

## Major Hopping: A Cohort Analysis

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In 1993, Georgia Tech embarked on a series of General Education Assessment seminars with the aim of studying how to measure the impact of our programs in the general educational arena (as opposed to the curricula defined by academic majors). These seminars were designed after the Harvard Assessment Series led by Dr. Richard Light. One issue that arose in these discussions was the pattern of major changes at Georgia Tech. There is a lot of folklore at Tech about these patterns and there is a generally held belief that they differ by gender. Drs. Lynn Fountain, then of the Center for Education Integrating Science, Mathematics, and Computing (CEISMC) and Donna Llewellyn, of the School of Industrial and Systems Engineering, set out to see if this modern legend would hold up to the scrutiny of data. During the course of the data collection and analysis, Drs. Fountain and Llewellyn became part of an NSF funded multi-institutional project called InGEAR (Integrating Gender Equity And Reform) whose goal is to impact gender equity in education through teacher preparation programs. Part of this grant is dedicated to institutional self-studies for the five universities and colleges involved. Since by the time InGEAR had started at Tech the General Assessment Seminar Series had finished, the major changing pattern study was folded into this institutional self-study.

Fairly unique among engineering programs, Georgia Tech enjoys a higher retention rate for its women in engineering majors than its corresponding men. There are many proposed reasons for this anomaly including

1. Tech does not have a large physical science component so that there are not many obvious places for disillusioned engineering students to transfer to within Tech;
2. There is a sample bias of the women who decide to matriculate at Tech - they have already decided that they want a quantitative education in a predominantly male environment;
3. There is usually a strong family pressure to remain at Tech once enrolled.

There was a hypothesis, though, that women find explicit coping mechanisms in order to remain at Tech. One proposed such mechanism is changing majors - the search for a niche where they can feel comfortable. In order to properly investigate these hypotheses, there are several necessary steps:

1. Analyze major changes to see if there is a quantitative difference across gender;
2. If there is a quantitative difference, investigate if the patterns of changes are different;
3. Interview students to find out their opinions of major changing.

Investigation of number one above was immediately hampered by the fact that Georgia Tech does not explicitly keep records of students' major changes. At any time, there is a one line computer record of the student's current major - it is overwritten whenever the student changes

majors. The only place that the history of majors is kept is on the students' transcripts - the current major is listed at the end of the grades for each quarter. Therefore, transcripts would have to be inspected to see if the this listing changed from one quarter to the next in order to detect major changes. The thought of looking at thousands of paper transcripts was daunting and so Drs. Fountain and Llewellyn sought the assistance of Mr. Bob Hume, of the Minority Educational Development Office (OMED). Bob Hume had experience accessing the registrar's database of transcript information and so proved invaluable to this study.

Mr. Hume, with the assistance of Ms. Arlene Heredia obtained student information files from the registrar's office and built the database for the study. In order to control the size of the database, it was decided to look only at a student's major in the Fall quarter of each academic year. If a major changed between consecutive Fall quarters, then that counted as one change. There is one obvious danger with this method - if a student were to make more than one major change in an academic year (including the possibility of changing majors and then changing back again), these extra changes would be missed. Therefore, our count would be a conservative (underestimate) of the number of major hops. There is another problem with this method that is a little less obvious. If a student is not registered in any given quarter, the student information files do not indicate if the student has left Georgia Tech, graduated from Tech, or gone on a work assignment through the Co-op program. The Co-op program at Tech is extremely active with approximately 3700 students enrolled during an academic year, so this last possibility can not be ignored! These issues made database reliability a major issue for Mr. Hume and Ms. Heredia. One last problem had to be resolved before the start of the analysis. Most students enter Georgia Tech with a declared major. However, there is a substantial percentage which enter "undecided" within one of three of the Colleges on campus (other undecided options are not allowed). So, a student can enter classified as "Undecided Engineering," "Undecided Science," or "Undecided Ivan Allen." The decision was made that if a student entered Tech as an undecided student and made their first major declaration within the College of their entrance, then that was not to be classified as a change of major. However, if the first major declaration was in a different College, then it was a change of major. For example, a declaration of ME (Mechanical Engineering) for an Undeclared Engineering student is not a major change but such a declaration for an Undeclared Science or Ivan Allen student is a major change.

