

# Graduation Rates, Grade-Point Average, and Changes of Major of Female and Minority Students Entering Engineering

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**Abstract** – This paper describes analysis of five cohorts of students matriculating into undergraduate engineering programs at nine southeastern universities from 1996-2002. We report retention by semester and graduation success as a percentage of all matriculated students. For students subsequently leaving engineering, we also report grade-point average, departure semester, and destination major. Statistical analyses determined which differences were significant between underrepresented and majority students. The results are compared to a previous study of engineering students at a private institution (University of Southern California).

The most striking result was that the graduation rates both within engineering and elsewhere in the university are higher for female students than for males. This was true for both the current and previous data sets. Analysis of previous cohorts in the current data set indicates that this trend begins with the 1992 freshman cohort. Differences between the two studies indicate that students at the private university, particularly females, were quicker to switch out of engineering majors. In other words, retention rates in the first few semesters were lower at the private university than in the current study, though both sets converged to similar values by the junior year.

*Index Terms* – Gender, Ethnicity, Retention, Benchmarking

## INTRODUCTION

Numerous recent reports indicate that although incremental change has been effected by diversity initiatives, the engineering workforce is far from reflecting the composition of American society [1], [2]. We know that fewer women than men choose to begin college in an engineering major and that generally the likelihood of receiving an engineering degree is greater among incoming male students [3]. A common assumption is that these students are not able to meet the academic challenges of an engineering program. A U.S. Department of Education (DOE) longitudinal study of

undergraduate engineering programs, however, reports that only 8.5 % of the students who leave engineering do so because of grades below C [4]. This DOE study points to poor teaching as a leading reason students leave engineering (98% cite this as one of the reasons). Seymour and Hewitt interviewed students about their decision to leave engineering and the sciences, finding that students at all types of institutions cited structural or cultural reasons, lack or loss of interest, poor teaching, and pace and workload concerns [5]. To make a persuasive argument to engineering faculty and administration that change is needed in their approach as well as the students', compelling statistical data like the DOE study cited above must be independently replicated.

This study makes use of a powerful database assembled to probe a wide variety of research questions related to the engineering undergraduate experience. We offer benchmarking values and related data analysis. Similar data from other sources, where available, are included.

## DATA

The Southeastern University and College Coalition for Engineering Education (SUCCEED) longitudinal database (LDB), which was used in this study, contains records for undergraduate students from 1987 to present (updated through 2002) at each of the SUCCEED institutions:

- Clemson University
- Florida A&M University
- Florida State University
- Georgia Institute of Technology
- North Carolina A&T State University
- North Carolina State University
- University of Florida
- University of North Carolina at Charlotte
- Virginia Polytechnic Institute and State University

A description of the database design is available, as are the results of a number of other studies [6 and references therein].

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The SUCCEED institutions are diverse by institutional size (729 to 6336 engineering enrollment), urban vs. non-urban setting, HBCU and non-HBCU, residential vs. commuter population, levels of transfer articulation, matriculation directly to a major vs. a freshman engineering program, and other characteristics. All are doctoral-granting state-sponsored universities. Institutional diversity provides sufficient variation to study a wide variety of policies affecting advising and retention.

Engineering Workforce Commission [7], [8] data show that SUCCEED schools enroll over 28,000 engineering undergraduates and award 1/12 of U.S. engineering degrees, a higher percentage of all U.S. engineering degrees awarded to women (1/10), and a significantly higher portion (1/4) of U.S. engineering degrees awarded to African-Americans. This sample size helps ensure that the results can be applied to other institutions. Statistics comparing the participating institutions to national averages are available [9].

#### THE POPULATION AND VARIABLES STUDIED

While the LDB contains data on both transfer students as well as First-Time-In-College (FTIC) students, the study was limited to FTIC students only. The results reporting format for the current study is modeled after a similar recent analysis of engineering retention and graduation rates for students at a private institution, University of Southern California [10]. Common findings would widen the applicability of the current study as well as future work planned with the LDB. Variability in the findings would be confounded between institution type (public vs. private) and geographic region (southeast vs. southern California) and require further study.

