FIRST-YEAR ENGINEERING STUDENTS' CHOICE OF A MAJOR: WHEN IT IS MADE AND WHAT INFLUENCES IT

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1. INTRODUCTION

The academic success and retention of engineering students is an important issue in engineering education and one of the key issues in engineering education for the coming century (NAE 2005) Also of concern is the fact that women and minority students continue to be underrepresented in the populations entering and graduating from engineering programs (Bordonaro, 2000; EWC, 2001). Students decide to pursue an engineering major for a variety of reasons, including prior success in high school math and science courses (Jagacinski and LeBold, 1981). The self-perceptions and attitudes students possess entering college are factors tied to the decisions students make throughout their college careers. According to Besterfield-Sacre, Atman and Schuman (1997), students who stay in engineering compared to students who leave differ in terms of perceptions towards engineering and engineering knowledge and skills. Specifically, students who may have otherwise performed well in engineering, but transferred out, report lower (a) impressions of engineering prior to starting an engineering program, (b) enjoyment of math and science courses, and (c) confidence in basic engineering knowledge and skill.

To help the transition to college and specifically into engineering, universities have initiated various programs (e.g., first-year seminars) to encourage students to identify a major most aligned with their interests and skills which will improve retention. Understanding how students choose and identify with a major is important in developing and assessing these programs. Yet very few studies have assessed the effect of these first-year programs on how students choose a major (Ohland and Sill, 2002; Montgomery, Follman, and Diefes-Dux, 2003). This paper explores when first-year students make their final major decision and what factors may influence this choice.

1.1 Purdue University's First-Year Engineering Program

Purdue University's Department of Engineering Education has responsibility for all of the approximately 1650 first-year engineering students. All engineering students are brought into the First-Year Engineering Program that is part of the Department of Engineering Education. They are required to complete a common first year core of classes shown in Table 1 before matriculating to their respective engineering major. They do not have to declare a major within engineering for the first year. The program is designed explicitly to allow students to change

their preference in the first year with no changes in coursework or time to graduation. Minimum grade levels are established for matriculation to the major of their choice. The department includes ten tenure track faculty and four academic advisors. This department has the responsibility for all of the academic advising for first-year students and primary teaching responsibility for the engineering lectures, seminars, help and assistance courses as well as the first engineering course, ENGR 106 - Engineering Problem Solving and Computer Tools.

Table 1: Purdue University First- Year Engineering Curriculum

Fall Semester	Spring Semester
Calculus I	Calculus II
Chemistry I	Chemistry II
Engineering Lectures (+ seminar option)	Physics (Mechanics)
Engineering Problem Solving and Computer Tools	Computer Programming (C or Fortran)
English or Communications	English or Communications
Optional Electives	

The Engineering Lectures (ENGR 100) provide an introduction to all the engineering fields. The complimentary seminars are designed to help students adjust to Purdue and to provide a small group environment for career exploration. Versions of the seminar are offered with either student instructors (ENGR 104) or engineering faculty (ENGR 103). Students are given the choice of seminars when they meet with an advisor during summer registration. Optional elective courses include introductory courses in a few engineering majors (ABE 120, MSE 190, NUCL 110) and the women in engineering seminar (ENGR 194). Additional resources provided by the department include academic advising, academic assistance, and career resources which can be accessed over the website and outside speakers from companies during the year.

1.2 Multidisciplinary Engineering

To accommodate students whose interests span traditional disciplines, Purdue has created a new degree, Multidisciplinary Engineering Program (MDE). This program is intended for the student whose interests and abilities are best served by a curriculum that builds on new and existing engineering and science disciplines, rather than focuses on one of the traditional disciplines.

Features of the MDE program include:

- An integrated plan of study that merges multiple engineering disciplines
- A scientifically-oriented approach to engineering with a strong biological component
- Opportunity to conduct research in emerging fields of study in eight signature areas
- Flexibility to tailor a plan of study to reflect in interests
- Bachelor of Science in Engineering (BSE) degree

A challenge with this program as with any new program is recruitment and placement of students who would be best served by this program. The program is part of the Department of Engineering Education and has provided additional motivation for this study.

2. METHODS

2.1 Participants and Setting

The participants (*N = 1256*) were first-year students whose first semester was Fall 2002. They were enrolled in the ENGR 106 course (mentioned above). The gender representation was 80% Male, 20% Female. The ethnic representation was 71.1% Caucasian, 11.1% International, 7.6% Asian American, 3.5% Hispanic American, 1.8% African American, and 5% Other.

