S-STEM Programs for Transfer and Non-Transfer Upper Division and Graduate Engineering and Computer Science Students

Dr. Mary R. Anderson-Rowland, Arizona State University

Dr. Mary R. Anderson-Rowland is the PI of an NSF STEP grant to work with five non-metropolitan community colleges to produce more engineers, but especially female and underrepresented minority engineers. She also directs two academic scholarship programs, including one for transfer students. An associate professor in Computing, Informatics, and Systems Design Engineering, Dr. Anderson-Rowland was the associate dean of Student Affairs in the Ira A. Fulton Schools of Engineering at ASU from 1993 to 2004. Dr. Anderson-Rowland was named a top 5% teacher in the Fulton Schools of Engineering for 2009-2010. She received the 2009 WEPAN Engineering Educator Award, the 2006 ASEE Minorities Award, the 2005 SHPE Educator of the Year, and the National Engineering Award in 2003. The National Engineering Award is the highest honor given by AAES. In 2002, Dr. Anderson-Rowland was named the Distinguished Engineering Educator by the Society of Women Engineers. She has over 180 publications primarily in the areas of recruitment and retention of women and underrepresented minority engineering and computer science students. Her awards are based on her mentoring of students, especially women and underrepresented minority students, and her research in the areas of recruitment and retention. A SWE and ASEE Fellow, she is a frequent speaker on career opportunities and diversity in engineering.

Dr. Armando A. Rodriguez, Arizona State University

Prior to joining the ASU Electrical Engineering faculty in 1990, Dr. Armando A. Rodriguez worked at MIT, IBM, AT&T Bell Laboratories and Raytheon Missile Systems. He has also consulted for Eglin Air Force Base, Boeing Defense and Space Systems, Honeywell and NASA. He has published over 200 technical papers in refereed journals and conference proceedings—over 60 with students. He has authored three engineering texts on classical controls, linear systems, and multi-variable control. Dr. Rodriguez has given over 70 invited presentations—thirteen plenary—at international and national forums, conferences and corporations. Since 1994, he has directed an extensive engineering mentoring-research academic success and professional development (ASAP) program that has served over 500 students. These efforts have been supported by NSF STEP, S-STEM, and CSEM grants as well as industry. Dr. Rodriguez’ research interests include: control of nonlinear distributed parameter, and sampled-data systems; modeling, simulation, animation, and real-time control (MoSART) of Flexible Autonomous Machines operating in an uncertain Environment (FAME); design and control of micro-air vehicles (MAVs), control of bio-economic systems, renewable resources, and sustainable development; control of semiconductor, (hypersonic) aerospace, robotic, and low power electronic systems. Recently, he has worked closely with NASA researchers on the design of scramjet-powered hypersonic vehicles. Dr. Rodriguez’ honors include: AT&T Bell Laboratories Fellowship; Boeing A.D. Welliver Fellowship; ASU Engineering Teaching Excellence Award; IEEE International Outstanding Advisor Award; White House Presidential Excellence Award for Science, Mathematics, and Engineering Mentoring; Ralf Yorque Memorial Best Paper Prize. Dr. Rodriguez has also served on various national technical committees and panels. He is currently serving on the following National Academies panels: Survivability and Lethality Analysis, Army Research Laboratory (ARL) Autonomous Systems. Dr. Rodriguez received his Ph.D. in Electrical Engineering from the Massachusetts Institute of Technology in 1990.

Ms. Anita Grierson, Arizona State University

Anita Grierson is the Director of the METS Center in the Ira A. Fulton Schools of Engineering at Arizona State University. She guides the activities of the METS Center and oversees its staff of engineering transfer students. Ms. Grierson has over twelve years corporate experience in Program Management, Business Development, and Biomedical Engineering, with products as diverse as air bag systems for helicopters, body armor, and orthopedic implants. She received her bachelor’s degree in Mechanical Engineering from the University of Michigan in 1990, her master's degree in Mechanical Engineering
from Northwestern University in 1994, and a master’s in Business Administration from Arizona State University in 2000.
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Abstract
Financing a college education is very difficult for many students. In the state of Arizona, many families cannot even afford the low tuition provided by a major public university. Since 2002, much needed National Science Foundation S-STEM scholarship programs have been held for upper division and graduate engineering and computer science students at Arizona State University. One S-STEM program is for upper division transfer students from local community colleges and out-of-state. A second S-STEM program is for non-transfer students and graduate students who have graduated through either of the S-STEM programs. Although the program is ranked highly by students and the scholarships, especially those for transfer students, have become very competitive, each year changes are made in an attempt to make the program even better. This paper describes recent changes that have been made to the program for improvement and in response to challenges.

