, students at the 75th percentile of participation experienced less change in self confidence than did respondents at the 25th percentile of Participation in Get Help Activities. The figures also show that the size of the effects is small, but the relationship is significant and it is a substantive addition to the understanding of how leavers' experiences in college engineering programs differs from that of stayers.

Figure 6-26
Effect of Participation in Get Help Activities on Self Confidence Change for Stayers

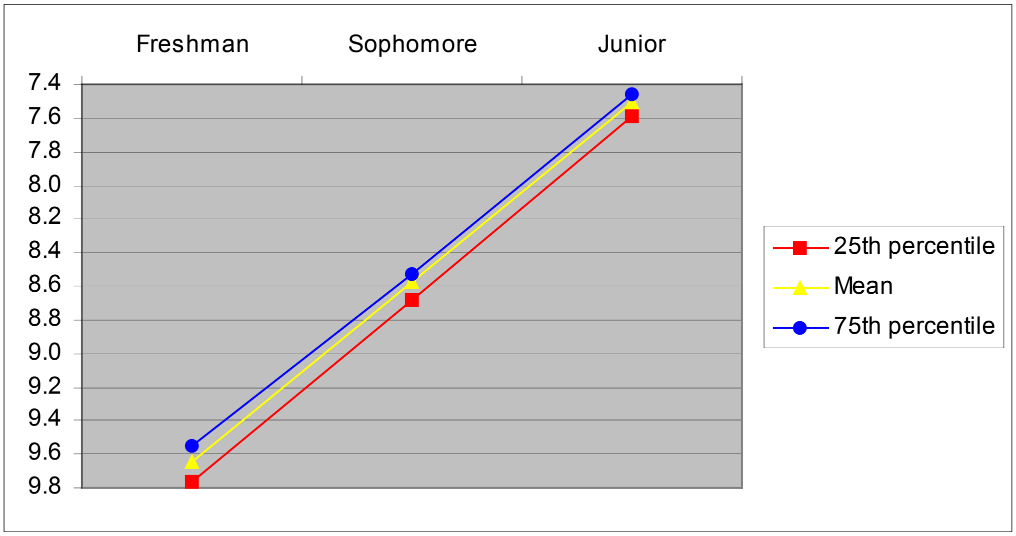
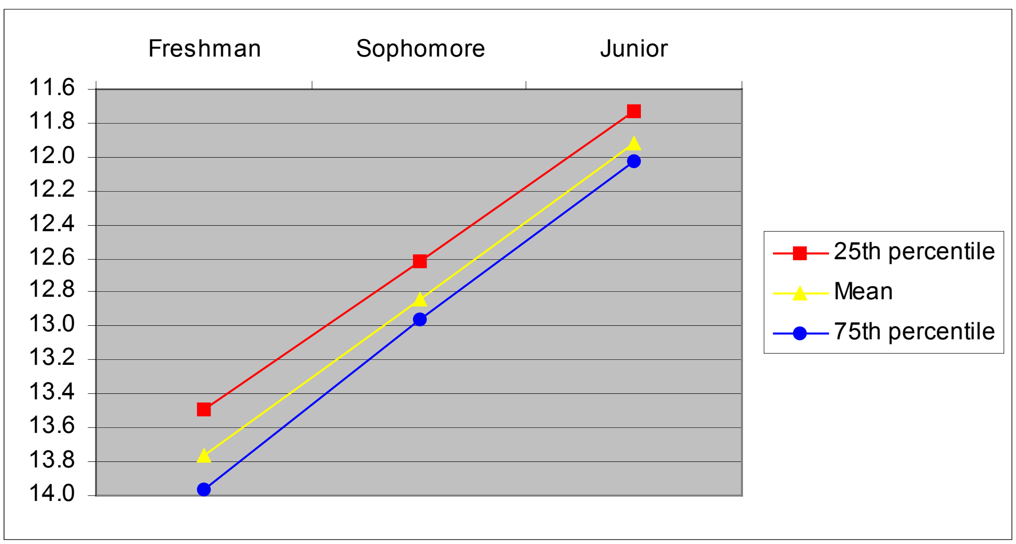


Figure 6-27
Effect of Participation in Get Help Activities on Self Confidence Change for Leavers



EVENT HISTORY ANALYSIS

Table 6-11 contains the event history analysis models showing the effects of the three scales Perception of Department Environment, Perception of Classroom Environment, and Self Confidence Change on the risk of leaving engineering at each year. Model 1 establishes the baseline risk of leaving for each undergraduate year while the other three models show the effect of the scales on that risk. Every effect in the table is statistically significant according to a simple t-test, which tests whether the coefficient is different from zero.

The table notes present findings from a different set of tests. These hypothesis tests assessed whether the effect of the scales differed by year in school. For example, are the sophomore and junior coefficients for Self Confidence Change statistically different? Most importantly these tests establish that the baseline risk of leaving is different at each year and that Self Confidence Change matters more in the early years than the later years of school.

Several constructed scales, as described above, were tested for their effect on the hazard rate for students leaving engineering in four undergraduate years. The models listed in Table 6-10 were all statistically significant**:** students' Self Confidence Change was significantly associated with their risk of leaving, as was their perception of the department environment and their perception of the classroom environment.

Log odds – as listed in Table 6-11 – are not easily interpretable, but they are convertible to predicted probabilities, in this case the probability of leaving. The probability of leaving is the risk of leaving which we call the hazard rate. Using the values from Table 6-11, together with mean and percentile values of the residuals for the scale variables used in the models, we calculated the hazard rates in the following manner:

$$(1 - (1 / (1+e^{(\text{<year intercept>} + (\text{<scale intercept>} * \text{<mean or percentile>}))})))$$

where <year intercept> represents the intercept coefficient for a specific undergraduate year (i.e. sophomore), <scale intercept> represents the intercept coefficient for the scale in question (i.e. Change in Self Confidence) and that year, and <mean or percentile> represents the residual for the scale variable at the point being calculated (i.e. 25^{th} percentile). The remaining figures in this chapter display calculated hazard rates instead of the raw log-odds displayed in the tables. The tables of hazard rates upon which the charts were based may be found in Appendix C-4.

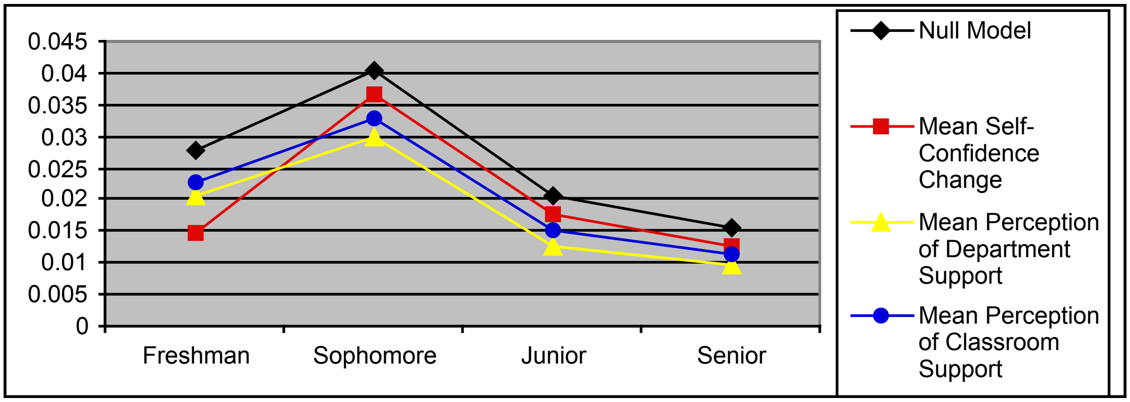
Table 6-11
The Effect of Self Confidence Growth and Perceptions of Environment Support on Whether a Respondent Stays or Leaves Engineering (Log-odds with Standard Errors)

Fixed Effect	Model 1	Model 2	Model 3	Model 4
Freshman	-3.554*** (0.082)	-4.166*** (0.102)	-3.862*** (0.092)	-3.769*** (0.089)
Sophomore	-3.169*** (0.086)	-3.251*** (0.084)	-3.460*** (0.096)	-3.381*** (0.093)
Junior	-3.857*** (0.110)	-3.967*** (0.111)	-4.319*** (0.134)	-4.139*** (0.122)
Senior	-4.157*** (0.139)	-4.326*** (0.146)	-4.548*** (0.167)	-4.393*** (0.155)
Freshman – Self Confidence		0.356*** (0.012)		
Sophomore– Self Confidence		0.101*** (0.012)		
Junior– Self Confidence		0.148*** (0.017)		
Senior– Self Confidence		0.184*** (0.024)		
Freshman – Department Environment			-0.274*** (0.015)	
Sophomore– Department Environment			-0.273*** (0.015)	
Junior– Department Environment			-0.342*** (0.023)	
Senior– Department Environment			-0.328*** (0.033)	
Freshman – Classroom Environment				-0.270*** (0.018)
Sophomore– Classroom Environment				-0.273*** (0.017)
Junior– Classroom Environment				-0.323*** (0.027)
Senior– Classroom Environment				-0.314*** (0.039)

Note: *** p<.001 ** p< .01 * p<.05
Model 1: All are statistically different from each other.
Model 2: Senior and Junior Self Confidence Change log-odds are statistically equal; all other Self Confidence Change differences are statistically different.
Model 3: Junior Perception of Department Environment log-odds is statistically different from the Sophomore and Freshman log-odds. All other Perception of Department Environment log-odds are equal.
Model 4: All Perception of Classroom Environment log-odds are statistically equal.

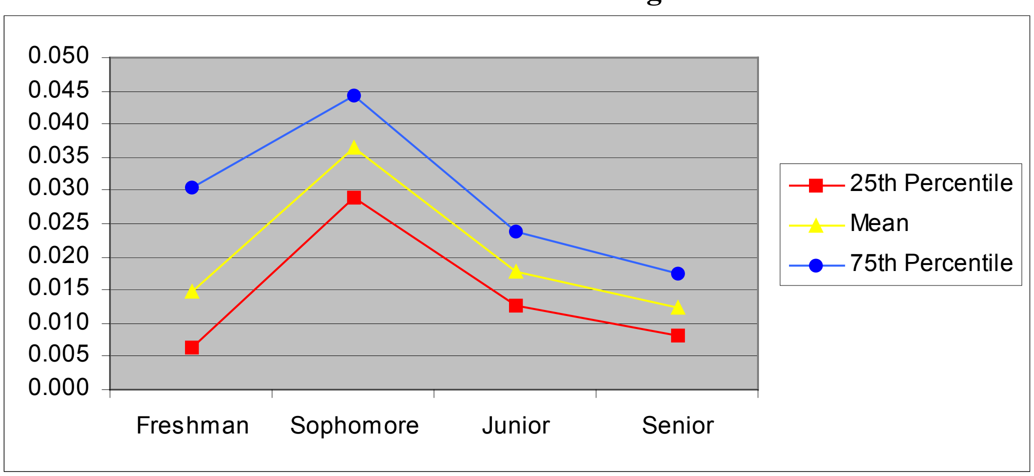
Figure 6-28 displays the effect of mean scores on self confidence growth and perceptions of environment on the hazard rates. The black line shows the probability of leaving at each year of school. Reflecting our earlier findings, the risk of leaving is greatest at sophomore year. The table also shows that mean Self Confidence Change has a more significant effect on the hazard rate for freshwomen than either Perception of Department Environment or Perception of Classroom Environment.

Figure 6-28
Hazard Models Controlling for Mean Self Confidence or Perceptions of Environment



Using the formula described above, it is possible to calculate the risk of leaving for students with mean Self Confidence Change, or an average perception of the environment within the department or within the classroom. It is also possible to calculate the risk of leaving for students with more positive or negative perceptions, by looking at those who scored at a high or low percentile on the perception scales. In Figure 6-28 only means are used, but in Figure 6-29 the effect of change in self confidence is shown at the mean level and at the 25th and 75th percentiles. The Self Confidence Change scale is reverse coded, meaning that a lower score indicates more positive change in self confidence. The figure shows that students at the 25th percentile on the self confidence scale (in this reverse coded scale, those with the most positive Self Confidence Change) had practically a zero chance of leaving engineering as freshwomen. Freshwomen at the mean level only had a 1.5% risk of leaving as opposed to a 3% chance of leaving for those at the 75th percentile. The effect of self confidence shrinks as students progress through college.

Figure 6-29
Model with Self Confidence Change as Predictor



Both Perception of Department Environment (Figure 6-30) and Perception of Classroom Environment (Figure 6-31) predicted fairly uniform hazard rate outcomes, unlike Self Confidence Change; both perception scales were associated most dramatically with changes in the sophomore year rate: sophomores with more positive perceptions had a stronger moderating effect on their risk of leaving than students in other years, and sophomores with negative perceptions were more likely to leave than similar students in other years. In both cases, students with more negative perceptions of their environment (students at the 25th percentile) had a higher risk of leaving engineering.

Figure 6-30
Model with Perception of Department Environment as Predictor

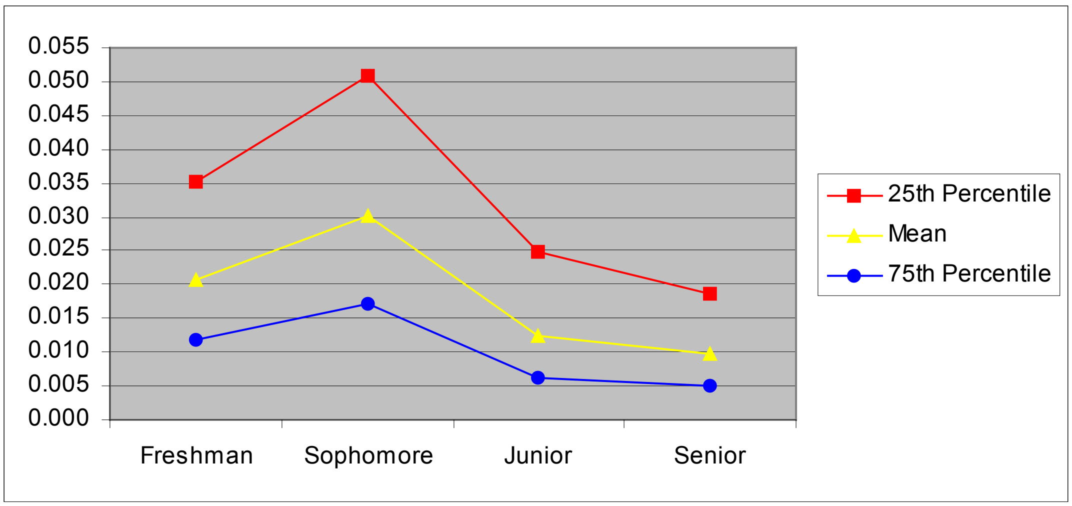


Figure 6-31
Model with Perception of Classroom Environment as Predictor

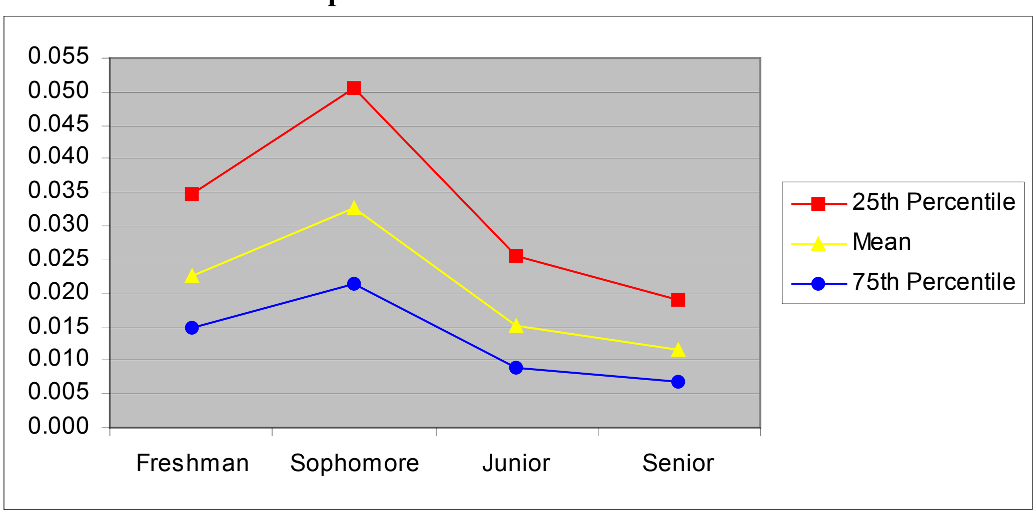


Table 6-12 is similar to Table 6-11 above but focused on the effects of participation in support activities on the risk of leaving engineering. Again the coefficients are log-odds, and are converted to predicted probabilities in Figures 6-32 to 6-37. The effects of overall program participation (Get Help, Give Help, and Social Enrichment combined) and the effect of Participation in Social Enrichment Activities significantly moderate the log odds of leaving engineering. Independently, Get Help and Give Help participation were not associated with the log odds of leaving engineering, so the models are not shown in Table 6-12.

The most important finding from the table is that the effect of Social Enrichment participation remains significant after holding both Self Confidence Change and Perception of Department Environment constant at the mean. This suggests that there is a unique attribute to social enrichment participation that affects a woman's decision to stay in engineering. The hypothesis tests summarized in the table notes reveal that, in general, participation effects are the same across years with the exception that Participation in Social Enrichment Activities is associated more strongly with mediating the risk of leaving for seniors than for freshwomen.

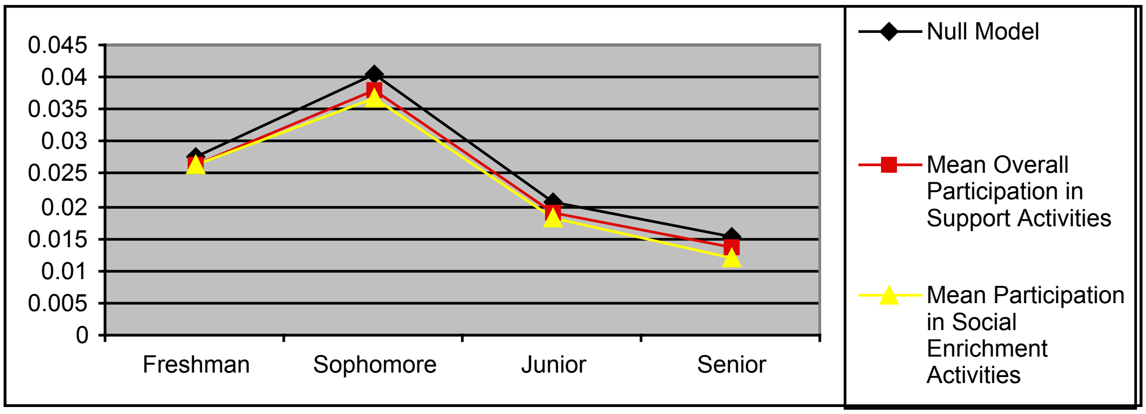
Table 6-12
The Effect of Participation in Support Activities on Whether a Respondent Stays or Leaves Engineering (Log-odds with Standard Errors)

Fixed Effect	Model 1	Model 2	Model 3	Model 4	Model 5
Freshman	-3.554*** (0.082)	-3.602*** (0.083)	-3.609*** (0.083)	-4.179*** (0.102)	-3.921*** (0.092)
Sophomore	-3.169*** (0.086)	-3.231*** (0.087)	-3.262*** (0.088)	-3.326*** (0.087)	-3.547*** (0.098)
Junior	-3.857*** (0.110)	-3.934*** (0.114)	-3.968*** (0.115)	-4.049*** (0.116)	-4.414*** (0.138)
Senior	-4.157*** (0.139)	-4.262*** (0.147)	-4.351*** (0.156)	-4.470*** (0.159)	-4.697*** (0.177)
Freshman - Overall Participation		-0.040*** (0.006)			
Sophomore - Overall Participation		-0.047*** (0.006)			
Junior - Overall Participation		-0.055*** (0.010)			
Senior - Overall Participation		-0.066*** (0.015)			
Freshman - Social Enrichment			-0.080*** (0.012)	-0.057*** (0.012)	-0.047*** (0.011)
Sophomore – Social Enrichment			-0.102*** (0.011)	-0.089*** (0.011)	-0.069*** (0.011)
Junior – Social Enrichment			-0.116*** (0.018)	-0.096*** (0.018)	-0.072*** (0.017)
Senior – Social Enrichment			-0.155*** (0.029)	-0.127*** (0.028)	-0.107*** (0.027)
Freshman – Self Confidence				0.346*** (0.012)	
Sophomore– Self Confidence				0.091*** (0.012)	
Junior– Self Confidence				0.134*** (0.017)	
Senior– Self Confidence				0.168*** (0.024)	
Freshman – Department Environment					-0.265*** (0.016)
Sophomore– Department Environment					-0.259*** (0.015)
Junior– Department Environment					-0.328*** (0.024)
Senior– Department Environment					-0.306*** (0.034)

Note: *** p<.001 ** p< .01 * p<.05
Model 2: The Overall Participation in Support Activities log-odds are statistically equal.
Model 3: Freshman Participation in Social Enrichment Activities log-odds are statistically different from the senior Participation in Social Enrichment Activities log-odds. All other Participation in Social Enrichment Activities log-odds are equal.
Model 4: All Self Confidence Change differences are statistically different except the difference between seniors and juniors. Only the Participation in Social Enrichment Activities difference between freshmen and seniors is statistically different.
Model 5: The juniors' Perception of Department Environment log-odds is statistically different from the estimates for freshmen and sophomores. All other Perception of Department Environment log-odds are equal. Only the freshwoman and senior Participation in Social Enrichment Activities log-odds are statistically different.

Figure 6-32 shows the hazard rates for leaving at the mean level of overall participation and social enrichment participation relative to the null model. Both Overall Participation in Support Activities and Participation in Social Enrichment Activities significantly moderate the hazard rate for leaving engineering. Participation in Social Enrichment Activities has slightly more effect than Overall Participation in Support Activities.

Figure 6-32
Hazard Models Controlling for Mean Participation in Support Activities



Figures 6-33 and 6-34 show the hazard rates for leaving at three level of participation. The black diamond line in each table represents the risk of leaving considering no other factors. It is the baseline hazard curve. Students who participate in support activities overall (Figure 6-33), and those who participate at the mean level or higher in social enrichment activities (Figure 6-34), are less likely to leave engineering than students who participate less frequently. This is especially true for sophomores. Students with Overall Participation in Support Activities at the 25th percentile as well as those with a Participation in Social Enrichment Activities score at the 25th percentile – those students who participate less often than the mean level of participation – have a higher risk of leaving than the estimated average risk of leaving for the entire sample of students. Again, this is more true for sophomores than for students in other years.

Figure 6-33
Model with Overall Participation in Support Activities as Predictor

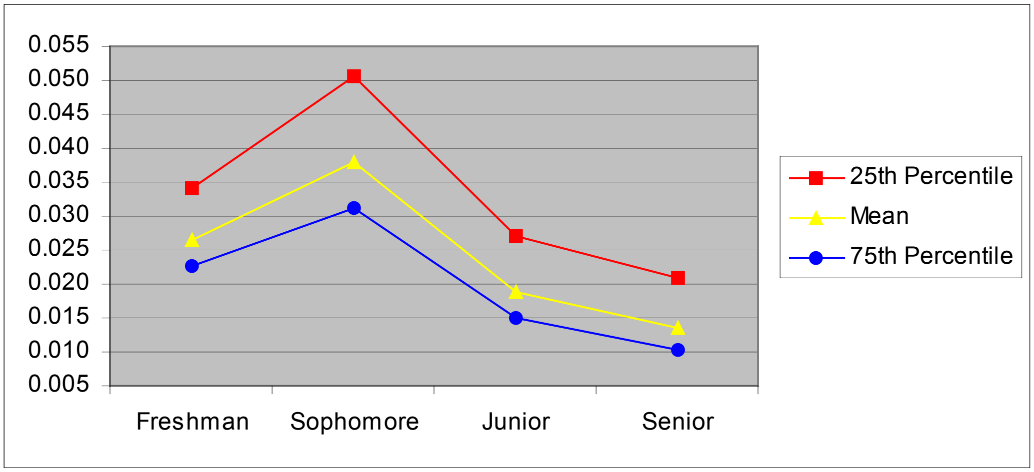
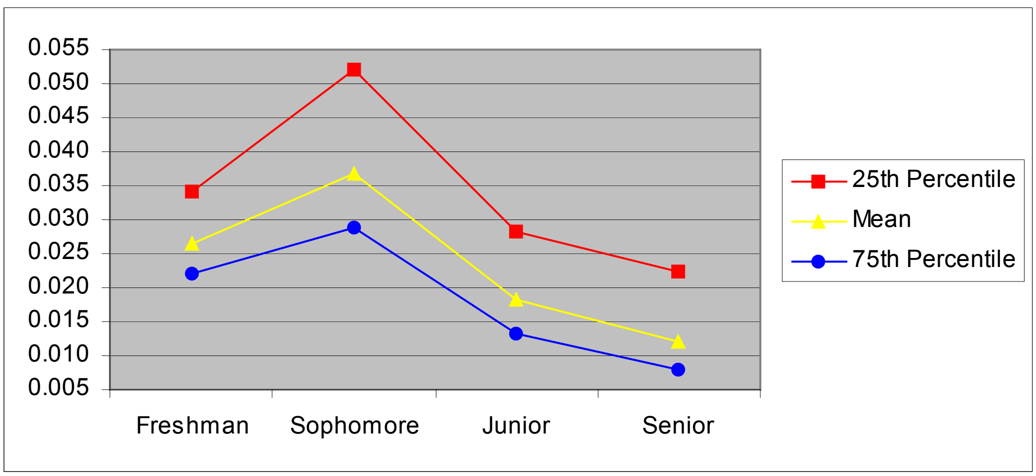
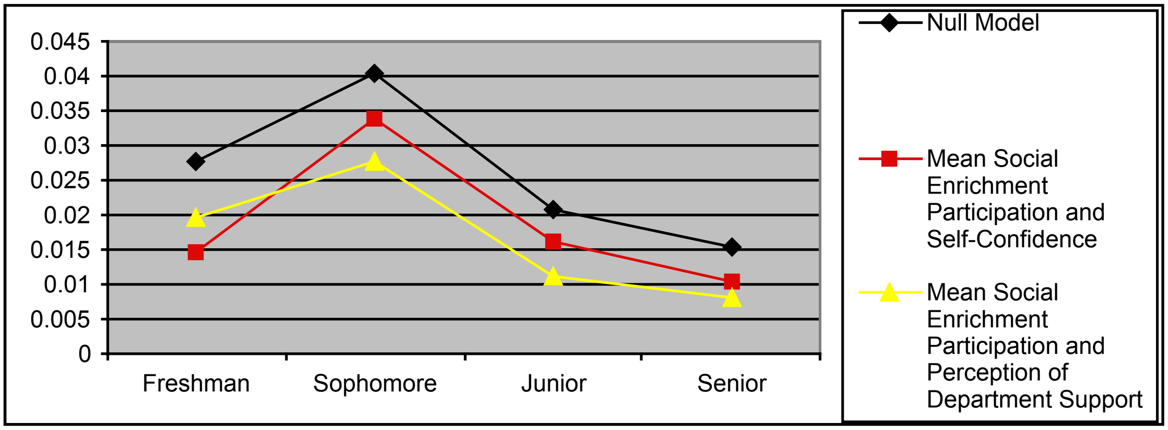


Figure 6-34
Model with Participation in Social Enrichment Activities as Predictor



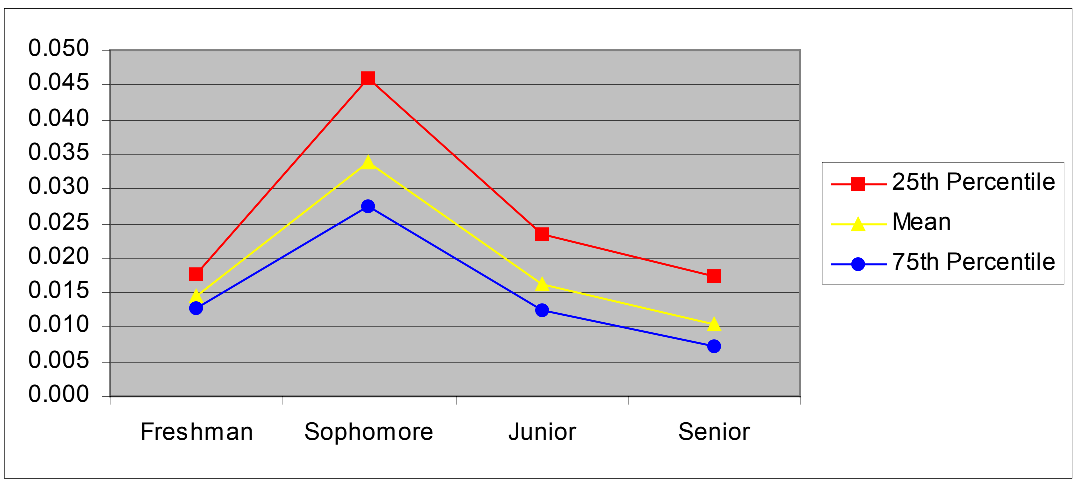
Participation in Social Enrichment Activities, even when controlled for mean Self Confidence Change (Figure 6-36) or, as in the next model, controlled for mean Perception of Department Environment (Figure 6-37), is consistently associated with a lower risk of leaving than the null model predicts (Figure 6-35). Students who participate in social enrichment activities are less likely to leave engineering than those who participate less, or do not participate.

Figure 6-35
Hazard Models of Participation in Social Enrichment Activities, with Other Controls



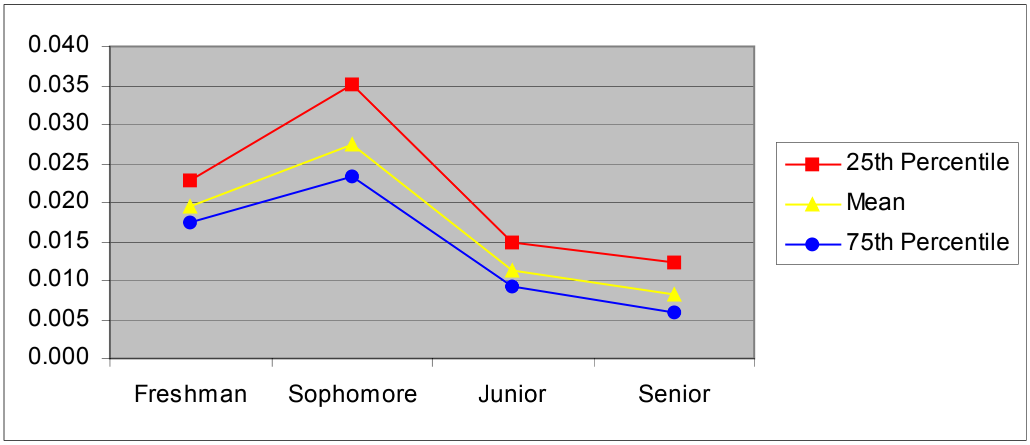
Even students who participate less frequently than the mean in social enrichment activities – students at the 25th percentile (Figure 6-36) – have a lower risk of leaving engineering than predicted by the null model, when they have a mean level of Self Confidence Change.

Figure 6-36
Model with Participation in Social Enrichment Activities as Predictor, Controlled for Mean Self Confidence Change



Participation in Social Enrichment Activities – even less participation than the mean – is associated with a lower risk of leaving, for students with mean Perception of Department Environment. This is especially the case for sophomores.

Figure 6-37
Model with Participation in Social Enrichment Activities as predictor, Controlled for Mean Perception of Department Environment



SUMMARY

Students receiving higher grades are more likely to later stay in engineering than those receiving lower grades. However, many students who received A's or B's later went on to leave engineering. These leavers reported finding their grades more discouraging than students with similar grades who subsequently stayed in engineering. Students who later stayed in engineering were more likely to report having participated in an internship, and reported more frequent participation in study groups, than students who subsequently left engineering.

Participation in support activities, particularly participation in activities to get help or social enrichment activities, was significantly associated with students having a more positive perception of their department. Students with more positive changes in self confidence also tended to view their departments more positively. Participation was associated with more positive departmental environment perceptions only for students who ended up staying in engineering, not by those who eventually left.

Students who participated in support activities and who had more positive changes in their self confidence also tended to view their classroom environment more positively than those who participated less or had less positive changes in their self confidence. Students who sought help, however, tended to feel more negatively about their classroom environment than those who did not participate in get help activities – with the effect stronger for leavers than for stayers.

Students' changes in their self confidence from the time they entered college were reported as more postive by those who had participated in either get help or social enrichment activities. Participation in social enrichment activities had a positive moderating effect for both stayers and leavers, but only stayers also experienced positive self confidence change after participating in get help activities: leavers had a more negative change in their self confidence.

Stayers were more likely to participate in all types of support activities than leavers. They also perceived their engineering department environment more positively than leavers. Students' perception of their department environment, their perception of the classroom environment, and their participation in support activities for social enrichment all predicted their likelihood of staying in engineering, with those students having more positive perceptions or participating more frequently in social enrichment activities being significantly more likely to stay in engineering in later years. Findings from event history analysis supported these results of the between-year leaver-stayer analyses.

Chapter 7: Student Focus Groups

During our site visits to the 11 schools, members of the WECE research team conducted 21 focus groups with female undergraduate students in engineering. The focus groups, held during spring term 2000 and fall term 2000, allowed us to obtain qualitative data that the web-based questionnaire, administered to thousands of students, could not gather. We also wanted to ensure that we had not overlooked in the student questionnaire any substantial factors that influence students' decisions about and pursuit of an engineering major.

Focus group questions were asked following a protocol designed by the research team (see Appendix B-7) and covered:

- Why students chose engineering
- Challenges in the major: workload, curriculum, and grading
- Being female in engineering
- Relationships with peers
- Quality and influence of engineering faculty

The remainder of this chapter contains a description of the student focus group selection process, followed by descriptions of the themes that emerged from the groups.

Student Focus Group Selection

At each of the 11 site visit schools, WECE staff randomly selected participants for the focus groups from a list of all female undergraduate engineering students currently enrolled. From the 30 to 40 we selected for each group, we hoped to net 10 participants. At a few of the schools we visited, we also recruited students who were active in either WIE or SWE, obtaining student names and contact information from the WIE program or SWE officers. Each student was contacted and asked to participate via email. In a number of cases, many more signed up than ultimately attended. Due to various schedule conflicts and no-shows, an average of six women attended each group, for a total across all groups of 123 participants.

At two schools, we conducted separate groups for first- and second-year students and third- through fifth-year students, surmising that students in the first two years of school would have different issues and concerns than more advanced students. However, due to the difficulty with scheduling these groups at times that did not conflict with study groups, lectures, lab, or other activities, at most schools we held two focus groups each of which included women from all undergraduate levels. Table 7-1 presents the type and number of participants in the focus groups.

Table 7-1
Type and Number of Participants in Focus Groups

Institution	Group Type	Number Attended
Tufts University	Mixed	6
Rensselaer Polytechnic Institute	First- and second-year	7
	Juniors and seniors	5
University of New Mexico	Mixed	5
	Mixed	5
Rochester Institute of Technology	Mixed	8
	Mixed	5
North Carolina State University	Mixed	6
	First- and second-year	3
Cornell University	Mixed	7
	Mixed	7
University of California, Davis	Mixed	4
	Mixed	7
University of Connecticut	Mixed	2
	SWE members	10
Oklahoma State University	Mixed	2
	WIE participants (sophomores and seniors in mentoring program)	5
Pennsylvania State University	WIE participants	16
	Mixed	2
University of Wisconsin, Platteville	SWE members	4
	Mixed	7
TOTAL ACROSS ALL 21 GROUPS		**123**

BACKGROUND OF FOCUS GROUP PARTICIPANTS

Prior to the focus group, we asked each woman to complete a background survey. Table 7-2 lists some basic statistics about those students who filled out the survey.

Table 7-2
Profile of Focus Group Participants

Undergraduate year	Participants	Majors
21 first-year students 22 sophomores 15 juniors 30 seniors 9 fifth-years	76 randomly chosen students 22 WIE participants	3 aeronautical/astronautical engineering 3 agricultural engineering 1 biological engineering 15 chemical engineering 13 civil engineering 13 computer science 11 electrical engineering 3 engineering science 1 environmental engineering 5 industrial engineering 15 mechanical engineering 3 materials science 15 other engineering majors

RESULTS OF FOCUS GROUP DISCUSSIONS

A number of themes emerged from the focus group discussions. These revolved around reasons for choosing the engineering major, the difficulties of the major, what it meant to be a woman in an engineering major, getting along with peers, and the role of faculty members and their teaching in the students' academic pursuits.

Why Students Chose Engineering

Many students said that when they entered college they did not know much about engineering or understand what an engineer really does – a feeling that for some persisted even after they had taken several engineering courses. Despite this, most students in our focus groups said they had decided to major in engineering before they entered college. Roughly one-quarter of the students explained that having a family member (parent, sibling, or other relative) who was an engineer was important in their decision to pursue engineering. Some students said that having relatives in engineering established a precedent that they wanted to follow. Others who said that the family member in engineering did not directly spur their interest said that that person, at the very least, had introduced them to the idea of engineering. The interest and the encouragement of high school teachers also drew a number of them to engineering.

