Career Planning by Women Engineering Students

Mary R. Anderson-Rowland
Arizona State University

Abstract

In this study, women and men mostly undergraduate students were asked to plan their first ten years after graduating in engineering or computer science. The students in the study are all academic scholarship students in a program sponsored by a grant from the National Science Foundation's S-STEM Program or by funding from the National Action Council for Minorities in Engineering (NACME). Most of the students have a GPA of at least a 3.0 and all have unmet financial need according to FAFSA. An emphasis of the programs is on women and underrepresented minority students.

In addition, to a $4,000 scholarship per academic year, the scholars attend six workshops per semester and turn in assignments related to the workshops. The workshops focus on time management with the 4.0 Plan, learning more about engineering opportunities, writing a good resume, interviewing well, and considering graduate school right after graduation with the Bachelor's degree. To help put graduate school on the radar screen of the students, each year a graduate student panel speaks and answers questions on graduate school and engineers with advanced degrees, who work in industry, come to speak with the students.

This study analyzes the results of the students' plans by gender, ethnicity, and if the student is a community college transfer, to discover if there are differences in the groups and if there are any patterns that would suggest a change in future programming for these students.

I. Introduction

Since the Fall of 2002, academic scholarship programs have been held in the Ira A. Fulton School of Engineering at Arizona State University (ASU). ASU with over 67,000 students on four campuses now has the largest enrollment of any public institution in the nation and the Tempe campus with over 53,000 students is the largest single campus. The Ira A. Fulton School of Engineering (without counting Construction majors) had close to 6,000 students in Fall 2008.[1] Of the near 6,000 students, 3,759 were undergraduates and 2,222 were graduate students. About 300 students transfer into the engineering school each year, mostly from local community colleges.

Since ASU is a large campus and the Ira A. Fulton School of Engineering is a large school, we need to encourage engineering and computer science diversity students both to ensure a better education for our students and for the nation's research programs and leadership. For

these reasons, the author began to direct academic scholarship programs in the fall of 2002. An emphasis of each of these programs is for women and underrepresented minority students to enroll, to participate, to graduate, and to go on to graduate school full-time. The author leads three programs. The first, since 2002, a program for upper division engineering students (henceforth in this paper engineering shall imply both engineering and computer science), is sponsored by the National Science Foundation (NSF). This program was funded for five years on a $400K CSEMS grant (#0123146) and is in its second year of a $500K S-STEM grant from NSF (#0631189). This program is called the Collaborative Interdisciplinary Research Community or CIRC. In 2003 a second academic scholarship program was begun on a $400K CSEMS grant from NSF (#0324212). This program is similar to the CIRC program, but is focused on transfer students only. This program is called CIRC/METS where the METS stood for Maricopa Engineering Transfer Students since at that time we were working with 6 community colleges in Maricopa County, the same county location as ASU. The METS now stands for Motivated Engineering Transfer Students since we are currently working with three non-metropolitan community colleges in Arizona and plan to soon work with an additional two. After five years of this funding for transfer students, the program is continuing with an S-STEM grant for $600K from NSF (#0728695).

Both of these programs are designed especially for women and underrepresented minority students and during the years of the program, on average, 60% of the students have been female, underrepresented minority, or both. In both programs the students need to be US citizens or permanent residents, have a GPA of at least 3.0, be full-time upper division engineering students, and have unmet financial need as determined by FAFSA. To apply, the students need to complete an application, including a statement of purpose, and to furnish two letters of recommendation, at least one of which must be from a professor. In most cases, if a student completes the application and is eligible, the student is selected into the academic scholarship program on a first-come, first served basis. The students in both programs must attend six meetings per semester and do assignments.[2,3] The yearly scholarship stipends for the CSEMS programs was $3,125 which covered most of the tuition in the early days of the grant. The yearly scholarships in the S-STEM programs are now $4,000.