The study began by examining the cohort of Class 1 (freshmen) students in the fall of 1991. Of the 2565 students enrolled as freshmen in the fall of 1991, 1793 of the students were either still enrolled or had graduated by the fall of 1995. For these 1793 (1337 men, 456 women) students, Heredia created a matrix showing student number, race, gender, initial major, and then declared major for each fall quarter. The results showed that 39.7% of men students changed majors at least once with the following breakdown: 35.4% changed majors once, and 4.3% changed majors two or three times. Of the women students, 45% changed major at least once with the following breakdown: 38.2% changed majors once and 6.8% changed two or three times. These results are in Table 1 and Charts 1 - 3.

We used the test of hypothesis of two binomial parameters being equal to see if the probability of a male student changing majors at least once could be considered equal to that for a female student [see Hines & Montgomery Section 10.10.] In this analysis, the "male" parameter value is .397 while the female parameter value is .45. We test the hypothesis that these can be considered equal to the overall parameter value which is .41. The results of the statistical analysis is that we can reject this hypothesis at the 95% confidence level.

An interesting extra piece of information gathered from our matrix of data is that fifty percent of the first major changes for men and women occurred before the fall of 1992 with 80% of the changes occurring before the fall of 1993. In other words, students who are likely to change majors do so during their freshman and sophomore years.

A similar study was performed for the 1878 (1379 men, 499 women) students who were classified as Class II or sophomores during the fall of 1991. The data are still being analyzed for this cohort.

Clear change-of-major patterns are difficult to determine based on one cohort. However, gross level trends did emerge for those classified as freshmen in 1991. Within the College of Engineering, the greatest turnover of majors (percentage-wise) occurred in the School of Aerospace Engineering which lost 74 (69%) of its declared majors. The School of Industrial and Systems Engineering (ISyE) experienced a loss of 22 students or 27%, the lowest percentage across the Schools in this College. ME lost the fewest women in the college (4 women or 18% of their original female majors). Equally interesting, ISyE attracted the largest number of students from those who changed majors across all colleges. Here, in order of decreasing numbers, men transfer to ISyE, ME, CE (Civil Engineering) and EE (Electrical Engineering); with the last two tied. In order of decreasing numbers, women transfer to ISyE, CE, and ME (however here the gap between ISyE and CE is quite large). As for the myth that states ISyE is the last stop before Management, 38% (15 of 39) of the students who transfer out of the Ivan Allen College transfer to ISyE; while 50% (11 of 22) of the students who transfer out of ISyE transfer to the Ivan Allen College. These results are shown in Table 2 and Charts 4 - 6.

An interesting unexpected outcome of this study is that students who enter Tech with no declared major make fewer changes in their major. Of the 1793 students who were classified as freshmen in the fall of 1991 and who were still enrolled or who had graduated by fall 1995, 42.4% of these students changed majors at least once. In the Fall of 1991, 411 of these students had still not declared a major. Of these students, 36.5% changed majors at least once. Remember, a change from undeclared to declared was not considered a major change as long as the first declaration occurred in the school of entry. This difference grows even more remarkable if one looks specifically at the women students. Of the women who entered with a declared major and remained in school to be included in the study, 47.9% changed majors at least once. However, among the undeclared women, only 36.2% changed majors. Further if we do the same type of statistical analysis as above only for those students who enter with an undeclared major then we would have to reject the null hypothesis (indeed here the male parameter is .366 while the female parameter is .362 with the overall parameter value of .365!). An interesting question arises from noticing that the original cohort had 2565 students in it. How many of the 30% who did not succeed at Tech entered with declared majors? Are we retaining only a certain section of the undeclared students and does this explain the differences that we found, or is there something inherent in entering without a declared major that forces early exploration of the different majors that later reduces the number of major changes?