> *"My dad, grandfather, and sister [were all engineers]. It was predestined."*
>
> *"I have an uncle [in engineering]. I work with him, [although] he's not really the one who got me interested in doing engineering."*
>
> *"My high school teacher really got me thinking about the major."*

A majority of the students in the focus groups said they were drawn to engineering because they felt confident in their math and science abilities in high school, and they liked those subjects. Some said they took an engineering class in high school or completed an engineering internship. Students liked the "applied" aspect of engineering, and viewed engineering as an extension of math and science.

> *"The difference between scientists and engineers–[one's] thinking and [the other's] doing."*

Several women discussed their childhood background and early experiences with mechanics. A few students stressed that early "tinkering" with machines was important in forming an inclination towards engineering. They noted the joy they felt disassembling machines and figuring out how they worked, and how the experiences of taking things apart either at home or on their farms developed into a general curiosity about how things work. (Other students, who had not had this experience with machines, felt lacking in these skills.) A number of students also cited their abilities to solve problems, tackle challenges, and accomplish goals as qualities that oriented them toward engineering.

Another experience that attracted students to engineering was the pleasure of mastering a concept or learning more about the actual work of engineers as a result of doing a research project or an internship in industry.

> *"I meet a lot of people who say engineering is hard. Usually it's doable for those people who are passionate about what they are doing."*

Some students in our focus groups felt they did not have adequate experience with machines and thus felt lacking in skills that male engineering students often have in working with machines. One such student blamed her upbringing: *"My dad didn't teach me about engines, torque, all the things men [here] know about… machines, building things."* Another student explained, *"I took ballet lessons; I wasn't working on cars."* These students felt they missed a critical step their male peers took for granted. Nonetheless, there were other influences that overrode this feeling of "something lacking."

Many of the students in our focus groups said that they decided to become engineers because they wanted to prove to themselves, to their friends, to their families, or to society that they could succeed in this challenging field. Respect and social prestige attained while participating in a challenging college program were some of the most encouraging factors.

> *"People say, 'Wow, you're an engineer – you must be so smart!'"*

> *"Even if students aren't sure what engineers do, they know the name connotes achievement.*"

Other reasons for majoring in engineering or exploring the field (each mentioned by a few students) included:

- specific areas of engineering that attracted them, like construction or aeronautics
- a desire to help others, solve social problems, protect the environment, or conduct lifesaving medical research
- the value of an engineering degree in gaining entry to business or medical schools

Perceptions of the Engineering Major

Students viewed engineering as a discipline that requires "grit" and "perseverance." A common theme in all the focus group discussions was the idea that to graduate from college with an engineering degree one just needs to "stick with it" through the good and the bad, also expressed as "you either make it or fail." Several students spoke of the self-esteem they derived from simply getting through.

> *"College is hazing for engineering students."*

> *"It's not about how smart; it's about how determined [you are]."*

> *"There are only a select few that will succeed. I will stick with it. A few experiences have kept me going through these classes. What else would I be?"*

> *"I will cheat myself if I don't continue in engineering. Anything else is too easy."*

Challenges in the Major: Workload, Curriculum, and Grading

Students in our focus groups found at least three aspects of their engineering courses to be very discouraging:

- a heavy workload
- a restrictive curriculum
- the practice of grading on a curve

Nearly all students complained that they had more work than did their non-engineering peers. A number of women argued that that the high volume of work meant *"we don't have enough time to let things sink in."* A theme heard repeatedly in the focus groups was that the heavy workload left little time for extracurricular interests. Some students remarked that they were torn between having fun and being an engineer, referring often to the stereotype of engineers lacking social skills. Students noticed that their non-engineering friends were able to socialize more and didn't have to spend as much time studying and preparing for class.

> *"My roommate was a hotel major and I never saw her work the whole time. I never left my desk that whole year. Comparatively, my friends in the other schools have more free time, relax a lot more. All the majors in engineering work harder."*

The engineering curriculum bothered students as well: they felt they had "way too many" required courses, and many found the structure of their engineering curriculum frustrating; they were "stuck in large, theory-oriented lecture courses" in their first year and only learned "real" engineering concepts and practice later in their college careers. Some students also felt that the standard engineering curriculum was inflexible; at several schools, focus group participants said that the school revised curricular requirements for engineering while the students were enrolled in the program, but still held students to satisfying the new requirements.

Many focus group discussants opposed the way engineering courses were graded, with many citing grading on a curve as a source of anxiety and competition. While some students liked knowing where they stood in relation to others in the class, others felt that low class averages indicated that professors didn't care whether they learned what they needed to know.

> *"The average grade may be 40, but after a while you feel like crap. We're only getting 40% of the material."*

Being Female in Engineering

Almost all of the women in the focus groups commented on how few women were studying or practicing their discipline. Most said there were situations where this was acutely noticeable, such as being one of a few women in class.

> *"You see it on paper [the fact that engineering is mostly men], but [the ratio] doesn't sink in until you walk into a chemistry class and there are only five girls in a class of 70."*

One student observed that improving the gender ratio altered the dynamic.

> *"Having more women in classes and in the faculty changes the climate – it means that guys don't give you looks or grief."*

Despite this, many hesitated to link their discouraging experiences to their gender, saying that everyone in engineering is treated "equally crappy." By accepting engineering as difficult no matter what, women may see their minority status as just another challenge.

> *"I don't care [that engineering is a predominately male field], I'm a woman, and you can't change that... I'm extremely well suited for what I'm going to do."*

Some students in our focus groups said they have trouble distinguishing whether they are treated differently because of who they are as individuals or because they are part of a collective minority, that of women in engineering. As women in engineering, most are aware of the fact that they are more visible than their male peers, and so their experiences stand out. Many did however feel that being in the minority had affected their experience in engineering – for example, being assigned traditionally female roles.

> *"In a lab, it's not really anybody's fault, but it happens that it's always the girl who ends up taking notes, it's hard to speak up and change that, you feel like a complainer."*

Some students were keenly aware that they were not welcome.

> *"I've felt that I'm not at home anywhere [here]. Guys dominate spaces so I change places where I study regularly."*

A number of women seemed uncomfortable with extra attention afforded them because they were female, and thought the term "woman engineer" was derogatory. A few first- and second-year students recalled negative remarks from male peers.

> *"One guy told me that the only reason I got in was because I was a girl. [The WIE label] gives us a bad name. I want to be treated the same."*

Several sensed that their professors "did not like women" and recounted incidents of their tolerating sexist jokes or comments from male students in the classroom or lab.
As women progressed through their college careers, and especially after they took internships in industry, they became more aware of how their gender affected the way others treated them as engineers. Some juniors and seniors described being harassed by co-workers or peers – experiences that made them more aware of gender bias. (Analyses of the focus group discussions indicated that women who participated in Women in Engineering initiatives were no more likely to report incidences of bias than those who did not participate in WIE initiatives.)

Women's perceptions of themselves as female engineers also appeared to be shaped by societal expectations of women and of engineers. A common theme was that smart women were intimidating to men; another was that they couldn't show any weaknesses. Many perceived that women must be especially competent or more competent than their male peers to succeed in engineering and challenge stereotypes.

> *"I don't know if it's because we are female, but we don't want to admit we need help."*
>
> *"I hide my intelligence because it intimidates guys."*
>
> *"I think it's intimidating for males to have females who are smarter than they are."*

Others mentioned that males often act differently when females are around, by watching their behavior and language.

> *"My first two weeks of class I feel like I'm proving myself… after the first two weeks, people start to come to me [after they see I can do the work]."*

Several women said they were the ones whom men seek for tutoring or advice, whether academic or social. But others recalled that the stereotype of women engineers as geeks persists and that their male peers seek out women to date at other colleges at their university.

Some focus group participants described situations where they perceived that women had an advantage over men in engineering, or vice versa. *"I've never been treated badly,"* claimed one student. *"In fact it's been the opposite. I have been the teacher's pet, and guys resent that."* One student commented that she and a female co-worker, the only two women on their co-op, received *"anything we needed. [I am] not afraid to take advantage of my being a woman or [my status as] a minority."* Another mentioned that her department head took her out to lunch, and one first-year said that guys buy her books. However, most had not perceived many benefits from being female: *"I've gotten rejections from a lot of internships. I heard they want women engineers, but I haven't come to see the results of that."*

Relationships with Peers

Women in our focus groups discussed whether their engineering classmates of different genders interacted differently. They described the extent to which they relied on their peers for support, and how discouraging they found negative interactions with fellow students.

Students reported differing experiences with male and female peers. Some thought women did well when they teamed up, for either moral or academic support.

> *"Women work better in groups. I work better where I'm associating with people when I work. I am gaining confidence, and showing them [my peers] that they are capable."*
>
> *"[In class] the guys know what they are doing, the girls don't and we stick together."*

Others thought men were more likely than women to engage with them.

> *"Guys are more friendly in engineering than girls. If I am the only girl in a group of guys, then I get to be more tough [than they are]. With another girl there is more competition even if you don't want it."*
>
> *"When I've worked with girls, [they're] like, `You don't know this, let me go ask a guy.'"*
>
> *"A guy is more likely to come to a woman than go to another guy. Guys fool around more."*

Some perceived differences in the ways men and women approached their work.

> *"Boys seem to intuitively know more things [mechanical skills]."*
>
> *"Guys have an easier time in engineering."*
>
> *"Guys are smart but they don't do the work. We're good at multi-tasking, guys are tunnel-vision."*

At one school, most of the focus group discussants said that neither the women nor the men in their engineering classes were particularly supportive.

> *"It would be so much easier if there was [more] interaction among women in engineering. Sometimes I feel so lost. I don't do what guys do."*
>
> *"I thought guys were my friends, but there was one class I just couldn't attend, so I talked to the professor and asked him if I could skip class one week and make it up with him in private. So I missed class, and the next week the guys started ignoring me. 'We don't want your laziness rubbing off on us,' they said to me."*
>
> *"Sometimes when I broke down last quarter and got to the breaking point and had guys who said, 'that was what you get,' and 'you came here to prove yourself – look at yourself.'"*

Students at some schools described competitive environments; at other schools students reported more cooperation among students. Competition among students was encouraging for some students but discouraging for others – and different students could interpret the same competitive environment as "exciting and dynamic" or "cutthroat, cold": a finding replicated by the open-ended and encouragement/discouragement questions on the student questionnaire, where some students cited competition as "encouraging" and a reason to choose engineering, where others felt the opposite.

Some students said that grading on a curve made students less willing to help each other. The "weeding out" ethos of engineering led women students in our focus groups to compare themselves to their peers and to try to figure out "who is smart and who is not." On the other hand, some students felt the intensity and the rigor of the typical engineering courseload could bind engineering students together – the notion that "everyone is suffering with you."

Quality and Influence of Engineering Faculty

One factor that women in our focus groups routinely cited as either encouraging or discouraging was the quality of teaching in their engineering classes. Some schools we visited have responded to the call for better teachers by introducing faculty development workshops and stressing the importance of good pedagogy in engineering.

An engineering professor's ability to explain concepts and advise was of utmost importance to the students in the focus groups. Some reported really enjoying their engineering professors' approach to teaching.

> *"Most engineering classes bring in models, do problem solving, make you think things through."*

Others, however, felt that teaching was not a priority among many of the faculty.

> *"The professors make or break the class. Some are really absorbed in research and they are not especially concerned with the courses and the students."*
>
> *"If you are not here to be a professor, go get another job."*
>
> *"When you go for help, they [professors or teaching assistants] treat you like an idiot."*
>
> *"[I wish] that professors who are considered good could be an example to other professors and give a seminar for others."*

Nearly all of the women in our focus groups remarked how few female engineering faculty members there were at their school, and many said this was discouraging. One student commented that she calls her female professors – but not her male professors – by their first names. A few mentioned that their female professors were "more sensitive" to students' needs. Focus group participants tended to seek out female faculty members more often than male.

> *"Those women who are teachers in engineering, I respect a lot more because they have overcome domineering men to make it."*

A number of them mentioned their attempts to find good advisors, both male and female. A major source of discouragement for students was weak advising from their professors.

> *"My advisor doesn't know my name; he only evaluates me based on my transcript."*

SUMMARY

The results of the focus group discussions mirrored those of the large-scale student questionnaire. Among the 123 young women in our 21 focus groups, most had decided to major in engineering before they had entered college. A fair number of them were encouraged by family members and/or teachers. The majority had done quite well in and enjoyed math and science in high school. Some had the opportunity for hands-on engineering experiences early in their lives, but even those who hadn't knew they wanted to go into engineering.

The engineering major itself was viewed as challenging for a number of reasons; in fact, "perseverance" and "overcoming difficulties" were mentioned often. A heavy workload, a restrictive curriculum, and the practice of grading on a curve were discouraging to many of the focus group participants. Virtually all participants said the lack of many females in their major was noticeable, however, there were varying opinions about how this affected their experiences. Some felt that being a woman caused them to be singled out negatively or not be welcome, while others felt they had an advantage being a woman, and still others believed that everyone had a difficult time, female or male.

Participants also had varying relationships with their engineering peers and with engineering faculty, in terms of moral and academic support. The lack of female faculty members was discouraging to many of the young women. However, they wanted to find supportive, strong faculty advisors, regardless of gender.

Chapter 8: WIE Director Interview and Survey

Directors of WIE programs served as major informants for the WECE study. WECE staff interviewed and surveyed the WIE directors (n=28[1]) at every participating WIE institution – a 100% response rate. Given the constantly evolving nature of the programs, we collected data on three separate occasions: a short phone interview in summer 1998, a semi structured hour-long interview in fall 1999, and a short web survey in winter 2001. The primary purpose of the interviews and subsequent survey was to obtain a more comprehensive understanding of what exactly the WIE programs offered and what issues directors of WIE programs face.

The interviews included questions about five topics: the director's personal background, the history of the WIE program, faculty and administrative support, programs offered, and advice and future plans. The follow-up survey asked for a detailed breakdown of the program's funding sources and budget, both by staff salaries and by funding for activities; it also included space to indicate which activities the WIE program offered in the academic years 1999–2000 and 2000–2001, and it asked about the nature of the relationship between the WIE program and the Society of Women Engineers (SWE) chapter on campus.

In this chapter, we present the findings from our data collection with WIE directors, primarily from the one-hour interview. Appendices B-4 and B-5 contain the protocols for the interview and for the web survey.

RESULTS

As described in Chapter 3, institutions were eligible to participate in our study if the school's WIE director worked more than 25% time on the program and her position was paid by the university as a separate responsibility (rather than an extension of a faculty position).

Respondents' Backgrounds

All 28 WIE directors were women. Twelve had a Ph.D., eight had a master's degree, and eight had a bachelor's degree only. These degrees were primarily in either social sciences (12 of 28) or engineering (8) and science (4); two others had liberal arts degrees and two had professional degrees. Those with social science degrees had backgrounds in education, psychology, sociology, or student services. In a 1991 national study of Women in Engineering programs, Wadsworth and LeBold found an association between administrators with experience in education settings and significantly larger percentages of women enrolled in undergraduate engineering programs. They suggested that schools of higher learning should be more inclined to hire administrators who had been employed in educational settings for their previous experience in recruiting and retaining students (Wadsworth & LeBold, 1993).

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[1] There were 26 WIE schools in our sample, but two institutions had both a Women in Engineering program director and a Women in Science and Engineering program. At these schools, we interviewed both directors.

Of the WIE directors with doctorates, approximately equal numbers were in social sciences and in engineering. (There has been some disagreement about whether a WIE director should have an engineering degree. In 1993, Brainard argued that directors with social-science backgrounds were better equipped to administer support programs (Brainard, Kelley, & Wahl, 1993). However, the tide seems to have shifted more recently: some institutions are stipulating engineering degrees as prerequisites for WIE director positions.) About half had experience in engineering, either in industry or in academia. Eight of the directors in our sample had founded their school's WIE program.

Some programs in the sample are over twenty years old, while other programs were started very recently. The oldest WIE program, at Purdue, was started in 1969; the next oldest programs began in 1979 and 1987. The majority of programs in our sample (n=24) began between 1989 and 1995. The three youngest programs in our sample began in 1996, 1997, and 1998.

WIE programs are situated in different departments at their respective universities, depending on the university structure (Anderson-Rowland et al., 1999). Most of the WIE directors in our sample reported to a dean (11) or an associate dean (9) in the engineering or academic affairs departments of the universities; four reported to a provost and four to the president.

Responsibilities and Staffing

Directors' responsibilities most often included recruiting (22 of the 28 respondents), retention efforts (21), fundraising (14), and advising students (12). Not all directors worked 40 hours per week; some directors divided their time between WIE program activities and other responsibilities. Of the 13 directors who reported whether they were full-time or part-time, 10 of the directors spent 100% of their weekly hours on WIE programs, while the other three spent part of their weekly hours on WIE activities. Many WIE directors reported frequently feeling stretched too thin.

Many directors reported that their programs were inadequately staffed: most were supported by staff who were part-time (14) and/or work-study students (21). Only about one-third (9) had full-time staff.

Activities Offered by WIE Programs

Directors were asked to list their WIE program's current activities during the short interview in 1998 and were asked to verify and update the list in 1999. Table 8-1 summarizes the types of activities offered by the WIE programs at the 26 schools in the WECE sample and how many schools offered each.

Table 8-1
Activities Offered by WIE Programs at WECE Schools

	Activities	# of schools offering
Outreach Activities	Kindergarten-12th grade	24
	Prospective students	15
Scholarships	Scholarships	12
Mentoring	Professional mentoring	13
	Peer, group mentoring	15
	Mentoring by graduate students	2
Career Development and Exploration	Career preparation workshops	12
	Career resource center, advising	9
	Industry networking	9
	Internships	7
	Plant visits	6
Study Skills and Help	Study groups	6
	Introductory/overview classes	5
	Hands-on workshops & classes	5
	Tutoring	5
	Study skill workshops	3
Social Enrichment	New student welcome/orientation	7
	Retreats	5
	Outings	3
	Social activities	3
	Meeting/lunch space	2
Support	Focus groups and discussions	6
	Residential clustering	6
	Counseling	4
	Class clustering	3
Publicity	Newsletter	7
	Web page	5
	Electronic newsletter/ email	2

Most Valued Activities

To find out which WIE activities the directors thought were most important, we asked them which activity they would choose if they could only keep one; we also asked which activity they perceived as most popular among the students. Responses to those two questions are presented in Tables 8-2 and 8-3.

Table 8-2
Activity WIE Director Would Keep

Activity type	# directors citing
Mentoring	10
Orientation	4
Counseling	2
Internship	2
Summer camp	2
Special program	2
Class clustering	1
Female Eng. Dorm	1

Table 8-3
Most Popular Activities

Activity type	# directors citing
Mentoring	7
Career day	4
Orientation	4
Speaker	3
Internship	2
SWE	2
Scholarship	2
Female Eng. Dorm	1

Of the 24 directors who specified which single activity they would keep, 10 directors said they would keep the mentoring program; this was mentioned far more often than other activities, and also topped the list of most popular activities. Mentoring programs serve a larger number of students than do other types of activities, are relatively inexpensive to run, and can simultaneously build academic and social support networks.

> *"Just to have the support of an upperclass female engineering student who has been through the same thing can help them to network with each other; they find they are not alone, they study together sometimes; academic support, social support, wrapped up in one."*

Other single activities directors said they would keep if they had to choose only one included research internships, orientation programs, academic counseling, summer programs, classroom clustering, and engineering dorms. Programs directors chose as most popular among students, besides mentoring programs, were career-day programs and orientation activities.

Some directors had a hard time choosing between certain more costly and more intensive programs, such as research internships, and other less expensive and less involved programs such as mentoring.

> *"I'd probably stay with the [research internship] program. Very costly, serves different students, we're finding that research affects persistence, and if you can get the mentoring relationship with faculty [there are] effects long-term. There is other informal mentoring that goes on and there are other student mentoring programs that aren't in science. There are other mentoring groups on campus."*

One director thought that the offering of a variety of WIE activities increased each one's individual impact: *"There isn't any one single program, no silver bullet; it's the cumulative effects of a lot of influences."* This director also noted the absence of hard data on the effectiveness of many activities:

> *"The programs have to be evaluated with serious controls. Can't answer if none have been evaluated in a serious way…. If I could only run one, I'd run the [research program]. This shows [students] what the practicing scientific world is like.... [They] have peer advisors who meet with them weekly. Our research shows us that [participating] students tend to be proactive in seeking help. We can statistically show a difference [between students who participate in research internships and those who do not]. That program has controls, because they turn away students."*

How to Help Students at Various Stages of Their College Careers

The majority of directors, when asked in the interviews, said that they did perceive definite differences between under- and upperclasswomen and that they had tailored their activities to these differences. WIE directors thought:

First- and Second-Year Students:
- Are more likely to participate in WIE activities than older students (mentioned by 14 directors)
- Do not perceive effect of gender on their experience as a female engineering student (4)
- Prefer on-campus, class-related, or SWE activities (3)
- Are less committed to the program (2)
- Are more likely to try a bit of everything (2)

Upperclasswomen:
- Are more likely to be involved in leadership positions (mentioned by 11 directors)
- Are too busy to participate (5)
- Are more selective in participation (4)
- Select job related positions (4)
- Like to participate in outreach programs (2)

Some directors (7) said that their school's WIE program was designed primarily to meet the needs of first- and second-year students.

> *"Absolutely [there is an age difference]. And it's intended that way. My philosophy is that they should be engaged in their academic department by their senior year. I target programs for first- and second -year, target leadership and individual contributions for upperclass. This place [the WIE program] shouldn't be a place where they should hide out."*

Directors also feel that students are less likely to perceive gender inequities when they first enter the university.

> *"Younger students tend to participate in activities pertaining [to] declaring their major or deciding what they want to do within engineering in terms of major or career. Older students have chosen their department, they are more tuned into the climate for women, they're moved out of large lecture classes to the more technical classes that are smaller where they are one of a few [women] or the only woman. They become more aware of being a minority.... They are the ones who will come and participate in discussions about climate, assertiveness workshops, those types of programs. It's interesting, the younger students have heard 'women are a minority,' but they don't really experience it because they aren't into the technical classes, haven't been subjected to the feeling of being a minority; that shifts as they get further along."*

Some women do not take advantage of WIE services because they do not want to be singled out on the basis of their gender (Vest, Goldberg, & Sedlacek, 1996). Some directors said that the perception among younger students that gender discrimination no longer exists in engineering meant that they had to be careful how they advertised their services to students.

> *"When I took this job I thought [women would] be beating down the door. [There is some] hesitancy, no one wants to feel like they need the extra help, [but] they love the programs. [They] provide opportunities for learning moments. If they can hear and see where are the women, the lights go on. Show them, don't tell them, what goes on.... They've already figured out there's not a lot of women, [but] they push that back. [T]hey are high achievers. They'll read the articles and say 'That hasn't happened to me.' I realized I had to get the word out to everyone in a different way, the dinners, the workshops. Everything falls into place, just constantly being an advocate for them, advice, discussion, bringing current students to first-year retreat, leadership opportunity."*

> *"The younger students, even though they [see] some, often deny that there are any issues. They see a career workshop as there to give info, not because there are issues from women in these careers. The older women have started to encounter these issues. It's walking a tightrope; I want them to be aware these issues exist. Often times they immediately internalize it, then they leave. I'd like them to know the issues are societal. If you present too much too fast you scare them away."*

Virtually all of the directors we interviewed maintained that, contrary to the impression of young students, sexual discrimination and harassment did in fact exist at their school, and that it had a significant effect on the experiences of female engineering students. One WIE director said that it takes a while for students to connect the offhand comments they hear in the classroom to a larger pattern of gender discrimination: *"They don't understand how repeated incidents build into their psyche."*

Advice to New WIE Directors

When asked what advice they would give to a new WIE director, experienced WIE directors focused largely on garnering support on campus – from the administration, the faculty, and other support program staff – and off campus, through networking with colleagues, such as other WIE directors at conferences such as WEPAN.

Table 8-4
Advice to a New WIE Director

Advice	# of directors mentioning
Get support from administration	17
Get support of faculty	13
Talk with students	7
Connect with other WIE directors	7
Join WEPAN	5

Get Support from the Administration
Because university administrators often control financial decisions and play a role in establishing campus climate and priorities, garnering support for the WIE program from the administration is very important. Susan Metz, current president of WEPAN and a WIE director herself, has stated that "creating a climate that promotes success among women and men takes the commitment of the entire administration and faculty" (Metz, 1996). The WIE directors concurred: their most frequent advice (n=17) was to secure the support of the administration.

> *"It's important to have the central administration support. I can't imagine running a program without it."*
>
> *"You need to have the entire school's support, from the president on down. Especially the dean's support."*

Quite a few directors said that building this support means that administrators and departments need to feel invested in the programs.

> *"Make sure that they [the programs] are well integrated into the college. This is absolutely critical. You can have the best program in the world, but if you don't have the financial and the administrative support…. [Give them a sense of] ownership of the program; they feel like they have a stake in your success."*

WIE directors were queried in the interviews about how supportive their administration was of the WIE program. Eighteen directors felt that the university was “very supportive” of the WIE program, eight felt the university was “somewhat supportive,” and two felt the university administration was “not supportive.”

When asked to describe how the university demonstrated its support, directors mentioned administrators publicly recognizing the program (n=20), program funding (n=13), office space (n=2), and staff allocation (n=1).

> *“When I had a program I didn’t have the money for, I took it to the dean,[and] he was very helpful in making sure he got the seed money…. Supporting events and program through attendance, making it known that we exist, introducing us to the donors involved with the university, making sure they know that the program exists, we are doing things.”*
>
> *“The money is important, obviously, but you can be funded and not have support. I would prefer to have support over money, in terms of speaking out about what you do, including in publications, etc.”*

Get Support of the Faculty

One measure of faculty support for WIE programs is the level of faculty members’ involvement in program activities. Twenty-one of the 28 directors said that faculty were “actively involved” in the WIE program, four said faculty were “somewhat involved,” and three indicated that faculty were “not involved.” Faculty can contribute to WIE programs in a variety of ways, as displayed in Table 8-5.

Table 8-5
Faculty Participation in WIE Program

Type of faculty participation	# of directors citing faculty participation in activity
Attend WIE activities	14
Give workshops	9
Help with summer programs	6
Advise SWE	5
Serve on WIE advisory board	5
Mentor students	4
Sponsor internships and research	4

Another way faculty members can support WIE programs is through building relationships with the program’s students, via research programs, mentoring, small class settings, and informal situations. Developing positive relationships with faculty has been identified as one of the most important means to improve students’ retention in and satisfaction with their major (e.g., Vest et al., 1996). WIE programs can help these relationships along by educating faculty members about the needs of female engineering students – particularly younger and at-risk students.

"[For our] academic research internships…of about 300 tenure-track faculty, usually in any given year at least 100 respond to the call for mentors. Same ones year after year; [some faculty] take more than one [student]; some are men and some are women. It's a good indication that a good number of faculty support our office. That's one of the most obvious ways they support us."

Talk with Students
In addition to enlisting the support of administrators and faculty, WIE directors advised others to communicate with students. Involving students in creation and running of the WIE program gives them a feeling of ownership of the program and can contribute to program success (Brainard, 1992). Seven WIE directors mentioned the importance of talking with students in determining what the students wanted from the program, and three directors noted the necessity of student involvement.

"Don't guess what people want, and don't just be informed by the literature. Talk to constituents often….Use the literature to inform about trends, be involved with your populations, let them get to know you, see you, feel comfortable contacting you. I'm having good success getting people on board,[asking] what women faculty and undergrads would like to see.... It's a fallacy to think you're going to do good programming without input from those you serve. You have to be responsive."

"One of the most important things is to know your audience. We have a tendency to dream up what we think would be good, spend time implementing things, [and] find they are not interested in participating. Finding ways to get to know the students is important."

Connect with Other Directors
Most WIE directors spoke of the need to draw upon the expertise and support of other WIE directors: 19 directors said they had "lots of contact" with other directors, two said they had "some contact," and only three indicated they had no outside contact. The ways WIE directors established these connections are presented in Table 8-6.

Table 8-6
Networking Methods of WIE Directors

Networking method	# directors mentioning
Attending WEPAN conference	20
Corresponding with director from similar school	16
Joining WEPAN listserv	15
Attending other conference (i.e., NAMEPA, ASEE)	8
Attending SWE conference	4
Corresponding with director from same school (i.e., MEP)	5

Conferences, particularly the annual national WEPAN conference and regional WEPAN activities, were cited as a main source of networking. Beyond conferences, directors mentioned the WEPAN listserv, one-to-one correspondence with directors of similar schools, and working with a Minority in Engineering Program (MEP) director or Women in Science and Engineering (WISE) director at their school. Advantages to networking included getting ideas for programs, sharing the outcomes of programs, and having a source of support. However, as one director pointed out, activities do not always translate directly from one institution to another:

> *"A lot of the ideas of what we've developed come from networking. Making it work here had a lot more to do with understanding how things work here. There is never a situation where you can take an idea and input it exactly. You have your own culture."*

Funding for Directors and Programs

In addition to gaining support from inside and outside the university, securing funding for the WIE programs is essential to program survival. Anderson-Rowland (1999) noted that:

> *"Most WIE and MEP directors are expected to raise outside funding for some of their programming. Most outside funding agencies expect that the university will provide basic support, personnel, office support, space, and supplies. However, if such programs have not been institutionalized, then the directors must expend considerable energy each year just to maintain the program."*

In interviews, we found that most programs have a combination of university-funded and non-university-funded line items in their budgets. In 23 cases, the director's salary was fully funded by the university; one director received partial salary from the university, and two directors received some salary money from corporations and foundations. The follow-up survey asked each director how her salary was funded and whether the source was from stable funds (such as a line item in the university budget), unstable funds (such as a dean's discretionary budget), or other sources. Fourteen of the directors' salaries were funded entirely from stable university funds, six from a dean's budget, and three from a combination of stable and unstable funds.

Aside from their own salaries, WIE directors needed to find funds for the various WIE activities they coordinate. These funds come from a variety of sources, as outlined in Table 8-7.

Table 8-7
Funding Sources for Activities

Funding source	# directors citing
Corporations	22
University	19
Government	9
Foundations	7
Alumnae/Endowment	3

Directors had varying views of fundraising. Some directors interpreted a lack of funds from the universities as a lack of university support for the program, and they felt the time spent fundraising detracted from the time they should be devoting to running activities.

> *"Corporations think the university should be[supporting us financially], and because we are the academic part the dean does not have an expectation that we should be raising money. If we're doing that [raising money] then we're not doing the job we should be doing."*

Other directors explained that seeking outside funding kept the program "on track" with the needs of the corporations, who are, in effect, the "customers" for the WIE programs.

> *"[The university] provides a small budget for the program, and [anything beyond that] I need to raise.… Having industry pay for it means that the industry supports having more women in the workforce."*

Although some directors were awarded grants often, others expressed concern about the growing demand for a piece of a shrinking pie of corporate funds.

> *"Now corporations have different guidelines, tighter guidelines, smaller amounts to more people who make requests. Whether external funding is from corporations or donors, it's more difficult. We made the case that the institution needs to step in."*

Even after grants are awarded, they may only fund a program for a few years, making it difficult for directors to do long-term planning.

> *"It's a big problem that [outside] funders are willing to start [programs], we have some multi-year, do have people who want something different every year. I tell them that's not productive for us, it's a big problem. There are not many institutions who will fund for two or three years, but having longitudinal funding helps planning a lot."*

SUMMARY

Being a WIE program director has its challenges. In the absence of hard data on the effectiveness of any single program activity in attracting and retaining women students in engineering, a director must decide how to allocate funds and staff to these activities. The adequacy of her program's staff and funding is directly affected by her skill as a fundraiser and by the amount of support she can drum up in the administration, the faculty, and industry. Student satisfaction and involvement is crucial to the success and effectiveness of the program – which means she needs to communicate effectively with the program's students as well.

WIE programs seek to support students academically, socially, and experientially. WIE directors surveyed felt that mentoring programs were the most effective way to do this. Other activities valued by directors included research internships, orientations, career days, speakers, and various social activities.

Sexual discrimination exists in engineering, but young students often are not fully conscious of this, and this poses an interesting challenge for WIE directors: how to attract women students to a program designed to offset the effects of societal and institutional sexism, if students are not aware of, and sometimes actively deny, the forces that make such a program necessary.

Chapter 9: Results of Engineering Deans Questionnaire and Interviews

The primary source of data from deans of engineering was a web-based questionnaire (Appendix B-2) that the WECE team developed and administered in autumn 2000 to deans at the 53 schools. The questionnaire contained 14 questions – a combination of check boxes, rating scales, and open-ended questions – covering four main areas: the dean's own background, goals and challenges at the dean's school of engineering, trends in the field of engineering, and the resources offered for undergraduate women in engineering. A final question solicited any comments they wished to make.

In addition to the written survey, the WECE team conducted in-person interviews with the dean or acting dean at each of the 11 schools that were selected for site visits. The interviews expanded upon the questions asked in the survey and also solicited deans' goals for their school, as well as their perceptions of the WIE program or other women and minority in engineering initiatives.

Fifty-one of the 53 schools are represented in the questionnaire results (96% response rate). At two schools, two administrators (a dean and either an assistant or associate dean) each completed the questionnaire, yielding 53 responses. Of the 53 survey respondents, 47 were men and six were women. Almost two-thirds of them have been at their university for over 10 years, and almost half for 20 years. About two-thirds became deans in the past six years, and virtually all have become deans since 1990; 15 were appointed in 1999 or 2000, 19 between 1995 and 1998, 15 between 1990 and 1994, and four between 1975 and 1984.

During our 11 site visits we interviewed 36 deans, assistant deans, and associate deans. All of the deans were men; of the assistant and associate deans, nine were women (they represented six of the 11 schools). We interviewed between one and six deans and assistant/associate deans at each university we visited.

The remainder of this chapter discusses the results of the written questionnaire, which are supplemented by quotes from the in-person interviews conducted during the site visits.

REASONS STUDENTS CHOOSE THEIR UNIVERSITY FOR ENGINEERING

Deans indicated what they believed were the top three factors affecting a student's choice of university to study engineering. The reputation or ranking of the school was the top factor (72% of the deans), followed by the quality of learning experience (60%) and the location of the school (47%). Also cited by at least one out of five deans were close interaction with faculty (32%) and financial aid package (23%). A handful of deans mentioned availability of liberal arts classes, research opportunities, support programs or resources, and the technical orientation of the school.

MOST SIGNIFICANT CHALLENGES FACING SCHOOLS OF ENGINEERING

When deans were asked to select the three most significant challenges facing their school of engineering, not surprisingly, their choices mirrored those of deans in many faculties around the country. The following challenges were cited by approximately half of respondents:

- Fundraising (mentioned by 51% of the deans)
- Increasing the number of women and minority faculty (51%)
- Increasing the retention rate of students (47%)
- Balancing the dual commitments to research and teaching (45%)

- The second tier included the following:
- Improving the caliber of students applying to their school (32%)
- Retaining faculty (26%)
- Increasing the number of applicants (21%)
- Creating links with other parts of the university (11%)

Fundraising

The challenge of fundraising was mentioned by half the deans in the questionnaire and by virtually all of the deans we interviewed during site visits. With more institutions clamoring for a "piece of the pie," fundraising has become even more competitive, not just across institutions of higher education but within them. Increasing the endowment was mentioned as a top fundraising priority; deans indicated that contributions appear to be tied to program enhancement and demonstrated response to pressing engineering issues.

Hiring, Retaining, and Promoting Women and Minority Faculty

Most deans we interviewed expressed a desire to hire more women and minority faculty members. Some engineering schools we visited have become more proactive in recruiting women faculty, realizing that these women are in high demand from other academic institutions as well as from industry. Others said that they were learning that to retain female faculty, they needed to reexamine the tenure process and to provide adequate child care options.

Deans who wanted to actively recruit female faculty mentioned both legal and practical limitations. First, making female candidates a priority is a challenge within a political environment where hiring preferences are illegal: for instance, at public institutions in California, Proposition 209 limits the wording that schools can use in job announcements, not specifying that they seek female candidates. Second, state-funded schools around the country may not have the money to compete with more competitive schools (e.g., private universities with large endowments) or with industry for strong female candidates. Third, not all female candidates are strong teachers.

Deans were aware that many faculty and staff were critical of their engineering department's seemingly slow efforts to recruit women – an attitude we confirmed with faculty we interviewed. One successful strategy some institutions employed was to track female graduates through graduate school and then ask them to return to their alma mater and teach. Another recruitment technique was to hire two women in a department at once to help allay some of the pressures associated with being the only female faculty member in a department. Other tactics included forming a hiring committee with a well-researched plan for recruiting women and developing networks within which to tap women candidates.

