AC 2011-2517: CONSIDERATION OF HAPPENSTANCE THEORY IN MAJOR SELECTION AND MIGRATION IN A LARGE ENGINEERING PROGRAM

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Consideration of Happenstance Theory in Major Selection and Migration in a Large Engineering Program

Abstract

Approximately 1,000 second-semester engineering students, all of whom were admitted into a first-year program as General Engineering students, were surveyed to determine their initial interest in 14 different available engineering majors, their major choice, certainty of choice, and the information sources they valued for choosing an engineering major. Data showed that initially students were considering over three different majors on average, with women being more undecided than men. Approximately 6% of students were initially completely undecided about choice of engineering major. Even after major selection, there is an uncertainty that the proper choice has been made, but analysis of internal transfers within engineering indicate that after students choose a major they generally stay in that major or leave engineering. This effect is believed to be due to the system that allows students a minimum of one semester to consider the different options before making a choice. The system is designed so that the students are exposed to multiple sources of information, consistent with indications from happenstance theory regarding a successful outcome in making a decision on major. Highly valued information sources when choosing an engineering major include family, friends, other students, departmental information sessions, and departmental websites. Less valued sources include textbook readings, hands-on course projects, and instructors. There were also gender differences in value of sources, with women valuing departmental information sessions more than men, and men valuing departmental websites more than women. Overall the process of major selection correlates well with the happenstance theory of Krumboltz[1].

Introduction

A large engineering program is structured so that all entering freshmen are admitted as General Engineering (GE) majors. Approximately 1300-1600 students enter the program each year and are required to take courses in English, chemistry, mathematics, engineering, and physics before transferring to a degree-granting program. As a part of the first-year engineering courses the students are required to read about different engineering majors and attend special “open house” evening sessions hosted by the degree-granting programs, and they are encouraged to consult with other individuals including students, family members, and other acquaintances who are engineers. The findings in this paper are the result of an assessment to determine the sources of information students value in choosing a major. Data on internal transfers within the College of Engineering (College) is also considered.

Background

The College has 11 degree-granting departments that offer a total of 13 different Bachelor of Science degrees. In addition, a School of Construction, a joint organization between the College of Engineering and the College of Architecture and Urban Studies, offers a BS degree in Construction Engineering and Management. From the student point of view, a choice must be made from a total of 14 BS degrees offered by 12 degree-granting units. The degree-granting units and degrees offered are:

- Aerospace and Ocean Engineering: Aerospace Engineering (AE) and Ocean Engineering (OE)
- Department of Biological Systems Engineering: Biological Systems Engineering (BSE)
- Chemical Engineering Department: Chemical Engineering (ChE)
- Department of Civil and Environmental Engineering: Civil Engineering (CE)
- Department of Electrical and Computer Engineering: Computer Engineering (CpE) and Electrical Engineering (EE)
- Department of Computer Science: Computer Science (CS)
- School of Construction: Construction Engineering and Management (CEM)
- Department of Engineering Science and Mechanics: Engineering Science and Mechanics (ESM)
- Department of Industrial and Systems Engineering: Industrial and Systems Engineering (ISE)
- Materials Science and Engineering Department: Materials Science and Engineering (MSE)
- Mechanical Engineering Department: Mechanical Engineering (ME)
- Department of Mining and Minerals Engineering: Mining Engineering (MinE)

All first-year engineering students are admitted as General Engineering (GE) students. GE is not an undergraduate degree-granting program, so all students are required to change majors at least once. The faculty and staff of the initial department teach first-year engineering courses and provide academic advice to GE students until they are eligible to transfer into a degree-granting program of their choice. A complete list of requirements to transfer to the degree-granting departments (effective Fall 2008, with some changes made in Fall 2009) is included as Appendix A. The number of semesters it takes for students to complete the transfer requirements varies from one student to another and can actually take more than two years. The exception to this process is that if a student is on the Dean's List (GPA of 3.4 or better) during their first semester, they are offered the opportunity to choose a major at that point. In this case, the same courses and GPA requirements apply, as shown in Appendix A. Typically about half of the Dean's List students choose to select a major at that time, with the other half waiting until the middle of Spring Semester. Even at the middle of Spring Semester some students are not ready to choose a major and defer until later. This model of first-year engineering programs is not unique. In fact Brannan and Wankat[2] reported that 17 of 99 responses to a survey indicated that there was a dedicated first-year program in operation.

A number of activities and assignments are designed to assist students with gathering the information they need to choose a major, including:

- When students take the first engineering course, normally during their first semester as GE students, they are assigned reading from the textbook about the different fields of engineering.
- In the Fall Semester each department presents an Information Session in the evening to give interested students information about their degree program(s). There are thus 13 of these sessions, all on different evenings (since they are offered from the same department, AE/OE and CpE/EE are offered together), including one for the Green Engineering Minor. Students are encouraged to attend at least four information sessions by making attendance a homework grade in the engineering course. The Student Engineers Council normally hosts a 14th session, a mixer with students from all disciplines present.

- Students in the first engineering course work on a number of hands-on projects that deal with designing and building devices and/or computer programs for analysis of systems that are common in various engineering disciplines. The faculty believe that the students gain information on majors that are of interest to them from working on the projects.
- Before Spring Break students are sent an e-mail telling them that they will be choosing a major shortly after the break and suggesting that they consult with their family and other sources as they begin to make the decision.

At approximately the middle of the Spring Semester, GE students are asked to select the engineering degree program they want to enter when they have completed the requirements to enter the program. For a number of years there has been anecdotal evidence that some students are still somewhat undecided about what major to choose and that they want more information, which they can get from their faculty advisor and also from other sources. There is no data that indicates whether this indecision leads students to change majors later on. However, there are a relatively small number of internal transfers in the College with students moving from one engineering major to another.

Research questions

The purpose of this study was to provide data that could be used to determine if additional information on majors in the College needs to be provided, what that information might be, and if there are potential opportunities to provide valuable information that are currently being missed. Information on majors originally considered by students and how firm they are in their choice of major was gathered, as well as information on internal transfers, which indicate a poor choice of current major. The questions to be answered are:

- For new engineering students, in which majors were they originally interested?
- Does the current first year engineering program, consisting of introductory courses and information sessions for each engineering major, provide sufficient guidance to new engineering students to aid them in selecting a major with which they are ultimately satisfied?
- Of the information sources provided (assigned readings, course projects, instructor, graduate teaching assistants) which did GE students value in choosing a major?
- What other factors or people (e.g. family, friends, work experiences) assist students in choosing a major, and how are these factors valued in the decision-making process?
- Are Dean's List students who select a major after one semester more certain of their choice than other students who choose a major approximately eight weeks later?
- Are there discernable patterns of internal student migration within the College of Engineering?
- Are the data supportive of the happenstance theory of Krumboltz?

Review of the Literature

There is a considerable literature on how students choose, generally while in high school, to study (or not to study) any of the STEM (science, mathematics, technology, engineering) majors. The participants in the current study, however, have already chosen to study engineering and entered the GE program, so the focus of this article is how General Engineering students choose

from a number of different engineering programs, and how they subsequently migrate within a large college of engineering.

Adelman[3], based on an 11-year (1982-1993) study of college student transcripts, noted that of students who completed baccalaureate degrees before age 30, 16% entered college with no particular degree in mind, and only 42% of the balance earned a degree in their initial intention. He thus concluded that there is considerable migration within an institution and that this migration is a result of different factors that initially led students to their choice of major. He further concludes that of the most capable students there is no difference in completion rates between women and men and that the persistence to graduation of those students who reach the "threshold" (defined as completing entry-level courses) in engineering are higher than in most other fields. Adelman (op cit) defines "curricular momentum" as a phenomenon that begins in high school and carries through into college and is related to academic success in required courses within a curriculum. Adelman (op cit) reports that among men and women who indicated engineering/architecture as their intended field, 54.3% of men and 21.3% of women earned bachelor's degrees in their intended field. He also shows that engineering attracts a relatively high percentage of students who have a constant vision of their career goals and a low percentage of students who have a constantly changing vision.

Kroc, et al[4] considered graduation rates across university curricula using data for 130,000 students from 44 universities. They considered graduation rates as a function of major, noting trends in transfers between majors, considering in-migrants, or those who transfer into engineering from another field and out-migrants, engineering students who transfer out of engineering to another field. The concept of "swirling" was introduced to quantify major changes where

$$swirling = \frac{(\text{number of out} - \text{migrants}) + (\text{number of in} - \text{migrants})}{\text{number who graduated from the same program they entered}}$$

and further point out that engineering had the least amount of swirling and liberal arts and social sciences had the most. In their context the "program" is engineering, where in this paper "program" refers to a specific program within engineering. One other result of their study was that students who entered as undecided were as likely to graduate as any other student. This result is contrary to some strongly-held beliefs among engineering faculty. Another finding was that while graduation rates varied from one university to another, within a university graduation rates did not vary significantly from program to program.

