

TRACKING UNDERGRADUATE ENGINEERING STUDENTS FROM MATRICULATION THROUGH GRADUATION

Miriam K. Maslanik, Ph.D., P.E.
Associate Director, Women in Engineering Program

University of Colorado at Boulder
Boulder, Colorado

INTRODUCTION

In December of 1994, the Women in Engineering Program at the University of Colorado at Boulder initiated a project to create a tracking system to track all undergraduate engineering students through the College of Engineering and Applied Science. Almost all students enrolled in the College of Engineering and Applied Science anytime between the fall 1988 and fall 1995 semesters have been tracked. The focus has been primarily on those students who began as freshman in any fall semester between 1988 and 1995. Data on transfer students (from outside institutions) and intra-university transfer (IUT) students (from other colleges in the university) entering engineering in any of these fall or spring semesters have also been analyzed, but not to the same degree. We now have information such as:

- the retention rate of engineering students who begin as freshmen, by gender, ethnicity, and Colorado residency;
- the attrition patterns of engineering students, i.e., when they tend to drop out of engineering or the university;
- the graduation rate of students who begin as freshmen, and how long it typically takes to graduate; and
- how likely students are to graduate from the university if they start as freshmen in engineering.

There are of course many more questions we asked, and many more we can ask of the data. At this point, the major project is complete, with updates planned every semester or year, depending on staff availability. However, it is expected that the database will be revisited from time to time to obtain answers to new questions of interest. This workshop addresses basics about how an institution might initiate a comprehensive tracking project. Each institution will have different needs and questions, but there are common attributes and experiences from which to draw to implement such a project.

THE TRACKING PROJECT

Project Initiation

In December 1994, staff from the Women in Engineering Program met with staff from the Minority Engineering Program, Engineering Student Programs, and Engineering Student Services to learn the questions people had about student enrollment patterns that could be answered by tracking. After developing that set of questions, we determined the variables we needed to study. We then met with staff of the University of Colorado's Student Affairs Research Services (SARS) group, which does all the "number crunching" for the entire university. Staff from SARS helped to redesign some questions and to clarify what was really needed to accomplish the task.

The database of information was created by SARS and first made available to us in July, 1995. The majority of the data processing was performed from September, 1995 through April, 1996. The first major update was performed in August of 1996, and the final data processing for which results are reported here occurred in January, 1997.

Construction of the Database and Data Analysis

For consistency with other student information reported for the campus, and for ease of assistance with problems, we chose to use SAS, a well-known statistical analysis program, to analyze the data. I took three SAS courses over the space of one year, in order to learn how to use SAS effectively. Courses recommended to start are "Introduction to SAS - A Programming Approach," "SAS Programming," and "SAS Macro Language." The first two are critical, the third is helpful. I also recommend courses in SAS Report Writing and SAS Graphics. In retrospect, it would have saved us much time in table and figure generation. I cannot stress enough the value and necessity of starting this training before attempting to analyze the data.

The Student Information System (SIS) at the University of Colorado at Boulder lives on a large mainframe IBM/Amdahl-type computer. The SIS became operational in the fall semester of 1988. Complete data on students enrolled before fall of 1988 are not available, so all analyses begin from that point in time. Current student information is accessed easily on-line, in a menu- and screen-driven system. Historical information is accessed by preparing files of code to perform tasks and submitting jobs using Job Control Language (JCL). The Student Affairs Research Services (SARS) group processed data from "flat files," snapshots of student information at particular points in time - usually either at the beginning or at the end of a semester - to create SAS datasets, which were then analyzed.

Given the variables we wanted to study and the questions we wanted to answer, SARS created five (5) SAS datasets. SARS can provide updates after every semester, although updates have not been implemented that often due to time constraints. The current

datasets in use include information from the fall of 1988 to the spring of 1995, not including spring 1995 graduates. The next update will include student data up to fall 1996 graduation. In general, updates are at least four months behind current enrollment. A summary of the datasets follows. In all cases, the student ID is the "key" variable.