Some deans we interviewed were aware of the unique challenges women engineering faculty face – for instance, being asked to serve on many more committees. One dean noted: *"They have…gotten over putting a woman on every committee. We looked at this and said the women are getting worn out so that they are no longer going to do this. This was not fair."* Although this has eased up somewhat because of growing awareness of the problem, it is still often the case that women faculty members have to serve in this capacity more than men. One dean admitted, *"A male untenured professor may not serve on any committees; females don't have that luxury,"* implying that to succeed, women must endure that pressure.

Improvements in Teaching

Most of the deans at our site-visit schools recognized that teaching in engineering needs to improve, and they recognized that student satisfaction in the major depends on it. However, only a couple schools in our site-visit sample had begun formal initiatives to develop faculty members' teaching skills. Many have adopted a laissez-faire attitude to the "old boy" network of professors who resist change and are simply waiting for these professors to retire. As one dean confessed: *"These are respected faculty – it's hard to tell them what to do."*

Recruitment and Retention of Female Students

Although retention of female students in particular was not cited as a challenge, deans' comments indicated that they are searching for strategies to increase the number of women who apply to their school or college and to retain more women in engineering majors.

Some faculty and administrators have recognized that more women are now entering engineering because they are interested in engineering, not just because a family member prodded them into the field. Therefore, deans and others acknowledge, more recruitment needs to occur at the pre-college level, even before high school. Deans have also noticed that women have become leaders in engineering programs. One dean said that women make up the large majority on student council, professional clubs, and "concrete canoe" competitions, despite their minority status in the student population. One school started a pre-major program to attract students who wouldn't normally consider engineering as a major.

UNIVERSITY TRENDS

Responding to an open-ended question about ways they believe their university will change in the next 10 years, many deans' comments centered on the theme of growth and expansion – whether it was growth in the student body, in the faculty, in the university's physical facilities, or in degree programs. The growth trends described by the deans can be clustered into six major areas:

- Increased emphasis on research
- Changes within the student body and faculty
- Overall university expansion
- Increased use of technology
- Changes in curriculum
- Increased connections, local and global

Increased Emphasis on Research

One of the trends reported most often was that of the university placing greater emphasis on its research function, particularly at the graduate level – strengthening its research program or its reputation as a research university. Deans wrote that this emphasis on research necessitates a greater reliance on private funding, on economic development, and on growth and diversity among students and faculty – and that sometimes this shift in emphasis toward graduate-level research means a shift away from undergraduate education.

Changes within the Student Body and Faculty

Most deans described changes in both the student body and faculty as inevitable. They predicted that the student body will increase in enrollment, retention, preparedness, and diversity (racial, ethnic, and gender). They predicted that the faculty will also become more diverse, with more females, underrepresented minorities, and people from other countries. Turnover will increase, due to retirement.

In interviews we found that, by far, the biggest challenge facing the deans at our site-visit schools is bringing more students into engineering, especially women and underrepresented minority students. One dean asserted that the numbers are just too low: *"As a state and as a country we're below average – we're very cognizant of that. We see industries hiring engineers who were not born in the U.S.… It says we're not doing our share."*

Many also said that the need for more students has forced administrators to seek out untapped resources, even earlier in the pipeline. *"I think the [engineering] structure is not tapping into groups of students like females,"* explained a dean. *"We are not doing a good job of explaining what engineering is, at middle school and high school. There is not much we can do for students after they enter as freshmen."*

Overall University Expansion

A number of deans wrote that growth would be evident not only in the student body size but in the expansion of academic facilities and the physical plant. A surge in student enrollment would require hiring more faculty, except for those cases in which fewer faculty members are hired so that workload increases for current faculty. Adding new degree programs and/or new departments (e.g., biomedical engineering, aeronautical engineering) with an emphasis on academic reputation were mentioned by at least eight of the deans, while a similar number described new buildings that would need to be built to accommodate enhancements to academic programs, housing, and student services.

Increased Use of Technology

Hand-in-hand with expansion in the student body, faculty, and programs is an increased use of technology, described by at least 10 of the 53 deans. New facilities being planned or built will all be wired for telecommunications, and a few mentioned the growing impact of wireless technology on how engineering will be taught. A handful of deans anticipated an increasing emphasis on web-based distance-education courses, particularly at the graduate level. Some predicted that entire degree programs, not just courses, would be available via the web. Others wrote about using technology to complement more traditional teaching in the classroom. Technology may transform faculty into facilitators for learners, both on-site and at a distance.

Changes in Curriculum

A number of organizations and critics call for revamping the undergraduate engineering curriculum to make it more relevant to today's students, such as offering programs that are more interdisciplinary and innovative and that encompass and integrate biotechnology, life sciences, and business.

After increasing their institution's endowment and improving research, one of the biggest goals for the deans we interviewed was increasing the quality of the undergraduate experience. Many of the schools we visited revamped their curricula after conducting student surveys or similar internal evaluations, responding to feedback about students' struggles with time-intensive course loads and the rigidity of the engineering curriculum.

Several deans indicated that their schools had instituted changes to broaden the curriculum and introduce engineering concepts from the very first semester. For instance, at one school, small hands-on courses based in physics and real-world interests have replaced computer science and drafting lectures as the first-year core. Other schools have developed general engineering courses that introduce students to all the engineering majors available at that school.

Increased Connections, Local and Global

Six deans mentioned that, in a more global economy, engineering programs and the universities in which they operate must reach out more to local, national, and world communities. This includes strengthening links to industries and communities throughout the state and becoming more engaged with the economic development of their state. It also entails reaching out more to pre-college students through tutoring and mentoring programs and expanding activities for elementary and high school students.

TYPES OF INITIATIVES OR PROGRAMS FOR UNDERGRADUATE WOMEN IN ENGINEERING

Deans were asked to check boxes indicating which programs or initiatives for undergraduate women in engineering existed at their institution. The initiatives and programs checked by the deans mirrored those mentioned by the Women in Engineering (WIE) directors in their surveys, although there was not necessarily a one-to-one correspondence between what a dean and WIE director at any given institution mentioned. The lack of congruence between the dean and WIE director at more than half of the 26 institutions with such programs indicates that perceptions of the nature of what is offered and by what entity are quite different.

Programs with "official" recognized and paid administrators most frequently checked the boxes for Minority Engineering Program (MEP) (n=32, 60%), WIE Program (n=27, 51%), and Women in Science and Engineering (WISE) (n=21, 40%). Twelve indicated that their school had an Engineering Diversity Program. The majority of schools offer a variety of programs or activities for women engineering students, regardless of whether they have an official WIE and/or WISE program. The programs most commonly offered among the schools surveyed were:

- Society of Women Engineers (SWE) student chapter (100%)
- Internship/co-op program (85%)
- Introductory "hands-on" lab/course (81%)
- Pre-college orientation (74%)
- Mentoring program (72%)
- Summer bridge program for high school students (62%)
- Resource center (47%)

Most of the programs for women undergraduates in engineering are funded by the university (92%) and rely on corporate donations (87%), while 66% use alumni/ae endowment funds, 45% obtain foundation grants, and 38% obtain government grants.

ADMINISTRATIVE SUPPORT FOR WIE PROGRAMS

Deans we interviewed during site visits were asked what they felt the WIE program had accomplished at their school. The accomplishment most commonly cited by these deans (and also by WIE directors) was increasing the number of women in engineering. The WIE program was credited with increasing incoming students' awareness of engineering as a major. Deans also mentioned that the WIE programs helped guide strategies for recruitment and retention. The programs helped improve the climate, a result of building networks of resources and support and of establishing connections between students and the campus and between students and the community outside the college.

Several deans we interviewed displayed enthusiasm for their WIE program's presence. Some deans had been involved in the genesis of the programs themselves. The WIE programs at these schools were integrated with the rest of the administration. At one school, the WIE director sat in on department meetings, and at another the dean oversaw an external advisory board for the WIE program.

Despite these successes, several deans noted that WIE programs were not a panacea for recruiting students or changing the climate. Others believed that initiatives specifically for women were not in keeping with fairness. One dean realized that women were hesitant to take advantage of the WIE program resources: *"It's a challenge to give them the resources yet not make them feel like second-class citizens."* Another saw the environment as beyond the scope of the WIE program: *"The bias…a lot is not malicious or intentional. People don't realize how they are interacting. Once you know what to look for, you can really see it."* However, deans are taking note of the program's activities and successes: *"The WIE program is allowing a forum for discussing; women want to vocalize things. They need a place, a forum to bring things up. I think [the WIE director] and her mentoring program are a gift."*

SUMMARY

The knowledge, beliefs, and priorities of deans of engineering determine the decisions they make regarding funding, program offerings, course offerings, and hiring of faculty – decisions that directly affect the quality of the undergraduate experience of women engineering students. The primary goals of the engineering-school deans we surveyed were to improve the quality of research, to meet the demands of growth, to bring technology into the curriculum, and to continue and expand K-12 outreach activities. The biggest challenges deans reported were raising funds, building faculty development initiatives, recruiting and retaining female faculty, and recruiting more students, especially women and minority students.

During site-visit interviews, all deans expressed support of the WIE program, yet levels of enthusiasm and knowledge about the successes and challenges of the program varied.

The quality of undergraduate engineering education for women is but one of a constellation of priorities that today's deans must attend to, and solid, reliable data upon which to base their decisions can be hard to come by. It is hoped that the results of the WECE study will enable deans to make decisions regarding WIE programs that will optimize their benefit to women engineering students.

Chapter 10: Results of Engineering Faculty Questionnaire and Interviews

The two sources of engineering faculty input were a web-based questionnaire and interviews with selected faculty during our site visits. During autumn 1999, the WECE project sent a web-based questionnaire to all engineering faculty at the 53 participating institutions. The faculty questionnaire, like the student one, was designed to be computer-adaptive and to take faculty 5–10 minutes to complete; it included 50 closed-ended questions and one open-ended question, on the following topics: (1) fields of interest,s (2) advising responsibilities, (3) teaching responsibilities, (4) teaching practices, and (5) beliefs about engineering education. The survey also collected basic demographic information.

Each of the 53 participating institutions provided the WECE staff with a list of email addresses of all tenure- and non-tenure-track engineering faculty and instructors, for a total of 7,421 engineering faculty. We contacted each by email, inviting them to participate in the survey. Multiple reminder messages (one a week for 4 weeks) were sent to non-respondents. Although 2,183 faculty members completed the survey (for a response rate of 29.4%), unfortunately, due to a computer error part way through data collection, 798 consecutive surveys were irretrievably lost (a random sampling, as far as we are able to ascertain). The final count of usable surveys was 1,387, representing 19.0% of the sample.

Faculty from every one of the 53 schools in the sample responded to the survey; school response rates ranged from 7% to 50%. Nearly 86% of the surveys were completed by male faculty. Of senior faculty respondents (full and associate professors), 9.0% were female; 27.4% of junior faculty respondents (assistant professors and instructors) were female. Our sample includes a substantial overrepresentation of female faculty in engineering; the national average of female senior faculty in engineering and computer science is 4.3%; the national average of female junior faculty is 14.3%. Nationally, 6.9% of tenure-track engineering faculty are female. (National Science Foundation, 1999)

At the 11 site visit schools, we interviewed 37 faculty, of whom 21 were female. The number interviewed at each school ranged from one to five. Most of the faculty members who participated in our interviews were suggested to us by the WIE program director; some of these were active in the WIE program and others were knowledgeable and/or supportive of the WIE program or women's issues in engineering on their campus. The remainder of this chapter presents results of the written faculty questionnaire, supplemented by a description of themes that arose from the site visit interviews.

BACKGROUND OF FACULTY QUESTIONNAIRE RESPONDENTS

The questionnaire respondents were predominantly male (nearly 86%) and Caucasian (84%). Almost 70% were associate or full professors, three-quarters were 50 years of age or older, and nearly three-quarters began working at their current university in 1980 or later. The most predominant fields of engineering, taught by 89% of the sample, were, in order: mechanical, electrical, civil/architectural, computer science, chemical, and environmental. Table 10-1 displays the averages for respondents on these background variables.

Table 10-1
Background Variables of Faculty Respondents, by Gender

Question (N*)		%Male**	%Female**	Total% ***
Gender (1,380)	Male			**85.7%**
	Female			**14.3%**
Faculty Position (1,384)	Emeritus professor	**100.0%** / *2.5%*	**0.0%** / *0.0%*	**2.1%**
	Full professor	**95.0** / *49.5*	**5.0** / *15.8*	**44.6**
	Associate professor	**83.9** / *24.3*	**16.1** / *28.1*	**24.8**
	Assistant professor	**72.3** / *16.1*	**27.7** / *37.2*	**19.2**
	Adjunct professor (any rank)	**85.7** / *2.5*	**14.3** / *2.6*	**2.5**
	Lecturer	**65.2** / *2.5*	**34.8** / *8.2*	**3.3**
	Instructor	**76.9** / *0.8*	**23.1** / *1.5*	**0.9**
	Other ___________________	**61.8** / *1.8*	**38.2** / *6.6*	**2.5**
Racial/Ethnic Background ****(1,387)	White	**86.0%** / *84.7*	**14.0%** /*82.7%*	**84.1%**
	Indian Asian (e.g., Indian, Pakistani)	**89.9** / *5.2*	**10.1** / *3.6*	**5.0**
	Central/Southeast/East Asian	**76.6** / *4.1*	**23.4** / *7.6*	**4.6**
	Hispanic/Latino(a)	**79.2** / *1.6*	**20.8** / *2.5*	**1.7**
	Black/African-American/African	**81.0** / *1.4*	**19.0** / *2.0*	**1.5**
	Native American/Alaskan, Amer Indian, 1st Nat	**100.0** / *0.6*	**0.0** / *0.0*	**0.5**
	Other ___________________	**89.4** / *3.6*	**10.6** / *2.5*	**3.4**
Fields of Engineering Taught (1,387)	Mechanical	**90.4%** / *22.3%*	**9.6%** / *14.2%*	**21.1%**
	Electrical	**89.5** / *20.8*	**10.5** / *14.7*	**19.9**
	Civil/Architectural	**85.4** / *14.9*	**14.6** / *15.2*	**14.9**
	Computer Science	**82.0** / *11.6*	**18.0** / *15.2*	**12.0**
	Chemical	**84.2** / *10.8*	**15.8** / *12.2*	**11.1**
	Environmental	**83.4** / *10.7*	**16.6** / *12.7*	**11.1**
	Metal/Material Science	**83.9** / *8.8*	**16.1** / *10.2*	**9.1**
	Biological/Biomedical	**81.1** / *8.4*	**18.9** / *11.7*	**8.8**
	Engineering Science/Eng Physics	**89.2** / *9.0*	**10.8** / *6.6*	**8.7**
	Industrial/Operations Research	**83.0** / *7.4*	**17.0** / *9.1*	**7.7**
	Aerospace/Aeronautics	**87.6** / *6.6*	**12.4** / *5.6*	**6.4**
	Agricultural	**89.5** / *2.9*	**10.5** / *2.0*	**2.7**
	Nuclear	**90.0** / *1.5*	**10.0** / *1.0*	**1.4**
	Geological Science	**76.9** / *0.8*	**23.1** / *1.5*	**0.9**
	Other(s)	**73.8** / *7.6*	**26.2** / *16.2*	**8.9**

Year Began Working at Current Univ. (1,372)	1959 or earlier	**100.0%** / *2.4%*	**0.0%** / *0.0%*	**2.0%**
	1960 to 1969	**99.5** / *10.2*	**0.5** / *0.5*	**8.7**
	1970 to 1979	**95.4** / *18.7*	**4.6** / *5.5*	**17.0**
	1980 to 1989	**89.8** / *31.6*	**10.2** / *22.1*	**30.2**
	1990 to 1994	**75.6** / *14.1*	**24.4** / *27.3*	**16.0**
	1995 to 1999	**75.9** / *23.0*	**24.1** / *44.3*	**26.1**
Year of Birth (1,372)	1929 or earlier	**100.0%** / *3.3%*	**0.0%** / *0.0%*	**2.9%**
	1930 to 1939	**98.2** / *16.2*	**1.8** / *2.5*	**14.1**
	1940 to 1949	**94.7** / *3.0*	**5.3** / *1.0*	**27.1**
	1950 to 1959	**85.6** / *3.0*	**14.4** / *3.2*	**30.1**
	1960 to 1969	**71.3** / *19.3*	**28.7** / *48.1*	**23.3**
	1970 or later	**74.8** / *1.7*	**25.2** / *6.7*	**2.4**

* The N of the population responding varies because respondents were able to skip questions.
** The first number, in bold, represents the percentage male/female within the category. The second number, italicized, represents the percentage of the category for males or females.
*** Percentages may not add up to 100 due to rounding.
****Respondents were allowed to check more than one option, so percentages do not add up to 100.

Most of our analysis focused on the sample as a whole or on differences between the responses of male and female faculty. To test for gender differences in survey responses, we conducted Mann-Whitney tests of significance. For the most part, male and female faculty gave similar responses to questions; in some cases, however, their responses diverged significantly. In particular, males and females described university and departmental climate and support differently, had differing perceptions of workplace conditions, and reported different frequency of hearing undergraduate women complain about unfair treatment.

OPEN-ENDED RESPONSES

Besides the closed-ended questions, an open-ended question on the final page of the survey requested: "Please write any additional comments you have about the experience of women undergraduate engineering students at your institution." Forty-five percent of the respondents (n=626) chose to respond to the open-ended question at the end of the survey, elaborating on their perspectives on women in engineering, the experience of female undergraduates at their university, incidence of sex discrimination, and several other topics.

The clearest finding from this part of the survey is that engineering faculty hold definite opinions on whether and how engineering education has a different impact on female students than on males. Faculty care about this issue, and many pointed out that they care just as much, or more, about the issue of engineering education for minority students. The perspectives expressed by our survey respondents are, additionally, as varied as those to be heard in society in general about issues of discrimination and affirmative action.

Included with the results of the rating scales are selected faculty comments that were written in response to the open-ended question. The research team selected these quotes not necessarily because they are representative in any way; rather, they illustrate the variety of beliefs that underlie the particular ratings given. These comments have been valuable in understanding the wide range of opinions that both male and female faculty in engineering hold.

FACULTY PERCEPTIONS OF STUDENTS' ACADEMIC PREPARATION AND SKILLS

The survey asked faculty to compare the academic preparation and skills of female undergraduates in engineering to those of male students. Faculty of both genders responded to this question in similar ways, as shown in Table 10-2. The only question that was answered significantly differently by sex (p=.014) was the question on students' "study habits"; female faculty had a slightly better opinion of women's study habits than did male faculty. It is interesting to note that both male and female faculty members perceive that the "academic preparation" and "study habits" of female engineering undergraduates are as good as, if not better than, those of their male peers. Only in "laboratory skills" were women rated slightly worse in the aggregate than men.

Table 10-2
Faculty Comparisons of Academic Skills of Female and Male Engineering Students

Skill Area	Females are…		
	Better	No different	Worse
Academic preparation (n=1,338)	41.0%	56.0%	3.1%
Study habits (n=1,335)**	68.2	31.3	0.4
Laboratory skills (n=1,313)	13.5	65.9	20.5
Engineering abilities (n=1,335)	12.8	75.6	11.4
Mathematical abilities (n=1,337)	20.6	71.3	7.7

**The only category in which faculty ratings differed by faculty gender: p=.014

Open-ended comments revealed a wide range of opinions about students' abilities. The four most prevalent (differing) opinions were:

- Women perform better than men, because those women who make it to engineering are the "superstars" (though such women may have less confidence than men).
- Women do worse than men, because they lack the needed background in math and science classes or in 'tinkering' experiences.
- There is no difference between male and female students at all. (Faculty who stated this often cited it as a reason that there are more women in engineering now than there were previously.)
- There were too few women in any of the faculty member's classes for them to be able to make a fair statement about women's abilities in general.

In their own words…

> *"Women students outperform male students in terms of grades relative to their entering SAT scores. They also are overrepresented in student leadership positions and in scholarship awards. They drop out at the same rate, but with better academic records. The WIE Program is GREAT!"*
>
> (male professor)

"I have stated that the female students generally have poorer academic preparation – my belief is that there is significant bias at the middle school and high school level to steer females away from upper math/chemistry/physics."
(male assistant professor)

"Even among male students, generally those who come from ranches or farms have more intuitive problem-solving skills because they were confronted with tools and 'how the world is put together and works' earlier and more regularly. And, because most young females with math and physics aptitudes get so little experience in activities like racing go-karts, servicing and driving a combine, building fences and terraces, or a host of others, they do not bring the same tools (notwithstanding wonderful grades in school) to the engineering workplace."
(male assistant professor)

"The day of the 'superwoman' student seems to have passed. Female students are now to be found at all levels of performance, from the best to the worst."
(male associate professor)

FACULTY PERCEPTIONS OF CONDITIONS FOR WOMEN IN THEIR DEPARTMENT AND UNIVERSITY

Faculty members were asked to indicate the extent of their agreement with each of three statements about the support for women in their department and their university (Table 10-3). Faculty members' perceptions of support for women were generally positive. Most faculty surveyed agreed that their department "is supportive of undergraduate women" (88.0% overall agreed with this statement) and that their department "is genuinely committed to helping undergraduate women complete their engineering degree" (84.8% overall agreed with this statement). As one male professor wrote, *"Women in engineering are welcomed and supported in this institution. I am very proud of this fact."*

In contrast, fewer faculty (30.1% overall) agreed that the engineering climate at their university "favors undergraduate men." Furthermore, male and female faculty's perceptions significantly differed on this question, with over half of the women agreeing and over half of the men disagreeing with the statement. Male and female faculty members also differed significantly on the other two questions about conditions for women faculty and students in their department. Women were much more likely to disagree both that their department is "supportive of undergraduate women" and that it is "genuinely committed to helping [them] complete their engineering degree."

Table 10-3
Faculty Perceptions for Support for Students

(N=1,353)	Agree		Neither		Disagree		Signif.
	Male	Female	Male	Female	Male	Female	p-value

My department is supportive of undergraduate women.	90.4%	73.6%	7.7%	17.1%	1.8%	9.3%	.000
The engineering climate at my university favors undergraduate men.	26.1	53.9	21.7	19.2	52.2	27.0	.000
I believe my department is genuinely committed to helping undergraduate women complete their engineering degree.	87.0	71.4	9.9	15.1	3.1	13.6	.000

Faculty were asked how they believed conditions compare for male and female engineering undergraduates at their university (Table 10-4). Female faculty were significantly more likely to say that conditions favor men (p=.000), while male faculty felt conditions were equal for men and women.

Table 10-4
Comparing Conditions for Male and Female Undergraduates in Engineering

Conditions for male and female engineering undergrads. . . *** (N=1,362)	Male	Female
Favor men (much better to slightly better)	25.6%	62.1%
Are equal for men and women	60.8	34.7
Favor women (much better to slightly better)	13.5	3.2

***p=.000

As with their responses on other gender-related issues, the written comments of faculty about the climate in the engineering department for women clustered into several different camps. The five most prevalent opinions were:

- They saw specific problems: attitudes of other faculty and leadership, the presence of a few old-fashioned “hold-outs”, problems with undergraduate men.
- They saw other issues as problematic, such as: campus safety, a lack of women’s bathrooms, or the climate of the wider campus.
- They indicated that the climate could be radically different within each of the disciplines of engineering.
- They saw no differential impact of the climate on women.
- They were very pleased with their department’s support of women students.

In their own words…

> *“Our department talks a lot about supporting women engineers, however they look at it as purely a ‘women’s’ issue and feel that women faculty should do it. The top-level faculty do not participate at all.”*
> (female assistant professor)

"There's an ''old-boy'' network from the top down and many senior faculty who refuse to see that gender biased language is sexist and offensive to women students….What is most appalling here is the sexism on the part of male students who are terribly hard on female faculty (much more so than they are on male faculty). The male faculty don't recognize it."
(female assistant professor)

"I believe a key factor in the unfavorable environment for undergraduate women here is the very low number of female faculty members and the poor (often hostile) treatment that those few receive…"
(male associate professor)

"Women undergraduate students continue to struggle with being a part of a culture that has traditionally been male dominated. Most faculty are not gender biased, but there continue to be a few faculty with negative attitudes toward women and [they] have a disproportionate impact on the climate."
(male professor emeritus)

"There is still a strong current of opinion among male faculty that women 'don't belong' in engineering. There is resentment among male students when females succeed. The principal barrier to progress in enrolling and graduating more women in engineering in my institution is an absence of leadership from the top, from the President, Provost and Dean of Engineering. The Dean of Engineering has made it clear that he views women in engineering, both faculty and students, as a 'liability' against which male faculty must be protected. The President and Provost appear to accept this as part of the culture of engineering."
(male professor)

"This institution does not do enough to support undergraduates in general. I am not sure how much of a differential burden that places on female students."
(female associate professor)

"Because I have a joint appointment, I teach undergrads in [two departments]. [Dept. A] is MUCH more supportive of women in engineering than [Dept. B], and that's reflected in the relative numbers of women in the two programs… [Dept. B] at [this university] tends to be a very conservative, rigid department, dominated by an 'engineering scientist' mentality. It is not supportive of women undergrads largely because it is not supportive of ANY undergrads other than a few students who are clearly headed for Ph.Ds..."
(male assistant professor)

*"…I see no *real* differences between the opportunities provided by the university to women versus men. I make no distinctions between the two genders in my interactions with students. Nor do I distinguish based on 'race' (whatever that means these days)."*
(male associate professor)

> *"I have been teaching for 13 years. The climate for female students has noticeably improved during that time. Faculty and male students now take female engineering students seriously starting in the freshman year, whereas 13 years ago some faculty and many male students didn't take female students seriously until the women had reached the junior or even senior level."*
> (male professor)

TREATMENT OF UNDERGRADUATE WOMEN IN ENGINEERING

Faculty members were asked three questions about how often they heard undergraduates complain about how female students were treated (Table 10-5). Female faculty reported hearing more complaints than did male faculty about unfair treatment of women undergraduates in engineering, and a majority of male faculty reported never hearing complaints about women students being treated unfairly.

Table 10-5
Treatment of Undergraduate Women in Engineering

How often have you heard undergrad students complain about… (N=1,349)	= 1x/year		< 1x/year		Never		Signif.
	Male	Female	Male	Female	Male	Female	
teaching assistants, lab assistants, or section leaders at your university treating undergraduate women in engineering unfairly?	14.2%	28.3%	20.5%	18.8%	65.3%	52.9%	p=.000
undergraduate men in engineering at your university treating undergraduate women in engineering unfairly?	16.2	29.4	21.9	23.5	61.9	47.1	p=.000
faculty members at your university treating undergraduate women in engineering unfairly?	15.6	40.9	25.2	25.1	59.2	34.0	p=.000

In commenting on discrimination against female students, faculty most often mentioned one of five themes:

- Leadership effectiveness and/or problems with leadership
- Faculty who harass or discriminate against women and/or the positive effects of faculty supportive to women
- Problems with male undergraduates treating females unfairly, or improvements in how male students treat females
- Harassment of female faculty, especially by male undergraduates, and particularly as it affected female students
- No evidence of intentional discrimination in their departments at all

Several comments described in particular the discomfort of male faculty that they have to be particularly careful with women, so as not to be accused of harassment – for instance, several wrote of never closing the door when alone with a female in a room, being careful not to touch female students, and so on. A few male professors mentioned being pressured or harassed by female students who they felt wanted special treatment or thought they were being treated unfairly.

In their own words…

> *"While we offer lip service to supporting women, men (especially faculty) who harass or discriminate against women are tolerated."*
> (male professor)

> *"(Freshman) Engineering Fundamentals classes discriminate against women, and male faculty members are known to discourage women or subtly harass them. The issue is an old one, but little seems to get done. I hear my students complain of this problem every year."*
> (male instructor)

> *"Before I acquired tenure, two female undergraduate students came to me and one other female faculty and told us they had decided to transfer out of our program because of the negative attitudes of fellow male students, because their work was not reviewed by the instructor (due to incompetence on the part of the instructor, I believe), and because they were "put down" in lab classes by male peers. I also had, the year prior, a woman undergrad tell me that the instructor had basically told her that women shouldn't be in the classroom. Now, one of those instructors (the latter) has since retired, but the other one is still on the staff. These are things over which I personally have no control. I don't feel I can do much. How many other female students leave due to these reasons? I don't know."*
> (female associate professor)

> *"In my opinion, the real problem that women in engineering face is that presented by undergraduate male students. I have had a female graduate TA harassed by male students in my class, and I have heard of numerous incidents where male students have behaved aggressively/impolitely towards female faculty members..."*
> (male associate professor)

> *"The women students on the whole are pretty happy with their experiences. Most who comment however note that they see me being treated unfairly and do not themselves want to become engineering faculty members."*
> (female adjunct professor)

> *"My institution has an extensive support system for women in engineering, and it has been my experience that women are almost universally treated fairly in the college of engineering. I have heard of isolated incidents of male engineering students harassing female engineering students, but they seem to be isolated incidents and are never looked upon favorably by the faculty."*
> (male assistant professor)

FACULTY ATTITUDES ABOUT WOMEN'S SUPPORT PROGRAMS

A large majority of faculty respondents (76.5% overall) said that their university should make special efforts to recruit women into engineering programs. While about one-sixth of both men and women felt neutral about this, only a small percentage disagreed that recruitment of women should be a priority. Slightly fewer, but still a large majority (70.5% overall), thought their university should offer special programs to address women engineering students' needs. However, more disagreed with this statement than with the statement about recruitment.

When it came to retention of women in their own department, there was less global agreement. Although more than half of faculty respondents (56.5% overall) agreed that more should be done to retain women in engineering majors within their department, nearly one-third were neutral about whether their department should do more, and 11.4% overall did not believe the department should do more in this area. This was typified in a male professor's comment: *"All faculty encourage member[s] of any underrepresented group to become engineers. We are doing a lot in this area already, and thus I don't see a need to do more."*

Women on the faculty were more likely than men to agree that their department should do more to retain women students and that there should be special university programs to address their needs, as displayed in Table 10-6.

Table 10-6
Faculty Attitudes about the Recruitment and Retention of Female Students

(N=1,354)	Agree		Neither		Disagree		Signif.
	Male	Female	Male	Female	Male	Female	
I believe my department should do more to retain undergraduate women in engineering majors.	55.4%	62.7%	32.5%	29.5%	12.1%	7.8%	p=.020
I believe that a special effort should be made to recruit women for engineering programs at my university.	75.7	80.4	15.2	16.6	9.1	3.1	p=.072
I believe that my university should have special programs to address women engineering students' needs.	69.3	75.5	17.7	16.1	13.0	8.3	p=.001

Faculty expressed a wide range of opinions regarding the desirability of support programs for women – from firm opposition to conditional support to fuller support. At one end of the continuum were those who believed that men and women should be treated exactly alike and were opposed to "special treatment" in any sense. Justifications for this viewpoint clustered into two major themes:

- Backlash against women for having these programs, or women's feelings of inferiority engendered by the programs' existence, makes having such programs worse than not having them.
- Faculty are in the business of educating engineers; support programs interfere with that mission. Support programs may help substandard students to stay in engineering or attract students into engineering for the wrong reasons, thus doing a disservice both to those students and to the field.

In their own words…

> *"We are trying to turn out good engineers, not racial, ethnic, or gender engineers. After all, would you (who are responsible for this survey) want a bridge you drive over every day to be designed by an engineer who was trained by a program, the principal focus of which was to instill competence, or by a program that is focused on divisive racial, gender, or ethnic preferences? I personally, and the Engineering College at our University, are devoted to turning out well-trained, competent engineers, and [to] not subordinating this goal to faddish social engineering from outside the profession."*
> (male professor)

> *"I think it would be useful to investigate the harm of backlash versus the benefit of female programs. Every time I personally have been a receiver of female-specific help (fellowships, whatever) the backlash has been severe and much more likely to undermine the benefit of such a program by trying to convince me that the only reason I had received the award was because I was female, not for the real reason of being a good researcher!"*
> (female assistant professor)

A second set of faculty expressed conditional support for women's programs. This support fell into three main camps:

- Mentoring or other kinds of support were acceptable, but not special treatment that excluded men or came at the expense of men.
- More effort should be put into supporting racial and ethnic minority students; women's programs hurt minority programs.
- Support programs were justifiable to the extent that they made up for any disadvantages women brought with them to the university, or satisfied any particular needs they had upon entering, but not beyond.

In their own words…

> *"I firmly believe that all should be done to encourage women to enter the field of engineering. But not at the expense of encouraging men also. I believe that there is a shortage of good people in [the field] and we should do what we can to encourage all people (male or female) to enter this field."*
> (male assistant professor)

"You ask whether women should be favored. I don't think any student should be favored. However, students have different needs and I believe it is important to meet these needs. Women students do have different needs than men students particularly because they are in the minority. Should they be favored – no. Should their needs be addressed – yes."
(male professor)

"The situation that I deplore the most is the occasional woman who got overly pushed by the woman-in-science movement and found herself in the engineering major without having a real interest in the topic…. I wished that those engaged in the women-in-engineering movement were less militant and more constructive, by promoting curricular changes that better address the way women relate to engineering: room for more creativity, more emphasis on systems than on parts, and more freedom in project selection."
(male professor)

"The real problem in our department is the under-representation of ethnic minorities – especially black students. That should be the focus of any recruitment efforts. Too often in the past, 'Women's Programs' have [been] the umbrella under which the white middle class has stolen resources set aside for minorities – it is a national disgrace."
(male professor emeritus)

"...I also strongly question ''programs to address women's needs'' as the needs must be defined. Our program has too much of a remedial tone/flavor/impression which actually hurts women, as it sends the message that's what they (we?) need... However, programs that focus on skills and strengths and career development as well as ''interpreting the environment'' can add something and are different. I still feel the numbers are the strongest impediment to the environment and that with better representation the environment would be different. To achieve this, much more effort needs to be focused pre-college. We are not losing women so much as not getting them in the first place."
(female assistant professor)

A third group of faculty support women's programs, and some expressed a desire to participate more, if more were available. Several of these faculty mentioned specific support programs and the specific benefits they provided.

In their own words…

"... Several years ago, [this university] created an innovative program…. It provides substantial opportunities to women that were not available in normal classes. [This program] is a team-based project course in which the teams are large and must organize themselves. We have found that women have held more than 30% of the leadership positions, despite their constituting only approximately 18% of all the program's students. Many of these women students express satisfaction with [this program] because it shows how engineering can have a direct impact on society...not just industry, defense, technology, etc. Several women have stated that they would not have continued in engineering if it weren't for their experiences in [this program]..."
(male professor)

> *"The Women in Engineering program is very strong and beneficial to the undergraduates in engineering at my university. As part of that, the Society of Women Engineers (SWE) chapter provides many opportunities for undergraduate engineering students to develop leadership skills, to find female friends and mentors, to interact with industry, and to succeed in the college…"*
> (female associate professor)

Attitudes toward WIE Programs among Site-Visit Interviewees

The comments of faculty we interviewed during the site visits generally mirrored those from the broader faculty questionnaire sample in their attitudes toward and support of women's support programs. (It is important to note that the schools in our site-visit sample all had WIE programs.) In general, the faculty we interviewed supported the WIE program at their institution. However, some were skeptical as to the program's effectiveness; some women faculty were uncomfortable with women-specific programs and others thought these programs placed another burden on their time and resources.

Several of the female faculty we interviewed had fought to establish support programs for women in engineering at their university, and many were involved in their WIE program's activities. Some saw a real need for a place of support for women in a heavily male environment, although they recognized that programs are not the sole solution to improving the engineering climate for women. One female professor observed: *"People tend to get complacent when something is working. We need to come up with new things [student initiatives] so [the established programs] don't stagnate."*

A large number of the faculty we interviewed were concerned about or uncomfortable with women-specific programs. Some thought "segregating" women sent the wrong message. *"I don't think we should just take the females and put them aside,"* said one female faculty member. *"We should get beside the men and let them fight for their rights. They will have to work with the guys. This is preparation."* Another felt all-female societies like SWE get typecast as a group of "male-bashers." Some women faculty appeared to dislike their impression of the belief behind WIE programs that women need extra support. As one said: *"I think a certain number of students should be weeded out."*

Other faculty members complained that women's support initiatives were an undue burden on their time, and several mentioned that they hadn't seen enough evidence of the programs' successes. One female faculty member explained: *"I wish they would get rid of the program… I haven't seen the numbers for attracting students. [The WIE director] recently asked female faculty to call the prospective female students, [but] I stay away from the program. The more you are a part of it, the more you are tagged to do."* A male faculty member said he thought his school's WIE programs were popular, but they hadn't shown gains in retaining women in engineering after graduation. Another woman faculty member agreed that effective programming for women is often "too late," as female undergraduates don't notice gender bias until they are in their final year or have graduated.

FACULTY PERCEPTIONS OF CONDITIONS FOR WOMEN IN THE ENGINEERING INDUSTRY

Faculty were asked to respond to three statements about conditions for women in the engineering workplace (Table 10-7). Faculty tended to agree that some fields of engineering are easier for women to enter than others. However, female faculty were significantly more likely than male faculty to agree that conditions are more difficult for women in the engineering workplace than they are for men. Male faculty were more divided in their opinions, and more likely to say they "neither agree nor disagree" that conditions are better, or worse, for women.