While there is an enormous literature on why students choose engineering or one of the STEM fields, there is not much other than raw data on migration of students within engineering. Walden and Foor[5] examined migration into and within engineering by interviewing students within an industrial engineering (IE) program. A significant proportion (24 of 52) had previously been in another major, including 3 who were previously enrolled in non-STEM majors. They quote Seymour and Hewitt[6] that 10.5% of engineering students had "internally relocated" to another engineering major, while 51.4% were still enrolled in their original major in engineering. The data for the Oklahoma University cohorts 1996-2000[5] indicated that 25% of students were "internal resettlers" (IRs) compared to one sixth in the Seymour and Hewitt data. Significant among the reasons for the IRs in the Walden & Foor study was the perceived existence of

"weed-out" or "barrier" courses that students believed were "harder than they had to be." Some of the "push" for relocations were due to enrollment management (minimum grade point averages) required to move into upper division courses in some engineering majors, although most of the relocations were not mandatory. Two thirds of the relocators expressed having difficulty with course(s) or faculty member(s) in the original department. Both male and female relocators related negative encounters with faculty from the original department as the reason for the change. The "pull" for relocating to IE included formal and informal departmental recruiting and individuals who worked to create a welcoming environment. Of the 24 IRs, 16 reported learning about IE from a "third party individual." A significant portion of those individuals were friends or acquaintances who were enrolled in the IE major, although others were not IE students and included parents and others with knowledge of careers available to IE graduates.

Ohland, et al[7] considered persistence and migration in engineering programs using data from several sources. They also concluded that engineering has the highest rate of persistence and the lowest rate of inward migration. They noted the low percentage of women, but concluded in other aspects engineering students were demographically similar to students in other majors. They found that all students disengage to some extent over time and that the non-persisters disengaged earlier than the persisters. As with most other studies in the literature, there was no consideration given to how students selected a particular engineering major or subsequent migration within engineering.

Lichtenstein, et al[8] studied the post-graduation intentions of engineering students and found that a significant percentage was undecided on whether to actually practice engineering after graduation while somewhat smaller, but still significant, percentage had no intention of practicing engineering. They mention "the quixotic nature of many students' decisions about their careers" and also the importance of chance events in career decisions. They report

> *… during the span of students' tenure as undergraduates, their thoughts about career options were strongly swayed—we could even say disproportionately swayed—by a single experience, such as an internship, interaction with faculty or even staff, or advice from a mentor. The movement could be in either direction.*

The importance of "third party individuals" in major decisions is reinforced by Degiorgi et al[9] who found that for students studying at a business school in Italy there was a significant peer effect on major choice. Furthermore, the peer effect led students to choose majors for which they were not well matched, resulting in predictions of long-term negative economic effects for the students. This peer effect is consistent with the Oklahoma University findings. Moreover, the fact that peer groups are generally formed by chance underscores the relevance of happenstance theory in not only major selection but also career choice after the degree is earned.

While there is not a large literature on initial major selection and internal transfers within engineering, summary of the previously discussed sources includes:

- There are significant numbers of internal transfers within engineering, possibly up to 25%
- The "push" for transfer may come from academic difficulties, personal dissatisfaction, conflicts with instructors, and perception of "weed out" courses
- The "pull" for transfer may come from departmental recruiting, welcoming environments, or information provided outside the official communications of the department

- Peers play a significant role in providing information that results in both initial major selection and possible internal relocation.

There is a substantial literature and body of research on academic and career advising, with the consensus being that assisting students with choice of major falls under the category of career counseling, although in practice this function is generally performed by people who would describe themselves as an "academic advisor". In the literature there are many theoretical frameworks, and we have chosen to examine happenstance theory, believing that if our data correlate with that theory we can use the other tenets of happenstance theory to design better interventions to help students choose majors where they will be successful and that they can use as the basis for a successful career.

Happenstance theory[1, 10] follows from the work of Bandura[11] which asserts "chance encounters play a prominent role in shaping the course of human lives". Bandura further states that the outcomes of chance encounters are unpredictable but notes that personality plays a strong role and repeats Pasteur's belief that "chance favors the prepared mind." The key to being able to make good choices is said to be a strong sense of personal agency, which requires self-efficacy and self-regulatory capabilities for exercising self-directedness[11]. The implication is that the educational experience should foster those abilities in students. In a related work, Guindon and Hanna[12] discuss the concept of synchronicity as the "occurrence of a meaningful coincidence in time" in which conditions come together for what may actually be a life-altering experience (such as choosing a college major). In happenstance learning theory[1] it is believed that combinations of chance encounter and planned encounter combine to create opportunities for learning or career choice. The encounters may be a product of structured educational settings, or they may be a product of encounters that, while governed by chance at some level, have been encouraged during structured settings, as pointed out by Mitchell, et al[10] who also point out:

Planned happenstance theory includes two concepts:

a. Exploration generates chance opportunities for increasing quality of life, and
b. Skills enable people to seize opportunities

and further point out that according to planned happenstance theory career counselors should help their clients develop five skills: curiosity, persistence, flexibility, optimism, and risk taking. With regard to the choice of major, it is the responsibility of the teacher/advisor to first prepare the mind of the student to be open to considering different choices and then to create and/or encourage the student to actively seek out opportunities to learn about the options such that "planned happenstance" can occur. Personally, as advisors who have over the years encouraged many students to participate in career interest assessments, we are frustrated because it appears that happenstance theory discourages the use of those surveys because they tend to limit the choices students are willing to consider and may therefore lead students down a poor career path[1].

Methods and Instrumentation

Data for this project was collected using surveys administered at several stages during the first year of college. Since at the time of data gathering approximately half of the Dean's List students were already in a major, two different contact e-mails and two slightly different surveys were used to gather data. The e-mails and surveys are shown in Appendix B. The surveys were piloted

by a group of faculty and graduate students, all of whom were familiar with the first-year courses, most of them having taught in the first-year program. As can be seen from the surveys, the data for students who are still GE was gathered along with data about what major they have chosen to enter when eligible. For data on which major(s) students were initially considering, the question was asked several months after matriculation, which causes concern about the accuracy of that data. Data from the Dean's List students was gathered on a purely voluntary basis. As a consequence the response rate was somewhat low, although typical for survey research. Comparison of pre-matriculation responses in major interest over a number of years indicates that this survey is reliable, with some change from year to year. This is consistent with the cyclic nature of interest in engineering majors[13].

The surveys questioning the value of different sources in choosing a major were deliberately not arranged by the nature of the source. In fact, for our analysis we categorize the sources as Arranged (e.g. in-class assignments, learning communities), Encouraged (e.g. consultation with family), and Random (e.g. other students). It should be noted, however, that whether a particular student has family or acquaintances who are engineers is also happenstance.

Sample and Data Collection

The study's participants were the 248 (out of 465 total, or 53%) Fall 2008 Dean's List students who had already transferred to a degree-granting program who responded to the request for information and the portion of the 1,532 remaining GE students who responded to the survey before the data was pulled for analysis. Of the 248 eligible Dean's List students, 75 (30%) responded. The number of GE students responding before the data pull was 788, although not all students were responsive to all questions.

Results and discussion

Several interesting things should be noted about the data:

- Some GE students responded multiple times, with the following noted:
  - Sometimes the choice of major was different, with major choice changing within a few days
  - Sometimes the list of majors originally being considered was different for the same student, lending additional doubt to the validity of the data on majors they were initially considering.
- Of the GE students, there were responses from 788 individuals (138 women, 650 men). That ratio corresponds roughly to the demographic of the GE group. Not all students were responsive to all questions.
- Of the GE students, 49 (13 women, 36 men) reported that they were initially "completely undecided" about the choice of an engineering major and were considering all 14 available majors.

Results for Dean's List Students

A number of different views of the Dean's List (DL, n=75) student data were created to provide some insight into how the students' intentions changed over the course of a few months, even though they are already in their first choice major.