2.2 Data Collection

A web-based survey was used to collect data on students' first, second, and third preference for their major, the first and second influence on students' first preference, and students' confidence level in their first preference. The survey was administered four times (August, September, November, and December) and was a homework requirement for which points were rewarded.

Data on students' first major preference in the summer of 2002 was collected orally during summer registration and officially recorded. Data on students' major in 2005 was collected from the University's Registrars at the beginning of the Fall semester.

2.3 Data Analysis

To determine how early in their first semester students' are making lasting decisions about their major, students' first preferences in the summer, August, September, November, and December of 2002 were compared with their registration status in Fall 2005. For engineering students, the major and school are the same designation, so a direct comparison could be made. Students whose school was the same as their first preference were counted and recorded. This data was normalized into percentages by the number of students who took the survey in that time sample.

To determine what influences students' decision about their major, students were first divided into four groups:

- Group 1 – Students whose first preference in August was same as current major.
- Group 2 – Students whose first preference in August was different from current major but still engineering
- Group 3 – Students whose first preference in August was different from current major and a science, technology, or mathematics (STM) field.
- Group 4 – Students whose first preference in August was different from current major and a non-STM field.

Students who withdrew from Purdue were excluded from the analysis of influences. The first and second influence on students' first preference in August were counted for each group of students, and normalized into percentages by the number of students in that group. The same procedure

was followed for Groups 2-4 for students' first and second influence in December. The influences on Group 1 students in December were not of interest because it was assumed that these students' had made a firm decision in August.

There were eighteen different options on the "Influences" question. These influences were classified into three different categories: programmatic, personal, and other. The "programmatic" category includes all influences from the first year program: the first-year courses and seminars, and Purdue faculty and advisors. The "personal" category includes all influences outside the first-year program that were identifiable on the survey: extracurricular activities, high school teacher and counselor, family member, and Purdue student. And the "other" category includes all influences that could not be identified by the survey: other, none of the above and self exploration. The influences data were aggregated into these three categories to simplify comparison over time and between groups.

3. RESULTS

3.1 Time of decision

Table 2 shows the percentage of students surveyed that remained at Purdue and stayed with the same major as their first preference. One-third of students' final majors were the same as their first preferences the summer prior to their first semester. This ratio increases to close to one-half by the end of their first semester. Still, over one-half of all first-year engineering students either left Purdue or changed their minds about their major after their first-year.

For those students who stayed in engineering (Groups 1 & 2), however, the strong majority of students made their final major decision by the end of their first semester. Close to 50% of these students stayed with their first choice the summer before they matriculated.

Table 2: Percentage of all First Year Engineering Students whose First Major Preference Was their Final Major at Different Times in their First Semester.

Time	Summer	Aug.	Sept.	Nov.	Dec.
% of students	33.0	36.9	38.4	46.1	45.7
N	1058	1249	1241	1104	1102

Table 3: Percentage of Group 1 and Group 2 (Engineering) Students whose First Major Preference Was their Final Major at Different Times in their First Semester.

Time	Summer	Aug.*	Sept.	Nov.	Dec.
% of students	52.4	65.3	67.4	74.2	74.3
N	666	706	706	686	678

*These are all Group 1 students, by definition.

Table 4: Percentage of Group 3 and Group 4 (Non-Engineering) Students whose First Major Preference Was Non-Engineering

Time	Aug.	Sept.	Nov.	Dec.
% of students	0.39	4.3	10.2	12.7
N	254	254	206	204

3.2 Influences on decision

Table 5 shows the 1st and 2nd influences on Group 1 students' top choice of major in August. Tables 6-8 show these influences on Groups 2, 3, and 4 in August and December. The influences on all four groups are the same in August. "Self exploration" is the most common, followed by "Family member", "Extracurricular activity", and "High school teacher." Figures 1-3 show how the types of influences on Groups 2-4 change from the beginning until the end of the first semester. The programmatic influences increase for all three groups. This increase comes at the expense of the personal influences, which decrease for all three groups. By the end of the first semester, programmatic influences increase more for Group 2 than 3, but less than 4.

Table 5: Distribution of First and Second Influence on Group 1 (Same Final Engineering Major) Students' First Major Preference in August.