Men and women faculty did not share the same opinions about pay for women entering the engineering profession. Female faculty were significantly more likely to disagree that young women were generally offered higher-paying jobs at the start of their career.

Table 10-7
Faculty Perceptions of Conditions for Women in the Engineering Workplace

(N=1,351)	Agree		Neither		Disagree		Signif.
	Male	Female	Male	Female	Male	Female	
It is more difficult for a woman to balance a career and family in engineering than in most other fields.	38.6%	53.7%	26.9%	19.3%	34.6%	27.1%	p=.000
I believe women who are beginning their engineering careers are generally offered higher-paying jobs than are men.	28.1	14.5	43.1	33.2	28.8	52.3	p=.000
I believe it is easier for women to go into some fields of engineering than other engineering fields.	63.7	71.5	18.8	14.5	17.6	13.9	p=.002

Faculty were asked how they believed conditions compare for men and women in the engineering workplace. Male and female faculty had different viewpoints, with women significantly more likely to say that conditions favor men, as displayed in Table 10-8.

Table 10-8
Comparing Conditions for Men and Women in the Engineering Workplace

How do conditions compare for men and women in the engineering workplace? *** (N=1,348)	Male	Female
Favor men (much better to slightly better)	51.1%	84.8%
Equal for men and women	29.9	10.5
Favor women (much better to slightly better)	19.0	4.7

*** p=.000

Faculty who commented on conditions for women in the engineering workplace tended to mention specific problems: discrimination, lack of respect for women managers, problems with salary, and difficulty managing work and family. Some were particularly concerned about discrimination against minorities and about the barriers minority women in particular faced. Some faculty mentioned possible solutions, such as greater flexibility in hours and family leave.

Still others talked about preparing their students for the reality of work by telling them about what they might face and by putting them in touch with working engineers.

In their own words…

> *"In addition to being an Adjunct Professor at [university], I have been a Lab Director at a large lab for 20 yrs.… Since 1975, conditions for the female researcher have improved in industry but by no means are they satisfactory. For a female to become the boss of other male PhD researchers, she must be extremely capable not only technically, but also in handling the fragile male egos…"*
> (male adjunct professor)

> *"The main problem for female students begins when they have to pursue their professional career and, at the same time, have a family. In my opinion, it is in the interest of the whole society that they should get some help then. Longer maternity leaves, possibility of working from home, four day work week, name it."*
> (male professor)

> *"Women in the construction field are faced with the dilemma of long hours versus raising a family. Men in the field mention this to my students all the time. If any women are interested in construction, I try to put them in contact with women who are in construction so they can get a clearer picture of what they will face in the industry."*
> (male instructor)

> *"I think that there is still discrimination in the industrial workplace, particularly at high-level management positions. There also are very few women administrators in engineering academia. Although women still face significant discrimination, as evidenced by disparities in salary for example, I think that there is more discrimination against underrepresented minorities. There seems to be far less opposition to increasing the number of women in engineering than there is to increasing the number of underrepresented minorities. I think that minority women, in particular, face the greatest obstacles."*
> (male assistant professor)

> *"I believe it is a serious error not to prepare women, and minorities, for the discrimination they are going to face in the workplace. To pretend it does not exist is to hide one's head in the sand. It is important for them to know discrimination exists and to know how to deal with it in a professional manner. I tell my classes 'war stories' about women who have faced serious discriminatory problems and how they overcame those problems. To pretend that life is fair does a great disservice to our students."*
> (male professor)

ISSUES SPECIFIC TO FEMALE FACULTY

The questionnaire focused on faculty perceptions of students – students' abilities, conditions for students, and their own attitudes about female student recruitment, retention, and support. In the site-visit interviews, we also covered conditions for female faculty. A common theme in our interviews with female engineering faculty members was that they were overworked, and their inability to handle all of their responsibilities had an impact on the entire engineering school.

Female professors often discussed the multiple burdens of serving as a teacher, advisor, and role model for their students while trying to complete the necessary research required to get tenure and to earn the respect of their colleagues. As one said: *"Being a female means always to have to prove yourself more than the guys [do]."*

Most of the women we interviewed said they have at least double the advisees and work on twice as many committees as do their male peers. As a group, female engineering faculty constitute an even smaller minority than female students; sometimes they are the sole woman in their department. Yet they are sought out for advice more often than are male professors. One female professor said she found it hard to escape advising and committee work: *"A lot of people used to come to my door, but now I turn off the lights [in my office] and shut the door."* Balancing work with family was another concern for many women we interviewed. Some tried to ease their burden by working part-time or as a non-tenure-track faculty member.

Female faculty members have differing opinions on gender-related struggles. Many believe in the "weed-out" process – in the idea that only the tough survive engineering's rigor. However, more than a few faculty said they would appreciate some support themselves, for instance, in the form of a mentor. Overall, women faculty indicated that they thought the environment for women in engineering schools was getting better. Some said that their older male peers may have at first treated women in either a paternal or a hostile manner, but that now more male faculty have grown accustomed to the presence of women in engineering.

DISCUSSION

Engineering faculty we surveyed generally believed that female students' academic skills were comparable to those of male students, except for a slight disadvantage in the laboratory. Female engineering faculty were more likely than male faculty to say that the academic climate in engineering favored male students, and they reported hearing more complaints of unfair treatment of females.

A majority of both genders advocated actively recruiting female students into engineering programs, but there was less consensus on whether more ought to be done to retain women once they were there, and there was no consensus at all, among faculty of either gender, on the desirability of support programs for women students. Doubts included whether "special" status hurt women more than it helped, and whether the programs actually achieved their objectives of attracting and retaining females in engineering. Female faculty generally perceived conditions in the engineering workplace as more difficult for females than did male faculty, and they gave accounts of gender-specific pressures in their own careers as engineering faculty members.

Due to our low final response rate, the findings from this survey are not generalizable to the population of engineering faculty as a whole. However, we believe the results, both statistical and from the open-ended question, give valuable insights into faculty perspectives on issues of women in engineering. Seen through their lenses, schools of engineering are worlds in transition. We saw no clear consensus as to the state of the climate for women, or about whether and how women should receive special support. Faculty members of both genders hold a wide range of opinions, particularly regarding the need for and the impact of women's support programs. Since there is no consensus in educational and leadership circles on the current status of engineering climate and support programs, this comes as no surprise.

We do find it hopeful that so many faculty clearly care enough about the issues to have given them serious consideration. If the results of this small study are any indication, there are many engineering faculty making a serious effort to do their best by all their students.

We see our results as exploratory, laying the groundwork for further investigation into such issues as:

- the climate for women students and faculty in engineering;
- faculty perceptions of differences between male and female students and how this effects their teaching style as well as their treatment of students;
- ongoing perception of incidences of harassment and discrimination, and how well departments of engineering handle such incidences, whether they involve faculty, TAs, or other students; and
- faculty perceptions of the appropriateness and effectiveness of support programs for women, and how their perceptions can improve or undermine the scope and impact of support programs.

Chapter 11: Summary and Conclusions

The WECE study, begun in 1998, is the first study of its kind to statistically demonstrate the relationship between women's persistence in undergraduate engineering and their participation in support activities, as well as the relationship between persistence and departmental, institutional, and personal factors. It employed the first large-scale, national, cross-institutional sample—53 institutions of higher education participated—and it followed women longitudinally over a three-year period. Another unique feature was the development and use of a lengthy web-based, computer-adaptive survey.

The research design and methods are what set the study apart from other studies that have explored women's persistence in engineering. Our results corroborate previous studies that were either smaller-scale quantitative studies or were qualitative and/or anecdotal in nature. Therefore, much of what we found will not surprise those who have been studying women in engineering, but the quantitative nature of the study gives it much credence.

The WECE study was conceptualized as an evaluation of undergraduate Women in Engineering (WIE) programs and their institutions, compared to a control group of institutions without such programs. However, we realized that the study needed to be characterized in a broader context as an examination of the variety of experiences of all undergraduate women in engineering, experiences not limited to participation in a formal WIE program. WIE programs do not exist in a vacuum; they operate within a context of the larger climate for women in engineering and sciences, as well as many other characteristics of and influences upon students, including support programs offered outside the WIE program.

Additionally, our interviews and conversations with college and university administrators highlighted the fact that many schools without formal WIE programs offer similar activities and supports, under the auspices of departments or Society of Women Engineers (SWE) or some other support program such as Minority in Engineering Programs (MEP) or a diversity program. Moreover, as we began our research, we became more aware of the fluid nature of WIE programs. For the purpose of this study, we adopted a previously constructed definition for components that need to be present to classify a program as a formal WIE program (e.g., a program administrator who works at least 25% time). However, there were schools that did not meet these criteria that still consider their efforts as a WIE program.

Each year of the three years of our student data collection, many thousands of women completed the WECE survey, for response rates of 33% (n=6,926), 41% (n=9,231), and 36% (n=8,999) in 1999, 2000, and 2001 respectively. By standards of survey research with college populations, these are excellent response rates. Within the various cohorts of women, some were eligible to participate in our questionnaire only one of the three years, some were eligible to participate for two years, and still others were eligible all three years of our study. Over 3,000 women who were eligible to complete the survey two of the three years did so, and 1,300 women completed the survey all three years.

Our survey was computer adaptive based on students' prior responses. This meant that women who were continuing in engineering and those who were leaving or had left the major saw closely related, but slightly different, survey instruments that were tailored to reflect their current status in engineering. If a woman indicated she was no longer in engineering, she was administered a "leaver" survey. In the first year, 4% of our sample consisted of leavers; in the second and third years 8% were leavers. Many of our analyses compare the responses of stayers and leavers in the engineering major ("stayer-leaver analyses"). We also constructed a number of scales for analyzing the student data. Each scale consisted of questions that centered around one concept; by combining questions into scales, we were able to increase the power of our analyses. The scales (described more fully in Chapter 6) are:

- Perception of Department Environment (e.g., teaching, school size, overall department atmosphere, faculty, peers, advisors)
- Perception of Classroom Environment (e.g., grades, time required for coursework, classroom competition, pace of classes)
- Contentment (e.g., interest in engineering, student's happiness with choice of engineering major)
- Self Confidence Change (e.g., changes in math, science, engineering, and overall academic abilities)
- Participation in Social Enrichment Activities (e.g., field trips, guest speakers, engineering social events, engineering society events)
- Participation in Get Help Activities (e.g., tutoring, peer mentoring, career mentoring, and email mentoring)
- Participation in Give Help Activities (e.g., peer mentoring, tutoring)
- Overall Participation (sum of Get Help, Give Help, and Social Enrichment scales)

In addition to these scales, the variables "Participation in Study Group" and "Participation in Internship/Research Experience" were also used in analyses.

To situate the student data in its larger institutional context, we administered surveys and interviews of the WIE directors at the 26 institutions with WIE programs, a web-based survey of the deans at the 53 schools, and a web-based survey of engineering faculty at all 53 schools. During site visits to 11 schools, we interviewed WIE directors, administrators, and faculty and conducted 21 focus groups with a total of 123 women engineering students. The themes arising in the student discussions corroborated the quantitative findings from the large-scale student questionnaires.

The remainder of this chapter presents a summary of the student results, a summary of WIE director, dean, and faculty results, and some conclusions and recommendations based on the findings from all our informants.

SUMMARY OF STUDENT RESULTS

Pre-College Engineering Experiences

Most students made the decision to major in engineering before they entered college. Mothers and fathers were highly influential in students' decisions about the major, with over 70% of respondents citing a parent as the most or second-most influential factor in their decision to pursue engineering. Others who influenced students were likely to be engineers or high school math or science teachers. Students' decisions were also influenced by their abilities in math and science. The overwhelming majority took multiple courses in these areas in high school. They also participated in a wide range of other science, math, and engineering-related (SME) courses and after-school programs. Their SAT and ACT scores were higher than the national averages.

None of the major student background variables, including demographic characteristics or pre-college engineering experiences, were significantly related to whether a student stayed in or left an engineering major.

Reasons Students Enter Engineering

Both in the focus group discussions and in the open-ended questions on the questionnaire, students talked about the reasons they chose engineering. Most students said they decided on engineering because of their early interest and abilities in math, science, engineering, and technology. Some were attracted by the kind of work engineers do, especially the applications: for instance, helping people and society, building and designing, improving the environment, and exploring outer space. Many had experiences in high school that piqued their interest, such as clubs, classes, and workshops. Some had enjoyable experiences with machines and tinkering as they were growing up that led them to engineering.

On the survey, two-thirds of students cited "getting a good job" as at least one of the reasons they wanted to become engineers. Focus group participants were not as likely to bring up career-related reasons. However, both survey respondents and focus group participants mentioned the value an engineering degree would have even outside of engineering: for entering business, law, medicine, or a host of other fields. Some students were particularly happy with the social standing they gained in becoming engineers: being respected for their accomplishments and/or proving they could succeed in the face of many obstacles.

Pursuing Engineering

About two-fifths of student participants in all years of college reported that they had considered leaving engineering at some point during college. Sophomore year was most frequently mentioned as a year when students considered leaving engineering: about one-third of all sophomore and more advanced student respondents reported that they seriously considered leaving engineering during sophomore year. Students who would report leaving engineering in a later year of the study were about three times more likely to have considered leaving engineering in a prior year than those who would later stay, according to the stayer-leaver analysis reported in Chapter 6. Freshman and particularly sophomore year were, in fact, the years women were most likely to leave engineering.

Although women did consider leaving the engineering major, the vast majority in our sample would still either “definitely” or “probably” encourage other women to major in the subject. Only a very small percentage said they “definitely would not” encourage others. Eighty percent of senior and fifth-year students said they expected to be working in the engineering field in seven years.

Reasons Students Leave Engineering

That engineering is “challenging” was nearly universally agreed upon, and many students cite this as an attractive aspect of the field. However, one-half of all leavers cited dissatisfaction with their school’s program (e.g., grades, teaching, workload, pace) as a reason for leaving; another one-third mentioned their school climate: competition, lack of support, and discouraging faculty and peers. One-half of leavers said they left because they found they were not interested, or they were no longer interested, in engineering. One-third said they were attracted to another discipline.

Grades

The stayer-leaver analysis found that stayers, on average, received higher grades than did leavers in engineering-related courses. Chi-square tests indicate that the differences were significant. However, another important statistic is the percentage of leavers receiving grades of A’s and B’s in their engineering courses who still decided to leave engineering. In the year that they left engineering, almost 45% of leavers had A or B averages in their engineering-related courses, and two-thirds had A or B averages in a previous year. This suggests that many students capable of the academic work are still choosing to leave engineering.

The stayer-leaver analysis shows that leavers generally found their grades more discouraging than did stayers. However, women were discouraged by their grades even when they were doing very well academically. Of students with a B average, almost one-half of students who would later leave and about 40% of students who would stay in engineering in a subsequent year reported being discouraged by these grades to some degree. Among students with an A average, one-fifth of students who would later leave and nearly 10% of students who would stay in engineering in a subsequent year reported being discouraged by their grades.

When asked for three reasons that they decided to leave engineering, one-fifth of leavers cited dissatisfaction with their grades, and one-half mentioned they were unhappy with aspects of their classes or engineering program. Students in focus groups at the site-visit schools also mentioned being discouraged by grades and the process of grading. Some were frustrated with the practice of grading on a curve, saying that it promoted competition. Also, it was discouraging for them that the design of the exam to produce very low scores tended to suggest that they had not learned what the professor expected them to, regardless of what letter grade resulted.

Most Significant Sources of Encouragement and Discouragement

When women were asked to identify the single most significant source of encouragement in their pursuit of an engineering major that they had experienced during the past academic year, the majority selected interest in the subject matter of engineering; their father; their mother; employment opportunities; or college peers. (These sources were quite similar to the reasons they gave for choosing engineering as a major.) Students in the first or second years of the major also tended to choose pre-college teacher or salary potential. In contrast, upperclasswomen more frequently cited spouse/partner and internships or research experiences.

Similarly, women identified the single most significant source of discouragement they had experienced during the past academic year. The most common responses included grades, amount of time required for engineering coursework, low quality of teaching by instructors in engineering, and lack of interest in the subject matter of engineering. During their first two years of college, women indicated that competition in engineering classes was discouraging; in later years they found the atmosphere of the engineering department and courses and college faculty members significantly discouraging. In general, stayers were more likely than leavers to cite particular influences as encouraging, and less likely to find them discouraging.

Focus group participants had a great deal to say about the quality of teaching in engineering. They reported being encouraged by classes where concepts were explained well, where they could see models and applications, and where they could think things through. Many participants, however, complained that they felt that teaching was not a priority for too many of the faculty. Corroborating this were responses to the open-ended questions on the student survey. One-half of all leavers cited discontent with their school's engineering program as a reason that they left engineering. Both focus group participants and leavers filling out the survey said they were discouraged by professors who didn't explain concepts well, who didn't speak English well, or who didn't seem to care about their teaching and their students. These students were frustrated with their workload, the pace of classes, the atmosphere of classes, and poor teaching.

Being Female in Engineering

About one-third of first-year students who had an advisor reported that their engineering advisor was female. This fraction decreased each year; only one-fifth of seniors said their advisor was a woman. If a student reported having a mentor who was not their advisor, this mentor was almost equally likely to be male as female.

Students compared themselves more negatively to male peers than to female peers in understanding engineering concepts, solving engineering problems, commitment to engineering, and confidence in their engineering abilities. They tended to feel that they spent more time and effort on their class work than did males. In contrast, a majority felt that they worked better with other people than did their male peers. Most students felt they had no advantage or disadvantage compared to male peers in working with faculty and advisors, or finding a mentor.

In focus group discussions, students had a great deal to say about their experiences as women undergraduates in engineering. Nearly all participants commented on the visible lack of women peers and women faculty; many said they felt discouraged by it. Some noted that as women, they felt left out of peer interaction, or shunted into roles like the team note-taker. Some felt that males found them intimidating, or looked down on them; some reported sexist jokes, comments, or harassment. Some women said they constantly felt a need to prove themselves, or were unhappy with male competition and lack of support. Some felt that men were as likely as or more likely than women to be friendly and supportive, and others emphasized that the environment in the department was equally stressful and unsupportive for everyone.

Some women in the focus groups commented on what they saw as differences between male and female learning styles, manners of interaction, or background knowledge and experience. Often they noted that women were better at working in groups, while men brought more engineering knowledge and experience to the classroom.

Perceptions and Persistence

Women's perceptions of the change in their self-confidence, the environment of their department, and the classroom environment were all related to their persistence in the major. More negative perceptions in any of these areas were significantly associated with an increased risk of leaving engineering in every undergraduate year. Stayers tended to have a more positive change in their self-confidence, and they had more positive perceptions of both the classroom environment and the department environment in engineering, than did leavers. Corroborating the analytic results, leavers often wrote on the student questionnaire that their disenchantment with their classes and department atmosphere was a reason for leaving.

Focus group participants described the challenging, often difficult environment in college engineering. Though some expressed positive viewpoints that succeeding despite the obstacles would increase their self-esteem, their terms were often quite negative. They described their program as "hazing," with success having more to do with perseverance and grit than with intelligence and interest. Most complained about the heavy workload and the lack of time for other interests, with some saying that the curriculum was too restrictive and/or theoretical. We cannot say whether more positive perceptions are due to environment, student personality, or both, but it is clear that more positive perceptions were significantly associated with staying in engineering.

The Relationship of Participation in Support Activities and Perceptions of the Engineering Environment

Stayers were more likely to participate in all types of support activities than were leavers. A stayer's level of participation in Social Enrichment activities was significantly associated with more positive perceptions of the department and classroom environments and with increases in self-confidence. Her level of participation in Get Help activities was also positively associated with higher self-confidence and with positive perceptions of the department environment, but not with positive perceptions of the classroom environment. Stayers who participated more frequently in Get Help activities tended to have more negative views of the classroom environment in engineering. Possible explanations for this are that poor teaching necessitates seeking more help, or that receiving good help makes the classroom environment look worse in comparison.

Leavers, like stayers, perceived the engineering classroom environment more negatively if they participated more in Get Help activities. Unlike stayers, however, greater participation by leavers in Get Help activities was also related to decreases in self-confidence. In addition, greater participation in Social Enrichment activities—related to positive perceptions of the classroom environment and the department for stayers—was, for leavers, associated with negative perceptions of the classroom environment, and not significantly associated with other perceptions. For leavers, participation in support activities seems to have a very different impact on their perceptions of the environment than it does for stayers.

Participation in Support Activities as Related to Persistence

We measured whether participation in support activities and resources was related to women's persistence in engineering. WIE programs, where they were present, frequently were sponsors of mentoring, newsletters, engineering society activities, engineering speakers, social events, and outreach to pre-college students. Upperclass students were more likely to participate in most engineering support activities, whether or not sponsored by a WIE program, than were first-year students and sophomores. The vast majority of women who had previously participated in support activities indicated that they would definitely or probably participate in the activity again.

Students who ended up leaving engineering in a subsequent year participated in significantly fewer support activities (of all kinds) overall than those who remained in engineering during our study. Students who participated more frequently in support activities—particularly students who participated in social enrichment activities—were less likely to leave engineering than those who did not participate or who participated less frequently.

Social Enrichment Activities

Students participated in activities we classified as "Social Enrichment activities" for a variety of reasons. Most students participated in engineering society activities and engineering social events, in particular, to socialize with other women in engineering and to socialize with men in engineering. Students participated in engineering society activities in order to be in a supportive atmosphere. But they also participated in Social Enrichment activities to learn about opportunities in engineering, to talk about engineering issues that concerned them, and to learn more about specific topics and fields in engineering.

Students who in a later year became leavers participated in fewer Social Enrichment activities than those who subsequently stayed in engineering; this difference was significant. Social Enrichment activity participation was significantly associated with staying in engineering, even after taking into account students' change in self-confidence or their perception of the environment of the engineering department. This suggests that there is a unique attribute to Social Enrichment activity participation that makes women want to stay in engineering.

Giving Help

Wanting to help others, as a mentor or "buddy" to new students, is the primary reason students participated in "Give Help" activities, followed by opportunities to socialize with other women in engineering. We found no significant differences between levels of participation in Give Help activities and whether students stayed in or left engineering. Regardless of the importance students may attach to giving help to others, their participation in Give Help activities does not appear to be related to persistence in engineering.

Getting Help

Students participated in "Get Help" activities like career counseling and receiving mentoring to learn more about opportunities in engineering and to socialize with other women in engineering. Students sought tutoring, of course, for help with their coursework.

Though getting help and advice is certainly important to students and satisfies many of their needs, it does not appear to be related to persistence in engineering. Getting help does negatively affect students' perception of their classroom environment, but it positively affects their perception of the environment of the engineering department.

Study Group

Receiving assistance with engineering coursework was the main reason that students participated in study groups; they also participated to be in a supportive atmosphere, to socialize with other women and with men in engineering, and to help others.

Students who more frequently participated in study groups were more likely to stay in engineering than those who did not, or those who participated less often. From freshman year onward, students who stayed in engineering had been participating in study groups more frequently than those who left the major. Similarly, first-year students in study groups were significantly more likely to persist in engineering later.

Internship or Research Experience
Students participated in internships and research mainly to earn money, to learn more about specific engineering fields, and to learn about career opportunities in engineering. They also participated to learn about specific engineering-related topics.

A higher percentage of students who stayed in engineering in a subsequent year of the survey had held a research or internship position than those who subsequently left engineering. Though chi-square tests indicate that these differences are not significant—that internship participation does not predict persistence—internships seem to play an important role in students' education, one valued by students who have had the experience and desired by those who have not. Ninety-eight percent of students who held internships said they would likely participate again; 95% of those who did not have internships said they would probably take them if given the opportunity.

Relationship of Institutional Variables to Graduation Rates and to Participation

The higher the proportion of engineering students to the entire student body population, the higher the graduation rate in engineering. Besides that, however, we found no effect of size or selectivity, and none of our scale variables, averaged by school, was associated with the graduation rate.

Whether a school has a formal WIE program or not has no relationship to women engineering students' frequency of participation in Social Enrichment, Give Help, or Get Help activities. Many non-WIE schools offer a range of support resources and activities for women engineering students that are similar to those offered by WIE schools.

Other institutional variables did not bear any relationship to women's participation in engineering support programs. Neither the size of the engineering program at the institution, nor the size of the undergraduate engineering program, nor the percentage of undergraduates at the college or university who are engineering majors had any relationship to women's participation in social enrichment, give help, or get help activities. The only institutional-level variable that was significantly related to women's participation in some types of support programs was institutional selectivity. In more selective schools, mean participation in Social Enrichment activities was very slightly higher than in less selective schools, as was participation in give help activities. It could be that students in more selective schools are used to participating more in activities because this is expected of students who apply to these schools.

Nearly one-third of students who attended schools with WIE programs reported that they were influenced in their decision to attend that school by the presence of support programs for women in engineering on campus.

SUMMARY OF WIE DIRECTOR, DEAN, AND FACULTY RESULTS

Although female undergraduates in engineering were the main focus of our study, we also collected data from those at the college level most knowledgeable about the students: the directors of WIE programs at all 26 institutions with such programs, 53 deans (representing 51 institutions), and 1,387 engineering faculty from the 53 institutions.

WIE Program Directors

WIE programs seek to support students academically, socially, and experientially. Besides students, the WIE program director must respond to administrators, faculty, and industry. WIE program directors feel that for the WIE program to be successful, they as directors must have the support of the engineering administration and faculty.

WIE directors have a range of responsibilities: recruiting, retention efforts, fundraising, and advising students. The director must decide how to allocate limited funds and staff to the various activities the WIE program offers, using her own experiences and input from others to decide which ones to offer. WIE directors surveyed felt that mentoring programs were the most cost effective activities because they serve a larger number of students than do other activities, are relatively inexpensive to run, and can simultaneously build academic and social support networks. Other activities valued by directors included research internships, orientations, career days, speakers, and various social activities.

Directors say that students' needs differ depending on their year in school. First-year students and sophomores are less likely to perceive gender inequities than are older students. Directors also believe that these young women do not want to be singled out on the basis of their gender, yet they are more likely to feel isolated and overwhelmed by the demands of the major than upperclass students. A challenge for the directors was to tailor activities and venues to these different needs.

Engineering Deans

Deans of engineering make many decisions that directly affect the quality of the undergraduate experience of women engineering students—decisions regarding funding, program offerings, course offerings, and the hiring of faculty. Some top priorities listed by the engineering school deans we surveyed included: improving the quality of research, meeting the demands of growth in industry, bringing technology into the curriculum, and continuing and expanding K-12 outreach activities.

Deans said they faced challenges in raising funds, building faculty development initiatives, recruiting and retaining female and minority faculty, and recruiting more students. In site-visit interviews, all deans expressed support of the WIE program, yet levels of enthusiasm and knowledge about the successes and challenges of the program varied.

Faculty

The faculty questionnaire respondents were predominantly male, white, tenured, and 50 years of age or older. Female engineering faculty were substantially overrepresented in our sample (14%); nationally, close to seven percent of tenure-track engineering faculty are female.

Engineering faculty we surveyed generally believed that female students' academic skills were comparable to those of male students, except most felt that women were not as skilled in the laboratory as male students, while females were commonly regarded as having better study habits than their male peers. Female engineering faculty were more likely to say that the academic climate in engineering favored male students than were male faculty, and they reported hearing more complaints of unfair treatment of females.

The majority of faculty (of both genders) advocated actively recruiting female students into engineering programs, but there was less consensus on whether more ought to be done to retain women once they were there, and there was no consensus at all on the desirability of support programs for women students. Site visit interviews corroborated the same lack of consensus that the web survey found. Some faculty fought to establish such support programs, citing a need for them in culturally male environments. Others expressed doubts about program efforts, questioning whether "special" status hurt women more than it helped, and whether the programs actually achieved their objectives of attracting and retaining females in engineering.

In the web survey, female faculty generally perceived conditions in the engineering workplace as more difficult for females than did male faculty. During site visits, female faculty members we interviewed gave accounts of gender-specific pressures in their own careers as engineering faculty members: extra demands to serve on committees, being sought as advisors to female students, and needing to prove themselves as women engineers.

CONCLUSIONS

We believe that the quantitative findings from the WECE project as summarized above can inform the planning by WIE and other program administrators and help senior administrators in universities to better understand how campus support activities, resources, and other factors can best be used to maximize the retention of women in engineering. Below we describe conclusions we draw from the results and offer some recommendations upon which various stakeholders may act.

Pre-college exposure encourages students to pursue an engineering major.

Both individuals and organizations play an important role in encouraging young women to pursue college engineering majors. These include, but are not limited to, parents, schools, informal education programs, university outreach programs, and the mass media. The vast majority of student respondents knew they were going to be engineering majors before they entered college, even if they were not sure exactly what engineers do.

For a woman to select engineering as a major as an "informed consumer," she needs to be exposed to engineering prior to college. Ideally, this would happen on a widespread basis in schools and society, but right now parents generally play the most influential roles. Young women generally consider their parents their biggest supporters both before and during college. But the vast numbers of young women whose parents do not encourage them in engineering require exposure to engineering through other means.

Increasing numbers of young women participate prior to their college years in educational science, math, and engineering programs after school, on weekends, or during the summer, and others have had volunteer work experiences or internships in an SME field. These enrichment programs, while succeeding in whetting students' appetites, are typically focused on science rather than specifically on engineering. Informal activities are a promising way to introduce girls to engineering concepts and information about the profession. It is easier to implement engineering activities in informal settings because engineering is rarely taught as a required course in school. Only one state has instituted curricular frameworks for engineering, and there are currently no national standards for integrating engineering into the elementary or secondary curriculum. Only a few engineering curricula are used in formal settings anywhere in these grade levels.

Teachers and guidance counselors can play an important role in guiding students to consider and prepare for an engineering career. Exposing girls in elementary school and middle school classrooms to engineering on a more widespread basis could help increase the numbers of women entering the major in college, and guidance counselors could also play a natural role in guiding or at least exposing female students to engineering and getting them to consider the field. However, this requires that teachers and guidance counselors have an understanding of engineering, of what engineers do, and of what skills engineers need.

Universities can play a greater role in implementing outreach initiatives that teach girls and their teachers about engineering. A number of WIE programs carry out pre-college outreach. These efforts, particularly if conducted in concert with schools, can introduce girls to women who are majoring in engineering and women in engineering careers—allowing girls to see the person behind the job and hear about what it takes to do the work.

Within the engineering profession there are efforts to expose girls to the field (e.g., National Engineering Week, Introduce a Girl to Engineering Day). A general media campaign (newspapers, television, radio, billboards, etc.) would help the public better understand what engineers do. Even a prime-time television series about engineers (if reasonably realistic) would provide opportunities to see the practices of these professionals. For better or worse, the viewing public gets most of its understanding of what medical personnel and lawyers do from watching prime-time television shows, but do not have similar opportunities being exposed to what engineers do.

Women are most likely to leave engineering majors in their freshman or sophomore years.

Most colleges and universities, with the exception of technical institutes, do not accept women into a field-specific engineering major until their junior year. However, women are most vulnerable to leaving during the freshman and sophomore years. Thus, WIE programs have a particularly important role to play during these first two years. Non-WIE schools can and do provide activities and supports for those who actively seek them, but coordinating these efforts under the umbrella of a formal program may more effectively and consistently reach women in their first couple years of college who have not yet recognized the benefits of associating with engineering programs that will support them. For instance, engineering departments or schools could step up their efforts to educate and encourage *all* incoming students about the benefits of using support systems, whether they are a WIE program minority engineering programs, study groups, professional engineering societies, or student chapters of the Society of Women Engineers.

Engineering faculty have an important role to play—although if students do not declare their major until junior year, offering support through departments is difficult. However, engineering departments can offer engineering classes for freshmen and sophomores, and match up prospective engineering majors with advisors in the student's general field of study. Two years is a long time for students to sit through math and science prerequisites that have no obvious application to the field that first attracted their interest.

An advisor who takes the time to learn a student’s name, gets to know the student, and is interested in her progress can make a big difference in whether the student persists in the field. Talks, forums, social activities, and other department-sponsored activities or events can promote a sense of community. Departmental orientation for incoming students and monitoring of students are also crucial: as in the TV show *Cheers,* students really do want to go “where everybody knows your name.”

Students who participate, particularly those who participate in social enrichment activities, are more likely to stay in engineering than those who do not. Though it is possible that both are outcomes of a third factor, it seems most plausible to assume that participation in some way improves women's experiences, so they are more likely to stay. Of course, making community-building participation a possibility may require universities to scrutinize their curricular requirements; overwhelmed students will not feel they have the time to participate in support programs, no matter how beneficial those programs may be.

Women are not leaving engineering because they can’t make the grade.

Forty-five percent of the women who left engineering during our study had an A or B average in their engineering coursework. This shows that many students leave not because they can’t do the work (a notion that has been common among engineering faculty), but for reasons other than academic ability. These reasons can include negative interpretation of grades that may actually be quite good, diminished self-confidence, or reluctance to spend all of their waking hours “doing engineering.” The investment necessary to earn grades of A or B may be too much of a sacrifice and “not worth it.”

Because leavers were more likely than stayers to be discouraged about their grades, even if they had the same grades as stayers, more women engineering students might be retained if engineering faculty and administration take steps to ameliorate students' sense of discouragement: developing grading rubrics, explaining the grading system (pointing out how grading in engineering is different from that in other disciplines, if that is the case), setting clear goals for classes, designing tests that mirror the goals of a class, and basing grades on how well students meet educational goals. This may require departments to teach their faculty pedagogical strategies—how to plan course schedules, write a good syllabus and lecture notes, use lecture and recitation time effectively, tailor exams to students' ability and knowledge levels, and give useful feedback.

Women's self-confidence must be recognized as a major factor in persistence.

The decline in young women's self-confidence—even the confidence of very talented students who are succeeding in what they do—is a societal problem that extends far beyond undergraduate engineering departments, and a tough one to solve. A student's self-confidence increases when she feels that someone believes in her engineering abilities, cares about her, and wants her to be part of a community. Sensitivity to students' self-confidence by faculty, advisors, and mentors will help. Child development literature has shown that resilience emerges in a child during difficult times when an adult (not necessarily a parent) serves as a mentor or helper to the child; this is true for young adults as well. Our findings corroborate those of Seymour and Hewitt (1997), who found that *"For those who were less fortunate [who encountered discouraging faculty], it is the 'care-less' response of faculty in handling their crises of confidence which is a very common 'last straw' factor in switching decisions."* These findings suggest that sessions for faculty and staff on topics such as gender equity, creating more inclusive environments, and sensitivity training—updated for this decade—are still needed.

The climate in college engineering affects whether women persist.

The most discouraging factors for women in engineering in our study were their grades, the amount of time required for their coursework, the quality of teaching by faculty, their interest, and the atmosphere of the engineering department and their courses. These factors are related to the policies and climate of the institution, of the department, and of engineering classes—and many of the decisions that engineering administrators and faculty routinely make directly affect the quality of the day-to-day experience of engineering students.

A student's perception of the quality of support in their classes and department is related to whether she persists in engineering. Students with the most positive views of the environment of the engineering department and engineering classes are the ones most likely to stay in engineering. Although a causal relationship between these factors cannot be proved, and although assessments of "climate" are necessarily qualitative, it may be that if a department improves the climate within the engineering school, a larger number of talented students will stay in the department.

Some institutions are already trying to make room for students to pursue and develop other interests and skills so that students do not have to "eat, drink, and sleep engineering 24-7." Examples are making freshman year courses pass-fail, not requiring as many "grunt" courses in the first two years, mandating some electives, and using relevant examples in class that highlight applications and problem solving. Grades, pacing, and workload were mentioned as discouraging by a large percentage of students. Advisors who give students time, information, and encouragement can help make the climate less chilly for women. Any efforts in these areas can only improve retention.

Our study corroborates other research that shows women choose engineering because they want to help people ("save the world"), as well as because they are interested in good field and job prospects. Students' altruistic bent can be acknowledged and reinforced by infusing examples of how engineering has improved society or people's lives into the engineering curriculum.

Women undergraduates in engineering need community.

Participation in support activities is vital to women undergraduates, who need to feel that they are part of a larger caring community in engineering. Community allows students to build networks and to feel that their presence in engineering is important to others and valued. Networking can counteract the isolation that women feel—providing them with information, support, and the knowledge that they're not alone in the challenges they face.

This sense of community and sharing of information can be achieved through socializing with other students, through study groups, and through a variety of other support activities that can be offered by departments, by a WIE program, or by other college support entities. It can be gained from internships, in which women in the field work together and share their experiences. It can also be developed from interactions with older students, who can say, "I've been there too and I made it; I understand what you're going through. You can do it too." Mentors, whether peers or older, can offer advice as well as listen. Such supports are important throughout one's engineering college career. The ideal community also includes faculty and advisors, as well as peers.

Social participation and initiative in drawing upon resources is a sign of strength, not of weakness. For many high-achieving high school students who are used to working independently, this awareness comes gradually. Successful women develop and utilize strong interpersonal support networks. Our research has shown that students who participate in support activities are more positive about their department and their classes than students who do not participate. It seems likely that allowing students the time and resources to develop a sense of community will help them to feel better about the environment in engineering, which in turn will influence them to stay in engineering.