Retention rates were calculated for each semester by dividing the number of students remaining in any engineering major by the number of students initially matriculating into any engineering major. For example, students who switched from one engineering major to another were retained, while students who either switched to a non-engineering major or left the university were not retained. For the students that left, cumulative GPA at the time of major change was defined as student's cumulative GPA at the completion of the last semester in which the student's major was engineering. Results are also presented indicating the majors that students chose when they switched to a non-engineering major. Finally, graduation rates were calculated as a percentage of the number of students initially matriculating into any engineering major. Graduation rates from (1) engineering or (2) anywhere within the university (engineering and non-engineering combined) are reported for 4, 5, and 6 years after matriculation.

#### Current Data Set and Comparison Data Set Differences

Every attempt was made to analyze and report LDB data using the same definitions and used in the prior comparison study. Nonetheless, there were a few differences that should

be noted. In the comparison study, retention numbers were reported for cohorts matriculating from 1998-2003. The LDB is updated through 2002, so retention data are reported for an earlier set of cohorts: 1996-2001. (For graduation rates, both studies tracked the 1996-1999 cohorts.)

There were also some differences in the majors included in each database. Computer Science, included in engineering in the prior study, was not included in the current study because it is outside the engineering college at most of the SUCCEED schools and is therefore not usually included in LDB analyses. A final difference between the two data sets being compared was the semester in which freshmen matriculated. In the initial study, very few students entered during spring, and these students were included with the following fall cohort. The LDB includes a much larger number of students entering each spring. For consistency, all students entering in spring or summer were included with the following fall semester cohort. Cohort sizes in the prior study ranged from 350-405 students, while the LDB engineering cohorts are 4283-5984 students.

#### Statistical Methods

SAS statistical software was used to generate counts for the tables presented in this paper and perform statistical analysis. Categorical analysis tests were performed on each cohort to determine whether any of the output measures differed significantly for various genders or ethnicities.

### RESULTS AND DISCUSSION

#### Initial Major Selection

The percentages of female and minority students beginning in each program studied between 1996 and 2001 are listed in Table 1. The three departments with the highest percentage of female students are Industrial Engineering, Chemical Engineering, and Civil Engineering. This is very similar to the prior study, in which the top choices for female students were Biomedical Engineering, Civil Engineering, and Chemical Engineering [10]. The two least favored majors by the LDB female students, Mechanical Engineering and Computer Engineering, were also the least favored in the prior study [10].

Native American, Black or African American, and Hispanic students were designated minority. The three departments with the highest percentage of minority students are Industrial, Electrical, and Civil Engineering. Two of these were also the most popular in the prior study (Civil and Industrial). The least popular majors with minority students in the prior study were Computer Science, Undecided Engineering, and Biomedical Engineering. Undecided or General Engineering and Biomedical Engineering, if represented at LDB schools, would be included in the Other Engineering category, which is one of the least popular in Table 3. Overall, the departmental distributions for both women and minorities are similar to those published by an engineering education consulting firm [11].

