AC 2012-5342: UNDERSTANDING THE PATH OF ENGINEERING AND COMPUTER SCIENCE UPPER DIVISION TRANSFER STUDENTS TO A LARGE UNIVERSITY

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Understanding the Path of Engineering and Computer Science Upper Division Transfer Students To a Large University

Abstract

The community college is a critical source for growing the engineering and computer fields in the United States. The encouragement, recruitment, transfer and acclimation process for these students to a larger four-year school is very crucial in their successful graduation with an engineering or computer science Bachelor's degree. Successful academic scholarship retention programs for transfer students have been in existence at a Carnegie Research I University for ten years with the assistance of grants from the National Science Foundation. As a part of this effort, we are continually trying to learn more about our engineering transfer students in order to better be able to interest them in engineering, to be able to encourage them to consider a career in engineering, and ultimately to be able to help them transfer to a four-year school to graduate with a Bachelor's degree, and, hopefully, also a graduate degree.

In this study done in Fall 2010, 61engineering and computer science transfer students taking an Academic Success Class sponsored by the National Science Foundation were surveyed to determine why and when they decided to go to a two-year college, when they decided on their major, and when they decided that they would transfer to a four-year school. The average age of the students was 24.5 years. Over 60% of the transfer students knew "from the beginning" that they would attend a four-year college. However, 21% did not know until they had attended a community college (CC) for up to three years that they would go to a four-year college. Only one-third of the transfer students knew that engineering or computer science would be their major before they attended a community college. The experiences of the transfer women are compared with those of the transfer men.

In this paper we consider the findings of the survey and the implications of this information. The late decisions of CC students to major in engineering or computer science mean that it is very important for four-year schools to reach out to CCs to encourage their students to consider engineering and computer science as a major and to continue on to a four year-school.

I. Introduction

As efforts continue to help the nation's competitive edge by strengthening the US engineering workforce, more attention is being focused on community colleges (CCs). As tuition rates soar,

many capable students choose to spend their first two years of post-secondary education at a community college. A CC offers small classes, lower tuition, and a short commute from home to save money on housing. A larger proportion of women and underrepresented minority students attend two-year colleges than four-year colleges. There are three basic steps for the process of a CC student to become an engineer: (1) having engineering and computer science on their radar as a good decision for their major, (2) the successful transfer to a four year college or university, and (3) the successful college or university retention to graduation.

The base setting for this paper is Arizona State University (ASU), a Carnegie Research I University and the largest public university in the nation with 72,254 students. The Ira A. Fulton Schools of Engineering is located on ASU's Tempe Campus, the largest single US campus with 59,794 students. There are over 4,400 undergraduates and 2,100 graduate students in engineering and computer science. In this paper, "engineering" includes computer science, but not construction.

In Fall 2010, ASU had three NSF grants which supported transfer upper division and graduate students. The primary scholarship funding for transfer students was an NSF S-STEM grant (#0728695) called CIRC/METS (Collaborative Interdisciplinary Research Community/Motivated Engineering Transfer Students) for 2008-2012. If transfer students in this CIRC/METS Program graduated and continued on to graduate school full-time right after graduating, they could receive a scholarship for up to four semesters from a CIRC Program for non-transfer students funded by NSF S-STEM (#0631189) for 2007-2011. These two programs featured $4,000 per year scholarships and an emphasis on females and underrepresented minority students. Since the ASU tuition and fees is under $9,000 per year, a $4,000 scholarship is a substantial sum for ASU students. A third program (2009-2014) supported by the NSF STEP Program (#0856834) is METSTEP (Motivated Engineering Transfer Students/STEM Talent Expansion Program). This program supports a METS Center at ASU for transfer students, activities for five non-metropolitan CCs (four are 3-4 hours away), $4,000 scholarships for students from five targeted CCs, and $300 scholarships for additional transfer students who choose to take an Academic Success Class and complete all of the assignments.

