

AC 2008-2649: RETENTION, GRADUATION, AND GRADUATE SCHOOL: A FIVE-YEAR PROGRAM FOCUSING ON WOMEN AND UNDERREPRESENTED MINORITY ENGINEERING AND COMPUTER SCIENCE STUDENTS

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Retention, Graduation, and Graduate School: A Five-Year Program Focusing on Women and Underrepresented Minority Engineering and Computer Science Students

Abstract

The Collaborative Interdisciplinary Research Community (CIRC) program was initiated in Fall 2002, in the Ira A. Fulton School of Engineering, supported by a CSEM grant from the National Science Foundation. With a no-cost extension, the grant of \$400,000 for four years actually supported the program for five years. The primary purposes of the program were to help academically sound junior and senior engineering and computer science students with financial need to improve retention, to expand their horizons about the field of engineering, to provide professional improvement, and to encourage the students to go on to graduate school right after completing their Bachelor of Science in Engineering or Bachelor of Science (in Computer Science) degree. Students received CIRC scholarships of up to \$3,125 per academic year, depending on unmet financial need. The program focused on women and underrepresented minority engineering and computer science students who made up close to 60% of the total enrollment in the program.

Sixty-seven CIRC students participated in the program with 49 of the 62 (5 entered the program as graduate students) undergraduates graduated with a Bachelor's degree and 20 of these students immediately enrolled in graduate school (41%, compared with 17.9% nationally). The program retention is 97%. Forty-two percent of the participants have been female and 25.4% of the participants have been minority students. A total of 39 CIRC students are either minority or female (58.2%). The average GPA of the Spring 07 students was 3.61.

This paper will review the major lessons in program improvement learned over the five years. Also included in the paper are summaries of program events, evaluations, and observations by program participants.

I. Introduction

In Fall 2002, the first 22 scholars were admitted to the National Science Foundation (NSF) supported CSEMS Collaborative Interdisciplinary Research Community (CIRC) Program (Grant # 0123146). The program was established to help more women and underrepresented minority students graduate with an engineering or computer science degree. However, above this, we wanted the students to be exposed to research, to graduate school, and to the value of the graduate degree in industry, as well as academia. The primary purposes of the program were to help academically sound junior and senior engineering and computer science students with financial need to improve retention, to expand their horizons about the field of engineering, to provide professional improvement, and to encourage the students to go on to graduate school right after completing their Bachelor of Science in Engineering or Bachelor of Science (in Computer Science) degree. Students received CIRC scholarships of up to \$3,125 per academic year, depending on unmet financial need. The program focused on women and underrepresented

minority engineering and computer science students who made up close to 60% of the total enrollment in the program. Through the programming, the CIRC students were exposed to topics not normally found in the classroom such as portfolios, writing a good resume, and talks by practicing engineers on what it is “really like in industry”. The program has been determined to be very successful and is being continued with an NSF S-STEM grant.

II. Program History

This first group was composed of 12 transfer students, 9 women, 5 minority students, and 2 freshman minority students who were unable to attend Arizona State University without scholarship assistance. All of the students had at least a 3.0 GPA and all were in need of financial assistance as determined by their FAFSA. The program started somewhat tentatively the first semester as we experimented with meetings (with refreshments) and gave the students assignments that they needed to put into a portfolio. From the beginning the students recognized that they were being treated as “special scholars” and were afforded insights into engineering, the School, and the workplace that most engineering students never encounter. The program quickly took shape with six hour-long meetings each semester.

From that first group of 22, 20 graduated from engineering or computer science with their Bachelor’s degree (average GPA 3.34), one transfer student dropped out from ASU after two semesters with a low GPA, and one student transferred to pre-business and is still working on his degree. Of the 20 graduates, 11 had GPAs over 3.5 and all but one had GPAs over 3.0. Seven of the students went on to graduate school, four of them into PhD Programs.