SAS Datasets

EN_POP. This dataset includes all students who have ever been enrolled in engineering anytime between fall of 1988 and spring of 1995 (to be updated). Data include demographic information such as ID, gender, ethnicity, residency (Colorado or not Colorado), term of entry into the university and into engineering, entry type (freshmen, transfer, intra-university transfer), entry level, and college and term of first degree.

EN_EOT. This dataset contains all "end-of-term" information for all students in EN_POP. Variables include dorm (if applicable), college and major (1st and 2nd), attempted hours, term gpa, cumulative gpa, information about earned and transferred hours, and academic actions and stops (suspension).

EN_ENREL. This dataset contains information related to enrollment, such as college and major at entry, year of entry, first declared major, predicted GPA, and enrollment relative to the first term the student is enrolled. It also indicates the semester of graduation.

EN_ENABS. This dataset shows absolute terms students are enrolled. I have not used this dataset for my analyses.

EN_CRS. This dataset contains grades for all students in each section of freshman engineering and "pre-engineering" courses, such as Calculus 1 and 2, Chemistry for Engineers, Computer Programming, Physics 1 and 2.

Data analysis

In order to analyze the data, I started with EN_POP and one or more of the other datasets. Using student ID as the "key," I sorted and merged to create needed subsets, usually with fewer variables to save space and computing time. From these datasets, I ran SAS procedures to tabulate, compute frequencies, calculate means, or perform the necessary statistical procedures.

I started by computing basic demographics of each entering freshmen class, including size, ethnicity, gender, and SAT scores. For the most part, we knew this information from admissions and normal pre-semester data processing, and *this was one way of verifying the integrity of the datasets.*

In order to compute graduation and retention rates, I created datasets containing only students who started as freshmen in fall of 1988 through 1995. For each class, I followed students from semester to semester to determine how many were enrolled after each semester. I also tracked students to graduation (or drop out) to determine how long it took to graduate from engineering.

Definition of retention and graduation rates

At this point, I call your attention to a definition of retention and graduation rate. First, each must be quoted with a time context. Second, one must be specific concerning where the student is retained or from which college he or she has graduated. For example, you might want to look at a 1-year retention rate and a 4-year retention rate. They are significantly different, but both are important. SARS would consider any student who starts at CU-Boulder and is still enrolled at CU-Boulder as retained, regardless of his/her college. SARS would also compute a total graduation rate from the university, regardless of college of entry and college of graduation.

We define **engineering retention rates** as follows:

$$\begin{aligned} \text{1-year engr retention rate} &= \frac{\# \text{ students enrolled in engr in the 2nd fall semester}}{\# \text{ students enrolled in engr in the 1st fall semester}} \times 100 \\ \text{4-year engr retention rate} &= \frac{(\# \text{ students enrolled engr in the 5th fall semester} + \# \text{ students graduated from engr before the 5th fall semester})}{\# \text{ students enrolled in engr in the 1st fall semester}} \times 100 \end{aligned}$$

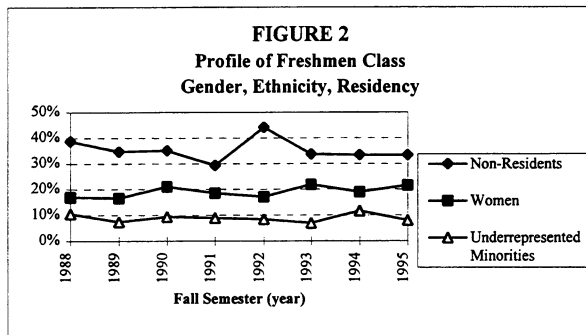
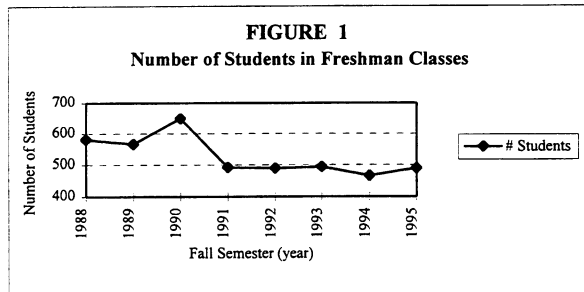
We define **graduation rates** as follows:

$$\begin{aligned} \text{4-year engr grad rate} &= \frac{\# \text{ students graduated from engineering within 4 years}}{\# \text{ students enrolled in engr in the 1st fall semester}} \times 100 \\ \text{4-year total grad rate} &= \frac{\# \text{ students graduated from CU-Boulder within 4 years}}{\# \text{ students enrolled in engr in the 1st fall semester}} \times 100 \end{aligned}$$

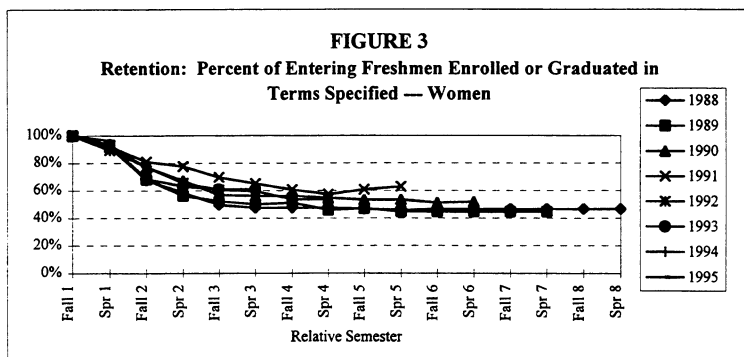
We report 4-year, 4 1/2-year, 5-year, etc. graduation rates as cumulative percentages, not additive percentages. In other words, if 18% of students graduate in 4 years, and 35% graduate in 4 1/2 years, the 35% figure includes all students who graduate within 4 1/2 years.

RESULTS

I have a binder full of graphs and tables showing all the results, broken down by gender, ethnicity and residency. I can only include a few here. In order to put the results in context, it is important to understand the characteristics of our freshmen. Figure 1 shows the size of each freshman class from 1988 to 1995. Figure 2 shows the profile of each freshman class from 1988 to 1995, showing the percent of women, underrepresented minorities, and non-Colorado residents in each class.



Figures 3 and 4 show the engineering retention rates of engineering students, women and men respectively, who started as freshmen in fall 1988 through 1995. Note that there is variation from year to year. Table 1 summarizes the average one-, two-, and four-year retention rates. Table 2 presents information about students who left engineering, either involuntarily or voluntarily, within the first two years. Table 3 shows the average engineering graduation rates and average total graduation rates for students starting in engineering between 1988 and 1991.



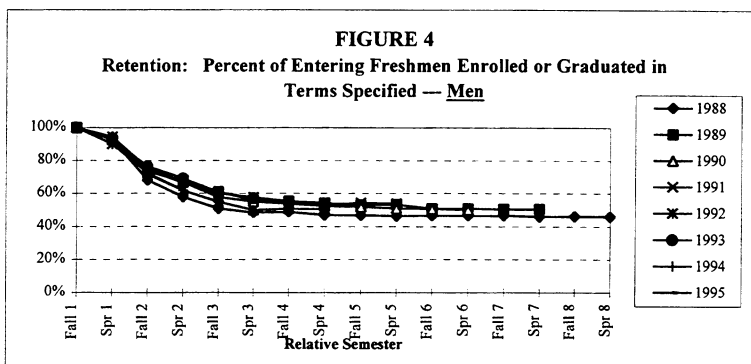


TABLE 1
Average Engineering Retention Rate for Students
Starting in Engineering Between 1988 and 1995

# of years	Average Engineering Retention Rate, %	
	<u>Women</u>	<u>Men</u>
1	73.8	72.9
2	58.3	57.5
4	51.8	51.5

TABLE 2
Information about Students Who Left Engineering Within the First Two Years