This study has several limitations. First, for majors which have traditionally low enrollments, a change of a few students indicates a high percentage of overturn for this major. To avoid the danger of looking at statistics for small populations, it is necessary to examine the change-of-major patterns for several entering classes to see if a stronger change-of-major pattern emerges. Second, this study provides no information on why students change majors and why they drop out of Tech. Do these reasons differ for men and women students? [Recall that this study was never designed to provide information on why students change majors - but rather to provide a quantitative justification for such a study.] Another study, using the data already collected, could

be conducted to see if a low GPA is a reason for students leaving Tech. In addition, Llewellyn and Fountain recommend an exit survey or interview for students who change majors or who leave Tech to determine the reasons for departure. Finally, this study ignores students who transfer to Tech after having completed two years at another institution. What challenges do these students face?

While our original hypothesis has been proven in a limited cohort study, there is still much research to be done. Within the InGEAR project, this data will continue to be analyzed, and further cohorts will be added to the study. In addition, this work indicates a need to look at our undeclared students and to study what is happening to them as they progress through Tech.

Undeclared

	Men	Women	All
0 changes	63.39%	63.79%	63.50%
1 change	31.19%	31.03%	31.14%
<sup>3</sup> 2 changes	5.42%	5.17%	5.35%
Total	1	1	1

Declared

	Men	Women	All
0 changes	59.40%	52.06%	57.60%
1 change	36.56%	40.59%	37.55%
<sup>3</sup> 2 changes	4.03%	7.35%	4.85%
Total	1	1	1

Overall

	Men	Women	All
0 changes	60.28%	55.04%	58.95%
1 change	35.38%	38.16%	36.08%
<sup>3</sup> 2 changes	4.34%	6.80%	4.96%
Total	1	1	1