Since determining the amount, availability, and quality of support programs is well within the purview of the engineering administration, deans may want to consider how best to build support for students and draw them into an engineering community. Fostering such a community is an important and viable step an institution can take to improve rates of persistence among undergraduate women in engineering.

WIE programs are beneficial, and they are challenging to administer.

WIE programs meet many needs of female engineering students. They serve as advocates for women, provide meeting places (both literally and figuratively) for students seeking contact with one another, and provide mentors, internships, and social and academic activities and resources for women across the board. In our research, many women enumerated the challenges specific to being female in engineering; WIE programs exist to help students with these extra challenges.

The biggest challenge to the existence of WIE programs is not whether they can do what they set out to do, but how they are perceived. Many students, faculty, and administrators see WIE programs as providing remedial or "hand-holding" services to students who would not otherwise succeed. Other faculty and students, though they may appreciate the services a WIE program offers, do not participate in WIE-sponsored programs because they do not want to be labeled as "needy" or under-qualified. When they enter college, many women engineering students do not believe that they will face any challenges related to their gender in college or in the engineering workplace. According to these young women, gender-based discrimination existed in their parents' generation but has been eliminated.

How can a WIE program surmount the resentment or contempt that can arise in response to the WIE program's focus on helping the female minority group? A number of the WIE programs we studied have worked to overcome this challenge, with varying degrees of success. Some WIE programs make their services available to all students, although they continue to focus on providing activities specifically tailored to women's needs—because, after all, an undergraduate engineering program is seldom a picnic for anyone of either gender. Other programs underplay their sponsorship of activities, instead working "in the background" through SWE or other organizations.

Another possibility would be for the WIE program to operate under the umbrella of engineering student affairs, working as part of an organization to manage student community/life for all students. The WIE program could continue to advocate for women's often-overlooked perspectives and provide networking centers, mentoring, engineering applications lectures and classes, and community-building, but as a normalized part of a team focused on the needs of all students. Many of the findings of the WECE study regarding what improves women's retention—more understandable grading, improved pedagogy, a better sense of community, and more individual attention—are likely to benefit all students, not only the female minority.

Most WIE directors profess that their job is to put themselves out of business. They hope that their existence is short-lived and that, at some point in the future, discrepancies in the number or treatment of women in engineering will not exist and that the field will evolve to be attentive to women's concerns while it encompasses their strengths. However, until this happens, WIE program administrators—who are well-versed in women's issues in engineering and who work to provide female students with awareness, understanding, and support to help them navigate the engineering path—should be considered an important resource for students and administrators.

Schools can benefit from close institutional data keeping and analysis.

"Keeping tabs" on students throughout their college careers can benefit an institution as well as the students themselves. To keep a finger on the pulse of student life, engineering administrators could administer brief questionnaires to their students—for instance, incorporating a mini-WECE questionnaire into online registration. This would give administrators a regular measurement of students' perceptions about the department, their courses, the instruction, and their self-confidence.

Schools should longitudinally track individual students in engineering departments from the time they enter until they graduate or otherwise leave the major, collecting data on who leaves, how long students take to complete their degrees, and which majors have the highest attrition rates and the lowest number of women and other minorities. Since reliable figures for institutional graduation rates are extremely rare, a profitable avenue of further research would be to devise better ways to glean such numbers.

This data keeping could be integrated with monitoring/mentoring of all students, especially younger undergraduates. A program such as WIE, which exists to help support and build the engineering community, can work with the college or school administration to carry this out. Data on the tracked students' engineering coursework could be analyzed to determine whether the courses they take or the sequence in which they take them is related to whether they persist. To complete the picture, schools could conduct exit interviews with students who leave the engineering major.

IN CONCLUSION …

The WECE study has answered the questions about women's persistence in undergraduate engineering that we outlined back in 1995. However, while the study provided a first quantitative glimpse into the factors affecting college engineering persistence, the study was by no means definitive, and, as with much research, it has raised more questions. One perplexing question arising from our results is why we found no statistically significant differences in persistence in engineering majors between women at WIE and non-WIE institutions. Our research suggests that one possible explanation may be that many schools without WIE programs offer similar types of programs that are run by other organizations (such as SWE). Others run WIE programs but they did not exactly meet our criteria to be included as a WIE school. Therefore, it may be that the distinction between a formal WIE program and some other entity (non-WIE) is somewhat artificial. What is important is young women having access to a range of support activities.

In focus groups, women who were involved with activities sponsored by the WIE programs expressed their appreciation for the opportunity to know there were people or a place that they could go to for advice or assistance. We did find that different kinds of activities influence women's persistence differentially—those that promote social enrichment are most closely linked to women's persistence.

Does the popularity of a WIE program suggest that a school's climate for women is negative, necessitating a support program, or does a successful WIE program experience tend to lead to reduced participation as women become happier in their environment? Do women engineering students have needs that aren't being met by WIE? If women were to reach "critical mass," would WIE programs be needed anymore? What inherent issues in engineering must be addressed before women can achieve full parity? These are much bigger questions to be tackled as engineering institutions move through the next few decades.

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Appendix A: Selection of Participating Institutions

APPENDIX A-1: PARTICIPATING INSTITUTIONS

Institutions with WIE program*	Institutions without WIE program
California Polytechnic State University, San Luis Obispo	Bradley University
Cornell University	Brigham Young University
Dartmouth College	California State Polytechnic University, Pomona
Georgia Institute of Technology	Florida Institute of Technology
Illinois Institute of Technology	George Mason University
Iowa State University	Johns Hopkins University
North Carolina State University	Lehigh University
Ohio State University	Michigan State University
Oklahoma State University	Northwestern University
Pennsylvania State University	Rice University
Purdue University	South Dakota School of Mines and Technology
Rensselaer Polytechnic Institute	State University of New York, Buffalo
Rochester Institute of Technology	Texas Tech University
Tufts University	University of Alaska, Fairbanks
The University of Texas, Austin	University of Arkansas, Fayetteville
University of California, Davis	University of California, Los Angeles
University of Colorado, Boulder	University of California, Riverside
University of Connecticut	University of Cincinnati
University of Iowa	University of Hawaii, Manoa
University of Kentucky	University of Illinois, Chicago
University of Louisville	University of Southern California
University of Michigan, Ann Arbor	University of Tennessee, Knoxville
University of Minnesota, Twin Cities	University of Vermont
University of New Mexico	Vanderbilt University
University of Wisconsin, Platteville	Villanova University
Virginia Polytechnic Institute and State University	West Virginia University
	Worcester Polytechnic Institute

* status at time of sample selection

APPENDIX A-2: STRATIFICATION USED IN SELECTION OF MATCHING INSTITUTIONS

Region

The IPEDS database classifies postsecondary educational institutions into eight geographic regions of the United States. For the purpose of our selection process, we collapsed the IPEDS codes into four regions: Northeast, Midwest, South, and West.

Table A-1
Region Classification Codes: Original & Revised for the WECE Study

Original IPEDS classification codes	WECE classification codes
New England (CT, ME, MA, NH, RI, VT)	Northeast
Mid East (DE, DC, MD, NJ, NY, PA)	Northeast
Great Lakes (IL, IN, MI, OH, WI)	Midwest
Plains (IA, KS, MN, MO, NE, ND, SD)	Midwest
Southeast (AL, AR, FL, GA, KY, LA, MS, NC, SC, TN, VA, WV)	South
Southwest (AZ, NM, OK, TX)	West
Rocky Mountains (CO, ID, MT, UT, WY)	West
Far West (AK, CA, HI, NV, OR, WA)	West

Carnegie Classification

A school's Carnegie Classification describes both its diversity of programs and degrees offered, and in the case of a doctorate-granting institution, its emphasis on research. The following table outlines the six Carnegie classifications, as specified in the IPEDS database, and our three collapsed codes: Master's, Research, and Doctoral.

Table A-2
Carnegie Classification Codes: Original and Revised for the WECE Study

Original Carnegie classification codes	WECE codes
Research Universities I: Offer a full range of baccalaureate programs, are committed to graduate education through the doctorate, and give high priority to research. They award 50 or more doctoral degrees each year. They receive annually $40 million or more in federal support.	Research
Research Universities II: Offer a full range of baccalaureate programs, are committed to graduate education through the doctorate, and give high priority to research. They award 50 or more doctoral degrees each year. They receive annually between $15.5 million and $40 million in federal support.	Research
Doctoral Universities I: Offer a full range of baccalaureate programs and are committed to graduate education through the doctorate. They award at least 40 doctoral degrees annually in five or more disciplines.	Doctoral
Doctoral Universities II: Offer a full range of baccalaureate programs and are committed to graduate education through the doctorate. They award annually at least 10 doctoral degrees (in three or more disciplines), or 20 or more doctoral degrees in one or more disciplines.	Doctoral
Master's (Comprehensive) Universities and Colleges I: Offer a full range of baccalaureate programs and are committed to graduate education through the master's degree. They award 40 or more master's degrees annually in three or more disciplines.	Master's
Schools of Engineering and Technology: Award at least a bachelor's degree in programs limited almost exclusively to technical fields of study.	Doctoral*

*So categorized because the one school in our sample offers doctoral degrees in engineering

Selectivity

The following table describes selectivity, as classified by Peterson's Guide to Four-Year Colleges. Selectivity is a measure based on the high school standing, SAT and/or ACT scores of the accepted students, as well as the percentage of applicants accepted. We combined Peterson's original classification codes into two collapsed codes: selective and moderately selective.

Table A-3
Selectivity Classification Codes: Original and Revised for the WECE Study

Original selectivity classification codes	WECE codes
Most Difficult: More than 75% of the freshmen were in the top 10% of their high school class and scored over 1250 (1310 recentered) on the SAT I (verbal and mathematical combined) or over 29 on the ACT (composite); about 30% or fewer of the applicants were accepted.	Selective
Very Difficult: More than 50% of the freshmen were in the top 10% of their high school class and scored over 1150 (1230 recentered) on the SAT I or over 26 on the ACT; about 60% or fewer of the applicants were accepted.	Selective
Moderately Difficult: More than 75% of the freshmen were in the top half of their high school class and scored over 900 (1010 recentered) on the SAT I or over 18 on the ACT; about 85% or fewer of the applicants were accepted.	Moderately Selective

Size of Engineering Program

Some schools in our sample had a relatively large proportion of their students in engineering – the technical schools all had more than a third of their students in engineering majors. Other schools had a comparatively small proportion of engineering students. In determining the size of the engineering program, we considered the percentage of graduating undergraduates receiving a degree in engineering. We categorized schools into three proportions of engineering degrees: low, medium, and high. This information was also calculated from the IPEDS database.

Table A-4
Classification Codes: Original and Revised for the WECE Study

Original classification codes	Revised WECE classification codes
2.5% to 13.0% of graduates receive engineering degree	Low
13.0% to 33.3% of graduates receive engineering degree	Medium
33.3% or more* of graduates receive engineering degree	High

*These were the Schools/Institutes of Technology

Size of School

We also considered the size of the undergraduate student population, as indicated in the IPEDS database. Schools were not stratified by size: instead, once a selection of non-WIE schools was found to match a WIE school on the first four criteria, the non-WIE school closest in size was chosen as the final match.

Appendix B: Instruments & Protocols

APPENDIX B-1: WEB-BASED STUDENT QUESTIONNAIRE

Notes and Specifications

Each question has a variable code (or set of variable codes, where a question is coded into more than one variable). These are the numbers in square brackets that preface each question. In front of each question is a set of codes that give information about which people will get the question and when. Variable and other codes do not appear on line. The key for the codes:

> F: Students should be asked this question only the first year that they participate in the survey. Note that first year is different than freshman year – they might be participating for the first time as a sophomore, for example.
> E: Students should be asked this question every year that they participate in the survey.
> M: This question needs to be modified for different populations of students, such as their year in school.
> L: This question should be asked of leavers – students who are no longer majoring in engineering.
> C: This question should be asked of continuers – students who are continuing in an engineering major.

Value codes, where more than two answers are possible, are indicated by angle brackets within the questions. These do not appear on the survey to participants. Sometimes the angle-bracketed value code takes the place where the web interface 'choice' button or box would appear; where it does not, the following symbols are used to indicate the different web interfaces:

> o: radio button
> □: check box

The Questionnaire Instrument

```
[Note: Entry page {page Entry-a} for as-yet unidentified students
and students not completing their second or third survey.]
```

Experiences in College Engineering Questionnaire

Please indicate your gender below.
F [01] o I am female   o I am male

```
[Note: {page Ineligible-a} This page is shown to students
choosing "I am male" on page Entry-a]
```

"Sorry, this survey is only for undergraduate women. Thank you for your time and interest.
–The WECE project staff."

```
[Note: Next page {page Entry-b} shown to students choosing "I am
female" on page Entry-a, and entering without a student ID.]
```

♦WECE♦

THE WOMEN'S EXPERIENCES IN COLLEGE ENGINEERING PROJECT

Funded by National Science Foundation ♦ Alfred P. Sloan Foundation

WELCOME TO THE WOMEN'S EXPERIENCES IN COLLEGE ENGINEERING PROJECT!
Your university has agreed to take part in the WECE project, a national, longitudinal study of the experiences of undergraduate women who are interested in engineering. Our project is gathering data from students, faculty, deans, and student support staff at 53 institutions nationwide. *All participant data we collect will be kept confidential, and data will be aggregated for all reports.* We invite you to participate in the student survey component of this study.

A DESCRIPTION OF THE WECE PROJECT

The WECE project aims to better understand women's experiences related to engineering and to identify aspects that encourage and discourage women. This study, the first of its kind, is funded by both the National Science Foundation and the Alfred P. Sloan Foundation and is conducted by Goodman Research Group, Inc. (GRG), an independent educational research company. The primary data for our research is a survey of undergraduate women who are, or once were, interested in engineering that we are administering for three years (1999, 2000, 2001). The survey will ask about your perceptions of, and experiences in engineering; your interactions with support programs; and background information. To situate student data in its larger institutional context, we are also surveying faculty, interviewing deans, and visiting a subsample of participating schools. We hope that the findings of this research will guide institutions and policy makers as they develop guidelines and programs to improve educational environments in engineering, especially for women.

If you already have been assigned a WECE ID, please enter it along with your School ID below and press the Login button to continue with the questionnaire.

Your WECE ID: [1008]
Your Password: [10]
[Login]

If you have already been assigned a WECE ID and have begun the questionnaire or have already completed it, but now wish to decline consent then press the button below.

[I no longer wish to participate]

[Note: {page Decline-a} Shown to students who press the button marked "I no longer wish to participate" on page Entry-b above.]

In order to decline to participate, please enter the information below and press the button. Thanks!

Your WECE ID: [ ]
Your Password: [ ]
[I no longer wish to participate]

[Note: Next page {page Decline-b} for those who press the button on page Decline-a marked "I no longer wish to participate".]

"Thank you for your response. We wish you the best in your future endeavors.
- The WECE project staff"

[Note: Next page {page Entry-c} for women students who pressed the "login" button on page Entry-b above, with their WECE ID and password entered. This page serves to double-check our records on whether the student is a first-time survey participant.]

Did you complete this survey either last spring (2000) or the year before (spring 1999)?

[Yes]

[No]

```
[Note: {page Entry-d} Page following Entry-c; or first page for
students entering with a valid Student ID.]
```

♦WECE♦

THE WOMEN'S EXPERIENCES IN COLLEGE ENGINEERING PROJECT

Funded by National Science Foundation ♦ Alfred P. Sloan Foundation

CONSENT FORM

This consent form explains the purpose of the WECE project, what we will be asking of participants, and the rights of participants. Please read it, and if you choose to participate in the WECE project, click the button marked "I agree to participate" below, and enter your name and email address. **You may withdraw your consent at any time.**

A DESCRIPTION OF THE WECE PROJECT

The WECE project aims to better understand women's experiences related to engineering and to identify aspects that encourage and discourage women. This study, the first of its kind, is funded by both theNational Science Foundation and the Alfred P. Sloan Foundation and is conducted by Goodman Research Group, Inc. (GRG), an independent educational research company. The primary data for our research is a survey of undergraduate women who are, or once were, interested in engineering. We are administering this survey for three years (1999, 2000, 2001). The survey will ask about your perceptions of, and experiences in engineering; your interactions with support programs; and background information. To situate student data in its larger institutional context, we are also surveying faculty, interviewing deans, and visiting a sub sample of participating schools. We hope that the findings of this research will guide institutions and policy makers as they develop guidelines and programs to improve educational environments in engineering, especially for women.

PARTICIPATION IN WECE: WHAT'S INVOLVED

We invite you to participate in the student survey portion of this study.

- **We would like you to fill out a questionnaire about your experiences.** The questionnaire should take about 30-40 minutes to complete. It will include questions about your engineering classes, interactions with faculty and other students, and your feelings about what experiences helped you to be or prevented you from being comfortable and happy in engineering.

- **All of your responses will be confidential.** No one outside the WECE research team will have access to the information and survey responses that you supply. After we have collected all of the survey data, e-mail addresses will be stripped from the survey responses and an unrelated WECE identification code will be assigned to identify responses. All data analysis will be conducted on the "stripped" data. A master copy of the original data will be saved only in a secure archive. At the end of the WECE study, some of the data may be made available to other researchers, but without the identifying information (email addresses, school names, or other specific identification.)
- **Short reports about engineering education will be given to the selected administrators in participating universities.** A short report will be distributed annually that includes aggregate data from all participating institutions as well as a statistical summary of data from the particular college. At the project's conclusion, we will publish a comprehensive report of the findings, which will be available to all universities, policy makers, educators, and the scientific community. Individual students or institutions will not be identifiable in any way in these reports.

ASSESSMENT OF RISKS AND BENEFITS

We do not foresee any risks to you, should you choose to participate. There are also no direct benefits to you - however, the data that you share with the WECE project may be used to improve engineering education for students in the future.

RIGHTS OF PARTICIPANTS

Your participation is voluntary and you have the right to withdraw your consent or discontinue participation at any time without penalty or refuse to answer particular questions. Your privacy will be maintained in all published and written data resulting from the study. If you have questions about your rights as a student participant, or are dissatisfied at any time with any aspect of this study, you may contact - anonymously, if you wish - Kim Rylander, of the Institutional Review Board of Goodman Research Group, Inc., 30 JFK Street, Floor 3, Cambridge MA 02138 (e-mail: rylander@grginc.com).

For questions about the Women's Experiences in College Engineering (WECE) project, please contact the WECE staff at staff@wece.org, or by phone at (617) 491-7033.

```
[Note: The data in this section is shown from our database for
non-listserv students; the fields are locked]
```

Your first name:
(if not already filled in)
Your last name:
(if not already filled in)

Your school email address:
(if not already filled in)
Your school email address again:
(as above for verification purposes)

I have read the above and:

I agree to participate

I w ill not participate

```
[Note: This section of page Entry-d shows up only for non-
listserv students.]
```

If your name and e-mail address are incorrect, please press the button below which will allow you to restart and enter in your correct information. Alternatively, you may e-mail staff@wece.org to let us know your correct information.

Incorrect Data

```
[Note: {page Entry-e} Page following Entry-c for listserv
students. Page following Entry-d for those who press "incorrect
data". Consent form exactly like page Entry-d but with empty,
unlocked data fields.]
```

```
[Note: {page Entry-f} Page following Entry-d or Entry-e for
students who press "I agree to participate".]
```

Your WECE ID code is: **1006**.
Your Password is: **35**.
Your Web URL is: **http://www.wece.org/College/Login.asp?wid=1006&pid=35**

If you have not done so already, write the above values down. You will need them if you do not finish the questionnaire now and want to finish it at a later time.

You will need to use the WECE ID and Password codes if you return to the questionnaire through the main WECE web page.

Alternatively, use may use the above Web URL which bypasses the main WECE web page and returns you directly back to the questionnaire.

Continue with the questionnaire

```
[Note: Students who press "I will not participate" on page Entry-
d or Entry-e are sent to page Decline-a.]
```

```
[Note: {page A-1} Page following Entry-f. Collects information
necessary for the questions that are marked with an M to be
modified appropriately. If a student answers "graduate student"
or "no longer a student" she is shown page Ineligible-a.]
```

E, C, L [02] Which of the following describes your college standing?

<1>o Freshman (1st year)
<2>o Sophomore (2nd year)
<3>o Junior (3rd year)
<4>o Senior (4th year)
<5>o 5th year or beyond
<6>o Graduate student
<7>o No longer a student

```
[Note: {Page A-2} follows page A-1 for students choosing <1>
through <5>.]
```

F [03] At any time in your college career did you ever consider or pursue a major in engineering? In our study, we are considering computer science a field of engineering.
o yes, I have considered or pursued a major in engineering or computer science
o no, I have **never** considered or pursued a major in engineering or computer science

---

```
[Note: {Page Ineligible-b} follows page A-2 for students who
choose "no".]
```

"Our study is designed to gather information about women who are or were interested in engineering. Your college indicated that you once expressed an interest in engineering. When you entered college, were you interested in engineering?"

Yes

No

[Note: {Page Ineligible-c} follows page Ineligible-b for students who choose "no".]

"You have indicated that you are not part of the population of students that we are hoping to study. Thank you for your interest in the WECE project.
–The WECE project staff"

[Note: {Page A-3} follows page A-2 or page Ineligible-b for students who choose "yes". Question [04]: Students who answer "yes" are "continuers" and should see questions with a C, while those who answer "no" are "leavers" and will get the "leaver" set of questions, all those marked with an L.]

Thank you for agreeing to participate in our study. We anticipate that this survey will take you between 25 and 35 minutes to complete. If you cannot complete the survey in one sitting, you can have our computer save your responses by pressing the "Finished for Now" button located at the bottom of each survey page and then login again at a later time to complete the questionnaire. If you have questions or concerns, you may contact the WECE staff at staff@wece.org, or press the "Help!" button at the bottom of each page.

E, C, L [04] Are you currently either majoring in engineering, or else considering majoring in engineering?

o yes, I am **currently** majoring or considering a major in engineering
o no, I am **no longer** majoring or considering a major in engineering

E, L[05] When did you decide to stop pursuing an engineering degree?
[Note: Drop down menu with the following choices:]
<1>January to June 2001
<2>July to December 2000
<3>January to June 2000
<4>July to December 1999
<5>January to June 1999
<6>July to December 1998
<7>January to June 1998
<8>Earlier than 1998

E, C [06] Are you currently in a **formal** 5-year engineering undergraduate degree program at your college?

o Yes
o No

E, C, L [07] Are you planning to graduate before September, 2001?

o Yes
o No

[Note: The following – page B-1 to page D-x – are the formal questionnaire sections. Each will be broken up on the fly into multiple pages so that each student sees approximately six questions per page, no matter which set of questions they see. At the bottom of every web page are 3 buttons. The first button, "continue", sends students to the next page in sequence if they have finished all questions. If not, "continue" sends the student to page Resubmit-a, shown below. The second button reads "Finished for now" and sends students to page Finished-a. The third button, "Help", sends students to page Help, shown below.]

[Note: {page Resubmit-a} Shown to students who press "continue" and have not completed all of the questions on the page. If they press the "proceed anyway" button, go to the next page.]

"Please complete all the questions on this page! The ones you missed have been marked in red. Fill in the remaining questions and resubmit. Thanks!"

[[Proceed Anyway]]

[Note: Include text of questions that were not completed.]

[Note: {page Finished-a}]

"Thank you for completing part of the survey. Your responses have been saved. To complete the survey at a later time, reenter the Web site, press the "Resume" button on the first page, and enter the same ID that you used to access the questionnaire this time. You will be able to pick up where you left off. We hope you return to complete the study soon!
–The WECE project staff"

[Note: {page Help} At the bottom of this page there is a button to return to the most recent survey page.]

"If you have questions or concerns about this questionnaire, please email WECE staff at staff@wece.org. If you have encountered a technical error, please let us know the problem, as well as the browser version you are using (i.e. Netscape 2.0 or Internet Explorer 4.0) and platform (i.e. PC, Unix, or Macintosh). Thank you.
–The WECE project staff"

[Note: {pages B-1 to B-x} This is the first formal questionnaire section.

Information about Engineering Major

F, C, L [101] When you first entered college, how seriously were you considering a major in the following fields?

	Possible Major	Not at all seriously	Slightly seriously	Moderately seriously	Very seriously
[v101_0]	Engineering	<1>	<2>	<3>	<4>
[v101_1]	Life science	<1>	<2>	<3>	<4>
[v101_2]	Physical science	<1>	<2>	<3>	<4>
[v101_3]	Mathematics/ Statistics	<1>	<2>	<3>	<4>
[v101_4]	Social science	<1>	<2>	<3>	<4>
[v101_5]	Humanities	<1>	<2>	<3>	<4>

E, L [102] Presently, how seriously are you considering a major in the following fields?

	Possible Major	Not at all seriously	Slightly seriously	Moderately seriously	Very seriously
[v102_0]	Life science	<1>	<2>	<3>	<4>
[v102_1]	Physical science	<1>	<2>	<3>	<4>
[v102_2]	Mathematics/ Statistics	<1>	<2>	<3>	<4>
[v102_3]	Social science	<1>	<2>	<3>	<4>
[v102_4]	Humanities	<1>	<2>	<3>	<4>

E, C [103] In what field(s) of engineering are you currently majoring or considering a major? **Check all that apply**. [Note: each variable is displayed as a checkbox, with a returned value of <1>.]

		Declared as a Major		Considering as a Major
Aerospace/Aeronautics	[v103_0]	□	[v103_1]	□
Agricultural	[v103_2]	□	[v103_3]	□
Biological/Biomedical	[v103_4]	□	[v103_5]	□
Chemical	[v103_6]	□	[v103_7]	□
Civil/ Architectural	[v103_8]	□	[v103_9]	□
Computer Science	[v103_10]	□	[v103_11]	□
Electrical	[v103_12]	□	[v103_13]	□
Engineering science/ Engineering Physics	[v103_14]	□	[v103_15]	□
Environmental	[v103_16]	□	[v103_17]	□
Geological Science	[v103_18]	□	[v103_19]	□
Industrial/ Operations Research	[v103_20]	□	[v103_21]	□
Mechanical	[v103_22]	□	[v103_23]	□
Metal/Material science	[v103_24]	□	[v103_25]	□
Nuclear	[v103_26]	□	[v103_27]	□
Other	[v103_28]	□	[v103_29]	□

E, C [v104_0] Currently, how confident are you that engineering is the right major for you?

<1>o Completely confident
<2>o Very confident
<3>o Moderately confident
<4>o Slightly confident
<5>o Not at all confident

F, C, M [v105_0] Regardless of when you declared your major to your college, when did you make your personal decision to major in engineering? `[Note: Modified electronically so that students only see their current year and those before it as well as "Have not yet decided to major…"]`

<1> Before college
<2> Freshman year (1st year)
<3> Sophomore year (2nd year)
<4> Junior year (3rd year)
<5> Senior year (4th year)
<6> Have not yet decided to major in engineering

E, C, L, M* [106] Did you ever seriously consider leaving engineering in any of the academic years below? `[Modified to show the student's current year and (for the first year of participation in the study) those before. Freshman leavers do not get this question.]`

[v106_0] Freshman (1st) year	<1> Yes <0> No
[v106_1] Sophomore (2nd) year	<1> Yes <0> No
[v106_2] Junior (3rd) year	<1> Yes <0> No
[v106_3] Senior (4th) year	<1> Yes <0> No
[v106_4] Fifth year or beyond	<1> Yes <0> No

E, C [v107_0] Do you have a faculty advisor in engineering?

<1> Yes [v107_1]What is his/her gender? <1> Male <2> Female
<0> No

E, L [v107_0] Did you ever have a faculty advisor in engineering?

<1> Yes [v107_1]What was his/her gender? <1> Male <2> Female
<0> No

E, C [v108_0] **In this study we are defining a mentor as someone with more experience in engineering to whom you turn for advice or support about educational or professional decisions (a mentor may be a more advanced student, a teaching assistant, a faculty member, someone who works in industry etc.).** If your faculty advisor is not the person whom you consider your primary engineering mentor, what is the gender of the person you consider your primary engineering mentor?

<0> My engineering faculty advisor is my primary mentor
<1> Male
<2> Female
<3> I don't have a mentor

E, L, C [v109_0] How many courses have you taken in an engineering department?

[Note: Pull down menu with 0 to 30 as choices]

E, C, L [v110_0] In the past academic year, how many women engineering faculty have been the primary instructors of the courses you have taken?
[Note: Pull down menu with 0 to 10 as choices]

E, C, M [111] Since last year have you: [Note: Not shown to freshmen students.]

[v110_0] Received any engineering awards <1> Yes <0> No
[v110_1] Been elected to any engineering honor societies <1> Yes <0> No

E, C [112] To what extent do you agree with the following statements?

	Strongly agree	Moderately agree	Slightly agree	Neither agree nor disagree	Slightly disagree	Moderately disagree	Strongly disagree
[v112_0] I have a high level of interest in engineering.	<1>	<2>	<3>	<4>	<5>	<6>	<7>
[v112_1] I feel there is a lot of competition in the engineering department among students.	<1>	<2>	<3>	<4>	<5>	<6>	<7>
[v112_2] I feel confident that I could find a job in engineering that pays well.	<1>	<2>	<3>	<4>	<5>	<6>	<7>
[v112_3] I am overwhelmed by the workload in my engineering courses.	<1>	<2>	<3>	<4>	<5>	<6>	<7>
[v112_4] I am very happy with my choice of engineering.	<1>	<2>	<3>	<4>	<5>	<6>	<7>
[v112_5] I am committed to engineering as a major	<1>	<2>	<3>	<4>	<5>	<6>	<7>

E, L [113] To what extent do you agree with the following statements?

	Strongly agree	Moderately agree	Slightly agree	Neither agree nor disagree	Slightly disagree	Moderately disagree	Strongly disagree
[v112_0] I have a high level of interest in engineering.	<1>	<2>	<3>	<4>	<5>	<6>	<7>
[v112_1] I feel there is a lot of competition in the engineering department among students.	<1>	<2>	<3>	<4>	<5>	<6>	<7>
[v112_3] I am overwhelmed by the workload in my engineering courses.	<1>	<2>	<3>	<4>	<5>	<6>	<7>

E, C, L [114] Since you entered college, how has your self confidence changed in:

Self confidence in:	Greatly increased	Moderately increased	Slightly increased	Stayed the same	Slightly decreased	Moderately decreased	Greatly decreased
[v114_0] Your math abilities	<1>	<2>	<3>	<4>	<5>	<6>	<7>
[v114_1] Your science abilities	<1>	<2>	<3>	<4>	<5>	<6>	<7>
[v114_2] Your engineering abilities	<1>	<2>	<3>	<4>	<5>	<6>	<7>
[v114_3] Your overall academic abilities	<1>	<2>	<3>	<4>	<5>	<6>	<7>

E, C [115] **Compared to other <u>WOMEN</u> in your engineering courses** how would you complete the following:

	Strongly agree	Moderately agree	Slightly agree	Neither agree nor disagree	Slightly disagree	Moderately disagree	Strongly disagree
[v115_0] I spend more time and effort on my classwork.	<1>	<2>	<3>	<4>	<5>	<6>	<7>
[v115_1] I understand engineering concepts better.	<1>	<2>	<3>	<4>	<5>	<6>	<7>
[v115_2] I am better at solving engineering problems.	<1>	<2>	<3>	<4>	<5>	<6>	<7>
[v115_3] I am more committed to engineering.	<1>	<2>	<3>	<4>	<5>	<6>	<7>
[v115_4] I work better with other people.	<1>	<2>	<3>	<4>	<5>	<6>	<7>
[v115_5] I have more confidence in my engineering abilities.	<1>	<2>	<3>	<4>	<5>	<6>	<7>

E, L [116] **Compared to other <u>WOMEN</u> in your engineering courses** how would you complete the following:

	Strongly agree	Moderately agree	Slightly agree	Neither agree nor disagree	Slightly disagree	Moderately disagree	Strongly disagree
[v115_0] I spent more time and effort on my classwork.	<1>	<2>	<3>	<4>	<5>	<6>	<7>
[v115_1] I understood engineering concepts better.	<1>	<2>	<3>	<4>	<5>	<6>	<7>
[v115_2] I was better at solving engineering problems.	<1>	<2>	<3>	<4>	<5>	<6>	<7>
[v115_3] I was more committed to engineering.	<1>	<2>	<3>	<4>	<5>	<6>	<7>
[v115_4] I worked better with other people.	<1>	<2>	<3>	<4>	<5>	<6>	<7>
[v115_5] I had more confidence in my engineering abilities.	<1>	<2>	<3>	<4>	<5>	<6>	<7>

E, C [117] **Compared to <u>MEN</u> in your engineering courses**, how would you complete the following:

	Strongly agree	Moderately agree	Slightly agree	Neither agree nor disagree	Slightly disagree	Moderately disagree	Strongly disagree
[v117_0] I spend more time and effort on my classwork.	<1>	<2>	<3>	<4>	<5>	<6>	<7>
[v117_1] I understand most engineering concepts better.	<1>	<2>	<3>	<4>	<5>	<6>	<7>
[v117_2] I am better at solving engineering problems.	<1>	<2>	<3>	<4>	<5>	<6>	<7>
[v117_3] I am more committed to engineering.	<1>	<2>	<3>	<4>	<5>	<6>	<7>
[v117_4] I work better with other people.	<1>	<2>	<3>	<4>	<5>	<6>	<7>
[v117_5] I have more confidence in my engineering abilities.	<1>	<2>	<3>	<4>	<5>	<6>	<7>

E, L [118] **Compared to MEN in your engineering courses**, how would you complete the following:

	Strongly agree	Moderately agree	Slightly agree	Neither agree nor disagree	Slightly disagree	Moderately disagree	Strongly disagree
[v117_0] I spent more time and effort on my classwork.	<1>	<2>	<3>	<4>	<5>	<6>	<7>
[v117_1] I understood most engineering concepts better.	<1>	<2>	<3>	<4>	<5>	<6>	<7>
[v117_2] I was better at solving engineering problems.	<1>	<2>	<3>	<4>	<5>	<6>	<7>
[v117_3] I was more committed to engineering.	<1>	<2>	<3>	<4>	<5>	<6>	<7>
[v117_4] I worked better with other people.	<1>	<2>	<3>	<4>	<5>	<6>	<7>
[v117_5] I had more confidence in my engineering abilities.	<1>	<2>	<3>	<4>	<5>	<6>	<7>

E, C, L [v119_0] During college have you ever been a part-time student? <1> Yes <0> No

E, C, L [v120_0] During college have you ever taken a leave of absence? <1> Yes <0> No

F, C [v121] For each of the following people, how much encouragement or discouragement did you receive about pursuing a degree in engineering (i.e., selecting a major or staying in engineering)? (If not applicable, choose N/A.)

`[Note: Encouragement and discouragement are spelled out in all column headers.]`

	A great deal of discouragement	Moderate discouragement	A little discouragement	Neither enc/ disc	A little encouragement	Moderate encouragement	A great deal of encouragement	N/A
[v121_0] Mother	<1>	<2>	<3>	<4>	<5>	<6>	<7>	<8>
[v121_1] Father	<1>	<2>	<3>	<4>	<5>	<6>	<7>	<8>
[v121_2] Most influential sibling(s)	<1>	<2>	<3>	<4>	<5>	<6>	<7>	<8>
[v121_3] Most influential high school peers	<1>	<2>	<3>	<4>	<5>	<6>	<7>	<8>
[v121_4] Most influential teacher	<1>	<2>	<3>	<4>	<5>	<6>	<7>	<8>
[v121_5] High school guidance counselor	<1>	<2>	<3>	<4>	<5>	<6>	<7>	<8>
[v121_6] Someone who works in a science/math/engineering field.	<1>	<2>	<3>	<4>	<5>	<6>	<7>	<8>

E, C [122] In the past academic year, how much encouragement or discouragement did you receive about pursuing a degree in engineering from each of the following people?
E, L [140] In the last year in which you studied engineering, how much encouragement or discouragement did you receive about pursuing a degree in engineering from each of the following people?

	A great deal of disc	Moderate disc	A little disc	Neither enc/ disc	A little enc	Moderate enc	A great deal of enc	N/A
[v122_0] Most influential college engineering faculty member	<1>	<2>	<3>	<4>	<5>	<6>	<7>	<8>
[v122_1] College advisor	<1>	<2>	<3>	<4>	<5>	<6>	<7>	<8>
[v122_2] Most influential graduate student or teaching assistant	<1>	<2>	<3>	<4>	<5>	<6>	<7>	<8>
[v122_3] Most influential peers in engineering	<1>	<2>	<3>	<4>	<5>	<6>	<7>	<8>

E, C [123] In the past academic year, to what extent did each of the following encourage or discourage you in your pursuit of an engineering major?
E, L [145] In the last year in which you studied engineering, to what extent did each of the following encourage or discourage you in your pursuit of an engineering major?