TABLE 1  
PERCENTAGE OF FEMALE AND MINORITY STUDENTS IN FALL COHORTS

|                          | Female Students |            |            |            |            |            | Six-Year   | Minority Students |            |            |            |            |            | Six-Year   |
|--------------------------|-----------------|------------|------------|------------|------------|------------|------------|-------------------|------------|------------|------------|------------|------------|------------|
|                          | 1996            | 1997       | 1998       | 1999       | 2000       | 2001       | Average    | 1996              | 1997       | 1998       | 1999       | 2000       | 2001       | Average    |
| <b>Aerospace</b>         | 23%             | 17%        | 19%        | 20%        | 16%        | 19%        | <b>19%</b> | 14%               | 14%        | 13%        | 11%        | 12%        | 10%        | <b>12%</b> |
| <b>Chemical</b>          | 38%             | 41%        | 41%        | 39%        | 41%        | 37%        | <b>39%</b> | 25%               | 27%        | 29%        | 20%        | 25%        | 22%        | <b>24%</b> |
| <b>Civil</b>             | 30%             | 28%        | 25%        | 26%        | 23%        | 22%        | <b>25%</b> | 21%               | 26%        | 32%        | 25%        | 31%        | 23%        | <b>26%</b> |
| <b>Computer</b>          | 8%              | 11%        | 13%        | 11%        | 13%        | 10%        | <b>11%</b> | 16%               | 22%        | 18%        | 18%        | 21%        | 18%        | <b>19%</b> |
| <b>Electrical</b>        | 17%             | 15%        | 15%        | 13%        | 15%        | 14%        | <b>15%</b> | 32%               | 34%        | 34%        | 25%        | 31%        | 33%        | <b>32%</b> |
| <b>Industrial</b>        | 35%             | 34%        | 42%        | 39%        | 42%        | 44%        | <b>40%</b> | 39%               | 49%        | 42%        | 15%        | 28%        | 39%        | <b>35%</b> |
| <b>Mechanical</b>        | 15%             | 15%        | 11%        | 13%        | 15%        | 11%        | <b>13%</b> | 24%               | 25%        | 26%        | 14%        | 19%        | 20%        | <b>21%</b> |
| <b>Other Engineering</b> | 23%             | 23%        | 22%        | 27%        | 24%        | 24%        | <b>24%</b> | 11%               | 12%        | 12%        | 14%        | 14%        | 13%        | <b>13%</b> |
| <b>All Engineering</b>   | <b>23%</b>      | <b>23%</b> | <b>22%</b> | <b>23%</b> | <b>22%</b> | <b>21%</b> | <b>22%</b> | <b>18%</b>        | <b>18%</b> | <b>19%</b> | <b>16%</b> | <b>18%</b> | <b>17%</b> | <b>18%</b> |

### SEMESTER THAT STUDENTS LEAVE ENGINEERING

Table 2 presents the percentage of male and female students from each cohort remaining in engineering by semester. (Results are not reported beyond the 6<sup>th</sup> semester, since most students that leave do so in the first two years.) For each of the 33 semesters reported, the retention rate of male students is higher than that of females, a commonly reported result [3], [10]. In the prior study, the retention rates were similar to those reported here (60-70% by the 6<sup>th</sup> semester).

The prior study also reported that female students leave engineering earlier than males (spring or summer of freshman year vs. fall of sophomore year). The difference was only statistically significant for one of the five cohorts studied [10]. For the current data, the average semester during which female students leave engineering is just slightly lower (3.01 vs. 3.15, both corresponding to fall of sophomore year for most students). Overall, it seems the students at the private university were quicker to initiate a change to a non-engineering major. A possible explanation is that the cost consequences of staying in the wrong major are higher at the private institution. In Table 2, the first semester retention rates round to 100%, while up to 10% (4 students) of the incoming freshman class had abandoned engineering in the first semester at the private university [10].

Table 3 presents similar retention rates for minority and non-minority students. In most semesters, the rates are similar, if generally lower for minority students. In the comparison study, there was no difference in when minority and non-minority students leave engineering. This is the case for the current data set as well; the average semester during which all students who leave engineering do so is their 3<sup>rd</sup>, or fall of sophomore year. The minority student retention rates at the private institution were lower than those reported here (59-63% by the 6<sup>th</sup> semester) [10]. This result might be expected, as the current data includes students from HBCUs.

The Consortium for Student Data Exchange (CSRDE) [3] reports graduation and retention rates for engineering and science students at highly selective schools (SAT > 1100). For freshmen entering in fall of 2000, the second year return rates (corresponding to 3<sup>rd</sup> semester in Tables 4 and 5) were

- 73% for female students,
- 77% for male students, and
- 72% for minority students [3].

The values for female and minority students included in the LDB are 3-4% lower than these, but it is unclear whether all the schools included fall into the highly selective category established by the CSRDE.