I. Introduction
Higher education has never been more important to global economic competitiveness, yet it has never faced greater challenges in Arizona and across the nation. By 2018, 61 percent of all jobs in Arizona will require some postsecondary education. But at the nexus of educating and training an able workforce are the fiscal realities of a changing economic landscape that has affected higher education in Arizona like never before. Though workforce trends indicate the need for a more college-educated population, we know that geographic, monetary and cultural barriers keep many qualified students from finding their way to, or through, the doors of higher education. Only 52 percent of Arizona’s high school graduates pursue any form of higher education after graduating high school. Furthermore, only 17 percent of Arizona high school students have a bachelor’s degree six years after graduating high school. In order for our state to have the qualified workforce it needs, the Arizona University System must dramatically change the way higher education is delivered and increase the number of students who complete degrees.¹

Arizona’s high tech demand is served by three major public universities. Many Arizona parents are not able to afford a university for their children. Some communities are more than three driving hours from a major city. These conditions give rise to a very large community college (CC) system in the state. The Maricopa County Community College District is composed of 10 colleges with over 260,000 students in the Phoenix metropolitan area. There are 11 additional CCs in the state, with 9 of these being non-metropolitan CCs. Arizona State University (ASU), the new American University, is reaching out to take in CC students in the state. In particular, ASU’s Ira A. Fulton Schools of Engineering has been collaborating with five non-metropolitan CCs for over three years. These five schools serve over 46,000 students. Fortunately, all of the
classes at the CCs and at the three state universities are classified in a guide according to their equivalency at each of the schools.

In 2002 an academic scholarship program sponsored by an NSF CSEMS grant (#0123146) was begun in the Ira A. Fulton Schools of engineering for full-time, upper division engineering and computer science majors with unmet financial need. Half of the students the first year were transfer students. Seeing the need for an emphasis on helping new transfer students, in 2003 a second NSF CSEMS program (#0324212) was begun for full-time, upper division transfer students in engineering and computer science with unmet financial need. At first we tried to hold separate meetings, but scheduling soon precluded that and the two groups of students meet together. It is an advantage for the new transfer students to be placed with students who are familiar with the ASU campus and can assist in acquainting new students with critical resources needed to survive well as transfer students. Now several years later, we are still continuing these programs with two NSF S-STEM grants (#0728695 for transfers and #1060226 for non-transfers). The grant for transfer students is in its fifth and final year. This year transfer scholarships are also supported by a $100K scholarship grant by the ASU Women & Philanthropy organization. The NSF grant for non-transfer students is in its second year.

A program for new transfer students is particularly important at ASU since it is a Research I school and the largest public university in the nation with over 73,000 students. The Tempe campus which houses the engineering schools has over 58,000 students. It is quite a shock for transfer students to leave small classes, familiar professors, and free parking and to make their way at ASU. In Fall 2012, there were 440 new transfer students in the Fulton Schools of Engineering with most of them upper division transfers from Arizona community colleges.

II. Program Demographics
Both programs continue to prosper. There are many more applications for the programs than we have scholarships, so the program is limited only by scholarship funding. These academic scholarship programs are built on the premise that a scholarship by itself is not enough to give a student with unmet financial need. We believe that it is also necessary to give encouragement, stretch goals, tips for success, and quite close “tough love” in order to give a student their best chances for success. Therefore each scholarship student is required to enroll in an Academic Success and Professional Development class each semester. At first a no credit, then an optional one credit, then a required one credit, this class became a required two semester credit class in Spring 2013. This change was made at the request of the students. The class does not count on a program of study, but does count in a student’s GPA. The requirements for the scholarship students have remained the same since the beginning of the programs:

- Full-time student in engineering or computer science
- At least a 3.0 GPA
- Upper division standing in engineering or computer science
- US citizen, permanent resident, or refugee
- Unmet financial need as determined by FAFSA
Students without scholarships are allowed to enroll for the Academic Success Class as long as they are upper division engineering or computer science students. Note that hereafter in this paper the word “engineering” shall include both “engineering and computer science”. Grant funding of $300 is available for students who complete the success class without a scholarship if they meet the requirements of the scholarships. This funding can be earned for a maximum of two semesters. Even though most students will tell you that if they had known what the course entailed, they would have taken it for free, the $300 does work as a good incentive to draw in new transfer students to help give them a good start at a large university.