Influence	1st –Aug (%)	2nd -Aug (%)	Combined-Aug
ABE 120	0.0	0.0	0.0
ENGR 100	1.8	2.1	3.9
ENGR 103	0.3	1.0	1.3
ENGR 104	1.5	0.8	2.3
ENGR 106	1.8	1.8	3.6
ENGR 194	0.0	0.3	0.3
Extracurricular activity	4.9	8.5	13.4
Family member	18.0	23.5	41.5
High school guidance counselor	0.0	0.5	0.5
High school teacher	4.6	9.0	13.6
MSE 190	0.0	0.3	0.3
None of the above	2.3	10.9	13.2
NUCL 110	0.0	0.0	0.0
Other	4.4	17.6	22.0
Purdue advisor	0.0	0.0	0.0
Purdue faculty	0.0	2.1	2.1
Purdue student	1.3	2.8	4.1
Self exploration	59.0	18.9	77.9
N =	388	387	

Table 6: Change in Distribution of First and Second Influence on Group 2 (Different Final Engineering Major) Students' First Major Preference from August to December.

Influence	1st –Aug (%)	1st-Dec (%)	2nd-Aug (%)	2nd-Dec (%)	Combined Aug	Combined Dec
ABE 120	0.0	0.0	0.0	0.0	0.0	0.0
ENGR 100	1.6	10.1	2.8	15.4	4.4	25.5
ENGR 103	0.6	3.9	0.9	2.0	1.5	5.9
ENGR 104	1.9	2.9	1.9	4.6	3.8	7.5
ENGR 106	1.6	2.3	2.2	2.3	3.8	4.6
ENGR 194	0.3	2.6	0.0	1.3	0.3	3.9
Extracurricular activity	3.5	3.3	5.7	4.2	9.2	7.5
Family member	15.7	12.7	23.3	13.1	39.0	25.8
High school guidance counselor	0.0	0.7	2.5	1.6	2.5	2.3
High school teacher	5.3	1.3	9.1	7.2	14.4	8.5
MSE 190	0.3	0.0	0.3	0.7	0.6	0.7
None of the above	6.9	3.3	13.5	6.2	20.4	9.5
NUCL 110	0.0	0.3	0.0	0.0	0.0	0.3
Other	6.9	8.2	14.8	11.8	21.7	20.0
Purdue advisor	0.3	0.7	0.0	0.7	0.3	1.4
Purdue faculty	0.0	1.0	0.3	2.0	0.3	3.0
Purdue student	1.9	5.2	3.1	6.9	5.0	12.1
Self exploration	53.1	41.5	19.5	20.3	72.6	61.8
N	318	306	318	306		

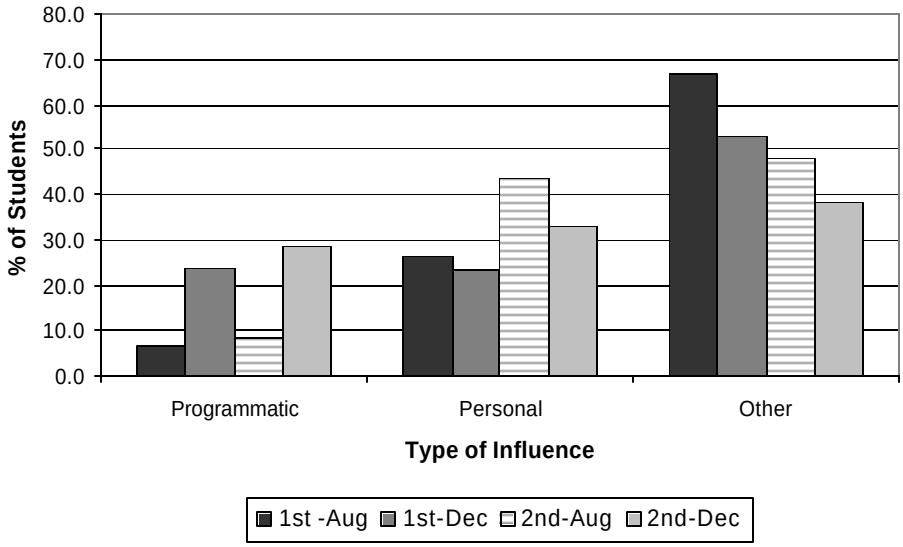

Figure 1: Change of Type of First and Second Influences on Group 2 Students' First Major Preference from Beginning to End of their First Semester

Table 7: Change in Distribution of First and Second Influence on Group 3 (STM Final Major) Students' First Major Preference from August to December.