The goal of these three NSF grants at ASU is to produce more engineering graduates. To do this, we want to retain undergraduate students to graduation in engineering and to encourage engineering graduates to go right on to graduate school full-time. The retention rate to graduation for undergraduate scholarship students in the non-transfer (native) student program which concluded in 2011 was 98.3% and is 96% for the first three years of the current transfer student program. The graduation rate for Fulton upper division transfer students not in this scholarship program is only 70% for men and 64% for women. Nationally, less than 20% of engineering graduates go right to graduate school full-time. The CIRC and CIRC/METS Programs rates are 56.4% and 59%, respectively, for the non-transfer and transfer undergraduate

students going to graduate after graduating. Upper division transfer students who are not in this scholarship program are attending ASU graduate school after graduating at a rate of 11%. The scholarship transfer students for the past three years have attended ASU graduate school in engineering at a rate of 48% and all graduate programs at 59%. Four CIRC students and six CIRC/METS students are currently in PhD programs.

The criteria for the $4K academic-year scholarships are as follows:

- U.S. citizen or permanent resident
- Full-time upper division native or transfer students or graduate students who are from the CIRC or CIRC/METS programs
- Major in engineering or computer science
- GPA of at least 3.0
- Unmet financial need according to FAFSA

At least 60% of the students in the programs are female or underrepresented minority students (Hispanic/Latino, Black, or Native American).

In order to successfully graduate our program students, we not only provide them with a scholarship but acquaint them with tools to be successful through an Academic Success Class. In general, we put the bar very high for the students, tell them that they are capable, and follow that with information, support, encouragement, and intensive advisement. The ASU plan follows the recipe for success determined by others in the recent report: "A Matter of Degrees: Promising Practices for Community College Student Success".[1] The same practices which work well at the CC work well for the transfer student, especially in their first year of transfer. According to the report the fundamentals of a good success program include the following: a strong start; clear, coherent pathways; integrated support; high expectations and high support; intensive student engagement; design for scale; and professional development.[1]

A requirement of the NSF scholarships is that the students attend a one-semester credit Academic Success Class each semester. The course content changes each semester. Transfer students who do not have the $4,000 scholarship can complete the success course and earn a $300 scholarship (can be repeated once). In this way, since there are many more eligible student applicants than there are scholarships, more students, especially new transfer students, can get encouragement, learn coping and learning skills, and are able to learn the skills to excel academically. Other upper division engineering students may also enroll in the class. The class assignments are designed to make them better engineering students. This class presents material that is not found in the regular classroom.

The class content has been described in other recent papers[2-9]; however, for completeness, a short description is given here. The Academic Success Class has six 75-minute meetings per semester (each meeting is held 5 times to accommodate student schedules). The basis of the class is the

"Guaranteed 4.0" developed by Donna O. Johnson.[10] The students are taught how to develop a detailed time management schedule, which not only helps to organize their life, but reduces stress because the student can easily see the extra time they have to do unexpected assignments. Other meeting topics include:

- Resumes, Interviews, Working a Career Fair
- Research and Internship Opportunities
- Mentors
- Internet Research Data Bases
- Recommendation Letters
- Speakers from Industry with graduate degrees
- Panel of graduate students who "tell it like it is" (a favorite)
- Career and Life Planning for out to 10 years after the BSE

Even though our program based on the three NSF grants is successful, we are continually trying to learn more about our engineering transfer students in order to be better able to recruit more engineers. De Cohen[11] claims that "retention is not the problem: women aren't being drawn to engineering in the first place." Young women, in general, do not know what engineers do. Early education is very important. Visiting high schools with CC representatives to talk about engineering is part of plan of the METSTEP program. De Cohen also points out the need for "a better understanding of the many paths to engineering degrees, as our study and others suggest that women are likely to transfer into engineering."[11] No matter what the path, mathematics is needed as a foundation. Therefore, we visit mathematics and science classes in the CCs to point out the importance of these subjects to engineering and to encourage the students to take more math and science so they can have the option of studying engineering.

A survey by INTEL and Change the Equation of 1,000 teenagers showed that they are unaware of what engineers do.[12,13] The survey showed that teenagers were not avoiding careers in engineering because they think its geeky; they don't know what engineers do. The "survey showed 63 percent of the students ages 13 to 18 have never considered the career despite having generally positive opinions of engineers and engineering."[12] A factor in not considering engineering as a career includes the perception that engineering is difficult. The report also showed that about "one-third of teens can't name any potential job opportunities in engineering fields"….and "a full 20 percent of these teens have no concept of just how much engineering shapes the world around us."[12] Another interesting outcome of this survey was that "after learning that engineering majors make an average annual income of $75,000, 61 percent of teens said they were more likely to consider engineering, while more than 50 percent were enticed by the fact the unemployment among engineers is more than 5 percent lower than the national rate".[12] Even though this study suggests that the majority of students who choose STEM do so in high school, there are still many students who make their career decision in the CC or four-year college.