Six of the CIRC transfer students were transferred to the Collaborative Interdisciplinary Research Collaborative/Maricopa Engineering Transfer Scholars (CIRC/METS) Program, a second CSEMS NSF grant that began in Fall 2003.

Twenty new students joined the CIRC program in Fall 2003. In this group 13 were women and 7 were underrepresented minority students. Eighteen of the students completed their Bachelor’s degree in engineering or computer science; one student who came in as a graduate student completed her Master’s degree in engineering; and one student left the program with a 3.59 GPA for no known cause.

In the 2004-05 year five new students, including one woman became CIRC scholars. All five have completed their bachelor’s degree and one completed his Master’s degree at the end of Fall 07.

Twelve new students joined the CIRC Program for the 2005-06 academic year. Three students were women and three students were underrepresented. One of these students was both. Six of these students have completed their Bachelor’s degree in engineering or computer science. Four are still enrolled in their undergraduate program. Two women students joined the program at this time as graduate students. One woman has completed her Master’s degree and the second is still working on her PhD. Three of the students went on to graduate school after completing their Bachelor’s degree, one in a Master’s program and two in a PhD program.

Finally, 8 new students became CIRC scholars during the fifth and last year of the program, 2006-07. This group included four women and two underrepresented students, one of whom is female. Of this group three have graduated and all three are enrolled in PhD programs. Two of these new students were graduate women. One of the women is completing her engineering Master's degree in Fall 07 and the other is still enrolled in her engineering PhD program.

A summary of the degree achievement of the 67 program participants is shown in the following table:

Acad. Year	Total New Students	F	M	Underrepresented Minority	BSE/BS earned	BSE/BS enrolled	Total On to Grad School	MSE/MS earned	MSE/MS enrolled	PhD enrolled
2002-03	22	9	13	5	20	1 (bus.)	7	2	3	4
2003-04	19	12	7	6	18	0	7	4	3	0
2004-05	5	1	4	0	5	0	1	0	1	0
2005-06	10	1	9	3	6	4	3	0	1	2
2006-07	6	2	4	2	3	3	3	0	0	3
Totals	62	25	37	16	52	8	21	6	8	9
Percentage	100%	40.3%	59.7%	25.8%	83.9%	11.3% Engr. 12.9% total	40.4%* (21/52)	11.5% (6/52)	15.4% (8/52)	17.3% (9/52)

TABLE I. Summary of CIRC Program Undergraduate Participants 2002-2007 as of September 2007.

*Minimum known students to go on to graduate school

In summary, we note that the retention rate of the undergraduate students admitted to the CIRC program is 96.8% at ASU and 95.2% in the Ira A. School of Engineering. Only two students dropped out of the program: one was a new male transfer student who withdrew after one year of low grades and the second was a female who inexplicably withdrew with a 3.59 GPA.

The purpose of the program is to not only to retain and to graduate the students in good stead but also to encourage them to go on to graduate school. To date, at least 40.4% of the students have gone on to graduate school and all but two enrolled in an engineering Master's degree. Two of the students went into MBA-type programs. Since the national rate of engineering graduates going on to graduate school is about 17.9% nationally, the CIRC graduates are attending

graduate school well over double the national rate. It is gratifying to report that over 17% of the CIRC graduates are currently PhD students.

An emphasis of the program has been to support women and underrepresented minority students. Over 40% of the undergraduates accepted into the program have been women and over 25% minority students, considerably higher than the general undergraduate representation by women (17.6%) and underrepresented minority (19.5%) students in the Engineering School.

Five students, all women, were admitted to the CIRC Program as graduate students. Two women have completed their Master's degree and one will complete her Master's degree in December 2007. The other two women are working on their PhD degrees. One had a CIRC scholarship early in her PhD program, but is now funded by research support, which is the goal for all of the PhD students. Only a limited number of students are admitted to the CIRC program as graduate students. In the future, only first and second year graduate students will be given CIRC scholarships. Students who enter the CIRC program as undergraduates, graduate, and go on to graduate school can expect CIRC support, if needed, for their first two years of graduate work. Table II below summarizes the status of the graduate student participants in the CIRC program.

