

Grade-Point Average, Changes of Major, and Majors Selected by Students Leaving Engineering

Matthew W. Ohland¹, Guili Zhang², Brian Thorndyke³, and Timothy J. Anderson⁴

Abstract - Graduation success, grade-point average, and destination major of ten cohorts of students matriculating and subsequently leaving undergraduate engineering programs at nine southeastern universities are studied from 1987-2002. Grade point averages are frozen at the time students leave engineering to investigate the role of grades in their decision to leave engineering and their choice of a destination major. This study adds to evidence indicating that poor performance is not the primary reason students leave engineering. Students leaving with low grades most likely select business, students with high grades more likely choose natural science majors and, interestingly, 10 to 20% at all performance levels choose education or a social science. The study also found that 10 to 15% of the students leaving engineering at all performance levels changed majors at least a second time before graduating, suggesting that changing majors is, for some, a journey of exploration rather than a matter of settling for one's second choice.

Index Terms - Advising, Change of Major, Longitudinal Study, Retention.

THE PROBLEM UNDER STUDY AND THE DATABASE USED TO STUDY IT

The goal of academic advisers is to guide students to identify a field of study in which they can succeed and which will lead to a career that they find fulfilling. Professional advisers are faced with confounding influences that can cause a student to choose a major that will not satisfy both of these objectives. This paper describes the first of a series of studies that are planned to investigate some of these influences through the longitudinal study of student records. Specifically, this work lays the groundwork for the study of the influence of state-sponsored scholarships (e.g., Bright Futures in Florida and Hope Scholarships in Georgia) on the academic choices of students.

A U.S. Department of Education (DOE) longitudinal study of undergraduate engineering programs reports that only 8.5 % of the students who leave engineering do so because of grades below C.[1] This DOE study points to poor teaching as a leading reason students leave engineering (98% cite this as one of the reasons). To make a compelling argument to

engineering education faculty, the results of the DOE study must be independently replicated.

The Southeastern University and College Coalition for Engineering Education (SUCCEED) longitudinal database (LDB), which is 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.[2-14]

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 measures. All are doctoral-granting state-sponsored universities. Institutional diversity provides sufficient variation to study a wide variety of policies affecting advising and retention, including the effect of state-sponsored scholarships—Florida, Georgia, and South Carolina (home to five of the nine SUCCEED institutions) have state-based scholarship support, while North Carolina and Virginia (four of the nine institutions) do not.

Engineering Workforce Commission [15, 16] data show that SUCCEED schools enroll over 28,000 engineering undergraduates, 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 Blacks; this sample size helps ensure that the results can be applied to other institutions. Summary statistics comparing the participating institutions to national averages are available elsewhere.[2]

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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.

Further, FTIC undergraduate students are only included in the study if they remained at the University, changing their major from engineering to another major. Students who drop out, stop out, or transfer to another college or university (~30% of matriculated students) are lost to this study. As a result, the model developed in this work does not apply to all students— applies only to those remaining at the university when they leave engineering. Policy changes implemented as a result of this study may change the character of the population under study if a significant number of students remain at the university who would previously have left the university when they left engineering. Since this would be a positive result, it is not a significant concern at this time.

This study focuses on six-year graduation in a non-engineering discipline as one of its outcomes. Since the last set of graduation data included in this study are for 2002, only the 1993-1996 Georgia Tech cohorts are affected by a state-sponsored scholarship program. As the study develops, those cohorts will be deleted from the baseline study to properly separate the effect of scholarship-driven academic strategizing.

In this study, graduation status has three possible outcomes: graduation in the first non-engineering discipline to which a student changes, graduation in another non-engineering discipline (different from the first non-engineering major to which a student changed), and failure to graduate in any discipline within six years.

Cumulative GPA at the time of major change was defined as students' cumulative GPA at the completion of the semester prior to the change of major to a non-engineering discipline. Students were divided into eight equal-ranged groupings of cumulative GPA (by half points): 0.0-0.50, 0.51-1.00, 1.01-1.50, 1.51-2.00, 2.01-2.50, 2.51-3.00, 3.01-3.50, 3.51-4.00. The success of students within each cumulative GPA group was examined and compared across groups.

Since data for the cohorts from 1987 to 1996 are aggregated, each graph summarizes the collective behavior of tens of thousands of students. Cohort differences were not examined due to the focus of establishing a baseline that represents a longitudinal average of conditions prior to the introduction of state-sponsored scholarships. Cohort differences will be studied subsequently to ascertain if any trend was present in the baseline data that might suggest changes taking place before the introduction of the scholarship programs.

When the relative rates at which students change into various non-engineering majors are studied, the analysis is limited to those majors that attract at least 5% of the students leaving engineering.

Where is the Time Dimension of the Data?