We are well aware that many of the CC students with whom we come in contact may be interested in attending a school other than ASU, but if we can get more students to consider and to choose engineering as a career, this will help our nation and our goals with NSF. Since the primary purpose of the NSF grants is to produce more engineers, the first step is to make sure that engineering is on a student's radar for career choices. Since many people do not have any idea of what an engineer is or does, we need to first interest the student in engineering. Once we have their attention, we then need to be able to encourage them to consider a career in engineering and ultimately to be able to help them transfer to a four-year school to graduate with a Bachelor's degree in engineering, and, hopefully, also an engineering graduate degree.

II. The Survey

It is assumed that the scholarship and non-scholarship transfer students in this program are quite typical of all engineering transfer students at ASU. Since transfer students must have a minimum 3.0 GPA to transfer into engineering, the requirement for a 3.0 minimum GPA for the scholarships should not make these students substantially different. Since the scholarships are competitive and GPA is one criterion, the scholarship students may have a slightly higher GPA than the average transfer student. Over 90% of the ASU transfer students who request consideration for financial aid are able to prove that they do have unmet financial need.

This paper is based on a survey of 61 engineering transfer students in Fall 2010. These students are now either in school, have graduated and are employed, or are in graduate school. These transfer students from the three separate NSF programs described above were all enrolled in a one semester credit Academic Success Class in the Ira A. Fulton Schools of Engineering. All 61 transfer students in the class were surveyed and are representative of the over 150 transfer scholarship students who have participated in these programs since 2002. The Academic Success Class credit does not count toward a Program of Study, but the grade for the course does count in the GPA. In Fall 2010, 61 of the 98 students enrolled in the class were transfer students:

- 31 $4K Scholarship transfer students not from non-metropolitan CCs
- 13 $4K Scholarship transfer students from the five non-metropolitan CCs
- 1 $4K Scholarship transfer student was in graduate school
- 11 transfer students earning $300 scholarships
- 5 other transfer students

Thirty-one of the 61 students were in the CIRC/METS S-STEM program for upper division transfer students. One transfer student, a graduate student in Fall 2010, was part of the CIRC program. Thirteen students, from non-metropolitan CCs, were part of the METSTEP program. Eleven students earned a $300 scholarship (funded by the METS grant) for successfully completing the homework assignments in the Academic Success Class that semester. The remaining 5 students were non-scholarship transfer students taking the class.

These transfer students completed the survey at the end of Fall 2010. Of these students, 62.3% were female or underrepresented minority. See Table I.

	Female	Male	Totals
Minority	5	20	25 (41%)
Non-Minority	13	23	36 (59%)
Totals	18 (29.5%)	43 (70.5%)	61 (100%)

Table I. Gender and Ethnicity Distribution of Survey Students

In order to learn more about the students and to better understand their path to engineering, the students were asked questions about:

- Demographics/ Family commitments/ Work hours/Graduate study
- Commuter time/Ability to study during commute?
- When did you know you would go to a CC?
- When did you know you would go to a 4-year school?
- Why did you choose the first college school?

III. The Analysis

The range of the female ages is 17-35, with an average of 24.5 years. The range of the male ages is 18-39, with an average of 24.6 years. The family commitments are shown in Table II.

	Pre-ASU	Now (time of survey)
Females	12 (66.7%)	9 (50%)
Males	15 (34.9%)	18 (41.9%)
Totals	27	27

Table II. Transfer Student Family Commitments Before and After Transfer

We note that the number of females with family commitments decreased after they came to ASU, but the number of males with family commitments increased. Over 44% of these transfer students had family commitments at the time of the survey when they were enrolled at ASU.