TABLE 2  
RATES OF RETENTION IN ENGINEERING BY SEMESTER AND GENDER (CUMULATIVE)

|                  | 1 <sup>st</sup> Semester |      | 2 <sup>nd</sup> Semester |      | 3 <sup>rd</sup> Semester |      | 4 <sup>th</sup> Semester |      | 5 <sup>th</sup> Semester |      | 6 <sup>th</sup> Semester |      |
|------------------|--------------------------|------|--------------------------|------|--------------------------|------|--------------------------|------|--------------------------|------|--------------------------|------|
|                  | Female                   | Male | Female                   | Male | Female                   | Male | Female                   | Male | Female                   | Male | Female                   | Male |
| <b>Fall 1996</b> | 100%                     | 100% | 90%                      | 94%  | 84%                      | 88%  | 78%                      | 84%  | 75%                      | 81%  | 73%                      | 79%  |
| <b>Fall 1997</b> | 100%                     | 100% | 86%                      | 92%  | 80%                      | 86%  | 74%                      | 81%  | 70%                      | 77%  | 68%                      | 75%  |
| <b>Fall 1998</b> | 100%                     | 100% | 91%                      | 92%  | 83%                      | 85%  | 79%                      | 81%  | 77%                      | 78%  | 75%                      | 75%  |
| <b>Fall 1999</b> | 100%                     | 100% | 87%                      | 89%  | 79%                      | 83%  | 73%                      | 78%  | 69%                      | 75%  | 67%                      | 73%  |
| <b>Fall 2000</b> | 100%                     | 100% | 80%                      | 87%  | 69%                      | 79%  | 62%                      | 74%  | 61%                      | 74%  | 61%                      | 74%  |
| <b>Fall 2001</b> | 100%                     | 100% | 87%                      | 89%  | 86%                      | 89%  | N/A                      | N/A  | N/A                      | N/A  | N/A                      | N/A  |

TABLE 3  
RATES OF RETENTION IN ENGINEERING BY SEMESTER AND MINORITY STATUS (CUMULATIVE)

|           | 1 <sup>st</sup> Semester |      | 2 <sup>nd</sup> Semester |     | 3 <sup>rd</sup> Semester |     | 4 <sup>th</sup> Semester |     | 5 <sup>th</sup> Semester |     | 6 <sup>th</sup> Semester |     |
|-----------|--------------------------|------|--------------------------|-----|--------------------------|-----|--------------------------|-----|--------------------------|-----|--------------------------|-----|
|           | Minority                 | Non  | Minority                 | Non | Minority                 | Non | Minority                 | Non | Minority                 | Non | Minority                 | Non |
| Fall 1996 | 100%                     | 100% | 94%                      | 93% | 88%                      | 87% | 85%                      | 82% | 82%                      | 79% | 80%                      | 77% |
| Fall 1997 | 100%                     | 100% | 92%                      | 91% | 87%                      | 87% | 81%                      | 82% | 77%                      | 78% | 74%                      | 76% |
| Fall 1998 | 100%                     | 100% | 90%                      | 92% | 82%                      | 85% | 77%                      | 81% | 75%                      | 78% | 73%                      | 76% |
| Fall 1999 | 100%                     | 100% | 85%                      | 90% | 79%                      | 83% | 75%                      | 77% | 72%                      | 74% | 70%                      | 72% |
| Fall 2000 | 100%                     | 100% | 83%                      | 86% | 75%                      | 77% | 70%                      | 72% | 68%                      | 71% | 68%                      | 71% |
| Fall 2001 | 100%                     | 100% | 89%                      | 89% | 87%                      | 88% | N/A                      | N/A | N/A                      | N/A | N/A                      | N/A |

#### GPA OF STUDENTS LEAVING ENGINEERING

Table 4 presents the average GPA of male and female students leaving engineering during semesters one through six. Results are not included for students leaving engineering in the first semester because there were often no students leaving and at most two. A previous study of the same data reported that the majority of students leaving engineering have GPAs in the range of 2.0-2.5 [6], which is reflected in the results presented here. This is an important result that disproves the commonly held notion that students leave engineering because they cannot succeed academically.