A third academic scholarship program, also begun in the fall of 2003, is a program for underrepresented minority students funded by the National Action Council for Minorities in Engineering (NACME). Holding the program exclusively for minority students was disallowed after the first year and so additional non-minority students were added to the program and supported by the Ira A. Fulton School of Engineering. The application and criteria are the same as those for the first two programs except these scholarships are available for lower division engineering students and a slightly lower GPA is required. The scholarships are up to $2,500 per year. For five years a two-credit hour academic success class was held for entering engineering freshmen who held NACME scholarships. The freshmen met every other week during their second semester and then six times per semester after that.

During the workshops for these three academic scholarship programs, the students are given instruction on how to manage their time and learn well with a system (the Guaranteed 4.0 Plan[5]), how to write a resume, how to put together a portfolio, and how to interview and to

work a career fair. They are encouraged to participate in research as an undergraduate student either through research programs available at ASU or through summer Research Experience for Undergraduates (REU) programs which are sponsored by NSF at universities across the nation. The students are also encouraged to do an industry internship to get a better idea of what engineering is all about and to notice the different types of jobs done by engineers with Bachelors, Masters, or PhD degrees.

Since many engineering students do not have any idea about graduate school or believe that graduate school is only for those going into academia, the students are encouraged to think about, plan for, and to go to graduate school full-time right after their Bachelor's degree. Only about 18% of engineering students in the nation go right on to graduate school after graduation. The percentage of students who complete an engineering graduate degree while working full-time in industry is very low. An academic scholarship program assignment is to research three universities where they might go to graduate school after they graduate. The students are asked to critique why each school would be a particularly good school for them to attend or why it would not be a good choice. The students are also asked to critique why it would be good or bad for them to go right on to graduate school or to wait and work in industry first and have the company pay for their graduate work. Students are told that, especially if they are going for a PhD, their selection of a research advisor is a much more important decision than the choice of a particular school.

Academic and engineering speakers with graduate degrees are brought in as workshop speakers throughout the program. These speakers and the graduate student panel (usually students who have gone through the same academic scholarship program) are the favorite programs for the students. The program students especially enjoy asking questions of the graduate students and are surprised to learn that graduate school is not really hard, it is different, and that in graduate school the classes taken are, in general, ones in which you are interested. The term "imposter syndrome" usually became a topic of interest. Some of the graduate students can tell the undergraduate students that they, too, had felt that even though they had good grades as an undergraduate, they really didn't know much, and someone was sure to find out. The graduate students can assure the undergraduates that they do not have to be a genius to do graduate school, that they, themselves, are not geniuses, but, with reasonable good work, they can do graduate school.

Also attending the workshops are a few students who do not hold academic scholarships currently. These include students who have lost their scholarship due to low grades or transfer students who are earning a $300 scholarship for attending and doing the assignments and are hoping to be selected for a scholarship the next semester. A few students lose their scholarship because they no longer have unmet financial need, but choose to continue to participate in the workshops.

II. Career Planning

Throughout the program meetings, representatives from Career Services at both the School and University level, come as speakers to help the students. A major theme of Career Services is to start planning ahead early. For example, the students are urged to register with Career Services with their resume on file, even as freshmen. As a registered student, the

student will receive information on industry visits and openings. As a freshman or sophomore, it is good to practice doing career fairs, interviewing, and networking with several companies. If a student waits until they are a junior and then expects to be able to get an internship immediately, the student may be disappointed. Career Services has put together a "Career Planning" book for students that reminds them of activities they should begin doing each year in order to prepare themselves for graduation.

In the academic scholarship seminars, the students are given help in writing a good resume. A special resume checklist was developed that the students can use to determine if they have a good resume. [6] In evaluating their resume, the students are trained to look for gaps in the resume to help their career planning. Gaps in a resume can be remedied by evidence that shows good engineering skills. Another career planning tool used in the academic scholarship program is portfolios. At the end of each semester, the students are required to turn in a portfolio with all of their assignments. Included in the assignments are one or two artifacts per semester that the students are to select to show a project or accomplishment which in turn shows good engineering skills. The artifact is a page or two describing or showing an excellent report, a presentation, a project, or effort.[7]

In general, many students have not been encouraged to do life/career planning for after graduation with a Baccalaureate degree other than if they are going to industry or to graduate school. In Fall 2008, students from the three programs described above were asked to plan out what they would do for the first ten years after they received their undergraduate degree. The basic demographics of this group of 54 students by transfer status and gender is given in Table 1.