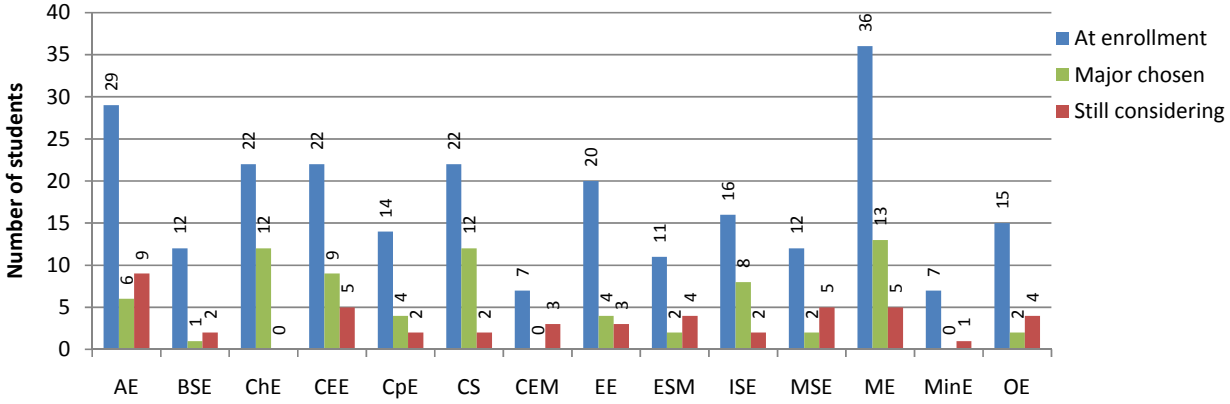

Figure 1: Number of Dean's List students considering various majors at different times (n=75)

Figure 1 shows the number of DL students considering different majors at enrollment, the major they were already in at the time of the survey, and the number of majors still being considered. The last item should be considered as a lack of confidence that they are currently in the correct major. It should be noted that at this point most have not yet taken their first in-major course, so that they cannot be said to have curricular momentum in their selected major and essentially have no curricular momentum in engineering. In addition, the DL students who choose major early have not had the opportunity for as many chance encounters with others as the students who choose a major later.

Figure 2 shows the number of DL students considering different majors on entry. On average, each student was considering 2.89 majors. Of the 75 respondents, 18 of the 22 Dean's List students (82%) who reported they were initially considering only one major actually chose the single major they were initially considering.

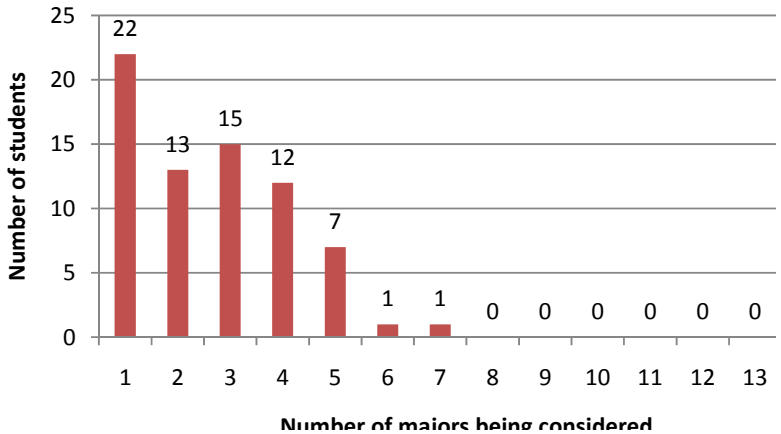

Figure 2: Number of majors originally being considered by DL students (n=75)

Figure 3 shows the number of majors still being considered by DL students who have already been transferred to a major. This data should be considered as a lack of certainty that they have chosen the right major. It appears that almost one third of the DL students who have already been transferred to a major are still not certain they have made the correct choice. The extreme case is an MSE student who is still considering AE, BSE, CpE, CS, and ESM. As previously stated, this lack of certainty can be partially attributed to the fact that most have not yet taken the first in-major course.

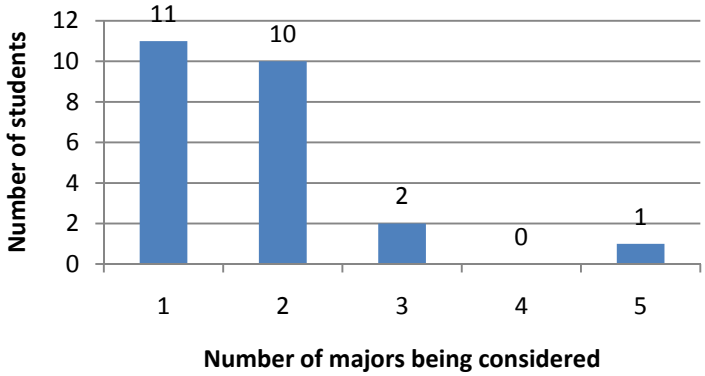

Figure 3: Number of majors still being considered by DL students already in a major

Figure 4 shows information on factors the DL students rated “very helpful”, “somewhat helpful”, and “not helpful” in choosing a major. It appears that the most valued sources were family members, acquaintances who are engineers, other students, departmental websites, and the information sessions. Least valued sources include the readings, course projects, and the course instructors and workshop leaders. It can be seen that the top four “very helpful” sources were either Encouraged or Happenstance. The top four “not helpful” sources were all Arranged.

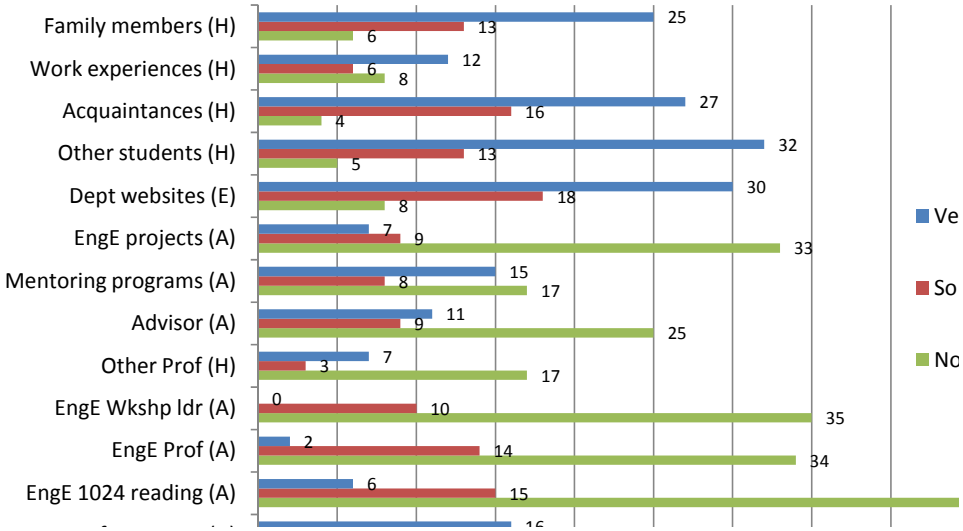

Figure 4: Dean’s List students’ relative value of sources in major choice (n=72)
(A) = Arranged, (E) = Encouraged, (H) = Happenstance

"Other" factors listed as very helpful in choosing a major were previous courses or other experiences in high school, personal interest, classes at another university, an advisor, visiting labs during tours, and summer programs. Personal information was not collected from the DL students, so differences by gender could not be determined for that group.

Results for Students still in GE

A number of different views of the data were created in order to provide some insight into how students' intentions changed over the course of a few months.

Figure 5 shows the number of GE students considering different majors at enrollment, the major they have chosen to enter when eligible, and the number of majors still being considered. The last item should be considered as a lack of confidence that they have chosen the correct major. There are very large decreases in interest for some majors. The data gathered for this evaluation do not permit determination of the factors that might have caused those decreases. In fact, a decrease in interest in one major indicates an increased interest in another major, so without considerable qualitative evidence it would not be possible to determine the reasons for those changes.

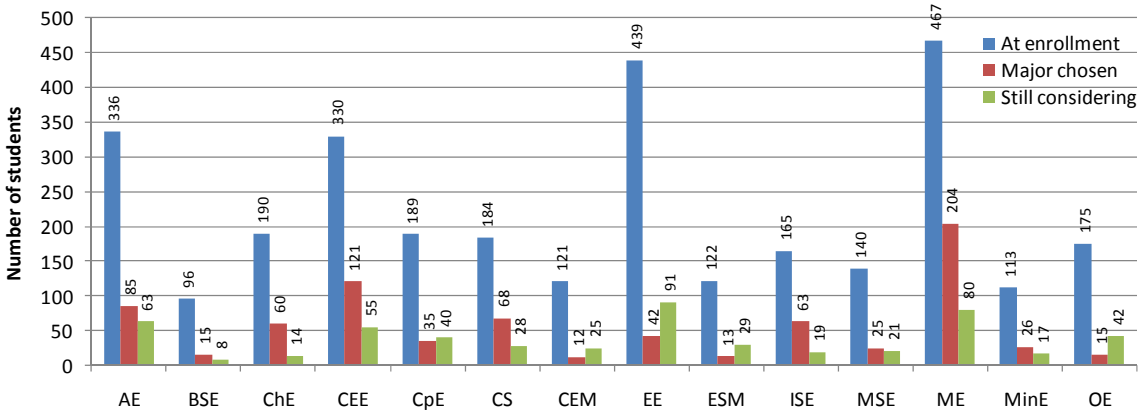

Figure 5: Number of GE students considering various majors at different times (n=788)

Figure 6 shows the number of students considering different majors on entry. On average, each student was considering 3.67 majors. The leftmost bar shows that 111 students (14%) reported considering a single major at first enrollment. Of those 111 students, 93 (84%) actually chose the single major they were initially considering, as shown in Table 1. In some cases the students considering a single major actually chose a major that some would believe is quite "different" from the original choice. Examples include a student who was only considering AE who chose CS and a student only considering CS who chose CE. The rightmost bar shows that 49 students (6%) were completely undecided.