Of the 26 semesters for which results are reported, there is only one instance in which the average GPA of the female students is not higher than that of the male students. The average GPA for female students leaving engineering before their 7<sup>th</sup> semester is 2.89, while the corresponding value for male students is 2.68. A t-test indicates that the difference between the GPAs of male ( $\bar{M} = 2.68$ ) and female ( $\bar{M} = 2.91$ ) students leaving engineering is significant  $t(6038) = 10.86$ ,  $p = .0001$ . Hence females leave engineering with higher GPAs than males.

Of all the results reported in this and the prior study, the earlier semester and higher GPA for female students leaving engineering have the most significant implications for Women in Engineering programs. The results point to some combination of lower self-esteem of female students and loss of interest in engineering. A number of sources provide advice on addressing these issues [12],[13].

Table 5 presents the average GPA of minority and non-minority students leaving engineering during semesters one through six. With the exception of just a few semesters in the junior year, the average GPA of minority students leaving engineering is lower than that of non-minority students leaving engineering. A t-test indicates that the difference between the GPAs of minority ( $\bar{M} = 2.58$ ) and non-minority ( $\bar{M} = 2.79$ ) students leaving engineering is significant  $t(6033) = 8.75$ ,  $p = .0001$ . The prior study also reported similar results, namely statistically significant lower GPAs among minority students.

#### MAJORS STUDENTS SELECT WHEN LEAVING ENGINEERING

Previous analysis of the LDB [14] indicates that the top four majors selected by female students leaving engineering are business (24%), biology (10%), physics (8%), and education (7%). Male students also prefer business (28%), but move to computer science (13%) and social sciences (10%) as their second and third choices. An earlier study of survey data from several thousand freshmen reported that women leaving physical sciences, biological sciences or engineering move most often to business or accounting (21%), education (13%) and "science-practitioner" (health professions, 6.7%). Male students in the same study moved to business or accounting (26%), military (7%) and law (4%) [15]. This study and others conclude that the difference arises from a strong desire by women to help others by working for the social good [15],[16]. Data for minority students is not available at this time.

TABLE 4  
AVERAGE GPAS OF STUDENTS LEAVING ENGINEERING BY GENDER

|           | 2 <sup>nd</sup> Semester |      | 3 <sup>rd</sup> Semester |      | 4 <sup>th</sup> Semester |      | 5 <sup>th</sup> Semester |      | 6 <sup>th</sup> Semester |      |
|-----------|--------------------------|------|--------------------------|------|--------------------------|------|--------------------------|------|--------------------------|------|
|           | Female                   | Male | Female                   | Male | Female                   | Male | Female                   | Male | Female                   | Male |
| Fall 1996 | 2.96                     | 2.71 | 2.95                     | 2.63 | 2.71                     | 2.44 | 2.90                     | 2.56 | 2.70                     | 2.51 |
| Fall 1997 | 2.94                     | 2.68 | 2.81                     | 2.60 | 2.70                     | 2.61 | 2.75                     | 2.56 | 2.78                     | 2.61 |
| Fall 1998 | 2.96                     | 2.75 | 2.91                     | 2.62 | 2.83                     | 2.67 | 2.73                     | 2.65 | 2.82                     | 2.69 |
| Fall 1999 | 2.93                     | 2.80 | 2.91                     | 2.61 | 2.84                     | 2.62 | 2.88                     | 2.66 | 2.87                     | 2.69 |
| Fall 2000 | 3.02                     | 2.77 | 2.85                     | 2.74 | 2.72                     | 2.63 | 2.79                     | 2.54 | N/A                      | N/A  |
| Fall 2001 | 3.17                     | 2.82 | 1.97                     | 2.58 | N/A                      | N/A  | N/A                      | N/A  | N/A                      | N/A  |