	Very greatly discouraging	Moderately discourag	Slightly discouraging	Did not affect me	Slightly enc	Moderately encouraging	Very greatly enc	N/A
[v123_0] Employment opportunities	<1>	<2>	<3>	<4>	<5>	<6>	<7>	<8>
[v123_1] Salary potential	<1>	<2>	<3>	<4>	<5>	<6>	<7>	<8>
[v123_2] Interest in the subject matter in engineering	<1>	<2>	<3>	<4>	<5>	<6>	<7>	<8>
[v123_3] Quality of teaching by instructors in engineering	<1>	<2>	<3>	<4>	<5>	<6>	<7>	<8>
[v123_4] Mentor	<1>	<2>	<3>	<4>	<5>	<6>	<7>	<8>
[v123_5] Study group	<1>	<2>	<3>	<4>	<5>	<6>	<7>	<8>
[v123_6] Your grades	<1>	<2>	<3>	<4>	<5>	<6>	<7>	<8>
[v123_7] Your spouse/Partner	<1>	<2>	<3>	<4>	<5>	<6>	<7>	<8>
[v123_8] Your peers	<1>	<2>	<3>	<4>	<5>	<6>	<7>	<8>
[v123_9] Internship/Research experience	<1>	<2>	<3>	<4>	<5>	<6>	<7>	<8>
[v123_10] Amount of time required for engineering coursework	<1>	<2>	<3>	<4>	<5>	<6>	<7>	<8>
[v123_11] Competition in engineering classes	<1>	<2>	<3>	<4>	<5>	<6>	<7>	<8>
[v123_12] Pace of engineering courses	<1>	<2>	<3>	<4>	<5>	<6>	<7>	<8>
[v123_13] Number of women in the major	<1>	<2>	<3>	<4>	<5>	<6>	<7>	<8>
[v123_14] Number of women faculty in engineering	<1>	<2>	<3>	<4>	<5>	<6>	<7>	<8>
[v123_15] Class size in engineering	<1>	<2>	<3>	<4>	<5>	<6>	<7>	<8>
[v123_16] Atmosphere of engineering department/courses	<1>	<2>	<3>	<4>	<5>	<6>	<7>	<8>

E, C, L [v124_0] To date, which was your single, most significant source of encouragement?
[Note: Questions 124 and 125 both contain their lists in pull-down menus.]

<1>Mother
<2>Father
<3>Sibling
<4>Spouse/Partner
<5>High school peers
<6>Precollege teacher
<7>High school guidance counselor
<8>Someone who works in a science/math/engineering field.
<9>College faculty member
<10>Graduate student or teaching assistant
<11>College peers
<12>Employment opportunities
<13>Salary potential
<14>Interest in the subject matter in engineering
<15>Quality of teaching by instructors in engineering
<16>Study group
<17>Grades
<18>Internship/Research experience
<19>Amount of time required for engineering coursework
<20>Competition in engineering classes
<21>Pace of engineering courses
<22>Number of women in the major
<23>Number of women faculty in engineering
<24>Class size in engineering
<25>Atmosphere of engineering department/courses

E, C, L [v125_0] <u>To date</u>, which was your single, most significant source of discouragement?
<1>Mother
<2>Father
<3>Sibling
<4>Spouse/Partner
<5>High school peers
<6>Precollege teacher
<7>High school guidance counselor
<8>Someone who works in a science/math/engineering field.
<9>College faculty member
<10>Graduate student or teaching assistant
<11>College peers
<12>Employment opportunities
<13>Salary potential
<14>Interest in the subject matter in engineering
<15>Quality of teaching by instructors in engineering
<16>Study group
<17>Grades
<18>Internship/Research experience
<19>Amount of time required for engineering coursework
<20>Competition in engineering classes
<21>Pace of engineering courses
<22>Number of women in the major
<23>Number of women faculty in engineering
<24>Class size in engineering
<25>Atmosphere of engineering department/courses

E, C, L [v126_0] Would you encourage other women to major in engineering?
<1> Definitely
<2> Probably

<3> Neutral
<4> Probably not
<5> Definitely not

E, C [v127] Reflecting on your experiences **during the past academic year**, to what extent were you at an advantage or disadvantage in the following areas **compared to MALE students** in engineering.

E, L [v150] Reflecting on your experiences **during the last year in which you studied engineering**, to what extent were you at an advantage or disadvantage in the following areas **compared to MALE students** in engineering.
`[Note: Disadvantage/advantage are spelled out in the column headers.]`

	Great adv	Moderate adv	Slight adv	Neither adv nor disadv	Slightly disadv	Moderate disadv	Great disadv
[v127_0] Interacting with faculty	<1>	<2>	<3>	<4>	<5>	<6>	<7>
[v127_1] Relating to advisor	<1>	<2>	<3>	<4>	<5>	<6>	<7>
[v127_2] Finding a mentor	<1>	<2>	<3>	<4>	<5>	<6>	<7>
[v127_3] Getting support from engineering faculty	<1>	<2>	<3>	<4>	<5>	<6>	<7>

E, C [128] Reflecting on your experiences **during the past academic year**, to what extent do you agree or disagree with the following statements?
E, L [155] Reflecting on your experiences **during the last year in which you studied engineering**, to what extent do you agree or disagree with the following statements?

	Strongly agree	Moderately agree	Slightly agree	Neither agree nor disagree	Slightly disagree	Moderately disagree	Strongly disagree
[v128_0] The content of my engineering courses was less relevant to women than men.	<1>	<2>	<3>	<4>	<5>	<6>	<7>
[v128_1] In my engineering lectures, my instructors made comments that demeaned women.	<1>	<2>	<3>	<4>	<5>	<6>	<7>
[v128_2] As an engineering student, I felt stigmatized by students outside engineering.	<1>	<2>	<3>	<4>	<5>	<6>	<7>
[v128_3] My engineering department was supportive of women students.	<1>	<2>	<3>	<4>	<5>	<6>	<7>
[v128_4] I felt more comfortable in my classes in departments outside of engineering than in my engineering classes.	<1>	<2>	<3>	<4>	<5>	<6>	<7>
[v128_5] The competitive climate in engineering favored male students.	<1>	<2>	<3>	<4>	<5>	<6>	<7>
[v128_6] I believe that engineering departments should have special programs to address women's needs.	<1>	<2>	<3>	<4>	<5>	<6>	<7>
[v128_7] I believe it is easier for women to go into some fields of engineering than other fields.	<1>	<2>	<3>	<4>	<5>	<6>	<7>
[v128_8] Being a woman improves my prospects of finding a job in engineering.	<1>	<2>	<3>	<4>	<5>	<6>	<7>
[v128_9] I believe women in engineering are generally offered higher-paying jobs than	<1>	<2>	<3>	<4>	<5>	<6>	<7>

men.							
[v128_10] It is more difficult for a woman to balance a career and family in engineering than in most other fields.	<1>	<2>	<3>	<4>	<5>	<6>	<7>

E, C, M [129] What are your plans for next year and the future? **(Check all that apply)**.

`[Note: "Next year" column and "Continue with my undergraduate program" row only appear for seniors and fifth years.]`

I plan to:		Next year		In the future
Continue with my undergraduate program	[v129_0]	☐	[v129_1]	☐
Enter a job in engineering	[v129_2]	☐	[v129_3]	☐
Attend graduate school in engineering	[v129_4]	☐	[v129_5]	☐
Attend graduate school in science or math	[v129_6]	☐	[v129_7]	☐
Attend medical school	[v129_8]	☐	[v129_9]	☐
Attend law school	[v129_10]	☐	[v129_11]	☐
Attend business school	[v129_12]	☐	[v129_13]	☐
Attend graduate school in a field not listed above	[v129_14]	☐	[v129_15]	☐
Enter teaching	[v129_16]	☐	[v129_17]	☐
Seek other employment outside of engineering	[v129_18]	☐	[v129_19]	☐
Other	[v129_20]	☐	[v129_21]	☐
Don't know	[v129_22]	☐	[v129_23]	☐

`[Note: Questions 130 and 131 appear only for Seniors and Fifth Years.]`

M, C [v130_0] Are your plans for next year definite?

<1> Yes <0> No

M, C [v131_0] How likely is it that you will be working in an engineering-related field 7 years from now?

<1> Definitely will
<2> Almost definitely will
<3> Probably will
<4> Probably will not
<5> Almost definitely will not
<6> Definitely will not

E, C [v132_0] During the past academic year, what has been your letter grade **average in your engineering-related courses**? *(If your school doesn't give letter grades, please translate your GPA the best you can.)*

E, L [v160_0] During the last year in which you studied engineering, what had been your letter grade average **in your engineering-related courses**? *(If your school doesn't give letter grades, please translate your GPA the best you can.)*

<1> A+ / A / A-
<2> B+ / B / B-
<3> C+ / C / C-
<4> D+ / D / D-
<5> F
**<6> Did not take engineering-related courses in that year

F, C [133, 134, 135] What are your three most important reasons for wanting to become an engineer?
[v133_0] Most important: [Text box, allow 200 characters.]
[v134_0] 2: [Text box, allow 200 characters.]
[v135_0] 3: [Text box, allow 200 characters.]

F, L [136, 137, 138] What are your three most important reasons for leaving or no longer considering engineering as a major?
[v136_0] Most important: [Text box, allow 200 characters]
[v137_0] 2: [Text box, allow 200 characters]
[v138_0] 3: [Text box, allow 200 characters]

[Note: {pages C-1 to C-x} contain two dynamically generated charts – any activities that students indicate they have participated in questions E201 or E202 then appear in questions 203 and 204 (on the next web page.) If the respondents did not participate in anything, questions 203 and 204 do not appear.]

Support Networks and Programs in Engineering

E, C [201] During the past academic year, how frequently have you participated in any of the following on your campus?
E, L [201] During the last year in which you studied engineering, how frequently did you participate in any of the following on your campus?

	Participation Frequency				
Activity	1x/ week or more	1-3x/ month	1-3x/ semester	1x/ year	Never
[v201_0] Study or support group	<1>	<2>	<3>	<4>	<5>
[v201_1] Internship/ Research experience	<1>	<2>	<3>	<4>	<5>
[v201_2] Received tutoring	<1>	<2>	<3>	<4>	<5>
[v201_3] Received academic advising	<1>	<2>	<3>	<4>	<5>
[v201_4] Received career counseling	<1>	<2>	<3>	<4>	<5>
[v201_5] Received peer mentoring	<1>	<2>	<3>	<4>	<5>
	1x/ week or more	1-3x/ month	1-3x/ semester	1x/ year	Never
[v201_6] Participated in online mentoring with a professional engineer	<1>	<2>	<3>	<4>	<5>
[v201_7] Been a mentor or “buddy”	<1>	<2>	<3>	<4>	<5>
[v201_8] Been a tutor	<1>	<2>	<3>	<4>	<5>
[v201_9] Read engineering newsletter or listserv	<1>	<2>	<3>	<4>	<5>
[v201_10] Engineering society activities (e.g., IEEE, ASME, SWE)	<1>	<2>	<3>	<4>	<5>
[v201_11] Engineering speaker	<1>	<2>	<3>	<4>	<5>
[v201_12] Field trip to industry site	<1>	<2>	<3>	<4>	<5>
[v201_13] Engineering social event	<1>	<2>	<3>	<4>	<5>
[v201_14] Worked with outreach to high school students	<1>	<2>	<3>	<4>	<5>

F, L, C, M [202] During your previous years of college, have you participated in any of the following on your campus?
[Note: Freshman do not see this table. Only years prior to the student's current year are shown, and the Never column.]

Activity	Year			
	Frosh	Soph.	Jr	Never
Study or support group	[v202_0]	[v202_1]	[v202_2]	[v202_3]
Internship/ Research experience	[v202_4]	[v202_5]	[v202_6]	[v202_7]
Received tutoring	[v202_8]	[v202_9]	[v202_10]	[v202_11]
Received academic advising	[v202_12]	[v202_13]	[v202_14]	[v202_15]
Received career counseling	[v202_16]	[v202_17]	[v202_18]	[v202_19]
Received peer mentoring	[v202_20]	[v202_21]	[v202_22]	[v202_23]
	Frosh	Soph.	Jr	Never
Participated in online mentoring with a professional engineer	[v202_24]	[v202_25]	[v202_26]	[v202_27]
Been a mentor or “buddy”	[v202_28]	[v202_29]	[v202_30]	[v202_31]
Been a tutor	[v202_32]	[v202_33]	[v202_34]	[v202_35]
Read engineering newsletter or listserv	[v202_36]	[v202_37]	[v202_38]	[v202_39]

Engineering society activities (e.g., IEEE, ASME, SWE)	[v202_40]	[v202_41]	[v202_42]	[v202_43]
Engineering speaker	[v202_44]	[v202_45]	[v202_46]	[v202_47]
Field trip to industry site	[v202_48]	[v202_49]	[v202_50]	[v202_51]
	Frosh	Soph.	Jr	Never
Engineering social event	[v202_52]	[v202_53]	[v202_54]	[v202_55]
Worked with outreach to high school students	[v202_56]	[v202_57]	[v202_58]	[v202_59]

[Note: {Page D-1 to D-x} generated with data from the previous questions. The "activities" in the chart in 203 and 204 are any of the activities that the respondent indicated they participated in in either question 201 or 202. The number of rows or columns will vary. If the respondent did not participate in any activities, neither of these questions appears. Question v203_0 to _14 will appear only for WIE schools. It will customize the web pages with the name of the university, the name of the women's program at that institution (if relevant), and the acronym for the program (if relevant).]

E, L, C, M [203] Were the programs in which you participated sponsored by the [WIE Program Name] ([WIE Acronym]) or by the Society of Women Engineers (SWE) at your college?
[Note: check boxes used]

	Sponsored by?		
Activity	[WIEAcronym]	SWE	Don't know
Study or support group	[v203_0]	[v203_1]	[v203_2]
Internship/ Research experience	[v203_3]	[v203_4]	[v203_5]
Received tutoring	[v203_6]	[v203_7]	[v203_8]
Received academic advising	[v203_9]	[v203_10]	[v203_11]
Received career counseling	[v203_12]	[v203_13]	[v203_14]
Received peer mentoring	[v203_15]	[v203_16]	[v203_17]
Participated in online mentoring with a professional engineer	[v203_18]	[v203_19]	[v203_20]
Been a mentor or "buddy"	[v203_21]	[v203_22]	[v203_23]
Been a tutor	[v203_24]	[v203_25]	[v203_26]
Read engineering newsletter or listserv	[v203_27]	[v203_28]	[v203_29]
Engineering society activities (e.g., IEEE, ASME, SWE)	[v203_30]	[v203_31]	[v203_32]
Engineering speaker	[v203_33]	[v203_34]	[v203_35]
Field trip to industry site	[v203_36]	[v203_37]	[v203_38]
Engineering social event	[v203_39]	[v203_40]	[v203_41]
Worked with outreach to high school students	[v203_42]	[v203_43]	[v203_44]

E, C, L [204] For each activity, which of the following reasons describe why you chose to participate? **Please check ALL that apply**.

Study or support group

[v204_0] □ Socializing with other women in engineering
[v204_1] □ Socializing with men in engineering
[v204_2] □ Getting advice or mentoring about engineering
[v204_3] □ Talking about issues of concern in engineering
[v204_4] □ Getting help with engineering coursework
[v204_5] □ Helping others
[v204_6] □ Getting career counseling or information
[v204_7] □ Learning about a topic of interest related to engineering
[v204_8] □ Being in a supportive atmosphere
[v204_9] □ Learning more about specific fields in engineering
[v204_10] □ Getting to know faculty in engineering
[v204_11] □ Earning money
[v204_12] □ Other

Internship/ Research experience
[v204_13] □ Socializing with other women in engineering
[v204_14] □ Socializing with men in engineering
[v204_15] □ Getting advice or mentoring about engineering
[v204_16] □ Talking about issues of concern in engineering
[v204_17] □ Getting help with engineering coursework
[v204_18] □ Helping others
[v204_19] □ Getting career counseling or information
[v204_20] □ Learning about a topic of interest related to engineering
[v204_21] □ Being in a supportive atmosphere
[v204_22] □ Learning more about specific fields in engineering
[v204_23] □ Getting to know faculty in engineering
[v204_24] □ Earning money
[v204_25] □ Other

`[Note: The rest of the activities are displayed, if relevant, in the same pattern as the two above.]`

Received tutoring: [v204_26] to [v204_38]
Received academic advising: [v204_39] to [v204_51]
Received career counseling: [v204_52] to [v204_64]
Received peer mentoring: [v204_65] to [v204_77]
Participated in online mentoring with a professional engineer : [v204_78] to [v204_90]
Been a mentor or "buddy" : [v204_91] to [v204_103]
Been a tutor: [v204_104] to [v204_116]
Read engineering newsletter or listserv: [v204_117] to [v204_129]
Engineering society activities (e.g., IEEE, ASME, SWE) : [v204_130] to [v204_142]
Engineering speaker: [v204_143] to [v204_155]
Field trip to industry site: [v204_156] to [v204_168]
Engineering social event: [v204_169] to [v204_181]
Worked with outreach to high school students: [v204_182] to [v204_194]

E, C [205] Would you participate, or participate again in any of the following activities if they were offered at your university?
E, L [210] If you were still in engineering, would you participate, or participate again in any of the following activities if they were offered at your university?

Activity	Definitely	Probably	Probably not	Definitely not
[v205_0] Study or support group	<1>	<2>	<3>	<4>
[v205_1] Internship/ Research experience	<1>	<2>	<3>	<4>
[v205_2] Receive tutoring	<1>	<2>	<3>	<4>
[v205_3] Receive academic advising	<1>	<2>	<3>	<4>
[v205_4] Receive career counseling	<1>	<2>	<3>	<4>
[v205_5] Receive peer mentoring	<1>	<2>	<3>	<4>
	Definitely	Probably	Probably not	Definitely not
[v205_6] Participate in online mentoring with a professional engineer	<1>	<2>	<3>	<4>
[v205_7] Be a mentor or "buddy"	<1>	<2>	<3>	<4>
[v205_8] Be a tutor	<1>	<2>	<3>	<4>

[v205_9] Read engineering newsletter or listserv	<1>	<2>	<3>	<4>
[v205_10] Engineering society activities (e.g., IEEE, ASME, SWE)	<1>	<2>	<3>	<4>
[v205_11] Engineering speaker	<1>	<2>	<3>	<4>
[v205_12] Field trip to industry site	<1>	<2>	<3>	<4>
	Definitely	Probably	Probably not	Definitely not
[v205_13] Engineering social event	<1>	<2>	<3>	<4>
[v205_14] Work with outreach to high school students	<1>	<2>	<3>	<4>
[v205_15] Participate in engineering orientation	<1>	<2>	<3>	<4>
[v205_16] Live in engineering dorm	<1>	<2>	<3>	<4>

F, C, L [206] At any time during college did you:

[v206_0] Participate in an engineering orientation <1>Yes <0>No
[v206_1] Live in an engineering dorm <1>Yes <0>No

F, L, C [v207_0] To what extent was your decision to attend your college influenced by the presence of support programs for women in engineering?

<1> Highly influenced
<2> Moderately influenced
<3> Slightly influence
<4> Not at all influenced

`[Note: {pages E-1 to E-x}]`

Background Information

F, C, L[v301] Which of the following describes your high school? (please choose one from each column)

[v301_0]	[v301_1]	[v301_2]
<1> Public <2> Private <3> Parochial/Religious <4> Homeschooled	<1> Single-Sex <2> Co-ed	<1> Urban <2> Suburban <3> Rural

F, C, L [v302_0] In what year did you graduate from high school:
`[Note: A pull-down menu containing the last 40 years is displayed.]`

F, C, L [v303_0] Approximately how many students were in your high school senior class?____
`[Note: A pull-down menu is displayed with the following ranges.]`
<1> 0-50, <2> 51-100, <3> 101-500, <4> 501-1000, <5> more than 1000

F, C, L [v304] During grades 9 to 12 (including summers) how many **semesters** of each of the following subjects did you study? (*Count a year-long course as two semesters and a summer course as one. Include AP courses and courses taken at a local college.)*
`[Note: radio button = number chosen as value]`

	Number of Semesters														
Course	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14
[v304_0] Biology	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o

[v304_1] Chemistry	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o
[v304_2] Earth science/Geology/Astronomy	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o
[v304_3] Physics	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o
[v304_4] Environmental science	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o
[v304_5] Other science	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o
[v304_6] Computer science	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o
[v304_7] Calculus	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o
[v304_8] Math/Statistics other than calculus	o	o	o	o	o	o	o	o	o	o	o	o	o	o	

F, C, L [305] Prior to entering college did you take any of the following advanced placement courses?

[v305_0] AP Calculus AB <1> Yes <0> No
[v305_1] AP Calculus BC <1> Yes <0> No
[v305_2] AP Physics <1> Yes <0> No
[v305_3] AP Biology <1> Yes <0> No
[v305_4] AP Chemistry <1> Yes <0> No
[v305_5] AP Environmental science <1> Yes <0> No

F, C, L [306] During high school (including summers) did you take an:

[v306_0] Engineering course <1> Yes <0> No
[v306_1] Independent science research course <1> Yes <0> No
[v306_2] A science or math course at a local college <1> Yes <0> No

F, C, L [307] What was your: *(If not sure, please give your closest estimate.)*

[v307_0] SAT Math score ____ `[Note: Pull-down with below ranges.]`
<1> 200-299, <2> 300-399, <3> 400-499, <4> 500-549, <5> 550-599, <6> 600-649, <7> 650-699, <8> 700-749, <9> 750-800
[v307_1] SAT Verbal score ____ `[Note: Pull-down with below ranges.]`
<1> 200-299, <2> 300-399, <3> 400-499, <4> 500-549, <5> 550-599, <6> 600-649, <7> 650-699, <8> 700-749, <9> 750-800)
or
[v307_2] ACT score ____ `[Note: Pull-down with numbers 1 to 36]`

F, C, L [308] Did you participate in any of the following **science, math, or engineering** experiences during grades 9 to 12?

[v308_0] Summer science, math, or engineering programs <1> Yes <0> No
[v308_1] Competitions or contests (e.g., Westinghouse) <1> Yes <0> No
[v308_2] After-school clubs <1> Yes <0> No
[v308_3] Special programs or workshops (on weekends, after-school) <1> Yes <0> No
[v308_4] Teaching science, math, or engineering <1> Yes <0> No
[v308_5] Research experience <1> Yes <0> No
[v308_6] Paid work experience in science, math, or engineering <1> Yes <0> No
[v308_7] Volunteer work experience or internship <1> Yes <0> No

F, C, L [v309_0] Which year did you first enter college? ____

[Note: Pull-down with: <1> Before 1985, then list 1985-2000 by year, incrementing the value by 1 for each year]

E, C, L [310] Have you used the following sources of support to finance your college education?

[v310_0]	Family support/personal funds/savings	<1> Yes	<0> No
[v310_1]	Scholarships/grants	<1> Yes	<0> No
[v310_2]	Loans	<1> Yes	<0> No
[v310_3]	Work-study employment during the school year	<1> Yes	<0> No
[v310_4]	Non work-study employment during the school year	<1> Yes	<0> No
[v310_5]	Summer or other employment	<1> Yes	<0> No

E, C, L [v311_0] **During the past academic year** on average how many hours of **paid** work did you do a week? (If you did not work, answer 0.)

____ hours

[Note: Pull-down with 0-40 listed, <41>More than 40]

F, C, L [v312_0]In what year were you born?

[Note: Pull-down with value = number chosen]

F, C, L [v313_0] What is your citizenship?:

<1> US citizen or territory [v313_1] Which state or territory?

[Note: Pull-down with states]

<1> Alabama, <2> Alaska, <3> American Samoa, <4> Arizona, <5> Arkansas, <6> California, <7> Colorado, <8> Connecticut, <9> Delaware, <10> District of Columbia, <11> Florida, <12> Georgia, <13> Guam, <14> Hawaii, <15> Idaho, <16> Illinois , <17> Indiana , <18> Iowa, <19> Kansas, <20> Kentucky, <21> Louisiana, <22> Maine, <23> Maryland, <24> Massachusetts, <25> Michigan, <26> Minnesota, <27> Mississippi, <28> Missouri, <29> Montana, <30> Nebraska, <31> Nevada, <32> New Hampshire, <33> New Jersey, <34> New Mexico, <35> New York, <36> North Carolina, <37> North Dakota, <38> Ohio, <39> Oklahoma, <40> Oregon, <41> Pennsylvania, <42> Puerto Rico, <43> Rhode Island, <44> South Carolina, <45> South Dakota, <46> Tennessee, <47> Texas, <48> Utah, <49> Vermont, <50> Virginia, <51> Washington, <52> West Virginia, <53> Wisconsin, <54> Wyoming

<2> Canadian citizen [v313_1] Which province?

[Note: Pull-down with provinces]

<55> Alberta, <56> British Columbia, <57> Manitoba, <58> New Brunswick, <59> Newfoundland, <60> Northwest Territory, <61> Nova Scotia, <62> Ontario, <63> Prince Edward Island, <64> Quebec, <65> Saskatchewan, <66> Yukon)

<3 or 4 if “other”> Citizen of another country [v313_1] Which country?

[Note: Pull-down with countries]

<67> China, <68> France , <69> Germany, <70> India, <71> Indonesia, <72> Iran , <82> Jamaica, <73> Japan, <74> Korea , <75> Malaysia, <76> Mexico , <77> Pakistan, <83> Phillippines, <84> Russia, <85> Singapore <78> Taiwan, <79> Thailand, <86> Turkey, <80> United Kingdom, <81> Other___[v313_2]____

F, C, L [314] How do you describe your ethnicity? **(Check <u>all</u> that apply):**

[v314_0] Black/African-American/African
[v314_1] Central/Southeast/East Asian (e.g., Chinese, Taiwanese, Vietnamese, Korean, etc.)
[v314_2] Hispanic/Latino(a)
[v314_3] Indian Asian (e.g., Indian, Pakistani)
[v314_4] Native American, American Indian, Alaskan Native, or First Nation
[v314_5] White
[v314_6] Other

F, C, L [315] At any time during high school did you:

[v315_0] Live with your mother	<1> Yes	<0> No
[v315_1] Live with your father	<1> Yes	<0> No
[v315_2] Live with a step-mother	<1> Yes	<0> No
[v315_3] Live with a step-father	<1> Yes	<0> No
[v315_4] Live with another relative	<1> Yes	<0> No
[v315_5] Live with a non-related adult	<1> Yes	<0> No

F, C, L [316] Which two people have had the greatest influence on your decisions about education?

[v316_0] Most influential [v316_1] 2nd most influential

[Note: Pull-down menu for each with the following items:]

<1> Mother
<2> Father
<3> Female sibling
<4> Male sibling
<5> Spouse/Partner
<6> Another relative
<7> Teacher
<8> Guidance counselor
<9> A non-related adult
<10> An employer
<11> A peer

[Note: {pages F-1 to F-x} use question 316 to customize 317 and 318. If the student did not choose Mother and Father for 316, extra pull-down menus for 317 and columns for 318 are created.]

F, C, L [317] What was the highest educational level of your:

[v317_0] [Mother] [v317_1] [Father]
[v317_2] [Most influential] [v317_3] [2nd most influential]

[Note: Pull-down menu for each with the following items:]

<1> Attended elementary school but did not finish jr/sr high school
<2> Attended high school
<3> High school diploma or equivalent

<4> Some college or technical school, associates degree
<5> Finished 4 year college or equivalent degree
<6> Some graduate school by did not earn degree
<7> Masters degree (e.g. MA, MS, MAT, MPS)
<8> Professional degree (e.g. JD, MBA)
<9> Medical doctor (MD)
<10> Doctoral degree (PhD, EdD)
<11> Other graduate degree
<12> Not sure

F, C, L [318] We've generated the following table based on your previous responses. Please indicate the fields in which they have worked. Have the following people worked in any of the fields listed below? **(Please check all that apply.)**

	[Mother]	[Father]	[Other Most influential]	[Other 2nd most influential]
Engineer	[v318_0]	[v318_1]	[v318_2]	[v318_3]
Scientist, lab technician	[v318_4]	[v318_5]	[v318_6]	[v318_7]
Computer scientist, system administrator, programmer , technician	[v318_8]	[v318_9]	[v318_10]	[v318_11]
Medical professional–including doctor, veterinarian, dentist, medical technician, nurse, physician assistant	[v318_12]	[v318_13]	[v318_14]	[v318_15]
Mathematician, statistician, actuary	[v318_16]	[v318_17]	[v318_18]	[v318_19]
Accountant, auditor, budget analyst, cost estimator, financial manager	[v318_20]	[v318_21]	[v318_22]	[v318_20]
Architect, surveyor, drafter	[v318_24]	[v318_25]	[v318_26]	[v318_27]
Math or science teacher	[v318_28]	[v318_29]	[v318_30]	[v318_31]
Another field related to math, science, technology, or engineering, but not listed above	[v318_32]	[v318_33]	[v318_34]	[v318_35]
None of the fields listed above	[v318_36]	[v318_37]	[v318_38]	[v318_39]
Not sure	[v318_40]	[v318_41]	[v318_42]	[v318_43]

E, C, L [v319_0] Do you have children or others who are dependent on you financially?
o Yes How many? ___
o No

E, C, L [v320_0] Do you have children who are currently living with you?
o Yes How many ? ___
o No

E, C, L [v400_0] Optional: Please write any additional comments you have about your experience as a woman undergraduate in engineering.
`[Note: Large text box here for input.]`

E, C, L [v401_0] Optional: Please write any comments you have about this survey or the WECE study.
`[Note: Large text box here for input.]`

E, M[v500_0] Check here to be entered in a drawing for prizes including Palm Pilots, TI calculators and personal organizers, and gift certificates for the on-line book and music store, Amazon.com. ☐ **Please enter me!**

`[Note: {page Finished-b} shown to leavers only.]`

Thank you for participating in the WECE study! Your insights will be valuable for our research. Ultimately we hope that the findings of this research will guide institutions and policy makers as they develop guidelines and programs to create educational environments in engineering that are more attractive to women. As you are no longer considering a major in engineering, we will not be contacting you to complete our questionnaires in the future. We wish you the best of luck in your future endeavors.

–The WECE project staff

`[Note: {page Finished-c} shown to continuers only.]`

Thank you for participating in the WECE study! Your insights will be valuable for our research. Ultimately we hope that the findings of this research will guide institutions and policy makers as they develop guidelines and programs to create educational environments in engineering that are more attractive to women. Our research is one of the first longitudinal studies of women interested in engineering. If you are not graduating this year, we will be contacting you again next year to ask you to complete another, shorter, questionnaire about your experiences in engineering during the 2000-2001 school year. We hope that you will again agree to participate in this survey. Again, many thanks–our study would not be possible without you.

–The WECE project staff

APPENDIX B-2: WEB-BASED ADMINISTRATOR QUESTIONNAIRE

Consent Form

This is a short survey for selected administrators at schools participating in the Women's Experiences in College Engineering (WECE) project being conducted by Goodman Research Group, Inc. in Cambridge, MA. As part of our longitudinal study, we are interested in administrators' opinions at the participating schools. Participating in this part of the study means completing a brief questionnaire. You will be asked eleven questions about your background and your views about your school of engineering now and in the future. We anticipate the survey will take 5-10 minutes to complete.

All of responses will be kept confidential. No one outside of the WECE research team will have access to the information and survey responses that you supply.

For questions about the Women's Experiences in College Engineering Project's Administrator Survey, please email the WECE staff or contact us by phone at 617-491-7033. Thank you.

[[I agree to participate]]

[[I decline to participate

In what year did you begin working at your university? 19_ _ (or 20_ _)
Please fill in last two digits.
In what year did you begin working in your current position at your university? 19_ _ (or 20_ _)
Please fill in last two digits.

What are the top three reasons students choose to attend your school of engineering?
(Make one selection per column in each of the three columns on the right)

	One reason	A second reason	A third reason
Location	O	O	O
Financial aid package	O	O	O
Reputation/ ranking	O	O	O
Quality of learning experience	O	O	O
Research opportunities	O	O	O
Support programs/resources	O	O	O
Technically oriented	O	O	O
Availability of liberal arts classes	O	O	O
Diversity of population	O	O	O
Recruitment program	O	O	O
Close interaction with faculty	O	O	O
Other: Please Describe:	O	O	O

What are the **three most significant challenges** facing your school of engineering today? (Make one selection per column in each of the three columns on the right)

	One challenge	A second challenge	A third challenge
increasing the number of student applicants	O	O	O
improving the caliber of students applying to our school	O	O	O
raising funds	O	O	O
increasing the retention rate of students	O	O	O
Retaining faculty	O	O	O
balancing dual commitments to research and teaching	O	O	O
adapting the curriculum to meet the needs of industry	O	O	O
implementing teaching workshops for faculty	O	O	O
creating links with other departments or schools of the university	O	O	O
increasing numbers of women and minority faculty	O	O	O
Other: Please Describe:	O	O	O

At your university, how many tenure track engineering faculty are male? ______
At your university, how many tenure track engineering faculty are female?_____

In your opinion, how will your university change in the next 10 years?
`[Note: Large text box here for input.]`

To the best of your knowledge, what types of initiatives does your university offer undergraduate women in engineering (Please check all that apply)

Women in Engineering (WIE) Program	□
Minorities in Engineering (MEP) Program	□
Women in Science and Engineering (WISE) Program	□
Engineering Diversity Program	□
introductory "hands-on" engineering lab or course	□
engineering summer program for high school students	□
pre-college orientation for engineering students	□
internship/co-op program for engineering students	□
mentoring program for engineering students	□
student engineering societies (e.g. Society of Women Engineers, ACSE)	□
resource center for engineering students	□
none of the above	□

Other: Please describe `[Note: Large text box here for input.]`

How are these programs funded? (Please check all that apply):

university funds	□
alumni/ae endowment funds	□
corporate donations	□
government grants	□
foundation grants	□
don't know/not sure	□

Other: Please describe [Note: Large text box here for input.]

What do you think the Women in Engineering program has accomplished at your school?
[Note: Large text box here for input.]

What do you hope the Women in Engineering program will accomplish in the future?
[Note: Large text box here for input.]

We are currently seeking additional funds to conduct further analysis of the data from the WECE project. Given the data that we have already collected, we have generated the following list of areas for further study.
Please indicate how useful each of the following would be to you as the dean of engineering.

	Very useful	Moderately useful	Slightly useful	Not at all useful
How characteristics of the school of engineering relate to women's persistence (e.g., presence of a co-op program, clustered living arrangements for engineering students).	O	O	O	O
The characteristics and pre-college experiences of women who enter engineering programs.	O	O	O	O
The characteristics of women who are most at risk for leaving engineering.	O	O	O	O
How female students' experiences and perceptions of engineering differ by race/ethnicity.	O	O	O	O
The encouraging and discouraging factors that are most salient to women in each year of their college careers.	O	O	O	O
A comparison of men and women students' perceptions of college engineering.	O	O	O	O

What other information would be useful for you as the dean of engineering?
[Note: Large text box here for input.]

If you have comments or questions, you may also type them here.
[Note: Large text box here for input.]

APPENDIX B-3: WEB-BASED FACULTY QUESTIONNAIRE

♦WECE♦

THE WOMEN'S EXPERIENCES IN COLLEGE ENGINEERING PROJECT

Funded by National Science Foundation ♦ Alfred P. Sloan Foundation

Welcome to the faculty survey component of the Women's Experiences in College Engineering Project! Your university has agreed to take part in the WECE project, a national, longitudinal study of the experiences of undergraduate women who are interested in engineering. Our project is gathering data from students, faculty, deans, and student support staff at 53 institutions nationwide. *All participant data we collect will be kept confidential, and data will be aggregated for all reports.* We invite you to fill out the faculty questionnaire which will take 10-15 minutes to complete.

A DESCRIPTION OF THE WECE PROJECT

The WECE project aims to better understand women's experiences related to engineering and to identify aspects of their undergraduate education that encourage and discourage women. This study, the first of its kind, is funded by both the National Science Foundation and the Alfred P. Sloan Foundation and is conducted by Goodman Research Group, Inc. (GRG), an independent educational research company based in Cambridge, MA. The primary data for our research are from a survey of undergraduate women in engineering that we are administering for three years (1999, 2000, 2001). The student survey asks about students' backgrounds; their perceptions of, and experiences in engineering; and their interactions with support programs. To situate student findings in their larger institutional context, we are also surveying faculty, interviewing deans, and visiting a subsample of participating schools. We hope that the findings of this research will guide institutions and policy makers as they develop guidelines and programs to improve educational environments in engineering, especially for women students.

PARTICIPATION IN WECE: WHAT'S INVOLVED

- **We would like you to fill out a questionnaire about engineering education at your institution.** The questionnaire should take 10-15 minutes to complete. It includes questions about your teaching, advising, and perspectives on recruiting and educating women engineering students at your university.

- **All of your responses will be <u>confidential</u>.** No one outside the WECE research team will have access to the information and survey responses that you supply. After we have collected all of the survey data, e-mail addresses will be stripped from the survey responses and an unrelated WECE identification code will be assigned to identify responses. All data analysis will be conducted on the "stripped" data. A master copy of the original data will be saved only in a secure archive. At the end of the WECE study, some of the data may be made available to other researchers, but without identifying information.