Influence	1st –Aug (%)	1st-Dec (%)	2nd-Aug (%)	2nd-Dec (%)	Combined Aug	Combined Dec.
ABE 120	0.0	0.0	0.0	0.0	0.0	0.0
ENGR 100	2.3	4.7	2.3	11.0	4.6	15.7
ENGR 103	1.5	0.9	0.8	0.9	2.3	1.8
ENGR 104	0.8	5.6	1.5	1.8	2.3	7.4
ENGR 106	2.3	2.8	3.1	3.7	5.4	6.5
ENGR 194	0.8	0.9	0.0	0.0	0.8	0.9
Extracurricular activity	6.2	2.8	12.3	13.8	18.5	16.6
Family member	14.6	13.1	16.9	11.9	31.5	25.0
High school guidance counselor	0.0	0.0	0.8	1.8	0.8	1.8
High school teacher	4.6	1.9	12.3	7.3	16.9	9.2
MSE 190	0.0	0.0	0.0	0.0	0.0	0.0
None of the above	6.9	8.4	13.1	12.8	20.0	21.2
NUCL 110	0.0	0.0	0.0	0.0	0.0	0.0
Other	6.9	8.4	13.1	12.8	20.0	21.2
Purdue advisor	0.0	0.0	2.3	4.6	2.3	4.6
Purdue faculty	0.0	0.9	3.1	0.9	3.1	1.8
Purdue student	1.5	1.9	0.8	3.7	2.3	5.6
Self exploration	51.5	47.7	17.7	12.8	69.2	60.5
N	130	130	109	107		

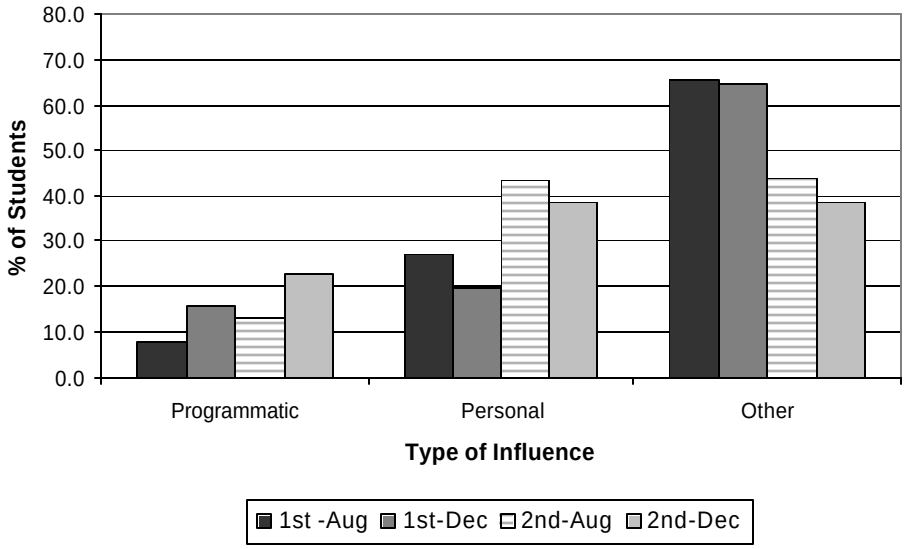

Figure 2: Change of Type of First and Second Influences on Group 3 Students' First Major Preference from Beginning to End of their First Semester

Table 8: Change in Distribution of First and Second Influence on First Major Preference from August to December for Group 4 (non-STM Final Major) Students

Influence	1st –Aug (%)	1st-Dec (%)	2nd-Aug (%)	2nd-Dec (%)	Combined Aug	Combined Dec
ABE 120	0.0	0.0	0.0	0.0	0.0	0.0
ENGR 100	3.2	13.1	1.6	12.2	4.8	25.3
ENGR 103	0.8	7.1	0.0	0.0	0.8	7.1
ENGR 104	0.8	2.0	3.2	2.0	4.0	4.0
ENGR 106	0.8	6.1	2.4	3.1	3.2	9.2
ENGR 194	0.0	1.0	0.0	2.0	0.0	3.0
Extracurricular activity	4.0	6.1	11.3	5.1	15.3	11.2
Family member	13.7	8.1	24.2	14.3	37.9	22.4
High school guidance counselor	0.8	0.0	3.2	2.0	4.0	2.0
High school teacher	3.2	5.1	7.3	4.1	10.5	9.2
MSE 190	0.0	0.0	0.0	0.0	0.0	0.0
None of the above	1.6	4.0	8.9	11.2	10.5	15.2
NUCL 110	0.0	0.0	0.0	0.0	0.0	0.0
Other	9.7	6.1	16.1	19.4	25.8	25.5
Purdue advisor	1.6	1.0	0.0	0.0	1.6	1.0
Purdue faculty	0.8	0.0	0.8	2.0	1.6	2.0
Purdue student	1.6	2.0	3.2	3.1	4.8	5.1
Self exploration	57.3	38.4	17.7	19.4	75.0	57.8
N	124	124	99	98		