Acad. Year	Total New Students	F	M	Under-represented Minority	MS/MSE earned	MSE/MS enrolled	PhD enrolled
2002-03	0	0	0	0	0	0	0
2003-04	1	1	0	1	1	0	0
2004-05	0	0	0	0	0	0	0
2005-06	2	2	0	0	1	0	1
2006-07	2	2	0	0	0	1	1
Totals	5	5	0	1	2	1	2
Percentage	100%	100%	0%	20%	40%	20%	40%

TABLE II. Summary of CIRC Program Graduate Participants 2002-2007 as of September 2007.

III. The CIRC Program

The CIRC program has been described in some detail in earlier papers.^{1,2,3} However, for readers who are not familiar with the program, a short review will now be given. The CIRC scholarship is advertised on the School's scholarship website. The main draw of the CIRC program is the renewable \$3,125 scholarship per academic year, which covers most of the tuition. Students must apply for the scholarships, provide a personal statement, and two letters of recommendation, at least one from a professor. In addition to unmet financial need as

determined by FAFSA, to be eligible for the CIRC program the student must be a US citizen or permanent resident, be enrolled full-time in the Fulton School of Engineering at ASU, and have a minimum 3.0 GPA. Once a student has been accepted into the CIRC program, the student must sign a letter of acceptance and write a thank you letter to the sponsor of the program. Only when these last two items are complete will the Fulton Scholarship Office award the scholarship.

The CIRC program consists of three facets: the scholarship, workshops, and assignments for a portfolio. Six 50-minute workshops are held each semester. Each particular workshop is held three times in one week (with the scholars from a similar academic scholarship program for transfer students) to accommodate the various student schedules. Scholars are allowed to miss one meeting per semester with an excuse, but have to do a makeup meeting and all assignments are still due. The first workshop of each semester is focused on the Guaranteed 4.0 Plan developed by Donna O. Johnson.⁴ Some of the workshops include topics presented by Career Services on topics such as resumes, interviewing, negotiating, portfolios, and career planning. Other programs include engineering speakers from industry (usually with a graduate degree), speakers from academia, and panels of graduate students to “tell it like it is.” An additional meeting includes information on the school’s research program opportunities for which the scholars are encouraged to apply.

The students are given assignments throughout the semester as a part of the CIRC program. At the beginning of each semester the students send a copy of their course schedule and must develop a detailed time management schedule of all 168 hours of the week which include the main building blocks of the 4.0 Plan: bullet point reading, bullet point notes, homework, bullet point concepts, and professor office hours for each class, as well as the their class and work times. There are a few more assignments designed to help the student stay on task with their time management plan. The students are given a checklist to help them with their time management plan.⁵ An updated resume is required each semester and brief summaries of the workshop programs including 3-5 new items they learned from the program. Another assignment includes speaking to a professor to discuss his/her research and to inquire about research positions or to collaborate on a proposal for a School-sponsored research grant. The scholars are asked to research graduate schools, to pick three that they might attend, and to give reasons why and why not that school would be a good school for them. The students are also asked to give five reasons why it would be advantageous to go right on to graduate school after completing the BSE and five reasons why it would be better to go right to industry. The assignments change from semester to semester and there are other options for students already doing research or who are enrolled in graduate school. (Students who are enrolled in the program can be supported for two years of graduate school with a CIRC scholarship if they continue to be qualified for the program.) Additionally, the students are asked to select one or two artifacts for their portfolio. At the end of each semester, the students are required to turn in a portfolio with their assignments in sheet protectors.

The purpose of the assignments is to make the CIRC students better engineers and to have a broader and more enlightened view on engineering opportunities and graduate school. During the academic year, the program director passes notices on to the students of the availability of internships and research opportunities in industry or other academic institutions. The director

often writes letters of recommendations and several students have been successful in obtaining one of these valued positions.