- **We will publish a comprehensive report of the WECE study's findings** at the project's conclusion. Individual students, faculty, or institutions will not be identifiable in the report. The report will be available to all universities, policy makers, educators, and the scientific community.

ASSESSMENT OF RISKS AND BENEFITS

We foresee no risks to individuals who participate in this study. Administrators and faculty will have the opportunity to learn about the population of women undergraduates at their school. Participating institutions will also benefit by comparing the effectiveness of various types of women's programs at their own institutions and at similar engineering programs across the country. This study will also benefit all parties interested in undergraduate engineering education - engineering companies, institutions with engineering programs, and engineering organizations - by providing valuable information about factors affecting women undergraduate students and their satisfaction with their engineering majors.

RIGHTS OF PARTICIPANTS

Your participation is voluntary and you have the right to withdraw your consent at any time, or to refuse to answer particular questions. Your privacy will be maintained in all published and written data resulting from the study. If you have questions about your rights as a study participant, or are dissatisfied at any time with any aspect of this study, you may contact - anonymously, if you wish - Lisa Christie, of the Institutional Review Board of Goodman Research Group, Inc., 26 Lee Street, Suite 1, Cambridge MA 02139-2204 (e-mail: lchristi@grginc.com).

For questions about the Women's Experiences in College Engineering (WECE) project, please contact Cathy Lachapelle, WECE Project Manager, at info@wece.org, or by phone at (617) 491-7033.

Please complete one of the following:

- I have read the above consent form, and <u>agree to participate</u> in the study.

- I have read the above and <u>do not wish to participate</u> in the study.

Please enter your information below:
This information will be used to assign you a unique identification code to calculate our response rate.We will **not release** any individual's information.

First Name__________

Last Name__________

Email Address__________

School__________

Thank you for agreeing to participate in our study. We anticipate that the survey will take you 10-15 minutes to complete. The survey has three sections; the first section asks about your fields of interest and your advising responsibilities, the second gathers information about the courses you teach, and the third focuses on your beliefs about engineering education. If you have any questions or concerns, you may contact the WECE Staff at info@grginc.com.

[101] What is your current academic rank?
- O Emeritus professor
- O Full professor
- O Associate professor
- O Assistant professor
- O Adjunct professor (any rank)
- O Lecturer
- O Instructor
- O Other __________________

[102] In what year did you begin working at <this university> as a faculty member?
19_ _

[103] How do you describe your ethnicity? **(Check <u>all</u> that apply):**
1. Black/African-American/African
2. Central/Southeast/East Asian (e.g., Chinese, Taiwanese, Vietnamese, Korean)
3. Hispanic/Latino(a)
4. Indian Asian (e.g., Indian, Pakistani)
5. Native American, American Indian, Alaskan Native, or First Nation
6. White
7. Other ___________________

[104] What is your sex?)
O Male O Female

[105] What is your year of birth? 19_ _

[106] In what fields of engineering do you currently teach or do research at <this university>?
(Please check all that apply)
- Aerospace/Aeronautics
- Environmental

- Agricultural
- Biological/Biomedical
- Chemical
- Civil/ Architectural
- Computer Science
- Electrical
- Engineering Science/ Engineering Physics
- Geological Science
- Industrial/ Operations Research
- Mechanical
- Metal/Material Science
- Nuclear
- Other(s)

[107] For how many of the following students are you currently the **official** advisor?
Female undergraduate students_____ Female graduate students_____
Male undergraduate students_____ Male graduate students_____

[108] Approximately how many students **who are not your formal advisees** seek your advice on a **regular basis** each semester?
Female undergraduate students_____ Male undergraduate students_____
Female graduate students_____ Male graduate students_____

[109] In your personal opinion, how do conditions compare for men and women **in the engineering workplace?**
O Much more favorable for women
O Moderately more favorable for women
O Slightly more favorable for women
O Equally favorable for women and men
O Slightly more favorable for men
O Moderately more favorable for men
O Much more favorable for men

[110] In your personal opinion, how do conditions compare for male and female undergraduates in engineering **at <this university>**?
O Much more favorable for female students
O Moderately more favorable for female students
O Slightly more favorable for female students
O Equally favorable for female and male students
O Slightly more favorable for male students
O Moderately more favorable for male students
O Much more favorable for male students

[111] How many undergraduate classes are you teaching during the 1999-2000 academic year? You may teach more than one class/section of a course. (If you are on leave or sabbatical, please report the 1998-1999 year)

`[Note: Questions 112 to 116 are generated based on answers to Q111 and Q114. If they say zero above, these 5 questions do not appear.]`

[112] How many of the classes you teach are introductory undergraduate courses?

[113] How many are intermediate or advanced undergraduate courses (have at least one prerequisite)?

[114] How many undergraduate students will you teach this year? Please give your best estimate of the total for all your classes.
`[Note: If they say zero for Q114, these next 2 questions do not appear.]`

[115] On average, what percentage of the **undergraduates** you teach are female?

[116] What percentage of the **undergraduate** students in your classes are fulfilling a requirement?

[117] How many **undergraduate** students are working with you on research projects:
How many men? _____ How many women? _____

[118] How strongly do you agree or disagree with the following statements?

	Strongly agree	Moderately agree	Slightly agree	Neither agree nor disagree	Slightly disagree	Moderately disagree	Strongly disagree
I encourage my students to do homework together.	o	o	o	o	o	o	o
I encourage my students to do projects together.	o	o	o	o	o	o	o
I believe gender neutral language should be used in the classroom.	o	o	o	o	o	o	o
I believe it is easier for women to go into some fields of engineering than other engineering fields.	o	o	o	o	o	o	o
It is more difficult for a woman to balance a career and family in engineering than in most other fields.	o	o	o	o	o	o	o
I believe women who are beginning their engineering careers are generally offered higher paying jobs than are men.	o	o	o	o	o	o	o

[119] I grade my classes on a curve.
O Always
O Usually
O Sometimes
O Never

[120] How would you compare female engineering undergraduates to male engineering undergraduates in the following areas?

	Females are:						
	Much better	Moderately better	Slightly better	No difference	Slightly worse	Moderately worse	Much worse
Academic preparation	o	o	o	o	o	o	o
Study habits	o	o	o	o	o	o	o
Laboratory skills	o	o	o	o	o	o	o
Engineering abilities	o	o	o	o	o	o	o
Mathematical abilities	o	o	o	o	o	o	o

[121] How strongly do you agree or disagree with the following statements?

	Strongly agree	Moderately agree	Slightly agree	Neither agree nor disagree	Slightly disagree	Moderately disagree	Strongly disagree
I believe my department is genuinely committed to helping undergraduate women complete their engineering degree.	o	o	o	o	o	o	o
I believe my department should do more to retain undergraduate women in engineering majors.	o	o	o	o	o	o	o
I believe that a special effort should be made to recruit women for engineering programs at my university.	o	o	o	o	o	o	o
I believe that my university should have special programs to address women engineering students' needs.	o	o	o	o	o	o	o

[122] In the past year, how many times have you attended or participated in any program for women undergraduates in engineering? ______

[123] How often have you heard undergraduate students complain about:

	More than 1x/year	About 1x/year	Less than 1x/year	Never
teaching assistants, lab assistants, or section leaders at your university treating undergraduate women in engineering unfairly?	o	o	o	o
undergraduate men in engineering at your university treating undergraduate women in engineering unfairly?	o	o	o	o
faculty members at your university treating undergraduate women in engineering unfairly?	o	o	o	o

[124] How strongly do you agree or disagree with the following statements?

	Strongly agree	Moderately agree	Slightly agree	Neither agree nor disagree	Slightly disagree	Moderately disagree	Strongly disagree
My department is supportive of undergraduate women.	o	o	o	o	o	o	o
The engineering climate at my university favors undergraduate men.	o	o	o	o	o	o	o
If there were two equally qualified applicants for an engineering faculty position at my university, a female candidate should be given preference over a male candidate.	o	o	o	o	o	o	o
I feel a sense of obligation to favor undergraduate women in my classes.	o	o	o	o	o	o	o
I feel pressure to favor undergraduate women in my classes.	o	o	o	o	o	o	o

[125] Optional: Please write any additional comments you have about the experience of women undergraduate engineering students at your institution.
`[Note: Large text box here for input.]`

[126] Optional: Please write any comments you have about this survey or our study.
`[Note: Large text box here for input.]`

Thank you for participating in the WECE study! Your insights will be valuable for our research. We wish you the best in your future endeavors. –The WECE Staff

APPENDIX B-4: WIE DIRECTOR INTERVIEW

Background about WIE Director

What is your official title?
The year you began as director was?
What year were you hired?
Who is your direct supervisor?
What is your educational background?
What other jobs have you held?
How do you spend your time?
What are your major responsibilities?

History of WIE Program

The program began in what year?
How did the WIE program start at your university?
Do you have other staff who work with you?
How is your budget funded?

Administrative and Faculty Support of Program

Do you feel your administration is supportive of the WIE program? Explain.
Are there any faculty members actively involved in the WIE program? How many? How many are male, female?
Do you feel like you have the support of faculty in the engineering department? Why or why not?

Activities Offered

What college programs do you offer?
What precollege programs do you offer?
Please list all of the activities your WIE program offers/ is involved with.
How did some of these programs get started or develop? Where have you gotten ideas for your programs?
What are your most popular activities?
How do students find out about the program?
Do you find that older students participate differently in WIE activities than younger students?
If you had to cut all of your programs but one which would you retain? Why?

Advice and Future Plans

What advice would you have for other WIE directors just starting their program?
What are the biggest challenges you have encountered in running WIE activities?
Do you have contact with other directors of similar programs? When? What do you talk about?
Would you like more contact?
What are some of your future plans for your program?
What are some other actions colleges could take to encourage women to stay in engineering?

APPENDIX B-5: WIE DIRECTOR SURVEY

Budget

1. Roughly, how are the budgetary funds for the «WIEN» allocated?

% for salaries	
% for programming/ activities	
% for scholarships	
% for other:	
% for other:	

2. Where does the funding for your salary come from?

% from university line item (stable)	
% from university dean's budget (year by year funds, not stable)	
% from grants/ foundations	
% from corporate funding	
% from alumnae/ endowment	
% for other:	

3. Where does the funding for the «WIEN» activities come from?

% from university line item (stable)	
% from university dean's budget (year by year funds, not stable)	
% from grants/ foundations	
% from corporate funding	
% from alumnae/ endowment	
% for other: please describe	

Hours

4. What is the total number of hours per week you work at «Inst_NAME»? ___________ hours

5. What is the total number of hours per week you spend on WIE-related programming?_________hours

Faculty

6. At your university, how many <u>tenure track</u> engineering faculty are male? __________

7. At your university, how many <u>tenure track</u> engineering faculty are female? __________

Activities

8. Please check the boxes next to the type of activities that you currently offer or have previously offered as part of the «WIEN» at «Inst_NAME». (Check all that apply)

Activity	Offered in 1999-2000	Offered in 2000-2001
Study or support group	□	□
Internship/ Research experience	□	□
Peer Tutoring	□	□
Academic advising	□	□
Career counseling	□	□
Peer mentoring or "buddy" program	□	□
Email mentoring	□	□
Tutoring (by people other than peers)	□	□
Engineering newsletter or listserv	□	□
Engineering society activities (e.g., IEEE, ASME, SWE):	□	□
Field trip to industry site	□	□
Engineering social event	□	□
Involve undergrads in outreach to high school students.	□	□
Engineering Dorm	□	□
Orientation Program	□	□
Scholarships	□	□

9. How would you describe the relationship between the «WIEN» and the Society of Women Engineers?

10. Do you involve undergraduates in outreach to k-12 students? O Yes O No
10a. If yes, please explain how:

Program overall

11. What do you think the «WIEN» has accomplished at your school?

12.What do you hope the «WIEN» will accomplish in the future?

Comments or Questions?

APPENDIX B-6: SITE VISIT SELECTION PROCESS

We selected schools for site visits based not on the reputations of their WIE programs or what activities the WIE programs offered but on empirical measures. We employed three statistical methods to assess quantitatively how happy or satisfied female engineering students were at participating institutions.

a) Happiness/Satisfaction Score

To measure students' happiness, commitment, and/or contentment in engineering, we used five variables from the student questionnaire and from our information about institutions:

- The degree to which participants thought their institution supported women in engineering
- How confident the participants were that engineering was the right major for them
- How committed a student was to engineering – this is a scale variable that is a composite of six separate variables:
    - The extent to which a student agreed she had a high level of interest in engineering
    - The extent to which a student agreed she were committed to engineering as a major
    - The extent to which a student agreed she were happy with their choice of engineering
    - To what degree a student felt she was more or less committed to engineering than other women in her classes
    - To what degree a student felt she was more or less committed to engineering than men in her classes
    - To what extent a student felt encouraged or discouraged by her interest in the subject matter in engineering
- Whether, and how often, student participants considered leaving engineering in any year of college.
- The percentage of graduating undergraduates in engineering that are women.

We assigned each school a "Total Score" based on the five variables above. Because one of the variables was a scale variable derived from the sum of six other variables, we also calculated a "Total Weighted Score" for each school by doubling the value of the scale variable. There was little difference between the list of participant schools rank ordered by Total Score and the list in order of Total Weighted Score; both produced the same list of top ten schools.

b) Principal Components Analysis

In addition to the above procedure, and as a secondary means of determining which schools to visit, we also calculated the mean scores for each university on all of the variables listed above, including the commitment scale variables both individually and as a scale. We ran a principal components analysis on those means, producing scores for each university for each of three principal components that resulted. We ranked the universities according to their scores on the first principal component; this order closely corresponded to the order obtained using the scoring method above.

c) Cluster Analysis

For a third perspective on the data, we ran a cluster analysis of the mean scores for each university. Top WIE schools and top non-WIE schools, according to the previous two analyses, tended to cluster together. We are particularly intrigued that WIE and non-WIE schools tended to cluster separately.

Data from these three separate statistical techniques considered together yielded a core set of WIE schools. The results of the three approaches produced a nearly perfectly consistent set of top schools. Since the schools' individual characteristics (region, Carnegie units, etc.) appeared to be fairly representative, we used this core set of WIE schools to select which universities we should visit.

- Tufts University (this was a pilot test school, chosen for proximity rather than with statistical techniques)
- Cornell University
- University of New Mexico
- Rensselaer Polytechnic Institute (RPI)
- University of Wisconsin, Platteville
- Pennsylvania State University
- University of Connecticut
- North Carolina State University
- Oklahoma State University
- Rochester Institute of Technology (RIT)
- University of California, Davis

APPENDIX B-7: SITE VISIT FOCUS GROUP PROTOCOL

Conducted by: **Date:**
School: **Number of participants:**
Cohort (under/upperclassmen/other):

I. <u>Background in Engineering</u>

A. How did you originally become interested in engineering?

What motivates you to continue in engineering? (e.g., love of subject, job possibilities)

What discourages you in engineering?

Have you ever considered leaving engineering? When? Why?

II. <u>Perceptions of Engineering Department</u>

A. How would describe the environment in the school/dept of engineering?

What is your engineering department doing well?

If you could change anything about engineering at your school what would it be?

B. How do your engineering courses differ from your non-engineering classes? (in terms of format, teaching, style, workload, competitiveness, grading)

How do engineering students compare with the students in other majors?

What do you think of the faculty in engineering at <YOUR SCHOOL>?
Are they supportive? Approachable? Good teachers?

What has surprised you most about your major in engineering?

C. What are the best engineering-related experiences (either internal/school-related or external/in an internship or job) that you have had?

What are the worst?

III. <u>Support Structures</u>

A. Who and/or what groups at <YOUR SCHOOL> has/have supported you in your engineering major?

B. Have you used any resources in engineering outside of classes?

C. Have you participated in any activities offered by the WIE program?

Which ones?

What did you think?

What sorts of resources (eg. study groups, mentors, internships, career counseling, shadowing programs, etc.) would be helpful to you in your engineering major?

IV. Perceptions of Women in Engineering

A. What percentage of the students in your engineering classes are women?

B. Have many of your friends have left an engineering major?

Why did they leave?

C. Have you noticed whether men or women are more likely to leave?

D. Why do you think that women are less likely to enter and/or more likely to leave engineering?

E. Are there any differences in the way that women students in engineering are treated or viewed compared with male students in engineering at <YOUR SCHOOL>? (describe, by whom)

F. Do you think that <YOUR SCHOOL> should offer special support programs for women in engineering?

Why or why not?

V. Final Reflections

A. If you could go back to when you entered college, would you still have chosen an engineering major?

B. Would you recommend the <YOUR SCHOOL> engineering program to a prospective (female) engineering student?

C. What advice would you give a first-year woman about pursuing a major in engineering?

Appendix C: Data Tables & Figures

APPENDIX C-1: STUDENTS' REASONS FOR PARTICIPATING IN SUPPORT ACTIVITIES

Table C-1
Reasons for Participating in Study or Support Group (n=19,629)

Reason	Freshman	Sophomore	Junior	Senior	5^{th}-year	All Years
Getting help with engineering coursework	71.6%	78.2%	81.2%	83.4%	80.5%	78.8%
Being in a supportive atmosphere	40.0	45.5	47.8	52.4	42.1	46.2
Socializing with other women in engineering	38.2	38.8	40.3	41.6	33.2	39.3
Helping others (n=6,910)	30.2	36.1	42.6	41.7	42.6	38.1
Socializing with men in engineering	30.1	35.3	39.0	41.1	29.3	36.0
Learning about opportunities in eng. (n=12,720)	21.5	21.1	23.5	23.1	21.5	22.3
Getting advice or mentoring about engineering	25.4	22.0	20.1	18.3	17.0	21.1
Talking about issues of concern in engineering	16.6	18.0	20.1	23.4	18.9	19.5
Learning about a topic of interest related to eng.	19.2	18.3	18.7	19.9	19.1	19.0
Learning more about specific fields in eng.	18.2	16.3	16.0	15.0	16.8	16.4
Getting to know faculty in engineering	13.8	13.5	13.1	11.5	10.2	12.8
Getting career counseling or information	11.9	10.2	10.3	10.8	11.3	10.8
Other	12.4	10.2	9.0	8.9	8.9	10.0
Earning money	4.3	4.1	4.8	3.2	2.6	4.0

Table C-2
Reasons for Participating in Internship / Research Experience (n=14,034)

Reason	Freshman	Sophomore	Junior	Senior	5^{th}-year	All Years
Earning money	15.7%	39.4%	59.4%	77.7%	76.6%	53.8%
Learning more about specific fields in eng.	25.0	40.5	54.7	68.3	72.3	51.5
Learning about opportunities in eng (n=10,317)	23.2	37.0	53.0	69.5	67.2	48.1
Learning about a topic of interest related to eng.	21.8	34.6	44.4	56.6	55.2	42.5
Getting advice or mentoring about engineering	26.5	28.7	31.6	32.9	30.3	30.3
Getting career counseling or information	18.6	23.4	28.0	29.8	28.0	25.9
Being in a supportive atmosphere	16.3	18.4	21.0	21.9	19.7	19.8
Talking about issues of concern in engineering	12.1	15.9	20.1	23.7	18.9	18.7
Getting help with engineering coursework	35.1	25.4	16.0	6.7	7.2	18.1
Getting to know faculty in engineering	15.4	17.5	16.3	16.7	12.8	16.2
Socializing with men in engineering	8.5	12.5	16.2	20.2	14.0	15.0
Socializing with other women in engineering	10.2	12.8	13.8	16.1	13.3	13.5
Other	15.2	14.0	12.5	11.3	12.3	12.9
Helping others (n=3,718)	11.6	6.3	6.4	8.0	8.6	7.6

Table C-3
Reasons for Receiving Tutoring (n=13,180)

Reason	Freshman	Sophomore	Junior	Senior	5^{th}-year	All years
Getting help with engineering coursework	49.1%	54.8%	55.9%	78.7%	76.9%	58.2%
Getting advice or mentoring about engineering	26.5	22.9	20.9	9.3	6.2	20.6
Learning about opportunities in eng (n=9,043)	25.0	20.9	19.0	3.5	2.0	18.3
Being in a supportive atmosphere	20.5	17.8	17.4	15.2	16.2	18.0
Getting career counseling or information	17.9	15.6	14.1	2.9	3.0	13.4
Getting to know faculty in engineering	12.9	14.1	12.9	8.0	5.8	12.2
Learning more about specific fields in eng.	16.1	13.3	10.8	4.2	4.9	11.7
Other	12.1	11.1	11.6	8.4	8.1	11.0
Learning about a topic of interest related to eng.	14.2	11.1	11.4	5.1	5.1	10.9
Socializing with men in engineering	11.1	9.0	8.8	10.1	3.5	9.5
Socializing with other women in engineering	12.6	10.1	8.1	5.7	4.0	9.4
Talking about issues of concern in engineering	10.4	10.4	8.8	4.0	2.5	8.6
Helping others (n=4,137)	8.3	4.9	6.4	4.5	3.1	6.0

Table C-4
Reasons for Receiving Academic Advising (n=19,541)

Reason	Freshman	Sophomore	Junior	Senior	5^{th}-year	All years
Getting advice or mentoring about engineering	44.9%	47.6%	45.2%	45.7%	39.7%	45.5%
Getting career counseling or information	35.9	37.0	38.0	33.3	30.0	35.7
Learning about opportunities in eng (n=12,095)	39.6	39.4	38.4	28.8	20.2	35.6
Getting to know faculty in engineering	25.9	27.0	28.1	29.8	19.7	27.2
Learning more about specific fields in eng.	28.5	26.7	23.7	17.6	13.7	23.5
Talking about issues of concern in engineering	20.1	20.5	19.3	16.8	11.6	18.7
Learning about a topic of interest related to eng.	19.9	18.3	18.0	11.4	9.1	16.5
Other	15.5	14.6	15.6	17.3	22.2	16.1
Getting help with engineering coursework	15.0	13.7	14.4	16.3	14.8	14.9
Being in a supportive atmosphere	18.2	15.9	15.3	11.1	8.6	14.7
Socializing with other women in engineering	12.2	9.1	7.8	2.9	1.5	7.6
Socializing with men in engineering	8.8	7.0	7.2	4.2	1.0	6.4

Table C-5
Reasons for Receiving Career Counseling (n=12,002)

Reason	Freshman	Sophomore	Junior	Senior	5^{th}-year	All years
Getting career counseling or information	38.0%	43.2%	47.6%	69.0%	61.5%	50.0%
Learning about opportunities in eng (n=8,325)	41.4	45.0	46.3	54.4	40.3	46.3
Learning more about specific fields in eng.	33.0	30.4	30.6	31.0	24.8	30.8
Getting advice or mentoring about eng.	29.2	28.4	26.3	31.0	23.6	28.3
Learning about a topic of interest related to eng.	26.0	25.8	23.1	17.4	16.3	22.7
Talking about issues of concern in engineering	19.8	19.6	18.5	16.1	11.2	18.1
Being in a supportive atmosphere	18.5	17.1	16.2	10.7	12.2	15.5
Socializing with other women in engineering	21.5	19.0	15.3	4.1	2.6	14.3
Other	15.4	13.7	13.3	9.3	10.7	12.8
Getting to know faculty in engineering	11.9	11.9	10.7	12.5	8.0	11.5
Socializing with men in engineering	11.1	10.8	10.7	4.0	1.2	8.7
Getting help with engineering coursework	10.1	7.7	6.3	3.3	3.0	6.6
Earning money	5.5	5.8	7.0	7.8	6.4	6.5

Table C-6
Reasons for Receiving Peer Mentoring (n=9,532)

Reason	Freshman	Sophomore	Junior	Senior	5th-year	All years
Socializing with other women in engineering	36.4%	36.4%	34.8%	31.9%	28.9%	35.0%
Learning about opportunities in eng (n=6,569)	37.0	36.7	35.7	28.4	22.5	34.9
Getting advice or mentoring about engineering	34.4	31.6	27.7	38.3	33.0	32.4
Being in a supportive atmosphere	29.5	29.9	30.1	32.4	31.8	30.3
Getting help with engineering coursework	22.6	22.7	21.3	32.5	27.2	24.0
Talking about issues of concern in engineering	21.8	23.1	24.6	23.9	21.7	23.2
Learning about a topic of interest related to eng.	24.5	24.2	24.6	17.7	15.9	23.0
Learning more about specific fields in eng.	24.5	24.0	24.1	16.1	17.6	22.7
Socializing with men in engineering	20.1	22.3	23.5	23.8	21.2	22.1
Getting career counseling or information	16.2	15.9	16.1	19.1	21.0	16.7
Other	16.2	16.4	16.8	11.5	14.7	15.7
Helping others (n=2,963)	7.0	7.5	12.1	8.2	10.9	8.7
Getting to know faculty in engineering	7.7	7.9	6.8	4.4	1.9	6.8

Table C-7
Reasons for Participating in online mentoring with a professional engineer (n=4,862)

Reason	Freshman	Sophomore	Junior	Senior	5th-year	All years
Learning about opportunities in eng (n=4,227)	37.7%	39.9%	37.2%	33.3%	27.8%	37.8%
Socializing with other women in engineering	40.5	34.3	35.6	32.4	22.9	36.0
Learning about a topic of interest related to eng.	31.2	34.4	32.2	22.1	22.9	31.5
Learning more about specific fields in eng.	31.6	33.1	31.1	28.1	34.9	31.7
Getting advice or mentoring about engineering	26.5	26.1	20.6	51.7	45.9	27.1
Talking about issues of concern in engineering	23.1	24.8	26.0	30.5	30.3	25.3
Being in a supportive atmosphere	24.4	24.6	23.5	24.8	22.9	24.1
Socializing with men in engineering	22.3	20.8	22.1	13.1	8.3	20.6
Getting career counseling or information	19.1	18.5	18.0	34.8	37.6	20.3
Other	15.9	16.6	19.6	11.2	11.9	16.8
Getting to know faculty in engineering	12.3	10.1	10.9	4.8	3.7	10.3
Getting help with engineering coursework	9.8	9.3	7.4	11.9	6.4	9.0

Table C-8
Reasons for Being a Mentor or "Buddy" (n=6,495)

Reason	Freshman	Sophomore	Junior	Senior	5th-year	All years
Helping others (n=2,040)	59.5%	68.0%	73.4%	75.0%	74.5%	70.5%
Socializing with other women in engineering	38.9	44.5	41.4	46.0	36.5	42.4
Being in a supportive atmosphere	22.8	28.5	28.5	35.6	30.1	29.2
Learning about opportunities in eng (n=4,455)	35.5	33.5	34.4	11.4	11.5	28.0
Talking about issues of concern in engineering	20.0	23.1	24.3	26.8	24.3	23.8
Socializing with men in engineering	24.1	26.0	24.9	17.2	14.2	22.5
Other	19.8	17.7	16.3	20.1	23.5	18.6
Learning about a topic of interest related to eng.	23.1	24.0	23.3	6.6	6.2	18.3
Learning more about specific fields in eng.	23.2	21.5	22.9	6.7	6.9	17.7
Getting advice or mentoring about engineering	16.0	14.7	13.0	14.3	11.1	14.1
Getting career counseling or information	11.1	10.0	10.1	6.5	5.3	9.1
Getting to know faculty in engineering	11.5	11.1	10.8	4.9	2.9	9.1
Getting help with engineering coursework	10.0	9.5	8.3	8.0	4.2	8.5

Table C-9
Reasons for Being a Tutor (n=6,405)

Reason	Freshman	Sophomore	Junior	Senior	5th-year	All years
Helping others (n=2,551)	73.8%	75.1%	80.6%	77.2%	76.1%	76.9%
Socializing with other women in engineering	30.0	28.8	27.3	18.9	10.6	24.5
Learning about opportunities in eng (n=3,854)	28.0	33.4	33.5	5.1	5.3	22.7
Socializing with men in engineering	24.8	24.5	24.0	17.2	9.1	21.2
Other	20.4	18.4	17.1	24.0	29.4	20.8
Being in a supportive atmosphere	20.1	18.3	19.8	21.6	14.4	19.6
Earning money	6.3	13.4	18.4	28.1	20.3	18.0
Learning about a topic of interest related to eng.	16.3	18.3	19.3	4.6	4.7	13.5
Learning more about specific fields in eng.	16.2	17.8	18.3	3.9	2.8	12.8
Talking about issues of concern in engineering	12.9	13.1	14.4	10.5	6.3	12.2
Getting help with engineering coursework	8.5	8.1	7.6	8.7	5.3	7.9
Getting advice or mentoring about engineering	9.0	8.5	8.9	5.9	2.8	7.5
Getting to know faculty in engineering	8.5	8.9	9.3	3.5	1.9	6.9
Getting career counseling or information	7.7	6.0	7.3	2.7	3.6	5.6

Table C-10
Reasons for Reading an Engineering Newsletter or Listserv (n=13,191)

Reason	Freshman	Sophomore	Junior	Senior	5th-year	All years
Learning about opportunities in eng (n=7,004)	59.8%	61.6%	60.0%	55.7%	45.9%	57.5%
Learning about a topic of interest related to eng.	53.2	55.5	57.3	56.8	54.6	55.8
Learning more about specific fields in eng.	46.5	47.6	48.2	47.4	46.1	47.3
Talking about issues of concern in engineering	25.6	25.9	26.4	24.9	18.1	25.0
Getting career counseling or information	25.1	24.2	23.3	22.0	17.1	22.9
Other	20.8	17.8	16.9	15.0	16.8	17.3
Getting advice or mentoring about engineering	20.6	17.5	15.7	15.1	9.3	16.2
Socializing with other women in engineering	12.6	14.3	14.4	6.4	5.6	10.9
Socializing with men in engineering	8.3	10.2	11.1	5.0	2.9	7.9
Being in a supportive atmosphere	6.4	7.5	7.3	5.4	4.7	6.4
Getting to know faculty in engineering	8.5	7.2	7.7	3.9	1.9	6.1
Earning money	6.2	4.9	3.7	4.0	3.6	4.5
Getting help with engineering coursework	5.3	4.3	3.8	4.2	3.1	4.3

Table C-11
Reasons for Attending an Engineering Speaker Presentation (n=9,035)

Reason	Freshman	Sophomore	Junior	Senior	5th-year	All years
Learning about opportunities in eng (n=4,414)	64.5%	60.2%	61.1%	58.7%	54.8%	59.7%
Learning about a topic of interest related to eng.	56.0	57.9	62.2	59.0	58.6	58.9
Learning more about specific fields in eng.	58.2	54.0	58.0	52.1	51.2	54.7
Talking about issues of concern in engineering	34.4	32.2	35.6	33.3	27.9	33.2
Getting career counseling or information	26.0	23.8	24.2	20.7	17.2	22.5
Getting advice or mentoring about engineering	27.6	23.9	23.9	19.2	14.7	22.0
Socializing with other women in engineering	17.0	18.0	19.0	16.6	17.3	17.5
Socializing with men in engineering	14.1	13.6	16.1	14.4	14.0	14.6
Other	16.0	14.2	13.3	12.3	13.7	13.6
Getting to know faculty in engineering	18.4	15.5	14.4	12.2	8.4	13.9
Being in a supportive atmosphere	12.7	10.1	11.2	8.7	11.4	10.4

Table C-12
Reasons for Participating in Engineering Society Sctivities (e.g., IEEE, ASME, SWE) (n=12,453)

Reason	Freshman	Sophomore	Junior	Senior	5th-year	All years
Socializing with other women in engineering	73.3%	70.7%	69.0%	63.7%	58.5%	67.4%
Learning about opportunities in eng (n=6,632)	58.4	57.0	58.3	54.1	42.3	55.0
Socializing with men in engineering	36.8	42.4	50.4	49.3	44.5	45.7
Being in a supportive atmosphere	45.4	45.8	42.3	38.5	35.0	41.6
Learning about a topic of interest related to eng.	37.6	39.1	40.7	40.1	36.0	39.2
Learning more about specific fields in eng.	37.6	37.8	38.4	36.6	32.4	37.0
Talking about issues of concern in engineering	34.3	36.2	35.9	36.3	28.5	35.2
Getting to know faculty in engineering	24.2	26.4	28.3	26.3	17.0	25.6
Getting advice or mentoring about engineering	31.8	28.7	25.4	21.6	15.6	25.0
Getting career counseling or information	24.8	25.2	24.7	22.7	14.6	23.3
Helping others (n=5,821)	13.9	14.1	17.4	18.7	20.2	16.5
Other	16.1	16.0	16.1	15.0	16.9	15.8
Getting help with engineering coursework	13.1	11.6	10.9	10.0	7.9	10.9
Earning money	6.4	5.0	3.4	3.7	1.2	4.1

Table C-13
Reasons for Participating in a Field Trip to an Industry Site (n=6,853)

Reason	Freshman	Sophomore	Junior	Senior	5th-year	All years
Learning about opportunities in eng (n=3,682)	59.0%	59.8%	57.2%	57.3%	48.9%	56.7%
Learning more about specific fields in eng.	56.5	52.1	57.7	55.8	56.4	55.8
Learning about a topic of interest related to eng.	48.9	48.4	49.8	51.3	54.4	50.7
Talking about issues of concern in engineering	20.1	17.1	17.9	19.7	16.9	18.6
Socializing with other women in engineering	20.2	21.0	21.3	16.9	13.5	18.4
Other	23.3	19.7	19.6	16.1	16.0	18.2
Socializing with men in engineering	19.0	19.0	21.1	17.3	12.7	18.0
Getting career counseling or information	18.3	17.5	17.4	13.8	12.3	15.5
Getting advice or mentoring about engineering	15.3	11.5	12.0	10.0	5.6	10.7
Being in a supportive atmosphere	11.6	8.4	8.3	6.5	6.0	7.7
Getting to know faculty in engineering	10.9	7.5	7.2	6.8	6.2	7.4
Earning money	5.9	6.7	5.4	3.4	2.5	4.5

Table C-14
Reasons for Participating in an Engineering Social Event (n=10,165)

Reason	Freshman	Sophomore	Junior	Senior	5th-year	All years
Socializing with other women in engineering	75.5%	78.3%	78.9%	70.4%	65.5%	74.0%
Socializing with men in engineering	60.1	67.5	72.9	66.8	60.6	66.4
Being in a supportive atmosphere	36.1	34.3	36.0	29.1	23.1	32.1
Learning about opportunities in eng (n=5,116)	36.6	33.6	30.5	27.6	24.9	29.8
Getting to know faculty in engineering	26.8	28.4	29.4	25.9	17.6	26.4
Talking about issues of concern in engineering	20.2	20.3	19.0	18.6	15.5	19.0
Learning about a topic of interest related to eng.	20.5	18.8	15.2	18.5	18.2	18.2
Learning more about specific fields in eng.	21.8	17.2	14.0	17.1	16.9	17.2
Other	15.9	14.6	15.0	13.1	16.3	14.6
Getting advice or mentoring about engineering	18.4	15.4	12.1	10.1	6.7	12.6
Getting career counseling or information	13.7	11.3	9.4	9.7	6.2	10.3
Helping others (n=5,049)	4.9	4.3	4.1	5.6	4.8	4.7
Getting help with engineering coursework	6.1	5.1	4.7	3.5	2.5	4.4

Table C-15
Reasons for Working with Outreach to High School Students (n=3,444)

Reason	Freshman	Sophomore	Junior	Senior	5th-year	All years
Helping others (n=1,803)	75.6%	75.0%	80.1%	80.7%	82.9%	78.6%
Other	28.2	26.9	29.3	32.4	33.5	30.3
Socializing with other women in engineering	35.7	29.4	29.3	28.8	22.1	29.1
Talking about issues of concern in engineering	22.2	23.3	25.6	26.4	23.4	24.8
Being in a supportive atmosphere	24.7	22.8	22.4	23.6	21.6	23.1
Socializing with men in engineering	14.6	14.0	17.2	17.9	15.2	16.3
Learning about opportunities in eng. (n=1,643)	16.8	19.4	10.5	12.2	11.4	13.1
Getting advice or mentoring about engineering	6.9	8.9	6.0	7.4	4.8	7.0
Learning more about specific fields in eng.	8.9	7.8	5.0	6.6	6.3	6.7
Learning about a topic of interest related to eng.	7.8	6.4	5.7	6.8	5.3	6.5
Getting to know faculty in engineering	6.7	7.9	7.2	6.0	2.8	6.3

APPENDIX C-2: BETWEEN-YEAR STAYER/LEAVER ANALYSIS

Table C-16
Leaver/Stayer Status by Considering Leaving in a Prior Year

Crosstabulations	Did not consider leaving engineering	Considered leaving engineering
Sophomore Stayer (n=1,049)	72.1%	27.9%
Sophomore Leaver (n=517)	38.1%	61.9%
Junior Stayer (n=852)	73.6%	26.4%
Junior Leaver (n=75)	26.7%	73.3%

Note: These crosstabulations are the basis for Figure 6-7

Table C-17
Grade Average in Prior Year and End Year by Status

Crosstabulations		Grade average					
		A	B	C	D	F	No classes
Stayer	Prior Year (n=5,178)	34.0%	47.7%	15.3%	0.8%	0.1%	2.0%
	End Year (n=5,208)	34.3%	48.3%	16.0%	0.8%	0.1%	0.6%
Leaver	Prior Year (n=440)	21.1%	44.3%	24.8%	2.5%	0.2%	7.0%
	End Year (n=414)	15.5%	29.2%	33.1%	7.2%	1.2%	13.8%