	Transfer Students	**Non-transfer Students**	**Total**	**%**
Female	7	11	18	33.3
Male	18	18	36	66.7
Total	**25**	**29**	54	
%	46.3	53.7		100.0

Table 1. Demographics of student by Gender and Transfer Status

Next, we consider the underrepresented minority students. Of the 24 minority students, one is Native American, three are African American, and twenty are Hispanic or Mexican American. Table 2 shows the numbers of students by minority status and gender.

	Underrepresented Minority Students	**Non-Underrepresented Students**	**Total**	**%**
Female	5	13	18	33.3
Male	19	17	36	66.7
Total	**24**	**30**	54	
%	44.4	55.6		100.0

Table 2. Demographics of student by Gender and Ethnicity

The assignment instructions given to the students were simply: "Give your career plan for each of the first 10 years after you complete your Bachelor's degree." The answers received varied from 10 lines to a page discussion of the ten years. Table 3 gives the primary information extracted from the 54 responses. Unless otherwise stated the Master's and PhD degrees are in engineering or computer science.

Plan	Female	Male	Total
No Graduate School	0 (0.00%)	2 (5.566%)	2 (3.70%)
PhD Engr. F/T	8 (44.44%)	15 (41.67%)	23 (42.59%)
PhD Engr. P/T	1 (5.56%)	1 (2.78%)	2 (3.70%)
Master's Engr. F/T	5 (27.78%)	12 (33.33%)	17 (31.48%)
Master's Engr. P/T	2 (11.11%)	5 (13.89%)	7 (12.96%)
MBA P/T	2 (11.11%)	1 (2.78%)	3 (5.56%)
Grad School Delayed	5 (27.78%)	5 (13.89%)	10 (18.52%)
Industry	16 (88.89%)	22 (61.11%)	38 (70.37%)
Consulting/Auditor/ Own Company	6 (33.33%)	8 (22.22%)	14 (25.93%)
Research	0 (0.00%)	4 (11.11%)	4 (7.41%)
Government	1 (5.56%)	4 (11.11%)	5 (9.26%)
Academia	0 (0.00%)	3 8.33%)	3 (5.56%)
Travel/Global	2 (11.11%)	1 (2.78%)	3 (5.56%)
Mission	1 (5.56%)	1 (2.78%)	2 (3.70%)
Family	2 (11.11%)	6 (16.67%)	8 (14.81%)
Totals	18 (33.3%)	36 (66.7%)	54 (100.0%)

Table 3. Summary of Results for Short Career/Life Planning Exercise.

Since the career planning assignment was so open, there was a wide variety of detail in the responses. Only a few students mentioned marriage and a family. Some of the students are already married and have children. One student plans to reduce her efforts in industry at a certain point and focus on a family for several years. It is interesting to note the large number (25.93%) of students who plan to consult, own their own company, or be an auditor. These numbers may have resulted because consultants have spoken in the seminars, as well as an auditor, who showed the students that you can be an auditor on the side of an industry job or make it a full-time job. She also pointed to the advantages of becoming an auditor by being able to apply what you learn in auditing to being a better manager and engineer. A few students want to take a year off after the baccalaureate degree and then to hit graduate school full-time. Others want to work for a couple of years and then go to graduate school full-time. Still others plan to work and let their company pay for their Master's degree. Two students intend to work after graduation and to earn a PhD part-time while they are working.