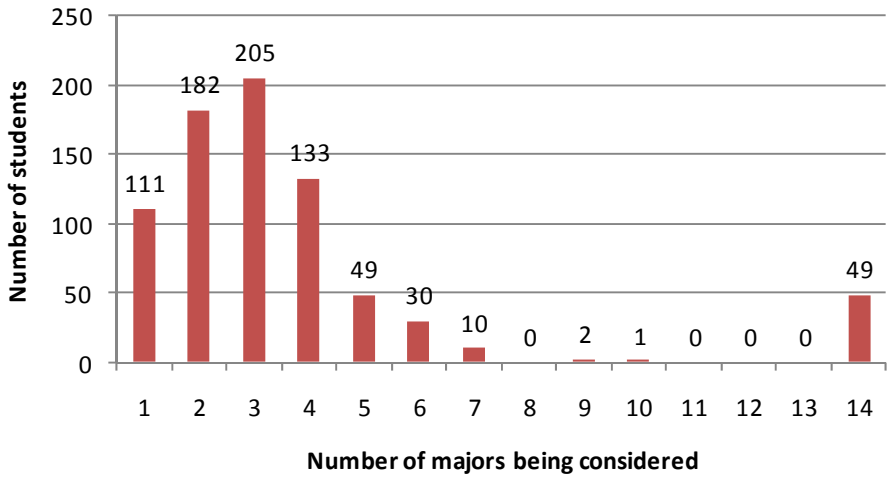

Figure 6: Number of majors initially being considered by current GE students (n=772)

Table 1: GE Students initially considering only one major

Major	Initially considering	Chose that major
AE	18	12
BSE	2	2
CEE	20	14
ChE	12	10
CpE	2	2
CS	14	13
EE	6	6
ESM	1	0
ISE	7	7
ME	25	24
MinE	1	1
MSE	1	1
OE	2	1
TOTAL	110	93

Figure 7 shows the number of majors other than the selected major that some current GE students are considering. From Figure 7 it can be seen that 314 of the 722 students responding (43.5%) are somewhat unsure of their choice. The limiting case is a student who chose ME but is also still considering CEE, CEM, EE, ESM, ISE, MinE, and OE.

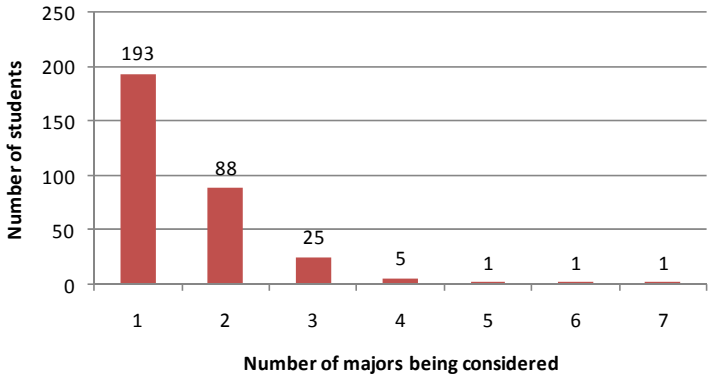

Figure 7: Number of majors other than selected major still being considered by current GE students (n=788)

One of the primary reasons for the current study was to determine the relative value, as reported by the students, of various sources of information with respect to choosing their major. Figure 8 shows responses students rated "very helpful", "somewhat helpful", and "not helpful" for purposes of choosing a major. Valued sources include family members, acquaintances who are engineers, other students, departmental websites, and the information sessions. This group of students also values the readings slightly more than the DL group, but they are still largely negative on the helpfulness of the readings. They also do not value the projects, instructors or the workshop leaders as sources of helpful information. It can be seen that the top four "very helpful" sources were either Encouraged or Happenstance. The top four "not helpful" sources were all Arranged.

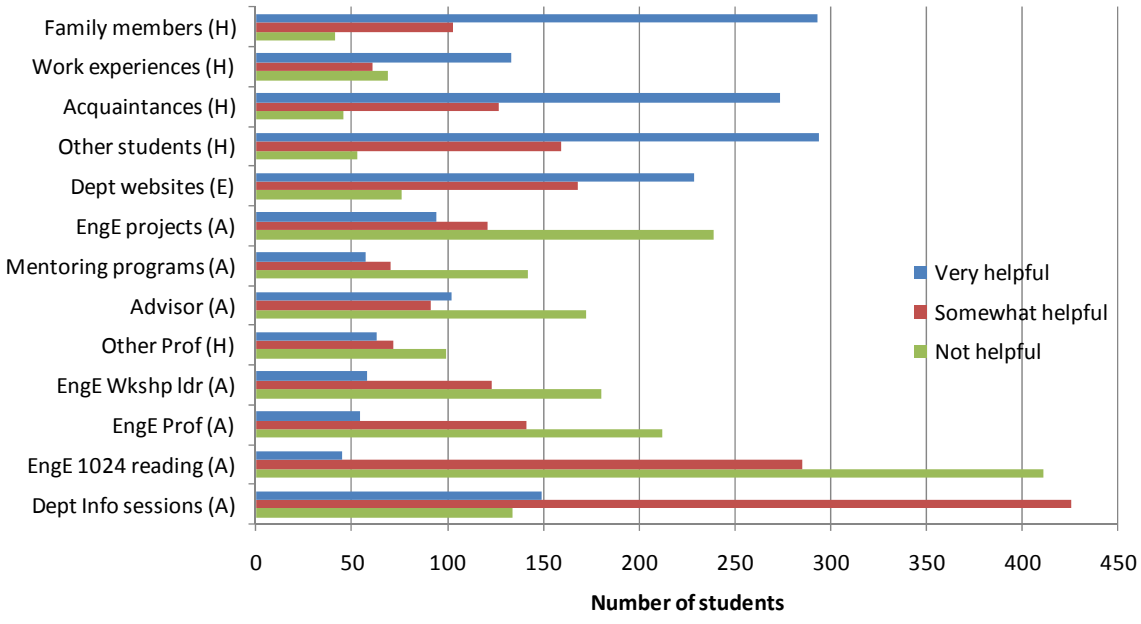

Figure 8: Relative value of sources for purposes of choosing a major for GE students (A) = Arranged, (E) = Encouraged, (H) = Happenstance

"Other" factors listed as very helpful in choosing a major included personal interest, online sources, teachers, graduate students, salary data, friends, lab tours, books, TV, movies, and other events attended.

Although not a part of the survey used to gather this data, it was desired to break the data out by gender. Figure 9 shows data at enrollment and chosen major by gender. Since the numbers of data points for "at enrollment" and "major chosen" are slightly different, it is difficult to draw significant conclusions from the data. As a reference, however, the "at enrollment" responses included 638 (82.5%) men and 134 (17.5%) women, or approximately 4.76 male responses per female response. It is noteworthy that there are very small numbers of women who have chosen certain majors and that female interest in some majors has decreased more than for others.

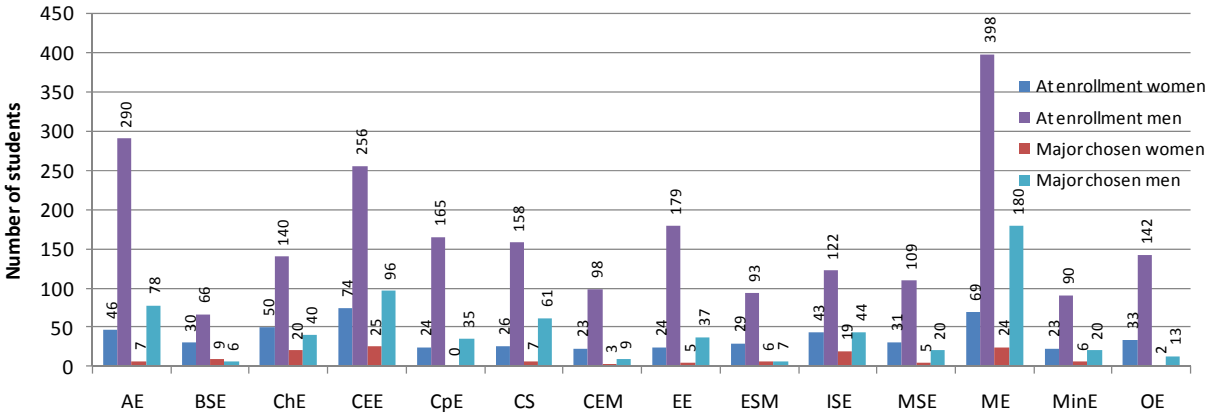

Figure 9: Students considering and choosing major by gender

Figures 10 and 11 present the number of majors initially being considered by women and men, respectively. From comparison of the data, initially women are considering more majors than men (3.58 vs. 2.91), which is also obvious from visual comparison of Figures 10 and 11. Use of a t-test to compare the populations indicates that the gender-based difference in average number of majors under consideration is statistically significant (p=0.023). The indication is that the women are initially more open-minded about major selection and that departments desiring to increase female participation should be encouraged to provide additional information before the decision is actually made.