Note: These crosstabulations are the basis for Figure 6-8

Table C-18
Change in Grades over Two Years

Crosstabulations	Change in Grades					
	Grades increased	Grades decreased	Grades same	Grades to No classes	No classes to Grades	No classes Both years
Stayer (n=4,959)	16.9%	17.1%	63.6%	0.4%	1.8%	0.2%
Leaver (n=407)	7.4%	28.7%	45.0%	11.5%	5.2%	2.2%

Note: These crosstabulations are the basis for Figure 6-9

Table C-19
Encouraged or Discouraged by Grades in Prior Year and End Year, by Status

Crosstabulations		Grades Encourage / Discourage						
		greatly discouraged	moderately discouraged	slightly discouraged	did not affect	slightly encouraged	moderately encouraged	greatly encouraged
Stayer	Prior Year (n=5,298)	4.7%	8.0%	22.6%	8.9%	17.8%	22.8%	15.1%
	End Year (n=5,299)	5.3%	8.3%	21.7%	12.7%	17.8%	21.9%	12.4%
Leaver	Prior Year (n=452)	10.8%	15.9%	25.0%	10.0%	13.5%	16.6%	8.2%
	End Year (n=424)	29.7%	16.0%	19.3%	16.7%	8.3%	7.1%	2.8%

Note: These crosstabulations are the basis for Figure 6-10

Table C-20
Encouraged or Discouraged by Grades in Prior Year by End Year Status

Crosstabulations		Grades Encourage / Discourage						
		greatly discouraged	moderately discouraged	slightly discouraged	did not affect	slightly encouraged	moderately encouraged	greatly encouraged
Stayer	Sophomore (n=1,291)	3.9%	8.4%	21.3%	12.1%	20.0%	22.3%	12.0%
	Junior (n=1,473)	4.2%	7.7%	23.2%	8.3%	16.2%	23.7%	5.1%
Leaver	Sophomore (n=234)	9.8%	15.8%	25.6%	14.1%	15.8%	13.7%	16.8%
	Junior (n=130)	11.5%	19.2%	26.2%	5.4%	13.1%	16.9%	7.7%

Note: These crosstabulations are the basis for Figure 6-11

Table C-21
Encouragement/Discouragement by Grade Average and Status

Crosstabulations		Grades Encourage / Discourage						
		greatly discouraged	moderately discourage d	Slightly discouraged	did not affect	slightly encouraged	moderately encouraged	greatly encouraged
A Average	Stayed (n=1,758)	0.6%	1.1%	7.8%	8.4%	16.3%	33.0%	32.9%
	Left (n=93)	1.1%	2.2%	12.9%	15.1%	14.0%	30.1%	24.7%
B Average	Stayed (n=2,465)	3.2%	8.8%	27.7%	10.0%	21.1%	21.9%	7.2%
	Left (n=195)	4.1%	16.4%	25.6%	11.3%	18.5%	20.0%	4.1%
C Average	Stayed (n=791)	17.7%	19.3%	39.7%	6.8%	10.9%	4.3%	1.3%
	Left (n=109)	26.6%	24.8%	30.3%	4.6%	7.3%	4.6%	1.8%
D Average	Stayed (n=42)	33.3%	26.2%	16.7%	7.1%	7.1%	4.8%	4.8%
	Left (n=11)	54.5%	18.2%	18.2%	0.0%	0.0%	0.0%	9.1%

Note: These crosstabulations are the basis for Figure 6-12

Table C-22
Frequency of Participation in Study Groups by End Year Stayer/Leaver Status

Crosstabs		Never	Up to one time per semester	2wks per semester	7wks per semester	14 wks per semester
Sophomore	Stayer (n=1,247)	18.0%	5.1%	18.8%	23.3%	34.8%
	Leaver (n=222)	27.9%	4.5%	16.7%	24.8%	26.1%
Junior	Stayer (n=1,418)	19.7%	5.0%	14.2%	20.4%	40.7%
	Leaver (n=126)	27.8%	7.1%	14.3%	21.4%	29.4%

Note: These crosstabulations are the basis for Figure 6-13

Table C-23
Participation in Internship by End Year Stayer/Leaver Status

Crosstabs		Stayer	Leaver
Sophomore	(stayer n=1,151) (leaver n=207)	9.0%	11.1%
Junior	(stayer n=1,250) (leaver n=112)	15.1%	10.7%
Senior	(stayer n=1,319) (leaver n=35)	35.2%	20.0%

Note: These crosstabulations are the basis for Figure 6-14

APPENDIX C-3: HLM GROWTH MODELS

Table C-24
Effect of Participation on Perception of Department Environment: Percentile & Mean Calculations

		Freshman	Sophomore	Junior
Model 1: Null model		23.50	23.36	23.22
Model 2: Effect of Overall Participation in Support Activities	25th percentile	22.78	22.59	22.45
	Mean	23.51	23.34	23.23
	75th percentile	23.96	23.79	23.72
Model 3: Effect of Participation in Get Help Activities	25th percentile	22.93	22.93	22.93
	Mean	23.35	23.27	23.21
	75th percentile	23.67	23.46	23.37
Model 4: Effect of Participation in Social Enrichment Activities	25th percentile	22.30	22.11	21.98
	Mean	22.99	22.87	22.86
	75th percentile	23.32	23.31	23.52
Model 5: Effect of Overall Participation in Support Activities controlled for mean Self Confidence Change	25th percentile	23.37	22.85	22.38
	Mean	23.96	23.47	23.02
	75th percentile	24.33	23.84	23.42
Model 6: Effect of Participation in Get Help Activities controlled for mean Self Confidence Change	25th percentile	23.60	23.17	22.73
	Mean	23.99	23.49	23.00
	75th percentile	24.29	23.66	23.14
Model 7: Effect of Participation in Social Enrichment Activities controlled for mean Self Confidence Change	25th percentile	23.46	22.89	22.37
	Mean	23.99	23.46	23.03
	75th percentile	24.24	23.80	23.53

Note: These calculations are derived from Table 6-5; they are the basis for Figures 6-15 to 6-17 as well as Figures C-1 to C-3.

Figure C-1
Growth Model of Effect of Overall Participation in Support Activities on Perception of Department Environment

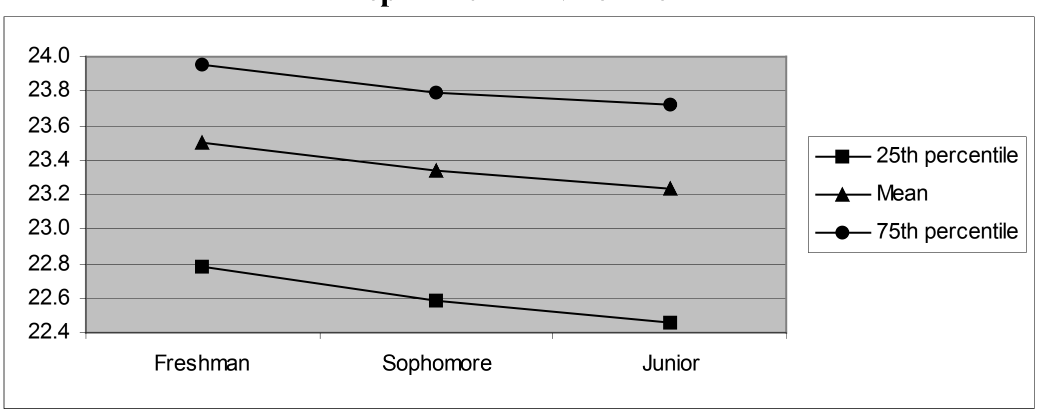


Figure C-2
Growth Model of Effect of Overall Participation in Support Activities Controlled for Mean Self Confidence Change on Perceptions of Department Environment

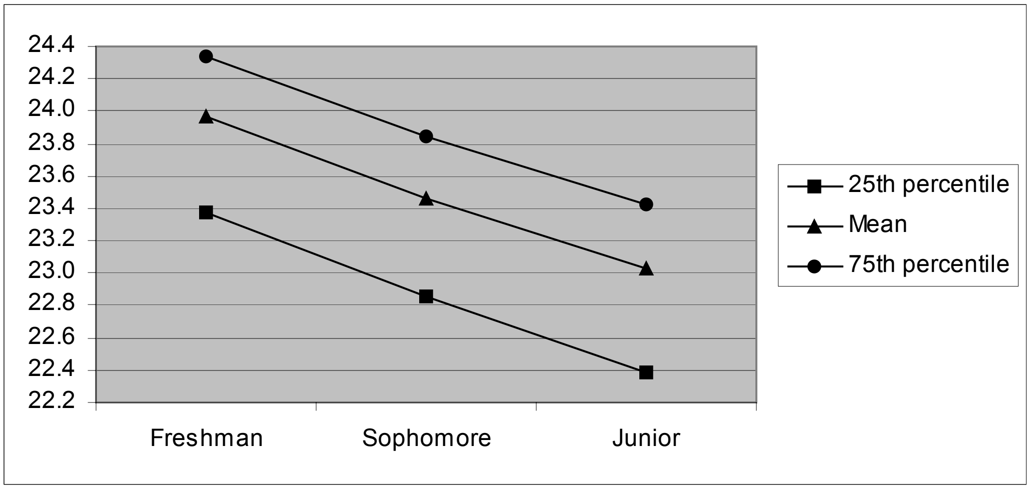


Figure C-3
Growth model of effect of Participation in Get Help Activities controlled for mean Self Confidence Change on Perceptions of Department Environment

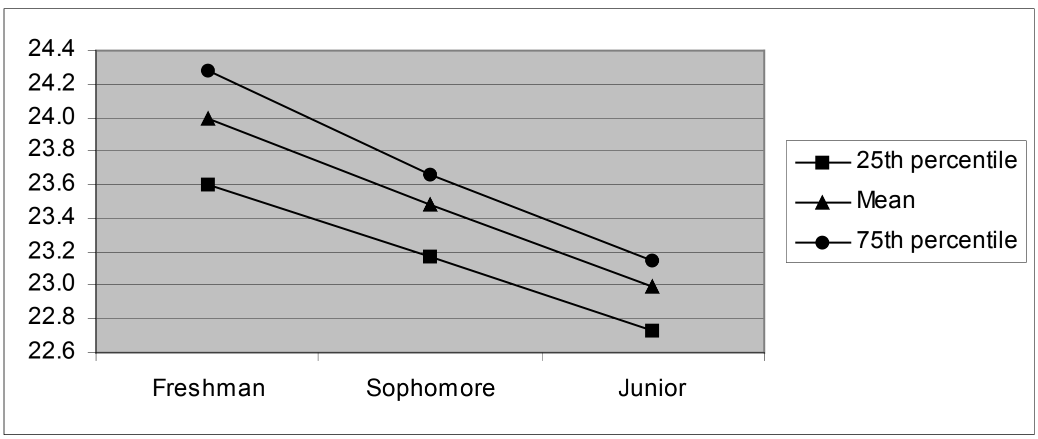


Table C-25
Effect of Participation on Perception of Classroom Environment: Percentile & Mean Calculations

		Freshman	Sophomore	Junior
Model 1: Null model		11.47	11.58	11.70
Model 2: Effect of Overall Participation in Support Activities	25th percentile	11.19	11.29	11.40
	Mean	11.47	11.57	11.70
	75th percentile	11.64	11.74	11.88
Model 3: Effect of Participation in Social Enrichment Activities	25th percentile	15.04	14.75	14.48
	Mean	15.20	14.92	14.67
	75th percentile	15.27	15.02	14.82
Model 4: Effect of Overall Participation in Support Activities controlled for mean Self Confidence Change	25th percentile	11.87	11.60	11.34
	Mean	11.98	11.72	11.46
	75th percentile	12.05	11.79	11.54
Model 5: Effect of Participation in Social Enrichment Activities controlled for mean Self Confidence Change	25th percentile	11.83	11.54	11.27
	Mean	11.99	11.71	11.47
	75th percentile	12.06	11.81	11.61
Model 6: Effect of Participation in Get Help Activities controlled for mean Self Confidence Change	25th percentile	12.10	11.82	11.54
	Mean	11.98	11.72	11.46
	75th percentile	11.89	11.67	11.41

Note: These calculations are derived from Table 6-6; they are the basis for Figure 6-18 as well as Figures C-4 to C-7.

Figure C-4
Growth model of effect of Overall Participation in Support Activities on Perceptions of Classroom Environment

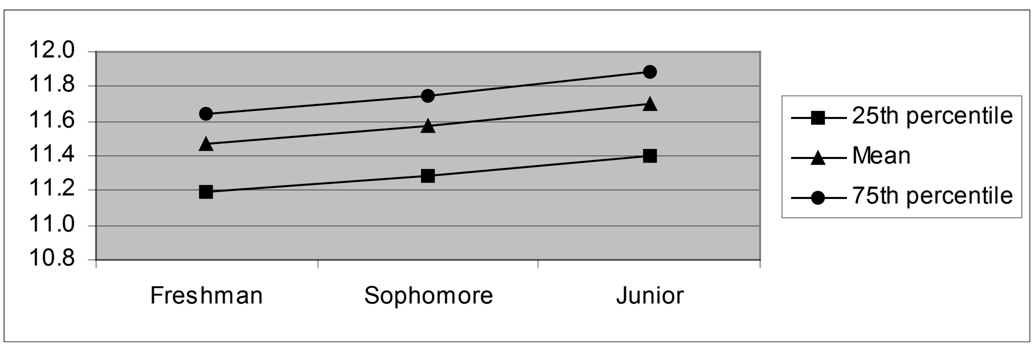


Figure C-5
Growth model of effect of Overall Participation in Support Activities controlled for mean Self Confidence Change on Perceptions of Classroom Environment

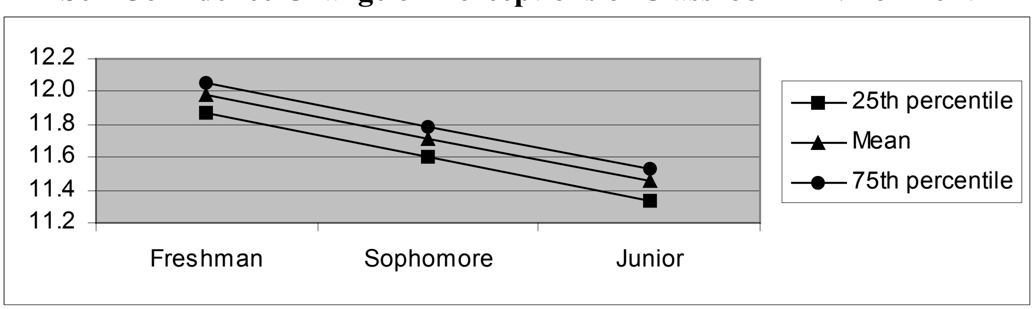


Figure C-6
Growth model of effect of Participation in Get Help Activities controlled for mean Self Confidence Change on Perceptions of Classroom Environment

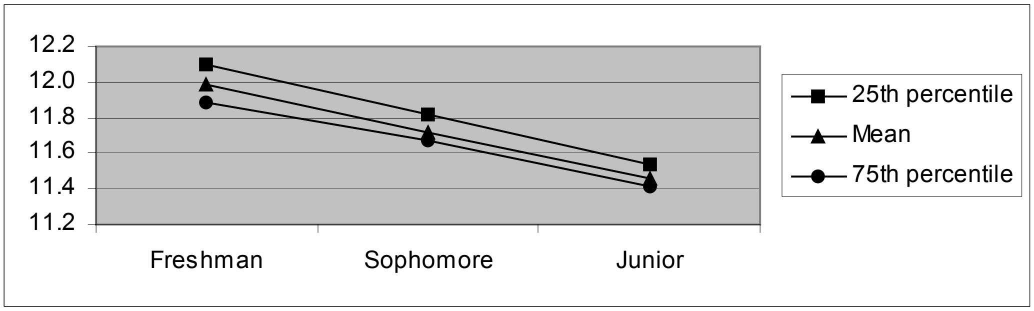


Figure C-7
Growth model of effect of Participation in Social Enrichment Activities controlled for mean Self Confidence Change on Perceptions of Classroom Environment

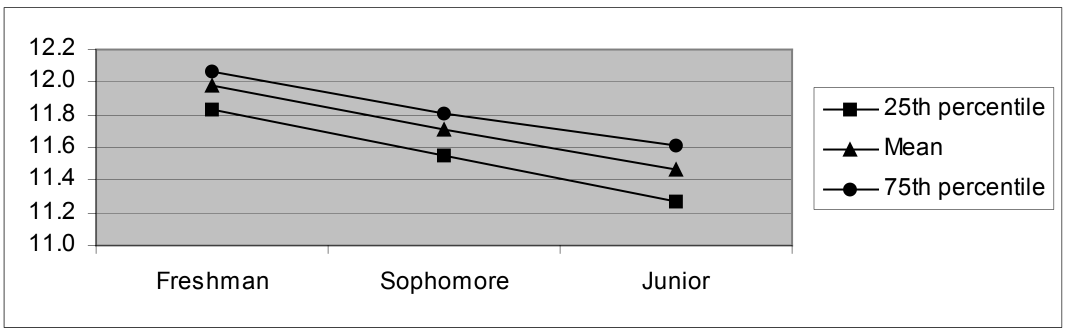
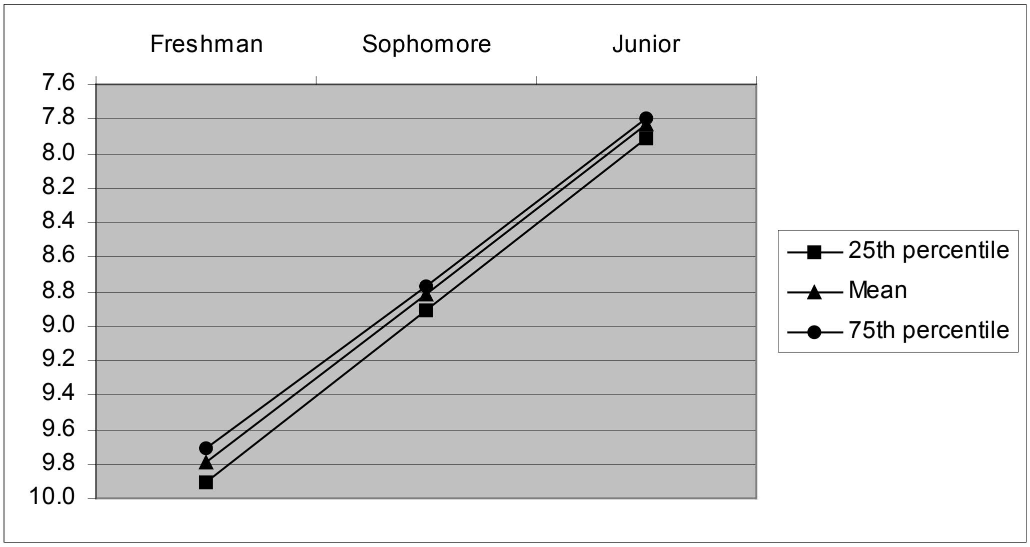


Table C-26
Effect of Participation on Self Confidence Change

		Freshman	Sophomore	Junior
Model 1: Null model		9.79	8.81	7.84
Model 2: Effect of Overall Participation in Support Activities	25th percentile	10.20	9.25	8.26
	Mean	9.79	8.83	7.82
	75th percentile	9.54	8.57	7.55
Model 3: Effect of Participation in Get Help Activities	25th percentile	9.90	8.91	7.91
	Mean	9.79	8.82	7.84
	75th percentile	9.71	8.77	7.79
Model 4: Effect of Participation in Social Enrichment Activities	25th percentile	10.09	9.16	8.21
	mean	9.78	8.82	7.82
	75th percentile	9.63	8.63	7.53

Note: These calculations are derived from Table 6-7; they are the basis for Figures 6-19 to 6-20 as well as Figure C-8.

Figure C-8
Growth model of effect of Participation in Get Help Activities on Self Confidence Change



Differences Between Stayers and Leavers

Table C-27
Effect of Participation in Social Enrichment Activities on Perception of Department Environment

	25th Percentile		Mean		75th Percentile	
	Stayer	Leaver	Stayer	Leaver	Stayer	Leaver
Freshman	23.13	17.90	23.74	17.90	24.03	17.90
Sophomore	22.94	17.90	23.60	17.90	23.98	17.90
Junior	22.79	17.90	23.56	17.90	24.13	17.90

Note: These calculations are derived from Table 6-8; they are the basis for Figure 6-21.

Table C-28
Effect of Overall Participation on Perception of Department Environment

	25th Percentile		Mean		75th Percentile	
	Stayer	Leaver	Stayer	Leaver	Stayer	Leaver
Freshman	22.98	17.92	23.72	17.92	24.18	17.92
Sophomore	22.84	17.92	23.60	17.92	24.07	17.92
Junior	22.76	17.92	23.56	17.92	24.05	17.92

Note: These calculations are derived from Table 6-9; they are the basis for Figure C-9.

Figure C-9
Effect of Overall Participation on Perception of Department Environment for Stayers

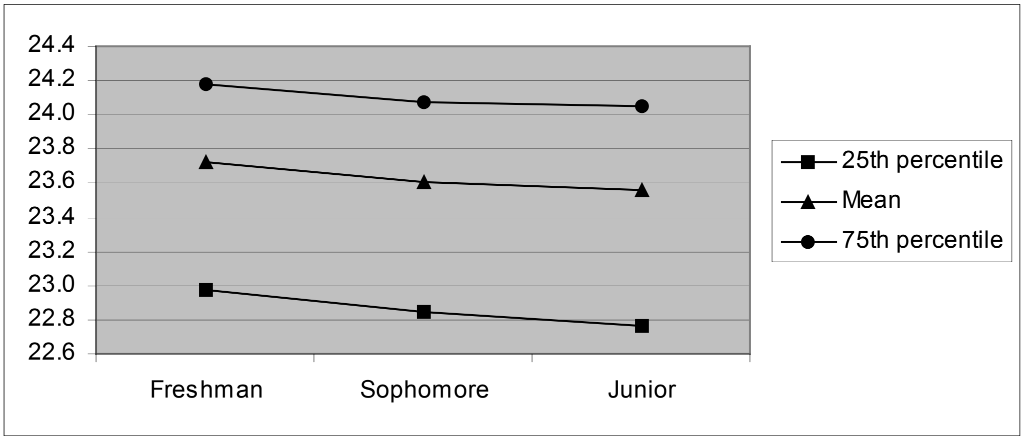


Table C-29
Effect of Participation in Get Help Activities on Perception of Department Environment

	25th Percentile		Mean		75th Percentile	
	Stayer	Leaver	Stayer	Leaver	Stayer	Leaver
Freshman	23.23	18.17	23.73	18.17	24.11	18.17
Sophomore	23.23	18.17	23.64	18.17	23.86	18.17
Junior	23.23	18.17	23.57	18.17	23.76	18.17

Note: These calculations are derived from Table 6-8; they are the basis for Figure C-10.

Figure C-10
Effect of Participation in Get Help Activities on Perception of Department Environment for Stayers

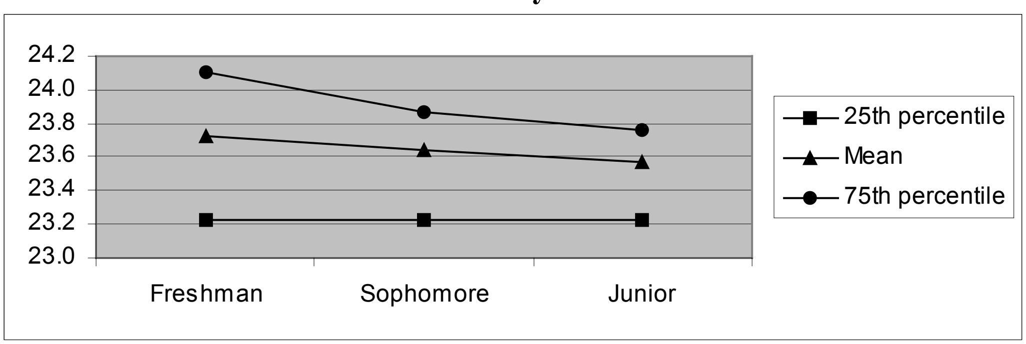


Table C-30
Effect of Overall Participation on Perception of Classroom Environment

	25th Percentile		Mean		75th Percentile	
	Stayer	Leaver	Stayer	Leaver	Stayer	Leaver
Freshman	11.29	8.49	11.55	8.13	11.72	7.91
Sophomore	11.44	8.50	11.72	8.13	11.88	7.91
Junior	11.62	8.49	11.90	8.10	12.08	7.87

Note: These calculations are derived from Table 6-9; they are the basis for Figures 6-22 and 6-23.

Table C-31
Effect of Participation in Get Help Activities on Perception of Classroom Environment

	25th Percentile		Mean		75th Percentile	
	Stayer	Leaver	Stayer	Leaver	Stayer	Leaver
Freshman	11.64	8.65	11.56	8.12	11.50	7.72
Sophomore	11.80	8.65	11.74	8.22	11.70	7.98
Junior	11.96	8.65	11.91	8.29	11.88	8.09

Note: These calculations are derived from Table 6-9; they are the basis for Figures 6-24 and 6-25.

Table C-32
Effect of Participation in Social Enrichment Activities on Perception of Classroom Environment

	25th Percentile		Mean		75th Percentile	
	Stayer	Leaver	Stayer	Leaver	Stayer	Leaver
Freshman	11.30	8.46	11.56	8.17	11.68	8.03
Sophomore	11.43	8.46	11.71	8.14	11.87	7.96
Junior	11.57	8.43	11.91	8.07	12.15	7.80

Note: These calculations are derived from Table 6-9; they are the basis for Figures C-11 and C-12.

Figure C-11
Effect of Participation in Social Enrichment Activities on Perception of Classroom Environment for Stayers

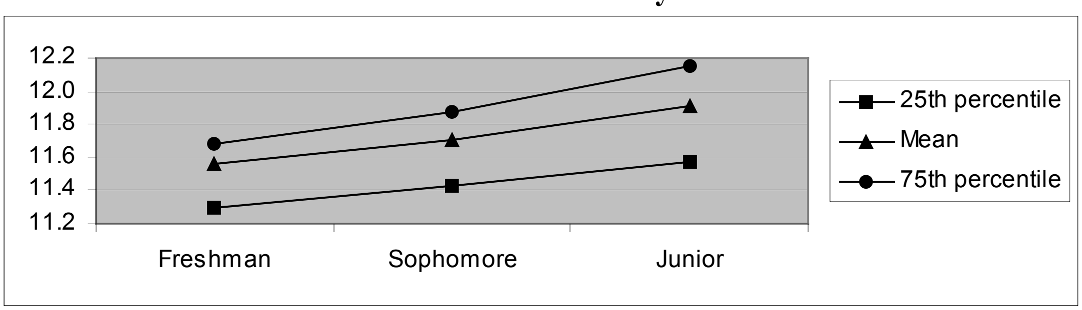


Figure C-12
Effect of Participation in Social Enrichment Activities on Perception of Classroom Environment for Leavers

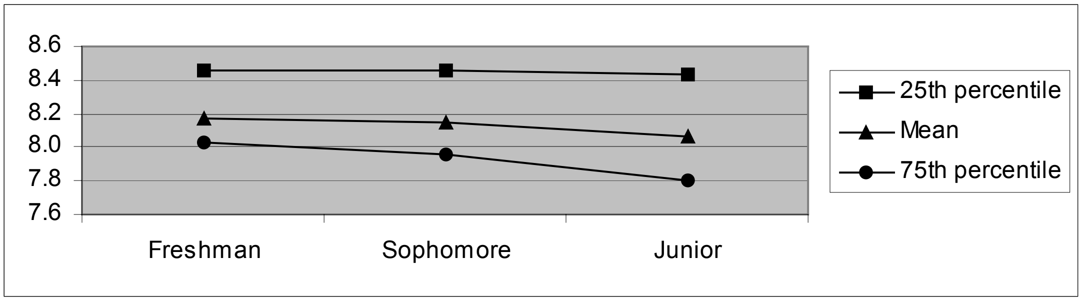


Table C-33
Effect of Overall Participation on Self Confidence Change

	25th Percentile		Mean		75th Percentile	
	Stayer	Leaver	Stayer	Leaver	Stayer	Leaver
Freshman	10.06	13.79	9.66	13.79	9.42	13.79
Sophomore	9.02	12.89	8.61	12.89	8.36	12.89
Junior	7.94	11.98	7.52	11.98	7.25	11.98

Note: These calculations are derived from Table 6-10; they are the basis for Figure C-13.

Figure C-13
Effect of Overall Participation on Self Confidence Change for Stayers

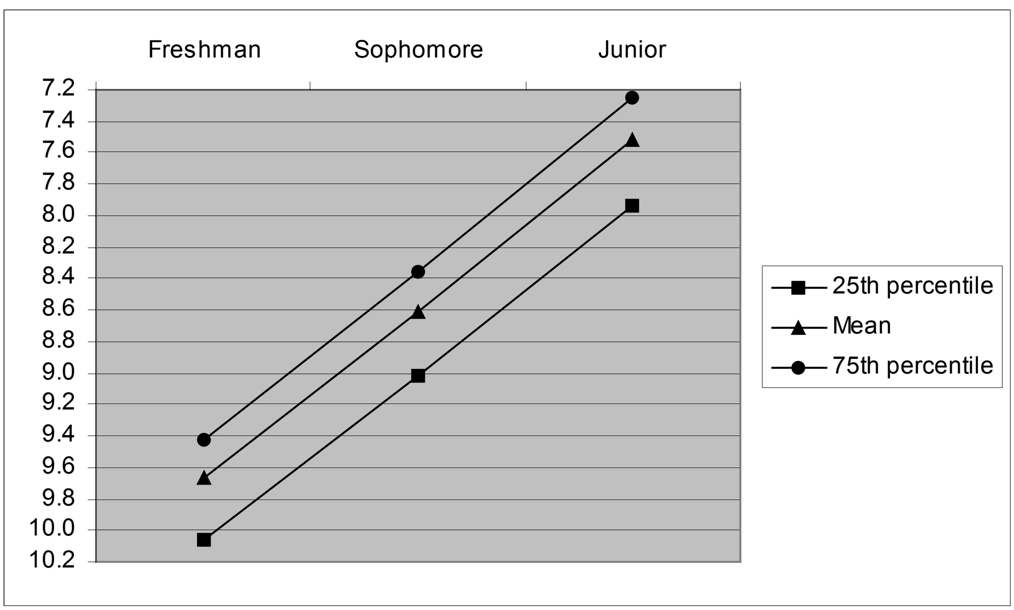


Table C-34
Effect of Participation in Get Help Activities on Self Confidence Change

	25th Percentile		Mean		75th Percentile	
	Stayer	Leaver	Stayer	Leaver	Stayer	Leaver
Freshman	9.77	13.49	9.65	13.76	9.55	13.97
Sophomore	8.68	12.61	8.58	12.84	8.53	12.96
Junior	7.59	11.74	7.51	11.92	7.46	12.02

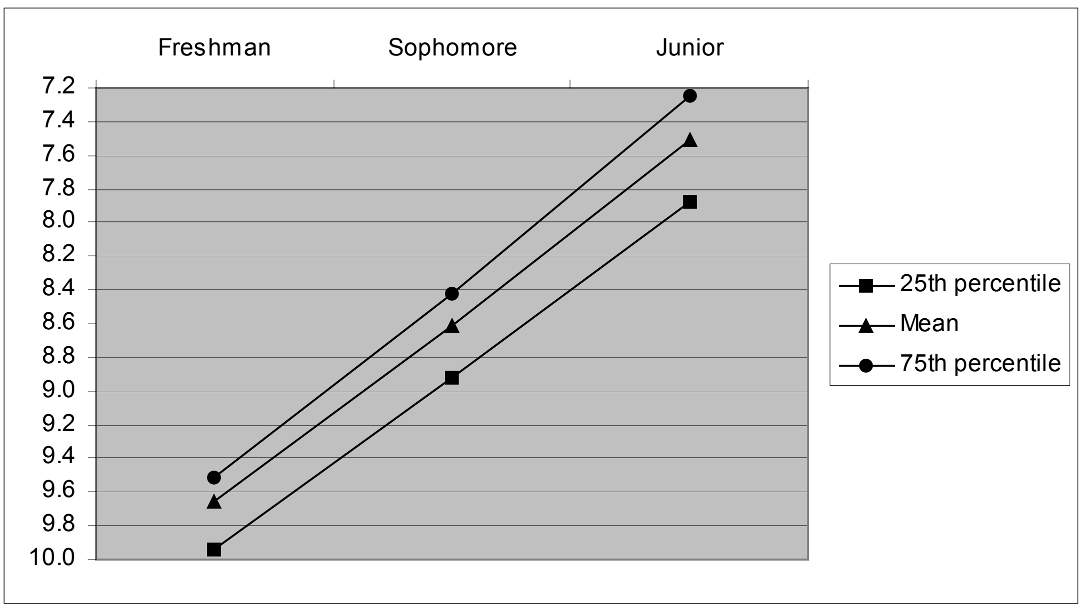
Note: These calculations are derived from Table 6-10; they are the basis for Figures 6-26 and 6-27.

Table C-35
Effect of Participation in Social Enrichment Activities on Self Confidence Change

	25th Percentile		Mean		75th Percentile	
	Stayer	Leaver	Stayer	Leaver	Stayer	Leaver
Freshman	9.94	13.78	9.65	13.78	9.52	13.78
Sophomore	8.92	12.88	8.61	12.88	8.43	12.88
Junior	7.88	11.98	7.51	11.98	7.25	11.98

Note: These calculations are derived from Table 6-10; they are the basis for Figure C-14.

Figure C-14
Effect of Participation in Social Enrichment Activities on Self Confidence Change for Stayers



APPENDIX C-4: EVENT HISTORY ANALYSIS

Table C-36
Model with Self Confidence Change as Predictor

	Null model	25th Percentile	Mean	75th Percentile
Freshman	0.0278	0.0063	0.0147	0.0303
Sophomore	0.0403	0.0288	0.0365	0.0443
Junior	0.0207	0.0125	0.0178	0.0237
Senior	0.0154	0.0081	0.0124	0.0176

Note: These calculations are derived from Table 6-11; they are the basis for Figure 6-29

Table C-37
Model with Perception of Department Environment as Predictor

	Null model	25th Percentile	Mean	75th Percentile
Freshman	0.0278	0.0352	0.0206	0.0119
Sophomore	0.0403	0.0509	0.0300	0.0173
Junior	0.0207	0.0248	0.0125	0.0062
Senior	0.0154	0.0185	0.0096	0.0049

Note: These calculations are derived from Table 6-11; they are the basis for Figure 6-30

Table C-38
Model with Perception of Classroom Environment as Predictor

	Null model	25th Percentile	Mean	75th Percentile
Freshman	0.0278	0.0347	0.0225	0.0148
Sophomore	0.0403	0.0506	0.0327	0.0213
Junior	0.0207	0.0256	0.0151	0.0091
Senior	0.0154	0.0190	0.0114	0.0069

Note: These calculations are derived from Table 6-11; they are the basis for Figure 6-31

Table C-39
Model with Overall Participation in Support Activities as Predictor

	Null model	25th Percentile	Mean	75th Percentile
Freshman	0.0278	0.0341	0.0265	0.0226
Sophomore	0.0403	0.0507	0.0379	0.0312
Junior	0.0207	0.0270	0.0189	0.0149
Senior	0.0154	0.0208	0.0135	0.0102

Note: These calculations are derived from Table 6-12; they are the basis for Figure 6-33

Table C-40
Model with Participation in Social Enrichment Activities as Predictor

	Null model	25th Percentile	Mean	75th Percentile
Freshman	0.0278	0.0342	0.0263	0.0221
Sophomore	0.0403	0.0522	0.0367	0.0287
Junior	0.0207	0.0281	0.0182	0.0133
Senior	0.0154	0.0224	0.0122	0.0078

Note: These calculations are derived from Table 6-12; they are the basis for Figure 6-34

Table C-41
Model with Participation in Social Enrichment Activities as Predictor, Controlled for Mean Self Confidence Change

	Null model	25th Percentile	Mean	75th Percentile
Freshman	0.0278	0.0176	0.0146	0.0128
Sophomore	0.0403	0.0461	0.0339	0.0273
Junior	0.0207	0.0234	0.0162	0.0125
Senior	0.0154	0.0172	0.0104	0.0072

Note: These calculations are derived from Table 6-12; they are the basis for Figure 6-36

Table C-42
Model with Participation in Social Enrichment Activities as predictor, Controlled for Mean Perception of Department Environment

	Null model	25th Percentile	Mean	75th Percentile
Freshman	0.0278	0.0227	0.0194	0.0175
Sophomore	0.0403	0.0350	0.0275	0.0233
Junior	0.0207	0.0148	0.0112	0.0092
Senior	0.0154	0.0124	0.0081	0.0060

Note: These calculations are derived from Table 6-12; they are the basis for Figure 6-37