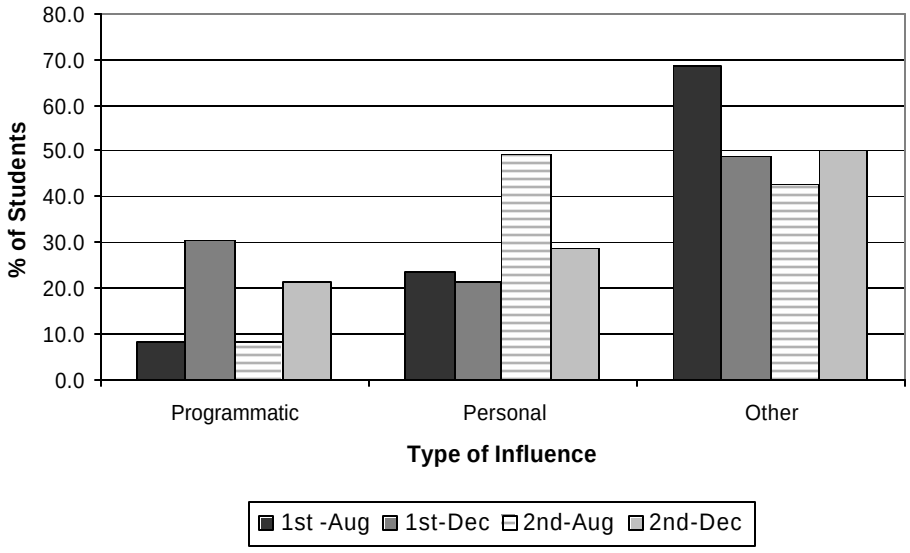

Figure 3: Change of Type of First and Second Influences on Group 4 Students' First Major Preference from Beginning to End of their First Semester

4. DISCUSSION

One-third of first-year engineering students made a final decision about their major before the first semester, and less than half of students made up their minds by the end of the semester. Only 12% of engineering students surveyed in August made a lasting choice during their first-semester. For students who remain in engineering (Groups 1 and 2), the majority (52.4%) make this decision the summer prior to matriculation. By the end of the semester, an additional 155 students – 22% of Groups 1 and 2 – have made a final decision about their engineering major. Therefore, 78% of first-year engineering students who stay in engineering decide on a major either before (52%) or after (26%) their first semester.

The conclusion that most students are not making a final decision during the first semester applies just as well to students who leave engineering. Of the 204 students surveyed in December who left engineering, only 26 (13%) put non-engineering as their first choice. Though this is a noteworthy increase from the one student who put non-engineering as his first choice in August, the results show the majority (87%) of students who leave engineering still intended to major in engineering at the end of their first semester. Even if one includes the 48 students from these groups that did not take the survey after September (possibly because they dropped the class) among those who decide to leave engineering the first semester, still only 29% of Group 3 and 4 students decided against engineering the first-semester.

One implication of this finding is that students need guidance and are highly impressionable vis-à-vis their choice of a major beyond their first-semester, and that first-year programs that educate students about the engineering profession and the different engineering majors might enhance their effectiveness by continuing these efforts after the first semester. A second implication, for new engineering degree programs, is that recruiting for these programs should include educating parents and students about the new program before the students enroll.

Another important finding is that the programmatic influences do have a measurable impact on students' preference for their major during their first semester. Though their influence is small at the beginning of the semester, it is substantial by the end of the semester: over 25% of students in Groups 3 and 4 rated programmatic elements as their primary influence and over 20% of students in Groups 2- 4 rated them as their secondary influence by the end of the semester. In total, 40% of students in Groups 2-4 rated a programmatic element as either their first or second influence in December.