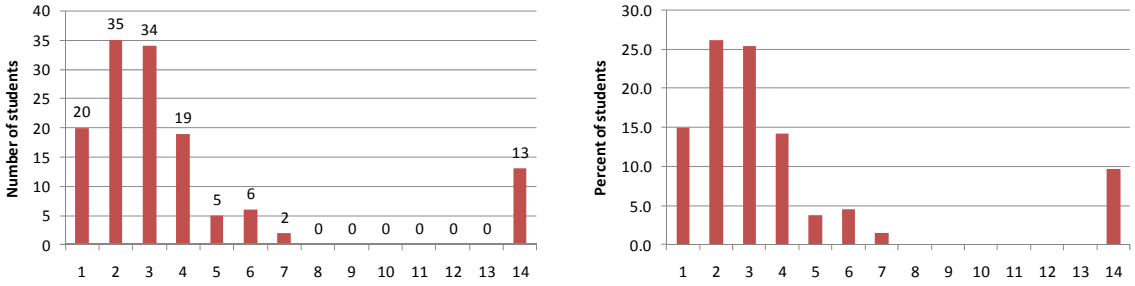

Figure 10: Number of majors initially being considered – women

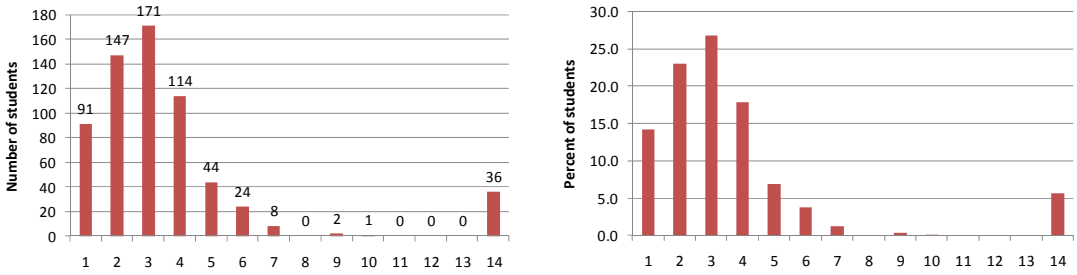

Figure 11: Number of majors initially being considered – men

Figures 12 and 13 show the number of majors still being considered, even though choice of major has been indicated, for women and men, respectively. These data are a measure of the lack of student confidence that they have chosen the correct major. It does not appear that there are significant gender differences, which was confirmed by use of a t-test (p=0.10).

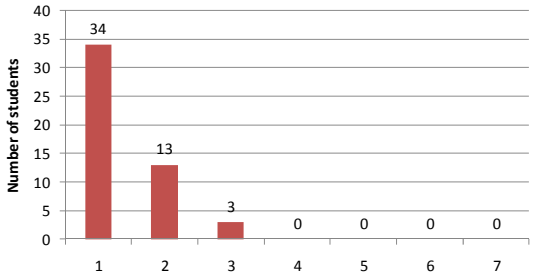

Figure 12: Number of majors still being considered – women

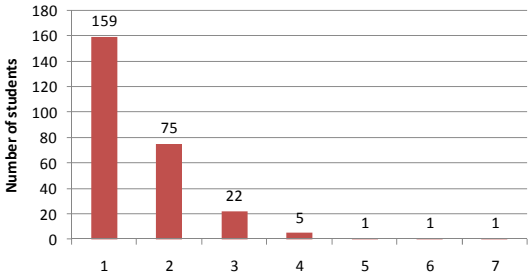

Figure 13: Number of majors still being considered – men

The relative importance of the various factors helpful or not helpful in choosing a major are shown for women and men in Figures 14 and 15, respectively. Visual examination of the graphs indicates that women valued departmental websites, mentoring programs, and the departmental information sessions more than the men. The men valued acquaintances who are engineers and the readings more than the women. Other factors appear to be consistent between the two groups, indicating that improvements in those areas should affect all students somewhat equally. Indication that some information was more helpful to one group than another may only indicate that different types of information were not equally available to the two groups. As an example, active participation in mentoring groups and learning communities may be higher among women than men. Overall, the top four factors were either Happenstance or Encouraged. This is consistent with the results from the Dean's List students.

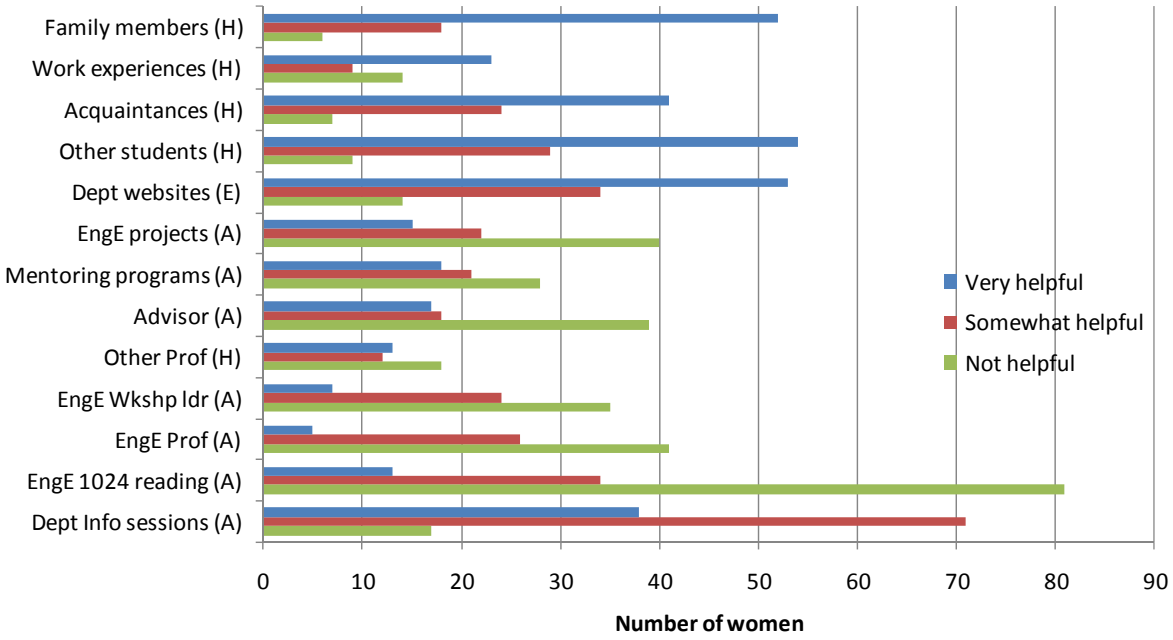

Figure 14: Relative value of sources for purposes of choosing a major for GE women
(A) = Arranged, (E) = Encouraged, (H) = Happenstance