TABLE 1

### Number of Major Hops for 1991 First Year Student Cohort

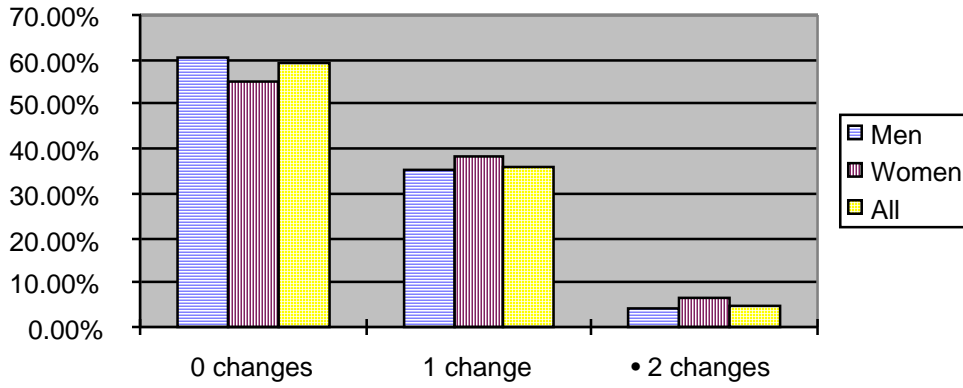


CHART 1

### Number of Major Hops for 1991 Declared First Year Student Cohort

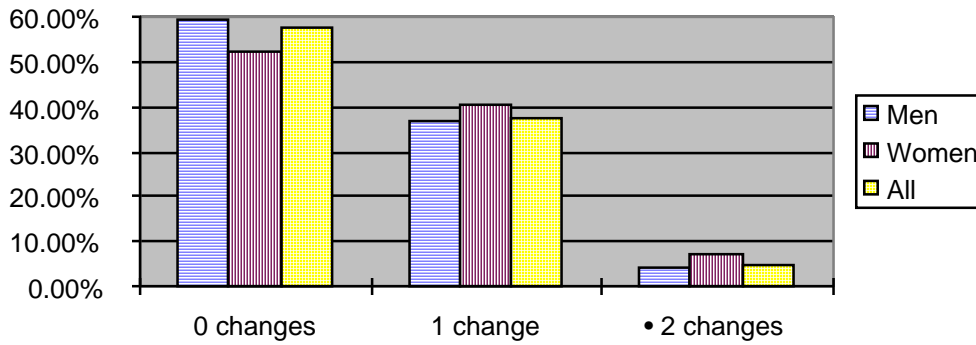


CHART 2

### Number of Major Hops for 1991 Undeclared First Year Student Cohort

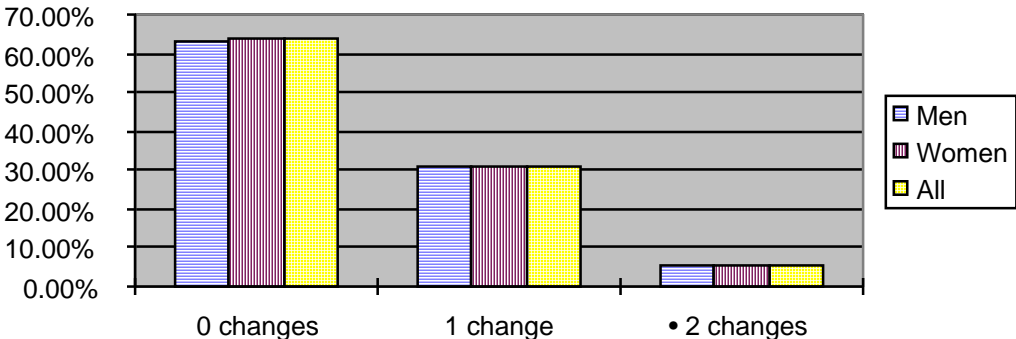


CHART 3

College of Engineering Hops out of Majors (Majors with at least 50 students to start)							
	A E	C E	Ch E	C M P E	E E	I E	M E
Original # All	107	69	158	61	218	83	170
Original # Men	97	55	117	52	185	52	148
Original # Women	10	14	41	9	33	31	22
# All Leave	74	21	62	36	83	22	49
# Men Leave	65	16	43	28	64	13	45
# Women Leave	9	5	19	8	19	9	4
% All Leave	69%	30%	39%	59%	38%	27%	29%
% Men Leave	67%	29%	37%	54%	35%	25%	30%
% Women Leave	90%	36%	46%	89%	58%	29%	18%

TABLE 2A

College of Engineering Hops into Majors (Majors with at least 50 students to start)			
School	# All Arrive	# Men Arrive	# Women Arrive
A E	0	0	0
C E	40	26	14
Ch E	19	15	4
C M P E	8	7	1
E E	28	26	2
I E	109	71	38
M E	69	64	5