Since the data for multiple cohorts are aggregated, the graphs do not show any time variation. This deserves special

mention, because many of those who have viewed this data attempt to read the data as a time series, because displays of cohort performance data are commonly viewed in that sense. In all cases, the abscissa variable is the GPA grouping, and each data point represents the behavior of a group of students leaving engineering for another major. Some of those students will have left after their first semester, while some may have left after four or more semesters. Since a substantial body of literature indicates that most attrition occurs within the first two years (half in the freshman year alone), students leaving in this time frame dominate the study.[17]

The GPA of Students Leaving Engineering

It is easier for engineering educators to assume that students leave engineering in large numbers because they are not able to succeed, especially when the alternative is acknowledging Adelman's conclusion that poor teaching is the most common reason.[1] Figure 1 shows that many leave with passing GPAs, and a significant number with GPAs above 3.0.

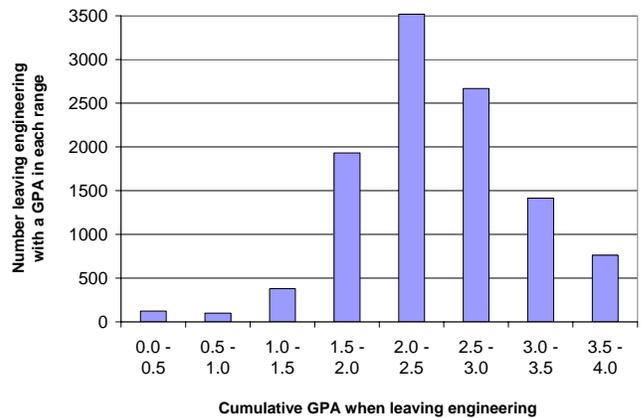


FIGURE 1
GPA OF STUDENTS CHANGING MAJORS FROM ENGINEERING (N=10,900).

Recall that the population under study excludes students who leave the university. Since many students at the low extreme of GPA are forced to withdraw, the population definition restricts the range of the data at low GPA. The small number of students with GPA < 1.0 results in erratic percentages, so the two lowest ranges have been omitted in later graphs.

The distribution of GPA for sophomores remaining in engineering is about ½ point higher in GPA. To compare the grades of students continuing in engineering to those leaving requires cohort analysis. A more comprehensive study of the grades of students leaving engineering will be possible with the addition of complete transcript information to the data set.[2] This will allow the study of how the grades students earn in specific courses affect their choice of major.

Institutional Differences

The factor most affecting the manner in which engineering students are advised is whether engineering students matriculate to a general program for all engineering majors (Clemson, Florida, FAMU, FSU, and Virginia Tech for this

study) or matriculate directly to a degree-granting engineering major (Georgia Tech and the North Carolina schools). This study does not analyze differences in the observed outcomes according to this factor, but focuses on broader patterns that emerge from the entire population.

WHAT MAJORS DO STUDENTS CHOOSE WHEN THEY LEAVE ENGINEERING?

Figure 2 shows a relationship between the major a student chooses when leaving engineering and their grade-point average prior to changing their major. Specifically, students with lower GPA's (< 2.5) are more likely to change into a business major. At higher GPA's, students are more likely to change into a physical science major (the breakdown of these majors is shown in Figure 4). A more interesting result is that education and the social sciences draw 10 to 15% of students in all ranges of GPA. In all categories of GPA, majors receiving fewer than 5% of the total population of students leaving engineering (not included in displayed groupings) account for a total of 25 to 30% of the population.

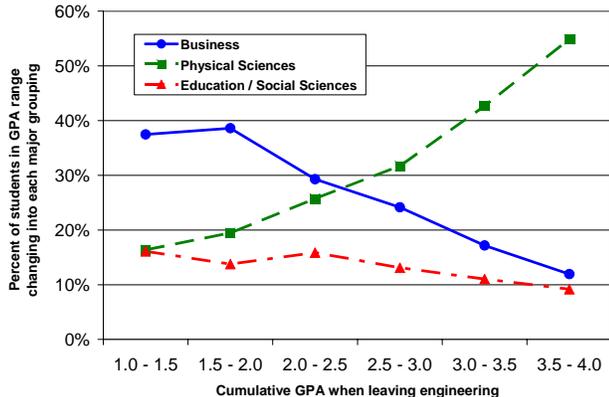


FIGURE 2
GPA WHEN LEAVING ENGINEERING IS RELATED TO CHOICE OF MAJOR.