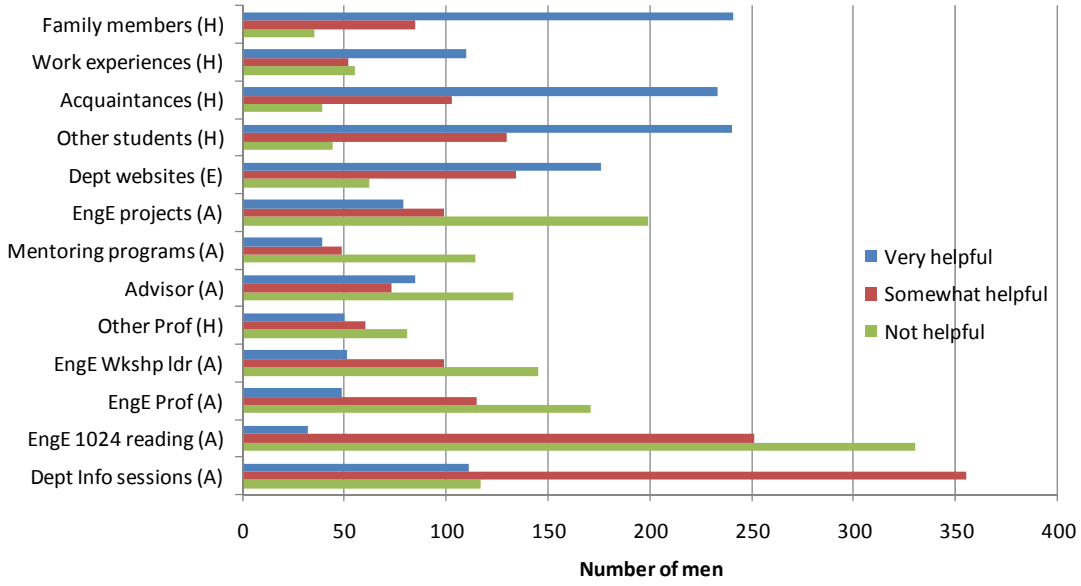

Figure 15: Relative value of sources for purposes of choosing a major for GE men
(A) = Arranged, (E) = Encouraged, (H) = Happenstance

Internal transfers within the College of Engineering

It has been mentioned several times that there are indications that students are not confident at this point that they have chosen the correct major. There are indeed transfers (migration) within the College that are known as “internal transfers.” Analysis of so-called internal transfers for four calendar years (2005-2008) shows an average of 129 internal transfers per year, which is

less than 3.5% of the total number of second, third, and fourth year students in the College per year. Comparison to Figure 7 shows that the number of internal transfers each year is roughly equal to the number of students still considering more than one major in addition to the one they have chosen, although that is probably a coincidence. For this purpose "internal transfer" was defined as a change that resulted in the student's first major being different with the exception that a student changing from BS in one program to BS/MS in the same program was not defined as a change. Figure 16 shows a summary of internal transfers during calendar years 2005-2008. Corresponding to the experience of Walden and Foor (op cit), ISE is seen to have the largest net gain from internal transfers, with CE showing a significant net gain as well. The largest net loss was AE, followed by CpE. EE showed a net gain, with approximately two thirds of that gain due to transfers from CpE. Transfers from ME were primarily to CE (38%) and ISE (27%).

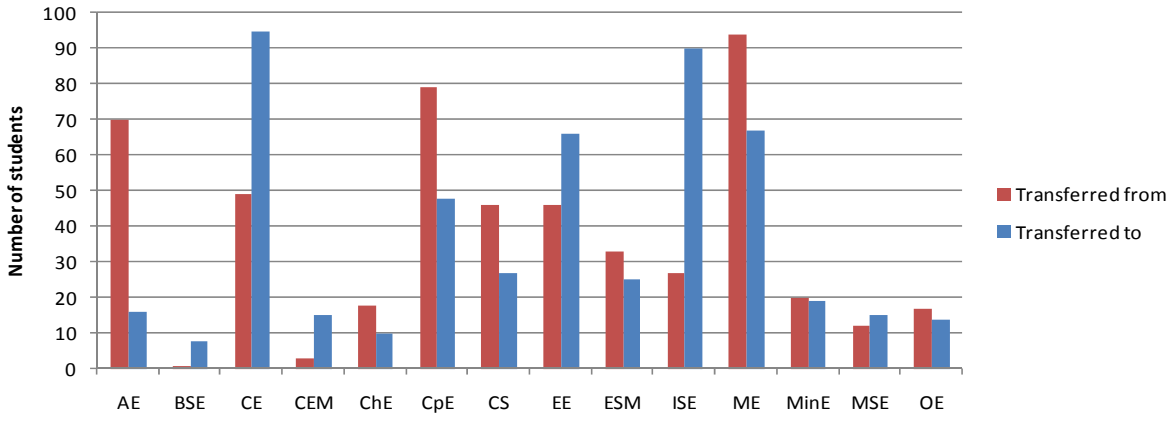

Figure 16: Internal transfers between engineering programs

During calendar years 2005-2008 a total of 23 students did more than one internal transfer. In many cases those multiple major changes were within a department such as transferring from AE to OE or EE to CpE. The conclusion is that once students have chosen a major in the College they usually either stay in that major or transfer out of the College, even if they are not initially confident about their choice. This may be due to the fact that once in a major students quickly develop curricular momentum and are reluctant to change majors. The relatively low number of internal transfers at our university (3.5%) compared to 16% in the Seymour and Hewitt[6] study and the 25% of the Walden and Foor[5] study are believed to be due to the initial enrollment as General Engineering students and the minimum one-semester period before major choice can be made, resulting in a more informed decision. The relatively low number of internal transfers is consistent with the low swirling described by Kroc, et al[4].

Discussion of results and recommendations

The following section presents answers to the questions posed at the beginning of the study and makes suggestions/recommendations as appropriate.

- For new GE students, in which majors were they originally interested?

  Original major interest for DL and GE students (all reported several months after first enrollment) are shown in Figures 1 and 5. DL students who transferred after one semester

reported being initially interested in an average of 2.89 majors, while current GE students were considering 3.67 majors. These data are all suspect since they were gathered so long after first enrollment, and it does not seem appropriate to draw conclusions from the data. Data on major interests should be gathered either before or just at first enrollment.

- Does the current first year program, consisting of introductory courses and information sessions for each engineering major, provide sufficient guidance to new GE students to aid them in selecting a major with which they are ultimately satisfied?

  Dean's List student responses from Figure 3 indicate that 33% of the students already in a major have some doubt that they have chosen the correct major. GE student responses presented in Figure 7 show that 43.5% of GE students who have just selected a major are somewhat unsure of their choice. From these data it appears that the students could use more information. Internal transfer information indicates that a relatively small percentage of students actually change majors within engineering, so the long-term data indicate that a large percentage of students have made the correct choice, although they are initially unsure of the decision. Since motivation, self-image, and self-efficacy have been shown to be significant factors in persistence to degree[14], information that would reduce the uncertainty of major choice should prove to be from a retention and persistence point of view.

- How valuable are the Information Sessions in helping GE students choose a major?

  Based on information from Figures 4 and 8, both DL and GE students valued the information sessions as an information source, with the GE students valuing them more. Since the information sessions are one of the few variables the College has control over, they should remain an important part of the program. The information sessions were valued more by the women than by the men.

- How valuable were the assigned readings in helping GE students choose a major?

  Students do not value the readings about majors highly in helping them choose a major. It is possible that these readings are assigned so early in the semester (week 2 in Fall 2008) that the students, who are under considerable stress that early in their first semester, simply do not remember the readings, partially because they may not understand the purpose at that early point in the semester. It appears that providing additional reading material to the students later in the first semester or during the second semester is warranted.

- How valuable were the course projects in helping GE students choose a major?

  Students do not value the projects for helping them choose a major. It is possible that while the projects could be used for that purpose the instructors and/or workshop leaders are not making specific connections for the students and the students are not making the connections themselves. It is suggested that specific connections of the projects to different majors that might perform such tasks be made for the students, possibly as part of the written problem statements.

- What other factors or people (e.g. family, friends, work experiences) assist students in choosing a major, and how valuable are these factors in the decision-making process?

  Student opinions of the relative values of various factors in helping them choose a major are shown in Figures 4 and 8. Highly valued sources for both DL and GE students include family, acquaintances who are engineers, other students, departmental websites, and the information sessions. This is consistent with the literature. Students who do not value those resources may not have access to some or all of them. Steps should be taken to maximize availability of valued resources to all students.

  Factors with low values include instructors, workshop leaders, and readings. It is not clear if students asked the instructors and/or workshop leaders for assistance and did not receive it or if they are reporting that the two groups did not present them with information that was helpful in choosing a major.

- Are Dean's List students who select a major after one semester more certain of their choice than other students who choose a major approximately eight weeks later?

  Data show that DL students who chose a major appear to be considering fewer majors after choosing than do GE students after choosing. It should be noted that only 53% of the DL students chose to change majors after one semester, so it should be assumed that the other 47% were not confident that they could successfully choose their major. The overall result appears to be that DL students are not more certain than the remainder of the cohort.

- Are the data supportive of the happenstance theory of Krumboltz?
  It is clear from the data presented for all groups (Dean's List, GE, Women, Men) that the four factors most valued by students in selection of a major were either Happenstance or Encouraged, with the four factors least valued being Arranged. We conclude that happenstance plays a large role in selection of a major, and our conclusion is consistent with other studies cited in this paper.

Conclusions

An analysis was conducted of survey data gathered from second-semester engineering students regarding their initial engineering major interest, major choice, and information on the factors they valued in making a choice of engineering major. Consistent with the literature, family and friends were one of the valued sources in major choice, with other valued information sources including departmental presentations and websites. Simply reading about different majors in a textbook was not valued as a source of information when choosing a major. There were gender differences in initial major interest and valued sources for choosing a major that should prove valuable for programs interested in increasing gender diversity.

