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Final Report of

The Women's Experiences in College Engineering (WECE) Project

Executive Summary

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The Women's Experiences in College Engineering (WECE) project is the first cross-institutional, longitudinal examination of undergraduate women's experiences and persistence in engineering majors. 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.

WECE is the first national longitudinal study to statistically assess women's persistence in undergraduate engineering majors.

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.

More than 20,000 college women participated over the three years of the study.

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' responses to earlier questions; 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 school's 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 Science, Math, and Engineering (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 eleven 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.
- During high school, 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

Interest in the subject matter, encouragement by parents, and attraction to what they think engineers do draw women to engineering majors.

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:

Despite the challenges of engineering, the vast majority of our sample would either definitely or probably encourage other women to pursue this major.

- About two-fifths of all respondents 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. Less than one percent 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 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. Juniors, seniors, and fifth year students also cited employment opportunities, salary potential, and internships/research experiences.
- The most significant sources of discouragement were grades and the 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, engineering class environments, and engineering 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 in academic abilities, the engineering department environment, and the engineering classroom environment were all related to women's persistence in the major.

- 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.

Women who participated more frequently in engineering support activities, particularly those combining social and academic interaction, were less likely to leave an engineering major.

- 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 have not.

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 skills. 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 engineering 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 altruism is a major reason many women choose engineering (and the knowledge that engineering does, in fact, help society and people).
- Nourishing students' interest in engineering 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.

- 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.
- 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 and 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 in the WECE project, 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 of engineering. 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.

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