Students Choosing Education and the Social Sciences

It is hypothesized that the reason the fraction of students leaving engineering that change majors to education and the social sciences is not strongly related to the GPA of the students leaving engineering (as shown in Figure 2) is that the students choosing these majors do so primarily because of a “calling.” While this is consistent with anecdotal evidence from discussions that both faculty and professional advisers have had with students, a more formal qualitative study would be required to clearly establish this connection. If qualitative study confirms this conclusion, the result has implications for funding programs that seek to guide engineering students into careers in science or math education.[e.g. 18] First, the result suggests there may be a ceiling on the number of students leaving engineering who will be called to education and the social sciences, thus providing information as to the ultimate effectiveness of such strategies. It might also be inferred that there may be a similar percentage of students called to education and the social sciences among those who *remain* in

engineering. While qualitative study is needed to confirm this, this would be valuable information for programs that seek to engage engineering students in educational pursuits [e.g., 19-22]

The Trade-Off between Business and Physical Sciences

The reduction in students changing into business majors at high GPA is offset by the gain in students changing into physical science majors in what is essentially a zero-sum situation. The most likely explanations of this observed trade-off are:

1. Students with lower GPA's are having trouble specifically with the mathematics and science courses required in the curricula of the physical sciences, so students with lower GPA's avoid those majors.
2. Students with lower GPA's have a better chance of success in business than in other majors.

The former reason will be explored when transcript data are available.[2] Regardless if the former reason is true, there must still be something about business that sets it apart from other majors that do not require the same level of physical and mathematical sciences in their curricula, so the latter reason must have some influence. A review of the career interest codes (Holland types) typically reported by engineers certainly indicates overlap, but does not consistently corroborate a relationship between those codes and the codes reported by those in business.[23] Anecdotal data from General Engineering advisers at Clemson indicate that one motivator is the perceived earning potential associated with a degree in business, but further study would be required to clarify that relationship. Even without knowing the underlying motivation on the part of the students, it is possible to explore the relative success of students in each of the degree program groupings shown. Figure 3 shows that students who leave engineering with a GPA below 3.0 and choose a business major are 10 to 15% more likely to graduate than students in the same range of GPA who choose the physical sciences. This difference is not observed for students with a GPA above 3.0.

While faculty in engineering and the physical sciences may wish to assume these results imply that business majors are “easier,” many alternative explanations exist—students may be more motivated in business, business faculty may be better educators, the preference for analysis that led to the students' initial choice of engineering may give them an “edge” over their counterparts who did not start in engineering when taking certain business classes. Qualitative study is again needed to investigate this relationship.

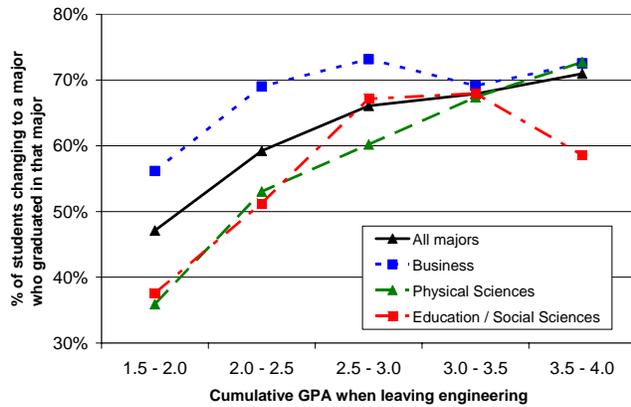


FIGURE 3
GRADUATION RATES IN VARIOUS NON-ENGINEERING MAJORS.

The Distribution Among the Physical Sciences

The distribution of choices of major among the physical sciences is shown in Figure 4. The relatively high percentage of students choosing computer and information systems is likely a result of the “boom” era of such professional opportunities in the time period of the study. The other sciences tend to have similar characters—attracting a larger share students from among students with higher GPA’s when leaving engineering—with the noted exception of natural resources majors. As with the other majors, “natural resources” is a grouping of majors that have similar names and program objectives. The fraction of students choosing the natural resources majors shows a trend similar to that of the education and social sciences in Figure 2—a small but fairly consistent fraction of students leaving engineering choose these fields, regardless of their GPA when they leave. This suggests that, for the institutions participating in the study, natural resources is in some way more like a social science than a physical science.

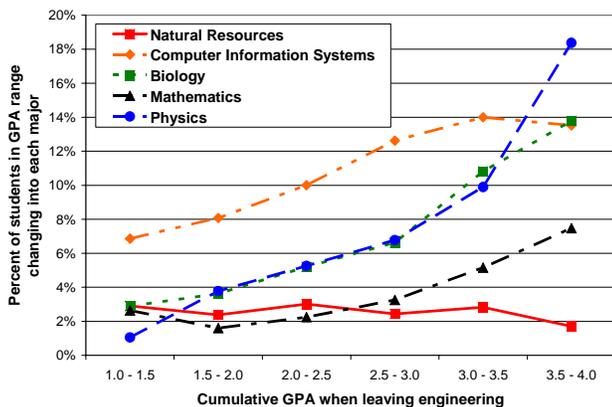


FIGURE 4
THE DISTRIBUTION OF MAJORS CHOSEN IN THE PHYSICAL SCIENCES.