The number of internal transfers is significantly lower than that reported in the literature. Since such transfers generally lead to additional credit hours at graduation, the low rate of migration leads to efficiencies on the part of instructors and advisors and reduced frustration for students, since changing majors represents a loss of curricular momentum and generally requiring the

student to take more courses, and possibly be in school longer, before graduation. Additional study of this phenomenon is indicated, with a qualitative component included, so that the causes and effects of internal transfer can be better understood.

We believe that the choice of major being influenced by a single experience, which might actually occur in passing in the hallway, is troubling, indicating that the entire future of a student could be affected by a chance meeting or a half minute conversation, possibly when the faculty member or advisor is not anticipating action to result from the conversation. It is the responsibility of educators to "encourage" the students to have as many of those chance encounters as possible, in agreement with happenstance theory.

Happenstance plays a significant role in selection of a major within engineering. Academic and career advisors should be aware of this fact and implement planned happenstance appropriately for their own setting so that students are prepared to recognize options and are inclined to consider different paths from the one they may be on at a given time.

Future work should include earlier information gathering on major interest, additional detail on how students gather information for choosing majors, and providing students with maximum access to highly valued sources of information as they choose majors.

Suggestions for educators

In keeping with happenstance theory, including planned happenstance, educators (advisors, instructors, and program administrators) should maximize the number of "chance encounters" available to students during the first year or two of their college education, or in other cases where "swirling" is noted. The timing and nature of these encounters is localized, depending on the size of the program, the nature of the area near the institution, technology available, and other factors. The fact is, however, that there are ways to create opportunities.

Our data indicate that initially women in the GE program were considering more engineering majors than the men. Since it is known that women transfer out of engineering at a higher rate than men, it appears that they are also considering majors outside of engineering. Appropriate chance encounters for women students would appear to be more needed, and also have higher potential for success, than encounters for men. There is an opportunity for programs who want to increase female participation to both increase the numbers of women in their program and simultaneously decrease the number of women who transfer out of engineering.

There are additional encounters that can be provided or offered to students that would be helpful. Such opportunities include early internships, even of short duration, where students learn about what engineers do and what engineering work is about. Job shadowing opportunities with engineers in the local area are also an opportunity for students to learn about engineering. Interviewing working engineers, even by telephone or videoconferencing, would also be helpful.

Acknowledgements

The authors wish to thank their former colleagues at Virginia Tech for support during the performance of this work and for helping pilot the surveys used for gathering the data. Thanks

also to Christi Boone for providing data on internal transfers. This work was performed under approval of Virginia Tech IRB #09-202.

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Appendix A
Requirements to transfer to a degree-granting department in the College of Engineering

Requirements to Transfer to Degree Granting Department

AE | BSE | CEE | CEM | ChE | CpE | CS | EE | ESM | ISE | MSE | ME | MinE | OE

DEGREE PROGRAM	CHEM	MATH	ENGE - 1st Sem (C- minimum)	ENGE - 2nd Sem (C- minimum)	ENGL(4)	PHYS	OTHER	MINIMU GPA
AE(1)	1035 1045	1205 1206 1114 1224	1024	1114 **or** 1104 & 1214	1105 & 1106 **or** H1204**	2305		--
BSE	1035 1045 1036 1046	1205 1206 1114 1224	1024	1104 **or** 1104	1105 & 1106 **or** H1204**	2305		2.0
CEE(2)	1035 1045	1205 1206 1114 1224	1024	1114 **or** 1104	1105 & 1106 **or** H1204**	2305		2.0
CEM(3)	1035 1045	1205 1206 1114 1224	1024	1114 **or** 1104	1105 & 1106 **or** H1204**	2305		2.0
ChE	1035 1036 1045 1046	1205 1206 1114 1224	1024	1114 **or** 1104	1105 & 1106 **or** H1204**	2305		2.0
CpE	1035 1045	1205 1206 1114 1224 ***(C- min)***	1024	1104 **or** 1114 & 1214	1105 & 1106 **or** H1204**	2305 ***(C- min)***	CpE bound students advised to take ECE 1574 in Spring	2.0
CS	1035 1045	1205 1206 1114 1224	1024	1104 **or** 1114 & 1204	1105 & 1106 **or** H1204**	2305	CS 1705 or CS 2984, ***(C min)***	2.3
EE	1035 1045	1205 1206 1114 1224 ***(C- min.)***	1024	1104 **or** 1114 & 1204	1105 & 1106 **or** H1204**	2305 ***(C- min)***	EE bound students advised to take ECE 1574 in Spring	2.0
ESM	1035 1045	1205 1206 1114 1224	1024	1114 **or** 1104 & 1214	1105 & 1106 **or** H1204**	2305		2.5
ISE	1035 1045	1205 1206 1114 1224	1024	1114 **or** 1104	1105 & 1106 **or** H1204**	2305		2.0
MSE	1035 1045	1205 1206 1114 1224	1024	1114 **or** 1104	1105 & 1106 **or** H1204**	2305		---
ME	1035 1045	1205 1206 1114 1224	1024	1114 **or** 1104 & 1214	1105 & 1106 **or** H1204**	2305		2.5
MinE	1035 1045	1205 1206 1114 1224	1024	1114 **or** 1104	1105 & 1106 **or** H1204**	2305		--
OE(1)	1035 1045	1205 1206 1114 1224	1024	1114 **or** 1104 & 1214	1105 & 1106 **or** H1204**	2305		--

Appendix B
E-mails and Surveys Used to Gather Data

Figure B-1. e-mail to Dean's List students who chose major after one semester

Hello.

I'm sending this note to all of the Dean's List students from Fall 2008 who chose to change majors. We are very interested in learning more about how you came to make your choice. We believe that information will help us improve the information we provide to GE students in the future.

We have created a survey to gather the information. We believe it will take less than 5 minutes for you to provide the information.

To access the survey, please visit [redacted]

Thanks VERY much for your help!

Prof. [redacted]

Figure B-2. Questionnaire for Dean's List students who chose major after one semester

How did you choose your major?

Because you were on the Dean's List in Fall 2008 you were offered the opportunity to choose an engineering major at that time, and you chose to do so. We are very interested in how General Engineering students go about choosing a major, and this survey is designed to help us understand that process. Participation in this survey is voluntary and will be used in a research study aimed at identifying the sources GE students use and value for gaining information about choosing an engineering major. We believe having this information will help us to provide better information to students in the future. We sincerely appreciate your help in gathering this information. We believe it will take you less than five (5) minutes to complete these questions. Any information you submit will be completely confidential. No names will ever be used or considered in the process of data analysis and reporting.

This study has been approved by the Institutional Review Board, IRB # 09-202.

Select the degree program you are now in.

Aerospace Engineering
Biological Systems Engineering
Chemical Engineering
Civil & Environmental Engineering
Computer Engineering
Computer Science
Construction Engineering & Management
Electrical Engineering
Engineering Science & Mechanics
Industrial & Systems Engineering
Materials Science & Engineering
Mechanical Engineering
Mining & Minerals Engineering
Ocean Engineering
no answer

Figure B-2. Questionnaire for Dean's List students who chose major after one semester (cont'd)

Had you completely made up your mind on your major choice as indicated above, or are you still somewhat undecided? Please check the appropriate boxes.

My mind is completely made up.
I am still interested in Aerospace Engineering
I am still interested in Biological Systems Engineering
I am still interested in Chemical Engineering
I am still interested in Civil & Environmental Engineering
I am still interested in Computer Engineering
I am still interested in Computer Science
I am still interested in Construction Engineering & Management
I am still interested in Electrical Engineering
I am still interested in Engineering Science & Mechanics
I am still interested in Industrial and Systems Engineering
I am still interested in Materials Science & Engineering
I am still interested in Mechanical Engineering
I am still interested in Mining & Minerals Engineering
I am still interested in Ocean Engineering

Please check all of the engineering majors you were considering when you entered [redacted] or check the first box if you were completely undecided.

I was completely undecided
Aerospace Engineering
Biological Systems Engineering
Chemical Engineering
Civil & Environmental Engineering
Computer Engineering
Computer Science
Construction Engineering & Management
Electrical Engineering
Engineering Science & Mechanics
Industrial and Systems Engineering
Materials Science & Engineering
Mechanical Engineering
Mining & Minerals Engineering
Ocean Engineering

Please indicate the value of the departmental information sessions in the fall in helping you to choose a major:

Very helpful
Somewhat helpful
Not very helpful
No help at all
Did not attend Information Sessions in Fall Semester
no answer

Please indicate the value of the assigned reading about majors in ENGE 1024 in helping you to choose a major:

Very helpful
Somewhat helpful
Not very helpful
No help at all
Did not take ENGE 1024 [redacted]
no answer

Figure B-2. Questionnaire for Dean's List students who chose major after one semester (cont'd)

Please indicate other sources of information that were VERY helpful to you in choosing a major. Check all that apply.