TABLE 2B

### Hops out of Majors - Numbers

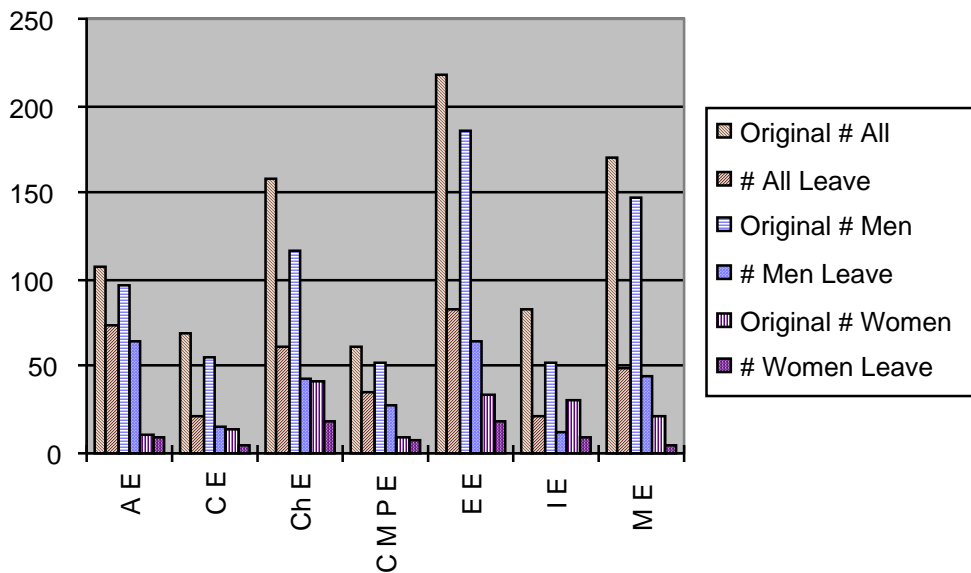


CHART 4



## Hops out of Majors - Percentages

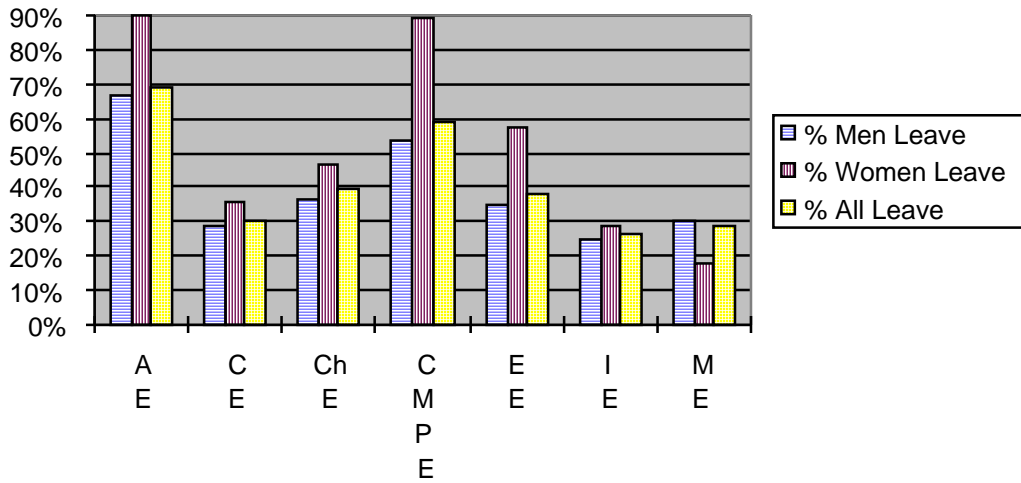


CHART 5

## Hops into Majors

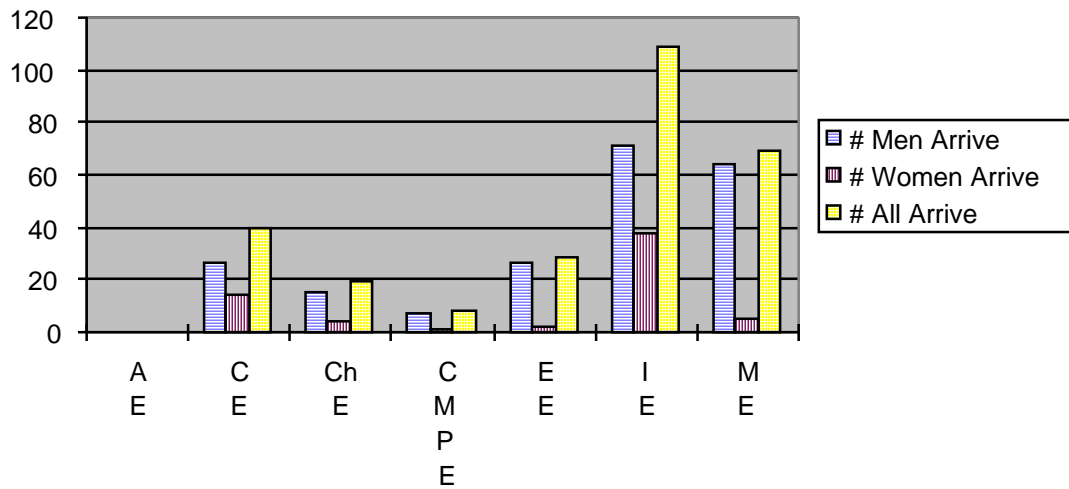


CHART 6

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Lynn Fountain earned her PhD in Physics from Georgia Tech in 1992 and then joined the staff of CEISMC. In 1996 she moved to the Georgia Tech Research Institute (GTRI) where she is currently a Research Scientist II.

DONNA LLEWELLYN, Ph.D.

Donna Llewellyn earned her BA in Mathematics from Swarthmore College in 1980, her MS in Operations Research from Stanford University in 1981 and her Ph.D. in Operations Research from Cornell University in 1984. She then joined the Industrial and Systems Engineering faculty at Georgia Tech where she is currently in the associate chair/director for Academic Support. Donna is the current chair of the Women in Engineering Division of ASEE.