	<u>Women</u>	<u>Men</u>
Average GPA at time of leaving engineering (4.0 scale)	2.38	2.24
% of women/men leaving in the first year who are suspended at the end of the first year	26.5	31.3
% of women/men leaving in the first two years, suspended at end of first year	14.3	17.0
% of women/men leaving in the first two years, suspended within first two years	25.0	27.2
% of women/men leaving who transfer to another college at UC-B within first two years	46.2	33.1

<p align="center">TABLE 3 Average Engineering Graduation Rates of Students Starting in Engineering as Freshmen Between 1988 and 1991</p>						
# years	<u>Engineering Graduation</u> Rates, %		<u>% of graduating students</u> <u>who graduated within</u> <u>time specified</u>		<u>Total Graduation</u> Rates, %	
	<u>Women</u>	<u>Men</u>	<u>Women</u>	<u>Men</u>	<u>Women</u>	<u>Men</u>
4	18.7	16.2	40.0	36.0	26.9	21.6
4 1/2	37.8	31.2	81.3	69.3		
5	42.0	42.0	90.3	93.3	64.5	55.7
6	45.6	45.6			75.1	63.8
7	46.5	45.0			76.8	63.3

DISCUSSION OF RESULTS

In general, we lose significant numbers of engineering students after the first, second, third and fourth semesters. The most dramatic dropoff is after the second semester. At that point, we lose about 26% of the women students and about 27% of the male students. Of those who leave in the first year, 26.5% of the women and 31.3% of the men are suspended. Of all the students who leave within two years, 14.3% of the women and 17.0% of the men are suspended after the first year, while 25.0% and 27.2% are suspended within the two years. A higher percentage of women (46.2%) than men (33.1%) who leave transfer to other colleges in the university. By the end of four years, retention of both men and women in engineering is under 52%.

About 46.5% of women and 45% of men who start as freshmen in engineering graduate in engineering. Of those, 40% of the women and 36% of the men who graduate do so in four years. 90.3% of the women and 93.3% of the men who graduate do so within five years. In general, women graduate sooner, but men catch up at five and six years. Women starting in engineering graduate from the university at higher rates than men starting in engineering (76.8% for women versus 63.3% for men).

It is important to understand that the tracking system does not monitor students in "real-time." Rather it establishes and documents historical data. It groups students and shows trends and patterns in enrollment. However, it in no way replaces the day-to-day or term-by-term data analysis to monitor progress of individual students. In addition, these data tell us very little about why the patterns are the way they are. Further study should include interviews and other methods of obtaining subjective information.

While the data are useful, they have limited context without knowing how students progress at like institutions. For example, it would be extremely beneficial for us to compare the same information with University of California - Davis, whose engineering college is quite similar in size to that at the University of Colorado at Boulder. However, resources are not available to analyze their data to this degree for comparison purposes.

OTHER ANALYSES AND RESULTS

In addition to what is reported here, we have determined that of all students who start as freshmen in engineering, women who graduate from engineering are overrepresented in the group of students with graduating gpa's of 3.0 and above. However, these same women enter with SAT math scores about 30 points below the men in the same range of gpa's. We have also made a rough estimation and prediction of the probabilities that individual students will pass Calculus 1, based on their SAT math scores (or equivalent ACT scores). Finally, we have also begun to analyze major change patterns within the college.

In addition to analysis of students who enter as freshmen, we have also determined retention and graduation rates for transfer students and intra-university transfer students.

FUTURE WORK

Updates are planned once or twice a year. No further analyses are planned at this time for the College of Engineering. However, the Women in Engineering Program will continue to track women to determine if there are any enrollment patterns of concern.

CONCLUSIONS

The Women in Engineering Program developed a comprehensive tracking system to monitor undergraduate student enrollment at the University of Colorado at Boulder, College of Engineering and Applied Science. College staff and administrators now have enrollment, retention, academic performance, and graduation data, with which to conduct planning, recruiting, intervention, and fundraising. This database of historical student information can be updated regularly and queried anytime to understand more about student enrollment at CU-Boulder.

THANKS

Many thanks for Drs. Lou McClelland and Ephraim Schechter of the Student Affairs Research Services Department at the University of Colorado at Boulder.