Many CC students were successfully able to work quite a few hours each week while taking a large load of classes at the CC. A problem that most of them find is that they are not able to do this as easily at the university. The students are warned that if they work 20 hours per week, the largest class load they should take is 12 semester hours (or 13 hours with the Academic Success Class). It is interesting to note (See Table III.) that the students did lessen their hours of work after they were at ASU. The students were now paying much higher tuition at the university than at the CC, but many of them were also receiving a $4,000 per year scholarship to help offset the cost. Some of the students were also able to receive additional scholarships.

Hours Worked/Week During Academic Year				
	Females		Males	
Hours	Pre-Transfer	Fall 2010	Pre-Transfer	Fall 2010
0-8	4	7	13	17
10-15	0	6	5	9
16-20	5	4	5	12
21-25	4	1	5	2
26-30	1		4	2
31-40	2		10	
40+	2		1	1

Table III. Transfer Student Hours Worked/Week Before and After Transfer in Fall 2010

We can see from Table III that none of the transfer women students were working more than 25 hours per week and only one male transfer student was working more than 30 hours per week, while 11 of them had been before transferring. We also note that 14/18 =77.8% of the women were working 10 hours or more per week and that only 26/43 = 60.5% of the men were working 10 hours or more. Single moms may have been a factor in this difference.

Many of the transfer students have to travel for some time to come to the university. Most of them were living close to a community college before they transferred. We asked the students about their travel time and if they were able to use any of that time for working on their classes. The results are shown in Table IV.

One-way Commuter Time	Females	F - # Who Can Study	Males*	M - # Who Can Study
≤ 30 minutes	8 (44.4%)	3	27 (65.9%)	2
31 minutes – 1 hour	6 (33.3%)		10 (24.4%)	7
≥ 1 hour	4 (22.2%)	2	4 (9.7%)	1
Totals	18		41*	

Table IV. Transfer Student Commuter Time by Gender and Ability to Study Enroute

*Two males did not report.

We note that a larger percentage (over 50%) of the female transfer students have a commute longer than 30 minutes, while only 34% of the male transfer students have a commute this long. Only 15 students reported that they were able to use any of their commuter time to study. The students who said that they could study while they commute were doing so on a bus or light rail transportation system that serves ASU and some outlying areas. Students report that sometimes the light rail transportation system is standing room only and under these circumstances is not very conducive to studying. One male student said he could study while carpooling. One female student listens to lecture tapes while she drives. When studying on the light rail is mentioned in a class meeting, there is usually at least one student who will respond to this suggestion as a great idea that they had not tried.

Since we make outreach trips to community colleges, we wanted to know if these efforts make sense. When do students who eventually transfer to a university decide that they will go to a CC, rather than a university or no college at all, and when do they decide to go on to a university? Table V shows the breakdown of answers to the first question.

When did you know you would go to a CC?			
When	**Females**	**Males**	**Totals**
From the beginning	1	7	8 (13.1%)
Middle School	3	1	4 (6.6%)
High School: Freshman/Sophomore Year	0	6	6 (9.8%)
High School: Junior/Senior Year	8	12	20 (32.8%)
Other	6	17	23 (37.7%)

Table V. CC Decision to Attend a Community College by Time and Gender

We can see from Table V that most of the decisions to go to a CC were made during the last two years of high school or by some other event occurring. Some males made this decision as freshman or sophomores in high school, while no females did. This is consistent with research that males in high school tend to make career decisions such as their college and major earlier than females do. It is interesting to note what some of the "other" situations were when a student chose to go to a community college. Some of the "other" reasons are:

- Last minute decision after withdrawing from HS and getting a GED
- After two or more years of work after HS
- After low grades at a university
- No money to go anywhere else
- After meeting the girlfriend's parent ("You will be going to college, right?")
- After coming to the US and learning the difference in the price of tuition between a university and a CC
- Event in family that required student to stay close to home

Since a majority of these students knew "from the beginning" that they wanted to go to a four-year school, we wanted to know why they choose their first college which was a CC in most cases. Table V reveals the responses. The students were asked to check all reasons that applied.