TABLE 5  
AVERAGE GPAS OF STUDENTS LEAVING ENGINEERING BY MINORITY STATUS

|           | 1 <sup>st</sup> Semester |     | 2 <sup>nd</sup> Semester |      | 3 <sup>rd</sup> Semester |      | 4 <sup>th</sup> Semester |      | 5 <sup>th</sup> Semester |      | 6 <sup>th</sup> Semester |      |
|-----------|--------------------------|-----|--------------------------|------|--------------------------|------|--------------------------|------|--------------------------|------|--------------------------|------|
|           | Minority                 | Non | Minority                 | Non  | Minority                 | Non  | Minority                 | Non  | Minority                 | Non  | Minority                 | Non  |
| Fall 1996 | N/A                      | N/A | 2.73                     | 2.80 | 2.56                     | 2.74 | 2.46                     | 2.52 | 2.45                     | 2.69 | 2.52                     | 2.56 |
| Fall 1997 | N/A                      | N/A | 2.45                     | 2.83 | 2.52                     | 2.68 | 2.45                     | 2.68 | 2.46                     | 2.64 | 2.65                     | 2.65 |
| Fall 1998 | N/A                      | N/A | 2.59                     | 2.87 | 2.61                     | 2.72 | 2.57                     | 2.74 | 2.49                     | 2.69 | 2.72                     | 2.71 |
| Fall 1999 | N/A                      | N/A | 2.61                     | 2.91 | 2.31                     | 2.76 | 2.51                     | 2.71 | 2.51                     | 2.76 | 2.67                     | 2.76 |
| Fall 2000 | N/A                      | N/A | 2.65                     | 2.91 | 2.56                     | 2.82 | 2.40                     | 2.70 | 2.71                     | 2.52 | N/A                      | N/A  |
| Fall 2001 | N/A                      | N/A | 2.72                     | 2.91 | 2.13                     | 2.77 | N/A                      | N/A  | N/A                      | N/A  | N/A                      | N/A  |

GRADUATION RATES

Table 6 lists four-, five-, and six-year graduation rates for male and female students in the 1996 through 1999 cohorts. In the prior as well as the current study, female students exhibit a higher graduation rate than males, even in engineering. Analysis of earlier cohorts in the LDB indicates that this trend begins with the 1992 freshman cohort, the first group for which females' four-, five- and six-year graduation rates in engineering exceed those of the male students. (For the 1987-1991 cohorts, male students graduated in engineering at higher rates than females.) In contrast, the Consortium for Student Data Exchange (CSRDE) [3] reported a higher six-year engineering graduation rate for male students entering highly selective colleges in 1995: 47% for males vs. 42% for females students. Both CSRDE [3] and DOE [4] rates for male students are similar to those listed in Table 6, whereas the values for females in the current study are much higher.

Table 7 lists graduation rates for minority and non-minority students. The four- and five-year graduation rates show multiple instances in which minority students graduated at higher rates than non-minority students. The six-year graduation rates, however, are disappointing. In the prior study, graduation rates were again higher than those reported here, but there were no instances in which minority students graduated at higher rates than non-minority

students. Statistical analysis of this prior data revealed significant differences in the four-, five-, and six-year university graduation rates of minority versus non-minority students as well as whether the students graduated in engineering, for all cohorts studied. CSRDE reports a 32% minority graduation rate in engineering and 54% minority graduation rate from the highly selective university within six years [3]. The engineering rate is similar to that reported here, but the university graduation rate for the current data is lower.

SUMMARY OF RESULTS

Data for seven cohorts of engineering students were analyzed and compared to results from a similar prior study of retention and graduation rates. Graduation and retention rates, GPA, departed semester, and destination major for students entering engineering at nine southeastern universities from 1996-2002 were compared to similar data for students at a private university in southern California.

The most striking result was that the graduation rates (a percentage of all students matriculating into engineering as freshmen) both within engineering and from the entire university (including engineering) were higher for female students than for males. This was true for both the current and comparison data sets but not in previously published reports [3],[4]. Analysis of 1987-1995 cohorts indicates this trend begins with the 1992 freshman cohort.