For the first three semesters of the scholarship program for non-transfer undergraduates and graduate students, called the CIRC (Collaborative Interdisciplinary Research Community) program, a total of 48 students have been awarded scholarships: 36 during the 2011-2012 academic year and 12 new students for Fall 2012. The graduate students in this program either graduated with a Bachelor’s degree while in this program as an undergraduate or while in the companion NSF S-STEM upper division program for transfer students. Minority students are those students identifying with the ethnicities of African American, Hispanic/Latino, and Native American.

The breakdown of the current CIRC students is as follows:

<table>
<thead>
<tr>
<th></th>
<th>Minority</th>
<th>Non-Minority</th>
<th>Total</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Female</td>
<td>3</td>
<td>12</td>
<td>15</td>
<td>31.3%</td>
</tr>
<tr>
<td>Male</td>
<td>18</td>
<td>15</td>
<td>33</td>
<td>68.7%</td>
</tr>
<tr>
<td>Total</td>
<td>21</td>
<td>27</td>
<td>48</td>
<td>100%</td>
</tr>
</tbody>
</table>

Table I. NSF S-STEM CIRC Students by Gender and Ethnicity.

We note that 33 of the 48 students (68.75%) are underrepresented in engineering: either a minority or a female or both. We have consistently had 60% or more of the scholarship students be underrepresented in engineering. Our program has nearly doubled the minority representation of our Fulton Schools of Engineering (43.7% vs. 22.4%). Although our percentage of females at 31.3% is 168% of the actual percentage of females (18.6%) in the Fulton Schools of Engineering, we would like to increase this percentage, especially for minority females.

In Table II we note the academic status of the students in the CIRC program. Of the 48 students, 15 were graduate students when they entered the program: eight in Fall 11, two in Spring 12, four in Fall 12, and one in Spring 13. One student received his BSE degree in Fall 11 and continued on full-time in a PhD program. Eight students completed their BSE in either the Spring or Summer Session of 2012. Of these eight, five went on to graduate school full-time, but one in business. Of the three who graduated in the Fall 12 semester, none went on to graduate school. At this point, 50% of the graduating students have gone on to graduate school full-time. This is more than double the national average, but less than the usual 60% mark that we have been achieving with these students. Only one of the undergraduate students has not been retained. A student in good standing did not enroll for Fall 12, giving a retention rate of 97% for
this program. Five of the 15 students who entered the program as graduate students have completed their Master’s degree. One graduate student withdrew in his third semester.

<table>
<thead>
<tr>
<th>STUDENTS</th>
<th>Fall 11</th>
<th>BSE 12/11</th>
<th>Spring 12</th>
<th>BSE 5/12 or 8/12</th>
<th>Fall 12</th>
<th>BSE 12/12</th>
<th>BSE Continuing to MSE</th>
<th>BSE Continuing to PhD</th>
<th>Continuing UGs</th>
</tr>
</thead>
<tbody>
<tr>
<td>Undergraduate</td>
<td>25</td>
<td>1</td>
<td>20*</td>
<td>8</td>
<td>22**</td>
<td>3</td>
<td>4***</td>
<td>2</td>
<td>22</td>
</tr>
</tbody>
</table>

Table II. Number of S-STEM CIRC Students by Academic Level
*One student received a large scholarship and no longer had unmet financial need and one student was dropped from the program as a disciplinary action. Both students are still enrolled at ASU.
**One student in good standing did not enroll this semester.
***One student continued to graduate school in Business

The program demographics for the CIRC/METS Program (#0728695) are a little less complicated since all of the students are undergraduates. Seventy-one students have had scholarships from this program. Forty-five of the 71 students (63.4%) are either female or underrepresented minority or both. The gender and ethnicity demographics are as follows:

<table>
<thead>
<tr>
<th></th>
<th>Minority</th>
<th>Non-Minority</th>
<th>Total</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Female</td>
<td>5</td>
<td>15</td>
<td>20</td>
<td>28.2%</td>
</tr>
<tr>
<td>Male</td>
<td>25</td>
<td>26</td>
<td>51</td>
<td>72.8%</td>
</tr>
<tr>
<td>Total</td>
<td>30</td>
<td>41</td>
<td>71</td>
<td>100%</td>
</tr>
<tr>
<td>Percentage</td>
<td>42.3%</td>
<td>57.7%</td>
<td>100%</td>
<td></td>
</tr>
</tbody>
</table>

Table III. NSF S-STEM CIRC/METS Students by Gender and Ethnicity.

The academic accomplishments of the CIRC/METS students is shown in Table IV.

<table>
<thead>
<tr>
<th>Year</th>
<th>Cohort</th>
<th>BSE/BS</th>
<th>Continuing to MSE</th>
<th>MSE Degree</th>
<th>Continuing MSE</th>
<th>Continuing PhD</th>
</tr>
</thead>
<tbody>
<tr>
<td>2008-2009</td>
<td>26</td>
<td>23</td>
<td>0*</td>
<td>7</td>
<td>1</td>
<td>5</td>
</tr>
<tr>
<td>2009-2010</td>
<td>17</td>
<td>12</td>
<td>4**</td>
<td>3</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>2010-2011</td>
<td>15</td>
<td>11</td>
<td>4</td>
<td>0</td>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td>2011-2012</td>
<td>13</td>
<td>3</td>
<td>10</td>
<td>0</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>2012-2013</td>
<td>0</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>71</td>
<td>49</td>
<td>18</td>
<td>10</td>
<td>8</td>
<td>7</td>
</tr>
</tbody>
</table>

Table IV. Number of S-STEM CIRC/METS Students by Academic Level
*3 students left the program: 2 left due to a family situation and are both enrolled at another engineering school.
**1 student switched majors to Infomatics which is not an engineering degree.

The retention to graduation of this group of students in STEM is 98.6% and in engineering is 97.2%. The retention to graduation in engineering at ASU is 94.4%. Forty-nine students (69%) have received their Bachelor’s degree and 25 (51%) of the students have continued on to graduate school. Seven of these students are in engineering PhD programs.
III. Programming
Graduate school is an emphasis in both S-STEM programs. The students are urged from day one to have graduate school in their plans. The students are told about the greater opportunities in industry with a Master’s degree and urged to keep a high GPA so they qualify for a “4+1” program in which two or three classes can be double-counted for the Bachelors and Masters degrees. A major factor causing hesitation by the students is financing for additional schooling. The students are strongly encouraged to become involved in undergraduate research which can lead to funded research for graduate school.

The first semester of the ASAP class is the most difficult as students are required to make a detailed time management schedule according to the Guaranteed 4.0 Plan by Donna O. Johnson. An additional new program feature is a special half-hour seminar given at the beginning of the semester by the course assistant and grader for students new to the class. In this seminar she explains the class and assignments in more detail and provides computer shells to make it easier for the students to do the class assignments. While there are basic materials that students new to the class need to hear, for students who have been in the program for over a year, some of this material is redundant. This past year, a concerted effort was made to have two programs at once from which the students choose to attend one. An example of this was to have a session on “Nuts and Bolts of Applying for Graduate School” for seniors, given by graduate students in the program, as well as a session on “Resumes and Working a Career Fair” given at the same time. This meeting was timed to occur shortly before the Fall Career Fair. Other changes included having students with the same major sit together in a meeting to become better acquainted and adding a sixth section of the meeting to accommodate all of the students’ schedules.

The second meeting of the fall 2011 semester was led by the second author on the topic “Getting Involved in Research”. The main message was that if students do not get involved in research by finding a topic that interests them, someone else will pick for them: when they go to industry they will go where assigned rather than follow a passion. Additional material on using computer databases for research and on writing a research proposal has been added to the Academic Success and Professional Development. The favorite program consisting of Graduate Student Panels again did an excellent job. Students in the program who go directly to graduate school after their Bachelor’s degree often cite the Graduate Student Panel as a convincing factor that gave them the courage to go on to graduate school. When students who are pondering graduate school hear their colleagues tell them that they can do graduate school, too, the students tend to believe them.