Why did you choose your first college school? Please check all that apply.			
Reason	**Females**	**Males**	**Total**
Low Tuition	14	34	48
Close to Home	10	30	40
Smaller Classes	11	21	32
Friendly profs who enjoy teaching	6	17	23
Individual assistance/Interaction with profs	7	14	21
Didn't know major	5	14	19
Education is good/better	4	13	17
Ample free parking	4	10	14

Table V. Choice of First College by Reason and Gender

Low tuition, close to home (saving rent and gas money), and smaller classes were the top three reasons for attending (in most cases) a CC. These reasons seem compatible with students who have unmet financial need when attending a university.

An even more important question for university outreach programs is "When did you know you would go to a four-year college or university?" When is the best time to talk to CC students about going on for a four-year degree? Table VI gives us the answer. It is somewhat surprising to note that over 60% of these students intended "from the beginning" to go to a CC and then to transfer to a four-year school. For university outreach teams, this means that there is a large audience at the CC interested in learning more about four-year schools, who can use encouragement. We need to remember that the students in this survey did all transfer to a four-year school with a major in engineering or computer science. Perhaps an even more important statistic seen in Table VI is that, over 21% of these students made the decision to transfer to a four-year school in engineering or computer science while they were at the CC. These are the students (and others like them) who were undecided when they entered the CC. Perhaps it was a case of the parents telling their child to go to a CC and save money until they know what they want to do and then help will come for them to go to a four-year school. This line of reasoning also makes sense when we recall that all of these students had unmet financial need.

When did you know you would go to a 4-yr College/University?			
When	**Females**	**Males**	**Totals**
From the beginning	13	24	37 (60.7%)
High School: Freshman or Sophomore	1	3	4 (6.6%)
High School: Junior or Senior		4	4 (6.6%)
Between HS/CC	1	1	2 (3.3%)
1st Year CC	2	3	5 (8.2%)
2nd Year CC	1	5	6 (9.9%)
3rd Year CC		2	2 (3.3%)
After working		1	1 (1.6%)

Table VI. Decision to go to a 4-yr College/University by Time and Gender

To better understand the decision process for these students, we asked them why they choose their particular first college. Table VII show these reasons. A popular reason for students to use to choose their first post-secondary school was if they had attended school there while in high school. The students were familiar with the campus and instructors and the transition was easy. There were many other reasons however as seen in the table. Only a few students chose their school because they were not confident of their academic ability or had done poorly in high school. A few students choose their college because they were offered a scholarship. Four of the students had a sports scholarship.

Why Choose First College?			
Reason	**Females**	**Males**	**Totals**
Attended school while in HS	5	5	10
No HS diploma/Did poorly in HS	1	5	6
Step to preferred school/^GPA	1	5	6
Can carry full load while work full-time	3	3	6
Not sure could make it at 4-year school	1	4	5
Little or no homework for some classes	2	2	4
Needed to improve English	1	0	1
Other	5	12	17
Scholarships	1 (sports)	3 (1 sports)	

Table VII. Choice of First College by Reason and Gender

The other reasons that students chose their particular first postsecondary school included:

- To review: had been out of school for a while
- Close to work
- Provided day care
- Had convenient night classes
- Had on-line classes so could work full-time
- Gave in-state tuition while 4 year school wouldn't
- Needed to be close to family to help
- Helped to establish residency

IV. Study Comparison

A similar survey was made of transfer students in the CIRC/METS program who were enrolled in the Academic Success program in Fall 2007. The results of this survey were published in 2008 with all 25 of the transfer students in the program responding to the survey.[3] In the 2008 survey, 36% of the transfer students were women compared with 29.5% in this current study. The average age of the women in Fall 2007 was 24.7 years compared with 24.5 years in Fall 2010. The average age of the men in Fall 2007 was 26.3 years compared with 24.6 years. In Fall 2010, 66.7% of the females had family commitments pre-ASU compared with only 34.9% of the males. At the time of the 2010 survey, only 50% of the females had family commitments, while 41.9% of the men had family commitments. In the 2007 survey both females and males had more family commitments after they were at ASU: the percentage of females increased to 77.8% and the percentage of males increased to 37.5%. About 60% of both females and males were working over 8 hours per week in the current study, while in 2007 66.7% of the females and 68.8% of the men were working, showing very little difference between the groups.