Given the earlier hypothesis, this would suggest that students also select natural resources because of a “calling,” likely among students who are eager to invest their careers in preserving the environment. Here again, qualitative study

would help to clarify this relationship, which has implications for the advising of students who are interested in these majors.

WHEN STUDENTS LEAVE ENGINEERING, HOW LIKELY ARE THEY TO GRADUATE?

This part of the study identifies the graduation outcome of the students in each range of GPA. Three outcomes were defined earlier:

- The student will graduate within six years in the first major to which they change;
- The student will graduate within six years after changing majors at least twice; or
- The student does not graduate within six years in any major. (This includes students who disappear from the database after changing majors.)

The distributions of these outcomes in each range of GPA are shown in Figure 5.

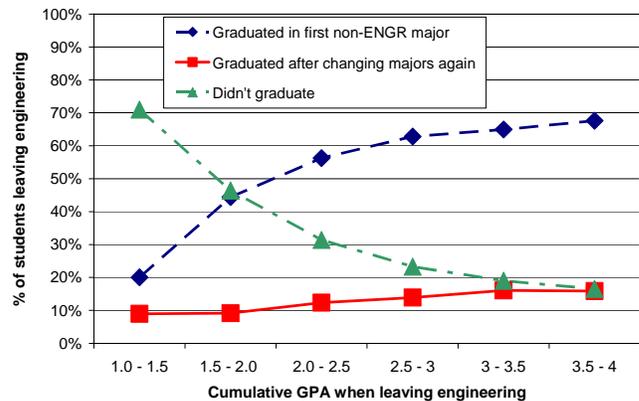


FIGURE 5
GRADUATION OUTCOMES FOR STUDENTS LEAVING ENGINEERING.

For each student leaving engineering, only one of these three outcomes is possible, so the total of the values of the three curves in a single range of GPA must total 100%. It is again noted that there is no time dependence in the results shown in Figure 5. Not surprisingly, students with low GPA’s are more likely to have the “did not graduate” outcome.

It is no surprise that students with GPA’s below 2.0 are much less likely to graduate after leaving engineering—institutions require that performance level. This is the foundation for the well-known relationship between a student’s freshman GPA and their likelihood of graduation. What is notable is that the likelihood of graduation is strongly connected to GPA at lower levels of GPA, but the connection is much weaker for higher GPA’s.

The interesting observation here is that, *regardless of GPA when leaving engineering*, 10 to 15% of the students leaving engineering will change majors at least once more before graduating.

Not All Who Wander Are Lost

The result in Figure 5 suggests that 10 to 15% of the students who start in engineering are searching for a journey more than

a destination. While advisers have long understood that exploration is one of the objectives of the college experience, it is not unusual for advising centers to be pressured to “correctly place” all the students in their charge, and advising assessment is sometimes linked to how many students are placed in the correct major. This thinking presumes that all students have a “proper destination” if only they can be pointed in the right direction; the results from Figure 5 suggest otherwise. By being able to quantify the fraction of students who are bound to wander, it is possible to at least estimate how many students we cannot expect to place correctly in the right major. This evidence is a powerful reminder that taking time to select a major is not a sign of academic weakness.

PLANS FOR FURTHER ANALYSIS

Multi-category logistic regression has been used to determine if a relationship exists between cumulative GPA and students’ choice of discipline when leaving engineering. The association between students’ graduation likelihood and their cumulative GPA at the time of major change is also being modeled. These results will be reported elsewhere due to space limitations.

Additional quantitative and qualitative studies are suggested above where clarification of certain relationships is necessary or desirable. Beyond these studies, those who have reviewed this work have suggested a number of ways in which this research might be extended. Professional advisers thought it would be useful to know how these results compare to what happens to students who matriculate into other majors. Since a study from that perspective would also aid the interpretation of the data from this study, it is a logical follow-up to this work. We will also look at the time distribution of when students leave engineering.

We are also interested in the gender dependence of the study results. It would be revealing to review the differences in the choices that female and male students make.

CONCLUSIONS AND RECOMMENDATIONS

This study provides valuable information for proponents of retention efforts, who must convince faculty that the additional students who are retained are of similar quality to those who would be retained without intervention. While the hope that these results will help engineering faculty better understand their students is appealing, these results have value beyond contributing to the ongoing discourse in engineering faculty development. Understanding more about the percentage of engineering students who change majors to business and studying the forces that cause them to do so suggests a stronger role for engineering-business curriculum partnerships. Advisers will find these results useful in better understanding their students and the choices they make, and thus be better equipped to advise them. Possibly more important, these results will help advisers of engineering students explain their role to mainstream engineering faculty. Funding agency policy makers will be particularly interested to learn more about the number of students leaving engineering who choose majors in education or social science.

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