The program of six workshops each semester consistently earned high ratings by the student participants. Each workshop is opened with food (to help make the students feel special) and an icebreaker, such as “describe one or two highlights of your Christmas break.” The icebreaker encourages the students get to know one another and to network. A special emphasis on how to learn has been a part of the CIRC program since spring 2005. At the beginning of the fall semester when new students joined the CIRC program, the first workshop was used to introduce CIRC students to the Guaranteed 4.0 Plan created by Donna O. Johnson. In the first meeting of the spring semester, the students were asked to talk about which parts of the 4.0 Plan worked best for them and gave their resolve to follow the Plan more closely the new semester. Listening to how other students successfully used the 4.0 Plan encourages students to commit to a time management schedule that includes all of the steps of the Guaranteed 4.0 System.

This learning system has been scientifically proven to work by an independent evaluation team and by many engineering students. After the presentation each semester, the students were given several assignments to help guide them into using the Plan. The assignments were checked by the author or a student hired to help with the scholarship programs. At the beginning of the Spring semester, the author gave a pep talk on doing well in the coming semester and encouraged use of the 4.0 Plan. A sample of student remarks (Spring 2007) about the 4.0 Plan and graduate school follow:

- 4.0 Plan has been helpful in improving grades and securing graduation. Speakers and grad student panels encouraged me to apply to grad school.
- I already had good grades, but the organizational part of the 4.0 Plan has helped me keep my grades up. I was not planning on attending grad school beforehand, but CIRC has helped me decide that I need to.
- This program has made me decide that I do want to attend grad school!
- (4.0 Plan) slightly helped grades, but biggest help (HONESTLY!) was getting me to think about grad school. Now I’m going.
- I have realized what a good choice graduate school is for me. CIRC has contributed to my decision to stay at ASU for grad school.
- I went and talked to my advisors about taking grad classes next year. Still not sure I want to go.
- I am a Manufacturing Engineer. I do intend on getting a Master’s. If I didn’t attend the CIRC program I wouldn’t have considered graduate school.

IV. Graduate School

Many engineering students do not go to graduate school because they never really thought about it for themselves. Usually not much about graduate school, the different types of Master’s degrees, and its application process is known to undergraduate students. Many engineering students have an attitude toward graduate school built on myths. Two strong myths are that graduate school is only needed by those engineers who wish to go to academia and become professors and that if you get a graduate degree before you go into industry, you will be overqualified and not able to secure a job.

The use of engineers with graduate degrees from industry was especially effective in showing the students the value of a graduate degree in industry and the many opportunities that were available to an engineer with a graduate degree. The students are shown that the jobs for which an engineer with a Master's degree would be overqualified are not the jobs that would be interesting and challenging over the long haul. The students are told that in fact one local manufacturing company, which hires many engineers from ASU, is currently hiring at least 50% of the engineers with graduate degrees.

Once or twice a year the students also met with a graduate panel of students who described graduate school to them, compared it with undergraduate work, discussed selection of an advisor, and talked about the challenges and rewards of doing graduate work. The CIRC students were also able to ask questions of the graduate students and appreciated getting the information from students actually in graduate school in engineering or computer science. As students in the program graduated and went on to graduate school, they were able to be excellent panelists for the undergraduate students in the CIRC program. Each time a panel of three or four graduate students speaks, the audience is ready with many questions about graduate school.

Some of the CIRC students have taken advantage of the recently developed BSE/MS programs in the college where an undergraduate student can apply to this program while still an undergraduate and be essentially accepted into a graduate program. The student can take up to three classes (9 semester hours of credit) in the undergraduate program of study and have these classes also count as 9 semester hours in the Master's program. Students are encouraged to take advantage of this offer which makes admission into graduate school very easy and shortens the time and money needed for the graduate program with only 21 more semester hours required for a Master's degree.