But do these programmatic elements have influence beyond the first semester? Of the 318 total Group 2 students surveyed in August, only 93 students' major in 2005 (29%) was the same as their top choice in December. Thus, 71% of Purdue engineering students who change their mind about their major after their first month in college seem to make their final decision after their first semester. This number suggests that though the first-year program influences what students want to major in their first semester, other experiences after the first semester may have a greater impact on their final decision.

It is surprising that a higher percentage of Group 4 students said that programmatic influences were the primary influence on their choice of major. The data, however, does not differentiate between a positive influence towards engineering and a negative influence away from engineering. One might surmise, though, that these influences had a negative influence on those students who also put as their first preference in December "Non engineering" or "Undecided engineering" after putting a specific engineering major in August. Of the 206 students in Groups 3 and 4 surveyed in December, only 32 students put non- or undecided engineering as their first preference in December. Fifteen of these students had a programmatic element as their first or second choice. Assuming that because they influenced students' choice of non- or undecided engineering they influenced students away from engineering, still only 7% of students who left engineering indicated a possible negative experience in the first-semester engineering program. Though these numbers are small, they do help explain why Group 4 students had the highest percentage (30%) of programmatic first influences. Five of these fifteen students were in Group 4 and put a programmatic element as the primary influence in December. These five represent 5% of Group 4 students who took the survey in December. Not counting these responses in the analysis, the percentage drops to 25%, which is about the same as the Group 2 students. This analysis leads to an even closer comparison of influences between Group 2 and Group 4 students, which further supports the claim that a majority of students who begin in engineering are making final decisions about their major after their first semester.

This reasoning leads to the conclusion that though this data is illuminating for when students make their major decision, it tells us very little about what influences them. Not only do we not have data on what influences students after their first semester, but most of students in this data set indicated influences that were not specified on this survey ("Other" or "None of the above") or that were too vague to ascribe to something concrete ("Self-exploration"). Further research should look at what influences students after their first semester and when do students who have not made a final decision their first semester do so. Additional research using qualitative methods could be used to elucidate what the self-exploration process looks like for students and what additional influences comprise the other and none of the above categories.

5. CONCLUSION

This data in this study show that the majority of first-year engineering students do not make a final decision about their major during their first semester. For students who stay in engineering, a majority appear to make this decision before they begin the first-year, while one-fourth decide after the first semester. For students who leave, the majority appear to make this decision after the first semester. This conclusion holds for students who remain in engineering and for those who leave engineering but remain enrolled at Purdue. Entering the university, students report self-exploration and family members as the most significant influences on their choice of major, regardless of whether they remain in or leave engineering. By the end of their first semester, self-exploration remains the top influence, though the influence of programmatic factors in the first-year engineering program increases significantly at the expense of such personal factors as family members. Because the majority of students choose their major after the first semester and because 'self-exploration' could mean many different things, this study points to the need for additional research to understand what influences engineering students' choice of a major.

REFERENCES

Besterfield-Sacre, M. E., Atman, C.J. and Shuman, L.J. (1997). "Characteristics of freshman engineering students: Models for determining student attrition and success in engineering." *The Journal of Engineering Education*, **86**, 139-149.

Bordonaro, M., Borg, A., Campbell, G., Clewell, B., Duncan, M., Johnson J., Johnson, K., Matthews, R., May, G., Mendoza, E., Dineman, J., Winters, S., and Vela, C. (2000). *Land of plenty: Diversity as America's competitive edge in science, engineering and technology*, Report of the Congressional Commission on the Advancement of Women and Minorities in Science, Engr and Tech. Development, Opportunities in Science and Engineering.

Engineering Workforce Commission (2001). American Association of Engineering Societies, www.ewc-online.org.

Jagacinski, C. and LeBold, W (1981). "A comparison of men and women undergraduate and professional engineers." *Engineering Education*, **72**, 213-220.

Montgomery, R., Follman, D., Diefes-Dux, H. (2003) "The relative effectiveness of different first-year engineering seminars", Frontiers in Education National Conference, Boulder, CO.

Ohland, M. and Sill, B.(2002) "Communicating the impact of an introduction to engineering course to engineering departments." Frontiers in Education National Conference, Boston, MA

National Academy of Engineering (NAE) (2005) *Educating the Engineer of 2020: Adapting Engineering Education to the New Century*