It is of interest to see if the transfer women have different career aspirations from women engineering students who began as freshmen at ASU. A notable difference in the first two years would be that the students at ASU are exposed to research opportunities through their

professors and the Ira A. Fulton's School of Engineering's Fulton Undergraduate Research Institute (FURI) program. In this program undergraduates write a proposal to be selected to receive funding for working several hours a week on research with a professor and the professor is also given a small stipend. In addition, funding is given for materials and partial funding is available for the student to travel to a conference to present the research findings. Because the transfer students have not been "around" research, they may be less likely to plan to go to graduate school.

Table 4 shows the graduate school plans and timing of the students by gender and if they are a transfer student. Since the plans are so varied, with many students including an MBA in their plans, several footnotes are given to the table to better explain the student's plan. Most students in the program initially think that the MBA is the degree to get after a bachelor's degree in engineering. They believe that the degree may be quite a bit of work, but it will certainly be easier than the engineering courses they have just gone through. They also generally believe that an MBA is the best shortcut to management and a higher salary. The testimony of the engineers with graduate degrees who speak at the seminars tell the students that a technical graduate degree can best help the engineer be the manager of interesting projects and the graduate degree will help them to gain respect due to their technical expertise. At a later time an MBA may be helpful to their career.

	Transfer Students		**Non-Transfer Students**		**Total**
	Male	**Female**	**Male**	**Female**	
PhD F/T	5	3[1]	10	3	21
PhD P/T	1			1	2
Master's F/T	7[2]	1[3]	3	4[4]	15
Master's P/T	1		2		3
Later Ph/D F/T		1		1	2
Later Master's F/T			2[5]		2
Later Master's P/T	2	2[6]			4
Later MBA P/T	1			2	3
No Graduate School	1		1		2
Total	18	7	18	11	54

Table 4. Graduate School Plans by Transfer Student, Gender, Degree, and Graduate School Start Time (F/T = full-time and P/T = part-time)

[1]One student will take a year off before beginning an MD/PhD program, one student intends to earn her MBA along with the PhD.

[2]One student is undecided between Master's F/T or PhD F/T; one student is undecided between Master's F/T or later Master's P/T; three students intend to follow the Master's F/T with an MBA or Business in Engineering degree P/T.

[3]Student is undecided between Master's or PhD F/T now or a Master's or PhD later.

[4]Two students intend to take a break after the Master's degree and then get a PhD F/T; one student intends to follow the engineering Master's with an MBA P/T.

[5]A civil engineering student expects to earn a Master's degree in Construction Management after working a few years.

[6]One student is undecided on an engineering Master's or an MBA; both students intend to work for a few years before the Master's degree. and then to enroll F/T in a PhD program;

Table 5 shows the data by whether the student is an underrepresented minority student or not and by gender on the same categories we used in Table 4.

	Underrepresented Minority Students		Non-Underrepresented Students		Total
	Male	**Female**	**Male**	**Female**	
PhD F/T	8	2[1]	7	4[2]	21
PhD P/T	1			1	2
Master's F/T	4[3]	1[4]	6[5]	4[6]	15
Master's P/T	3				3
Later Ph/D F/T		2			2
Later Master's F/T			2[7]		2
Later Master's P/T	2			2[8]	4
Later MBA P/T			1	2	3
No Graduate School	1		1[9]		2
Total	19	5	17	13	54

Table 5. Graduate School Plans by Underrepresented Minority Status, Gender, Degree, and Graduate School Start Time (F/T = full-time and P/T = part-time)

[1]One student will take a year off before beginning an MD/PhD program.
[2]One student also intends to earn an MBA about the same time as the PhD
[3]One student is undecided between Master's F/T or later Master's P/T; one student intends to follow the Master's F/T with an MBA P/T.
[4]Student intends to do a PhD F/T later.
5Two students are undecided between Master's F/T or PhD F/T; two students intend to follow the Master's F/T with an MBA or Business in Engineering degree P/T.
[6]One student will take a year of travel before beginning the Master's degree and will follow with an MBA P/T, one student intends to work for a few years after the Master's and then to enroll F/T for a PhD, one student in undecided between a Master's or PhD F/T or a Master's or a PhD F/T later.
[7]A civil engineering student expects to earn a Master's degree in Construction Management after working a few years.
[8]One student with a family is undecided on an engineering Master's or an MBA.
[9]Student was recently asked by new employer if he was interested in graduate school. He said "yes".