Some of the CIRC students had decided on graduate school before they entered the CIRC program. Some of the CIRC students were thinking about graduate school before they entered the CIRC program and had their thinking solidified into attending graduate school. Some of the entering CIRC students had never thought about graduate school or had decided that they definitely were not going to go to graduate school because they wanted to go to industry. Many changed their minds and decided that graduate school was the right way to go after graduation.

General end of the semester (Spring 2007) evaluation remarks by students on which CIRC program components were helpful to them include:

- Good prep for grad school
- Really enjoyed the career services and industry speakers
- All features of the program helped me become a better student and future employee
- All of the career service meetings and the leadership type meetings were very useful and informative
- The guest speakers from career services and industry helped convince me to stay on for grad school. I was also made aware of career services available to me on campus
- Got me thinking about graduate school
- Industry speakers, graduate student panels, career service speakers

- Dr. Anderson has guided me on applying for scholarships. The meetings have helped me get a better idea of what graduate students do after finishing
- The resume workshops, portfolio workshops, and representatives from industry (networking)

V. Program Evaluation

Each meeting of the semester ended with the students giving a short evaluation of the meeting. The evaluations were typed by the author and distributed to the students at the next meeting. Students were encouraged to ask questions on the evaluation form and the author would then answer the questions on the summary sheet of evaluations. The summary evaluation sheet for the last meeting was then distributed at the beginning of the next meeting. In this way the students could read the questions and answers and obtain more information about the School of Engineering and its academic program. The summary evaluation sheets were also a good way to give feedback and thanks to special speakers for the workshops.

Based on comments from the graduate student in CIRC, for the Fall 07 semester, the graduate students met separately from the other CIRC students. The graduate students then had some different speakers and also participated in the graduate panels for the other CIRC students and also for the transfer students who were in a second NSF sponsored CSEM academic scholarship program. One of the meetings for the graduate students featured two PhD students who were advanced in their programs and who discussed their observations of graduate school.

Each year the workshops include topics such as: research, resumes, how to interview, creating a portfolio, taking the GRE, and other such topics. The students were always eager to listen to engineers with graduate degrees who work in industry and to talk with a graduate student panel. The students were encouraged to develop their own portfolio and as such, each semester they were asked to select one or two additional artifacts of which they are proud and which go in their portfolio. At the end of the semester, the students are required to submit all of their assignments in a portfolio with sheet protectors.

Administrative support funds were primarily used to support a half-time student to check the assignments that were given to the students to help them as students, to encourage research, and to encourage matriculation into graduate school. Administrative support funds were also used for the modest refreshments at each of the six meetings per semester. The fare varied from pizza to subs with healthy food included such as fruit and veggie trays. In this way the students were treated as “special.” The students were appreciative of the excellent facilities that were provided by the Engineering School for the meetings and the refreshments that were provided by the grant. Fortunately, the present facilities for the CIRC academic scholarships program include a kitchen with refrigerator, freezer compartment, microwave, and a sink. These facilities allow food, bottled water, and pop to be stored between meetings and allow refreshments to be served with ease.

Checking assignments such as time management schedules and resumes can be very time consuming. In order to empower the students to make better schedules and to write better resumes, the author developed a Check List for the time management schedule and also, in

collaboration, a Check List for a resume.⁶ At the same time, use of the Check Lists reduced the time taken to check assignments and made it easy for the checker to point out how the time management schedule or resume could be improved.

As the program added new cohorts of students and older cohorts were still in the program, the challenge was to keep the assignments basic for the new program students, but flexible to keep it fresh for the returning students. A good solution to this problem was to give assignments with options: if the student was already doing research, they were to report on that research; if they were not doing research, then they were to learn about the research interests of a faculty member and then make an appointment to discuss the research and to explore the possibility of doing research with that professor. Assignments were designed to help the student talk with professors and to become engaged in research. Assignments to explore graduate schools and to evaluate why they would or would not be a good place to study encouraged the students to think about graduate school.