ENGE course professor
ENGE course workshop instructor
Other engineering professor
Academic advisor
Formal mentoring/residential program (e.g. [redacted])
ENGE class projects
Engineering Department websites
Current engineering students
Acquaintances who are engineers
Work experiences
Family members
other:

Please indicate other sources of information that were SOMEWHAT helpful to you in choosing a major. Check all that apply.

ENGE course professor
ENGE course workshop instructor
Other engineering professor
Academic advisor
Formal mentoring/residential program (e.g. [redacted])
ENGE class projects
Engineering Department websites
Current engineering students
Acquaintances who are engineers
Work experiences
Family members
other:

Please indicate other sources of information you thought would help but were NOT helpful to you in choosing a major. Check all that apply.

ENGE course professor
ENGE course workshop instructor
Other engineering professor
Academic advisor
Formal mentoring/residential program (e.g. [redacted])
ENGE class projects
Engineering Department websites
Current engineering students
Acquaintances who are engineers
Work experiences
Family members
other:

Figure B-2. Questionnaire for Dean's List students who chose major after one semester (cont'd)

Please enter any comments on other factors that assisted you in choosing a major and the reasons your choice of major changed from your initial intention (if that happened).

My choice of major was influenced by my [redacted] ENGE 1024, Engineering Exploration course in the following way:

No effect

Positive effect

Negative effect

Did not take ENGE 1024, Engineering Exploration this year

no answer

My choice of major was influenced by my [redacted] ENGE 1104, Exploration of the Digital Fugure course in the following way:

No effect

Positive effect

Negative effect

Did not take ENGE 1104, Exploration of the Digital Fugure this year

no answer

My choice of major was influenced by my [redacted] ENGE 1114, Exploration of Engineering Design course in the following way:

No effect

Positive effect

Negative effect

Did not take ENGE 1114, Exploration of Engineering Design this year

no answer

Figure B-3. e-mail to GE students

To all General Engineering Students:

It is time for you to tell us what engineering major you want to be transferred to when you have completed all of the courses required for eligibility. To see the eligibility requirements for each program, go to
http:/[redacted]Undergraduate/undergrad_req_for_trans.html

To tell us what major you want to be transferred to when you are eligible, go to
[redacted]

You will need to input your PID and password in order to get into the survey, and only current GE students can get into the survey.

If you want to double major, you must first pick a primary major. Once you are transferred to that major, you can begin the process of declaring a second major.

You will be transferred when you are eligible. It usually takes 3-4 weeks after the end of the semester you finish the requirements for all of the transfers to take place.

If you have questions, please consult with your advisor.

Prof.[redacted]

Figure B-4 Questionnaire for GE students

Departmental Choice

Once you have completed all of the requirements, you will become eligible to transfer to a degree-granting department (see http://[redacted]Undergraduate/undergrad_req_for_trans.html for requirements). Please fill in all the requested information and you will be transferred to the department of your choice when you are eligible.

Please fill out this survey accurately. Incomplete entries cannot be processed.

If you change your mind later, you may come to 660 McBryde Hall, in person, and request that your choice be changed.

NOTE: You will not be officially transferred into the department of your choice until approximately 3 weeks after the end of the semester when you complete the requirements.

Enter your student number (the number on your Hokie Passport, which is NOT your Social Security Number) without dashes or spaces.

Enter your last name

Enter your first name

Enter your middle name or initial (optional)

Enter your [redacted]PID - no aliases, DO NOT include the "[redacted]"

Figure B-4 Questionnaire for GE students (continued)

Select the degree program you wish to be transferred to when eligible. NOTE: If you want to double major, you must pick your primary major now and then add the other one later.

Aerospace Engineering

Biological Systems Engineering

Chemical Engineering

Civil & Environmental Engineering

Computer Engineering

Computer Science

Construction Engineering & Management (limited to 40 students - requires an essay for admission - you will be contacted to supply essay)

Electrical Engineering

Engineering Science & Mechanics

Industrial & Systems Engineering

Materials Science & Engineering

Mechanical Engineering

Mining & Minerals Engineering

Ocean Engineering

I prefer not to choose a major at this time.

I have decided to transfer out of engineering.

no answer

If you change your mind about your choice BEFORE you are transferred, come to the Engineering Education office, [redacted], and fill out a form to change your choice. If you change your mind AFTER you are transferred, you must go to 212 Hancock Hall to request a change of major.

We would also like to get some information about how you came to your decision. Please take a few minutes and answer the following questions.

Participation in the remainder of this survey is voluntary and will be used in a research study aimed at identifying the sources GE students use and value for gaining information about choosing an engineering major. We believe having this information will help us to provide better information to students in the future. We sincerely appreciate your help in gathering this information. We believe it will take you less than five (5) minutes to complete these questions. Any information you submit will be completely confidential. No names will ever be used or considered in the process of data analysis and reporting.

Please check all of the engineering majors that you were considering when you entered [redacted], or check the first box if you were completely undecided.

I was completely undecided

Aerospace Engineering

Biological Systems Engineering

Chemical Engineering

Civil & Environmental Engineering

Computer Engineering

Computer Science

Construction Engineering & Management

Electrical Engineering

Engineering Science & Mechanics

Industrial and Systems Engineering

Materials Science & Engineering

Mechanical Engineering

Mining & Minerals Engineering

Ocean Engineering

Figure B-4 Questionnaire for GE students (continued)

Have you completely made up your mind on your major choice as indicated above, or are you still having trouble deciding? Please check the appropriate boxes.

My mind is completely made up.
I am still interested in Aerospace Engineering
I am still interested in Biological Systems Engineering
I am still interested in Chemical Engineering
I am still interested in Civil & Environmental Engineering
I am still interested in Computer Engineering
I am still interested in Computer Science
I am still interested in Construction Engineering & Management
I am still interested in Electrical Engineering
I am still interested in Engineering Science & Mechanics
I am still interested in Industrial and Systems Engineering
I am still interested in Materials Science & Engineering
I am still interested in Mechanical Engineering
I am still interested in Mining & Minerals Engineering
I am still interested in Ocean Engineering

Please indicate the value of the departmental information sessions in the fall in helping you to choose a major:

Very helpful
Somewhat helpful
Not very helpful
No help at all
Did not attend Information Sessions in Fall Semester
no answer

Please indicate the value of the assigned reading about majors in ENGE 1024 in helping you to choose a major:

Very helpful
Somewhat helpful
Not very helpful
No help at all
Did not take ENGE 1024 [redacted]
no answer

Please indicate other sources of information that were VERY helpful to you in choosing a major. Check all that apply.

ENGE course professor
ENGE course workshop instructor
Other engineering professor
Academic advisor
Formal mentoring/residential program (e.g. [redacted])
ENGE class projects
Engineering Department websites
Current engineering students
Acquaintances who are engineers
Work experiences
Family members
other:

Figure B-4 Questionnaire for GE students (continued)

Please indicate other sources of information that were SOMEWHAT helpful to you in choosing a major. Check all that apply.

ENGE course professor
ENGE course workshop instructor
Other engineering professor
Academic advisor
Formal mentoring/residential program (e.g. [redacted])
ENGE class projects
Engineering Department websites
Current engineering students
Acquaintances who are engineers
Work experiences
Family members
other:

Please indicate other sources of information you thought would help but were NOT helpful to you in choosing a major. Check all that apply.

ENGE course professor
ENGE course workshop instructor
Other engineering professor
Academic advisor
Formal mentoring/residential program (e.g. [redacted])
ENGE class projects
Engineering Department websites
Current engineering students
Acquaintances who are engineers
Work experiences
Family members
other:

Please enter any comments on other factors that assisted you in choosing a major and the reasons your choice of major changed from your initial intention (if that happened).

My choice of major was influenced by my [redacted] ENGE 1024, Engineering Exploration course in the following way:

No effect
Positive effect
Negative effect
Did not take ENGE 1024, Engineering Exploration this year
no answer

My choice of major was influenced by my [redacted] ENGE 1104, Exploration of the Digital Fugure course in the following way:

No effect
Positive effect
Negative effect
Did not take ENGE 1104, Exploration of the Digital Fugure this year
no answer

My choice of major was influenced by my [redacted] ENGE 1114, Exploration of Engineering Design course in the following way:

No effect
Positive effect
Negative effect
Did not take ENGE 1114, Exploration of Engineering Design this year
no answer