When asked why they chose to attend a community college (or their first college), the number one answer in 2007 was "less expensive" with 60% of the students naming this as a reason. In 2010, 78.8% of the students named "low tuition" as their number one reason. "Close to home" was the second most selected reason for their college choice for both groups with 32% of the

2007 students and 65.5% of the 2010 selecting this reason. No other reason had more than a 16% response for the 2007 group. On the other hand, of the 2010 group 54% choose their school for smaller classes, 37.7% for friendly profs who enjoyed teaching, 34.4% for individual assistance or interaction with profs, and 31.1% who didn't know what they wanted to major in.

An interesting difference between these groups is that in 2007, only 2 (8%) of the students "knew from the beginning" that they would eventually go to a four-year school. A large number of students, 37 (60.7%), of the 2010 class "knew from the beginning" that they would attend a four-year school. Of special interest is the fact that in 2007, 72% of the students decided on a four-year school while in the CC. Only 23% of the 2010 class decided on a four-year school while at a CC.

V. Summary and Conclusions

The students in this survey were all full-time, transfer students with at least a 3.0 GPA, with unmet financial need, and majoring in engineering or computer science. The females and the underrepresented minority students made up 62.3% of the 61 participants. These 61 participants are all of the transfer students enrolled in the Academic Success class for Fall 2010. Both females and underrepresented minority students were overrepresented in this survey from their representation in the general student population of engineering and computer science majors. These students are also older than most upper division students. The average age for the females was 24.5 years and for the males, 24.6 years. We strongly suggest that other schools learn the characteristics of their transfer students to better understand how to recruit and to retain them at a four-year college or university.

Over 44% of these transfer students had family commitments. Over 55% of the females travel more than 30 minutes one way to attend school and while only 34% of the males do so. Only a very few can study while they are commuting to or from school. The students worked much less during the survey time than they did before they matriculated. Most of the students worked 20 hours or less as advised by the director of the Academic Success Program. Many of these students had $4K scholarships, but still over 61% of the females and 68.4% of the males worked 10 or more hours per week. These characteristics show that these transfer students have many activities demanding their time and that detailed time management properly used could be very important and helpful for these students.

Only 30% of these students knew they would be attending a CC or their first college by time they reached high school. Nearly a third of the students made this decision during their junior or senior year in high school. This information supports our visits to local high schools with the non-metropolitan community colleges in our METSTEP grant. At these visits, we are encouraging students to consider engineering and to attend their local CC. Nearly 40% of the students had special circumstances that helped steer them to a CC. The most common reasons

for going to a CC were: low tuition, close to home, smaller classes, friendly professors who enjoy teaching, and the individual assistance and interaction with professors. Not knowing their major was the next most mentioned reason for going to a CC (31.1%). About 25% of the students did not know that they would go to a four-year college or university until after they were out of high school. This means that there are many students at the CC level who need information and encouragement to go on to a university and to consider an engineering or computer science degree. This is good evidence that community college visits are very important to increasing the number of engineers in the US.

The most common reason given for selecting their particular first college school was that they had attended school there while in high school. The transition was familiar and easy. This could possibly be used as supporting evidence that bringing CC students to a university campus can increase the number of student who will transfer to a larger and more intimidating campus. Once they have visited the campus, seen the transfer center and met its staff, met students who have transferred from their CC, and met with advisors, the visiting CC student may feel more comfortable about transferring. The complete list of reasons for first school choice included a variety of reasons including: close to work, day care available, convenient night classes, on-line courses, in-state tuition available, and the need to be close to family.

An additional part of this study including: when did you decide on engineering or CS for a career, when did you decide on your major, what were your expectations and fears on transferring, and what was your reality after transforming will be reported in another paper.

This study confirms what we thought we knew about transfer students. Females tend to have more family commitments than men, both before and after transferring to a four-year school. The fact that a larger percentage of the females than males had commutes over 30 minutes was new information. These statistics tell us that the women in the program may need extra encouragement and support in handling their full schedule. The evidence from the earlier study told us that there were many CC students who had not yet decided on a major or whether they would continue past the CC. The results from this study are even stronger with a larger percentage of students (32.6% for males, 27.7% for females) choosing a CC because they do not know what they should select as a major.

This study justifies and calls for visits to community colleges, especially non-metropolitan community colleges, to talk about careers in engineering and computer science. There are many students (23% in the survey) who made their decision to attend a four-year school while they were at the community college.

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