In the next section, we analyze and discuss the data in Tables 2, 3, and 5.

III. Analysis and Discussion of Data

In looking at Tables 4 and 5, we note that two-thirds (66.67%) of the students plan to go right on to graduate school full-time. This percentage is very high. As was mentioned earlier, nationally less than 20% of engineering graduates go right on to graduate school. In these academic scholarship programs where graduate school has been emphasized, approximately 40% of the graduating engineering students who were not transfer students have gone on to graduate school full-time. Several of these students are now in PhD programs. For transfer students, about 30% have been going on to graduate school full-time after graduation. These high percentages are a testament to the academic scholarship programs which emphasize graduate

school as a good thing and that it is easiest to go to graduate school full-time right after graduation rather than at a later time. As an added incentive, students in the CIRC or CIRC/METS program can continue to get their annual $4,000 scholarships for the first two years of graduate school if they go right on at ASU. Additionally, in the last few years, several ASU engineering departments have begun the integrated BS/MS program whereby students can get permission to take three courses (9 semester hours) that double count for their undergraduate degree and as hours in a Master's program. Several scholarship program students have taken advantage of their offer. Each department has a minimum GPA that must be met before a student is accepted into this integrated program.

At the same time, we must remember that all of the students in this study had unmet financial need when they were selected for the programs. Students with debt upon graduation will be more inclined to want to go to work and to get rid of the debt. Most of the transfer students transferred from a community college. Many students choose the community college because the tuition and other costs are much lower than at a four-year school. Therefore, it can be expected that transfer students are not only less likely to know very much about graduate school, but also more likely to want to work to pay off debts upon graduation and have a company pay for their tuition for a Master's degree.

The 66.67% is intended, not actual, graduate school attendance, but nonetheless the number is encouraging. We see that the percentage of women planning to go to graduate school full-time is just slightly lower than the percentage for men. Interestingly, 25 of the students are planning on obtaining a PhD degree and the percentage of women and men are approximately the same, with a slightly higher percentage of women. Five of the students intend to get an MBA degree part-time while working in industry.

Several students are undecided on their plans. Tables 3, 4, and 5 display the best guess or first choice of plans for each student. Some of the indecision is given in notes below the table. Eleven of the 18 female students (61.11%) plan to go full-time to graduate school right after attaining the Bachelor's degree. Twenty-five of the 36 male students (69.44%) plan to go right on full-time to graduate school after completing their Bachelor's degree. We see then that the percentages are approximately the same for females and males. Several of these students are already in integrated BS/MS programs so have already taken three graduate courses before they graduate with an engineering degree. If we look at the students based on transfer status, 16 of the 25 transfer students (64%) intend to go right on full-time to graduate school. If we consider the students who did not transfer, 20 of the 29 non-transfer students (68.97%) plan to go right into graduate school full-time. In total, 36 of the 54 students (66.67%) plan to go straight to graduate school. The probability of each student going on to graduate school varies since the students range from sophomores to a few students already in graduate school. Since these percentages are considerably higher than the percentages of students who have already graduated, it will be interesting to see how many of the students follow through with their plans. It is very encouraging, however, to note that only two students of the 54, both males, do not plan to do any graduate work. As noted on Table 5, one of these students (with an excellent GPA) just graduated, accepted a job in a university city, and was asked in his interview if he was considering graduate school. The student said that he was.