TABLE 6  
GRADUATION RATES BY GENDER (CUMULATIVE)

|           | Four-Year Graduation Rates |       |                  |       | Five-Year Graduation Rates |      |                  |      | Six-Year Graduation Rates |      |                  |      |
|-----------|----------------------------|-------|------------------|-------|----------------------------|------|------------------|------|---------------------------|------|------------------|------|
|           | From Engineering           |       | From University* |       | From Engineering           |      | From University* |      | From Engineering          |      | From University* |      |
|           | Female                     | Male  | Female           | Male  | Female                     | Male | Female           | Male | Female                    | Male | Female           | Male |
| Fall 1996 | 0.92%                      | 1.76% | 2.75%            | 2.33% | 30%                        | 24%  | 47%              | 33%  | 49%                       | 45%  | 73%              | 62%  |
| Fall 1997 | 0.59%                      | 0.98% | 2.37%            | 1.99% | 26%                        | 22%  | 43%              | 34%  | 40%                       | 36%  | 63%              | 52%  |
| Fall 1998 | 0.50%                      | 1.06% | 1.80%            | 1.81% | 16%                        | 13%  | 27%              | 19%  | 23%                       | 15%  | 40%              | 30%  |
| Fall 1999 | 0.40%                      | 0.39% | 1.00%            | 0.63% | N/A                        | N/A  | N/A              | N/A  | N/A                       | N/A  | N/A              | N/A  |

\*Graduation rate from university includes both engineers and non-engineers.

TABLE 7  
GRADUATION RATES BY MINORITY STATUS (CUMULATIVE)

|           | Four-Year Graduation Rates |       |                  |       | Five-Year Graduation Rates |     |                  |     | Six-Year Graduation Rates |     |                  |     |
|-----------|----------------------------|-------|------------------|-------|----------------------------|-----|------------------|-----|---------------------------|-----|------------------|-----|
|           | From Engineering           |       | From University* |       | From Engineering           |     | From University* |     | From Engineering          |     | From University* |     |
|           | Minority                   | Non   | Minority         | Non   | Minority                   | Non | Minority         | Non | Minority                  | Non | Minority         | Non |
| Fall 1996 | 1.03%                      | 1.68% | 2.20%            | 2.48% | 24%                        | 25% | 34%              | 37% | 39%                       | 48% | 54%              | 66% |
| Fall 1997 | 0.61%                      | 0.96% | 1.83%            | 2.13% | 16%                        | 25% | 25%              | 38% | 27%                       | 40% | 39%              | 58% |
| Fall 1998 | 0.46%                      | 1.05% | 1.26%            | 1.94% | 11%                        | 14% | 16%              | 22% | N/A                       | N/A | N/A              | N/A |
| Fall 1999 | 0.00%                      | 0.47% | 0.29%            | 0.80% | N/A                        | N/A | N/A              | N/A | N/A                       | N/A | N/A              | N/A |

\*Graduation rate from university includes both engineers and non-engineers.

Students at the private university were quicker to both switch out of an engineering major and graduate from their chosen majors. Engineering retention rates in the first few semesters were lower at the private university than in the current study, although both sets converged to similar values by the 6<sup>th</sup> semester. In both data sets, female students on average left engineering majors earlier than males. At the private university, the difference was 0.5 semesters, while the difference for the current data set was only 0.14 semesters. These data, coupled with results that females leave engineering with higher average GPAs than male students, should be incorporated into mentoring activities. Differences were also revealed in the majors that female select when leaving engineering. Though both males and females favor business, emphasis for females appears to be on disciplines that help people.

### FUTURE WORK

This study provides statistical data to help target retention programs for female and minority students and provide a foundation for further study of the engineering undergraduate experience. Direct comparison of data from state-supported, southeastern schools to a private school in southern California illustrates which results are likely to be most generalizable to other schools and programs. An important next step would be to complement this work with qualitative inquiry to further illuminate the issues. A rich body of literature exists to help explain some of the discrepancies between the retention and graduation characteristics of women, minorities, and majority students in engineering. Nonetheless, old attitudes die hard, for example the belief that underrepresented students leave engineering because they are not academically competent. It will take the effort of many staff, faculty, and researchers from diverse disciplines and institutions, using a variety of approaches to continue changing engineering education.

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