At the conclusion of each meeting, the students are asked to do an evaluation on the meeting. The students are asked to identify the most important topic, the most interesting information, and what they need to know more about. For the fifth meeting, the Director gathered the most common questions from the evaluations of the past several meetings and discussed them one-by-one with the students. The meeting included discussion and additional questions from the students. The meetings were successful in clearing up many of the questions for the students.
The last meeting of the semester included reports from students who had held NSF REUs, an internship, or a research position. The Director showed pictures of Egypt and Uganda, giving the students a little taste of different world cultures.

During the spring 2012 semester the meeting topics were: Planning Your Career for 10 Years Beyond the BS/E, How to Catch Up When You Get Behind, How to Do Research on the Internet and Write ‘n Cite, Sandia Lab representatives, Research Proposals, Financial Affairs 101, and a Networking and Celebration meeting at the end of the spring semester.

Although tried and true successful programming was used for the CIRC and CIRC/METS programs this year, several new assignments were also piloted. A greater emphasis was put on identifying mentors. Evaluations are taken each meeting. The students are asked to answer the following questions: What was the most interesting part of the meeting, What was the most important part of the meeting, What do you need to know more about, What suggestions do you have for changes or future meetings, and an evaluation on the food. Since many of these questions are repeated each semester and some students have questions they never ask, we decided that it would be useful to list all of these common questions on the internet, with answers. By having these questions and answers on the Internet, we could also direct community college students who were potential engineering or computer science transfer students to this site to help answer questions, dispel myths, and encourage students to study engineering and to continue until they receive at least their Bachelor’s degree, and better yet, go right on to graduate school.

Professor Rodriguez compiled an initial list of 136 common questions. We gave an assignment to all of the students in the Academic Success Class to rank their top 20 questions in order of importance. Students were also encouraged to identify important questions that they had that were not on this list. From these rankings, the top five popular questions were identified by gender, academic class, ethnicity, and by age (≤21 and >21). The results of this study have been published in two papers. By determining the most important questions to these students, we are using this guide to answer the most important questions first on the internet. The most important questions also give us a guideline on important topics to discuss with potential engineering students when we are encouraging students to consider engineering as a career.

A second pilot assignment involved trying to help students get involved in research. Dr. Rodriguez is available through this grant to supervise research. He believes that research is a means to understanding what you are really interested in. Students come to him and say they want to do research, but when he asks them what they are interested in, they do not have any direction. In order to help students find some direction, a research assignment was made which combined this problem with information given by an engineering librarian on internet research. The students were asked to select two short research proposals with 10 references for one topic using the methods shown by the engineering librarian and 5 references for a second topic. The 5 references could be identified by any method chosen by the student. The students were given
additional instructions on what needed to be written about the two topics. Through this pilot we learned that many students needed to have the assignment broken down into smaller steps. A revision was made in the initial assignment and will be further revised for next year.

We also asked the students to update or write for the first time a 10 Year Career Plan after the BSE Degree. The requirements for this assignment were updated from the year before based on an evaluation done by the students the year before. Last year’s students suggested several addition topics and some structure changes. This study was published and almost all of the suggestions were incorporated into this year’s version.7

The PI and co-PIs of CIRC and CIRC/METS continue to write, present, and publish papers on the programs.3-7

IV. Summary and Future Plans
The CIRC and CIRC/METS programs continue to flourish. Each year we are receiving more applications for the scholarships. There are especially many more applications for the CIRC/METS program than we have scholarships. It is estimated that over 90% of CC transfer students have unmet financial need. As more students learn about the programs by looking at our website, reading our emails, through word of mouth from students who are greatly benefitted by the program, we are having more students enroll in the Academic Success and Professional Development course. Our biggest challenge is the continued funding of scholarships.

The program growth is welcome, but our METS Center is beginning to be at capacity for certain times during the week. Student usage of the Center has tripled in the last four years. We are holding each meeting six times to keep the size under 30 students. The class has grown to be at the maximum that can easily be handled by one instructor.

We continue to look to improve the program especially the mentoring and tutoring programs. The center is being ably handled by the Center Director, who is also doing an excellent job of training and using transfer students to assist in the Center.

References