From Table 5 we see that 15 of the 24 underrepresented minority students (62.5%) intend to go to graduate school full-time immediately for either a Master's or a PhD. Ten of the 24 minority students plan to get a PhD degree full-time (41.67%). On the other hand, 21 of the 30 non-minority students (70%) plan to go to graduate school full-time after the Bachelor's degree for either a Master's or a PhD and 11 of the 30 non-minority students (36.67%) intend to pursue a PhD degree full-time. These percentages are rather close with slightly more non-minority students going on to graduate school percentage-wise, but slightly more minority students going for a PhD percentage-wise. Four out of the five minority women (80%) plan to get a PhD, which is higher than any other classification. It is clear that work needs to be done to get more minority women into the academic scholarship programs.

If we consider the total number of students who plan to get a PhD, 13 of the 24 minority (54.2%) intend to do so, but only 12 of the 30 non-minority students (40.0%) plan to get a PhD.

IV. Conclusions and Future Plans

Based on the plans of the women, all 18 expect to go to graduate school either right after the Bachelor's or a little later. Eleven of the women (61.11%) plan to go right on to graduate school. This is especially encouraging because we know that the numbers are very low of working engineers that actually come back to school and complete a degree. Nine women (50%) plan on earning a PhD. Six women are planning to go on for a PhD in engineering right after graduation. One of these women has been admitted to a PhD program and will begin her PhD program in Fall 2009. It would seem that the academic scholarship program is being successful at encouraging women to go on to graduate school.

The numbers show that there should be more efforts to recruit minority women into the program. The data and analysis do not show any area of program weakness for either women or minority students. Therefore based on this conclusion, there do not seem to be any major changes that should be made in the program to better accommodate women or minority students.

For this first career planning exercise discussed in this paper, the students were just given one open question: "Give your career plan for each of the first 10 years after you complete your Bachelor's degree." In order to better evaluate the program and to assist the students in putting more effort into their career plans, this study is being followed by a second study where the Spring 2009 students were given the following assignment:

- Write a 3-5 page essay on: (1) How the NACME, CIRC, or CIRC/METS Program helped or did not help you (what things helped the most); (2) How you worked with the 4.0 Plan; (3) Which assignments helped you the most, (4) Your thoughts about graduate school, (5) Your plans for the next five years, and (6) Describe your dream situation 10 years from now (where would you be living, married?, children?, own your own home?, what vehicles will you own?, position, company, hobbies.)

The replies to this assignment will be analyzed both as an evaluation of the program and as the career plans of the students. Based on the results, the assignment will be revised for Fall 2009.

References

1. Office of Institutional Analysis, Arizona State University, http://uoia.asu.edu/files/ensmry/Enrollment_Summary_Fall_2008.pdf , accessed on 3/17/09.
2. Anderson-Rowland, M.R., "Retention, Graduation, and Graduate School: A Five-Year Program Focusing on Women and Underrepresented Minority Engineering and Computer Science Students," Proceedings of the American Society of Engineering Education Annual Conference, Pittsburgh, PA, June 2008, 10 pages.
3. Anderson-Rowland, M.R., Grierson, A., "An Academic Scholarship Program for Transfer Students in Engineering and Computer Science: A Five Year Summary," Proceedings of the American Society of Engineering Education Annual Conference, Austin, TX, June 2009, 15 pages.
4. Anderson-Rowland, M.R., Ruben, C., "Academic Achievement and Retention in a Minority Engineering Program," Proceedings of the American Society of Engineering Education Annual Conference, Pittsburgh, PA, June 2008, 13 pages.
5. Johnson, D,O. & Chen, Y.C., *Guaranteed 4.0*, Second Edition, JCYC Studio, Dallas, TX, 2004.
6. Anderson-Rowland, M.R. & Culley, P.I., "Helping Lower Division Engineering Students Develop a Good Resume," Proceedings of the 2007 American Society for Engineering Education Annual Conference & Exposition, Honolulu, Hawaii, June 2007, 8 pages, and www.asee.org
7. Anderson-Rowland, M.R. and Sharp, J.E., "Helping Students (and Ultimately Faculty) Write an Effective Recommendation Letter," 38th ASEE/IEEE Frontiers in Education Conference, Saratoga Springs, NY, 5 pages. http://www.fie-conference.org/fie2008/index.htm