The students learned networking and at the same time received tips about being a good engineering student and how to navigate the system. The author and program director was a mentor to the students and often was asked for guidance on issues about their academic or personal life. The director sent notices of undergraduate summer research positions, internships, jobs, and other opportunities regularly to the CIRC students. In turn, the director was often asked to write letters of recommendation for these positions or for admission to graduate school. The author taught the students to send an updated resume and the draft of a recommendation letter that they would like to have written about them. This resulted in strong recommendation letters and saved the author time in producing the recommendation. A recommendation letter Check List is currently being developed with a colleague.

The author believes that the main reason that many of the students in this program decide to go on to graduate school is that they have learned of the increased opportunities available in industry for an engineer with a graduate degree and for the first time considered graduate school as an option after the BSE degree. They have also listened to role models in graduate school who encourage them with “If I can do graduate school, you can do graduate school.” They have also had many of their myths about graduate school dispelled. The students are pleased to learn that they can switch engineering fields for graduate school and that most departments in the Fulton School of Engineering have BSE/MS programs that allow easy entrance into graduate school and nine credit hour can double for the BSE and MS.

The author believes that the financial aid the students receive in this program is not a major factor in deciding to go to graduate school. Because the students have unmet financial need, they are more likely to be thinking about working and earning a good salary as soon as possible to pay off debts and to not go further in debt. However, when they learn more about a graduate degree, how hard it is to go back to school after working in industry (even if industry pays for the schooling), how few engineers actually go back to get a Master’s degree after they begin working in industry, and learn that there is good financial support to go on to graduate school (in addition to the CIRC scholarship), many decide that they do want to go to graduate school right after their degree. Therefore, the extra attention and support that these students receive should work as an excellent approach to recruiting graduate students at other institutions without the

scholarship support of this program. However, the scholarship support makes the students a captive audience for two or more years and they are required to listen and to learn about graduate school many times, as well as to do assignments on graduate school, such as researching what three graduate schools would be the best for them and giving five reasons why they should and five reasons why they shouldn't go to graduate school full-time right after their Bachelor's degree. Often students will say that only after several programs on graduate school were they convinced that full-time graduate school was for them. A few students will decide that graduate school is for them, but family obligations preclude them from going to graduate school full-time and so they make sure that the company that hires them will support graduate school part-time while they work full-time.

In summary, the CIRC Program was judged very successful. The average GPA of the 26 CIRC students who were enrolled during Spring 07 was 3.57. The program was continued in Fall 07 with a National Science Foundation S-STEM grant. The PI and the students are very grateful to the National Science Foundation for providing the much needed financial support and programming for the 67 students through the CIRC Academic Scholarship Program.

Bibliography

1. Anderson-Rowland, M.R., "Evaluation of a Program to Encourage Underrepresented Minority and Women Students to Become Interested in Research and to Attain Graduate Degrees," Proceedings of the 2006 WEPAN Conference, Pittsburgh, PA, June 2006, 13 pages.
2. Anderson-Rowland, M.R., Buckingham, P.A., and Zerby, D.L., "Increasing the Number of Minority and Women Engineering Students Obtaining a Graduate Degree," Proceedings of the 2005 WEPAN/NAMEPA Joint Conference, Las Vegas, Nevada, April 2005, 10 pages.
3. Anderson-Rowland, M. R., and Johnson, P. C., "Encouraging Underrepresented Minority and Women Students to Become Interested in Research and to Attain Graduate Degrees," Proceedings of the 2004 American Society for Engineering Education Annual Conference, Salt Lake City, Utah, June 2004, 8 pages.
4. Johnson, D.O. and Chen, Y.C., *Guaranteed 4.0*, JCYC Studio, Dallas, Texas, 2004.
5. Anderson-Rowland, M.R. and Newell, D.C., "Improving a NACME Class with an Emphasis on Detailed Time Management", Proceeding of the 2006 American Society for Engineering Education Annual Conference, Chicago, Illinois, July 2006, 12 pages.
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.