Motivated Engineering Transfer Students/STEP after Six Years

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Mary Anderson-Rowland, Arizona State University MARY R.ANDERSON-ROWLAND is the PI of an NSF STEP grant to work with five non-metropolitan community colleges to produce more engineers, especially female and underrepresented minority engineers. She also directs an Academic Success and Professional Development program, with an emphasis on transfer students. An Associate Professor in Computing, Informatics, and Systems Design Engineering, she was the Associate Dean of Student Affairs in the Ira A. Fulton Schools of Engineering at ASU from 1993-2004. Anderson-Rowland was named a top 5% teacher in the Fulton Schools of Engineering for 2009-2010. She received the WEPAN President's Award 2014, WEPAN's Engineering Educator Award 2009, ASEE Minorities Award 2006, the SHPE Educator of the Year 2005, and the National Engineering Award in 2003, the highest honor given by AAES. In 2002 she was named the Distinguished Engineering Educator by the Society of Women Engineers. She has over 190 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.

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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 multivariable control. Dr. Rodriguez has given over 70 invited presentations - 13 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. Personal Web site: http://aar.faculty.asu.edu/

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Abstract

Over six years ago, an experiment was launched: Could two engineering professors from a large university in the West successfully interact with five rural community colleges (CCs) in a win-win partnership? The results were successful enough after a one year experiment with three CCs, that a five year effort was funded by the National Science Foundation STEP program for five CCs in 2009. The effort is still successful and evolving in spite of administrative changes at all five CCs. This paper will describe the results of this program and some of the lessons that have been learned.

Major goals of this program are to interest and encourage more CC students to consider engineering and computer science for majors. Next, we seek to facilitate the transfer process for these CC students to a large, Research I university. This also includes encouraging and supporting transfer students after they have transferred. This support includes a center for transfer students, center employees who are transfer students to help other transfer students, scholarships, and a two-credit Academic Success and Professional Development Class. At the same time, we have the goal to help build the engineering program at each of the CCs.

This paper will summarize program results for the past six years, including successes and major challenges and barriers.

I. Introduction

In 2011, President Obama's jobs and competitiveness council announced that it was calling for a short-term goal of graduating 10,000 more American engineers each year to bring the total to about 130,000 annual graduates.[1] The United States needs more engineers for its economics and health both locally and internationally. As the need for more engineers in the US has grown, more attention has been focused on the community college (CC). Although many students attend CC due to lower tuition, smaller classes, and the proximity to their home, saving on both room and board. However, many students attend a CC because they are not sure of their major. Among the transfer students they we receive in the Ira A. Fulton Schools of Engineering, a study showed that 30% of them only decided on their major after they were at the CC. This study of 61 transfer students also showed that over 50% of these student did not decide on an engineering or computer science major until they were at the CC.[2] It is known that most CC students do not get an Associate Degree or go on to a four-year school. A study of California Community Colleges found that 70 percent of students did not complete a degree, certificate, or transfer to a university.[3] Henceforth in this paper, when we use the word "engineering," we mean both engineering and computer science.,

In 2002, an upper division NSF CSEMS scholarship grant (#0123146) was awarded to ASU for engineering and computer science majors. When it was noted that nearly 30% of the scholarship students were transfer students, we became aware of the special needs of transfer students. The next year we were awarded another CSEMS award (#) for an upper division program just for

transfer students. This program ran from 2003-2008 and was renewed for 2009-2014 (#). Therefore, we had experience in working with transfer students after they had transferred,

However, we realized that we could help transfer students further by making contact with them while they were at the CC. Not only could we help them with transferring, but we could encourage students who were thinking about engineering, but perhaps we could help to get them to consider engineering as a major and career. We worked with local CCs for several years with the assistance of an NSF grant (#). A primary activity of this project was to visit the CCs and hold "Be An Engineer" Days. Through working with liaisons at each CC and with mathematics and engineering professors who would let their students out of class to attend the hour event. The event included engineering student role models and industry representatives. We would usually draw audiences of 50-100 students. Through these events we were also able to advertise our NSF scholarship program funded by NSF. Even after the grant ran out, we continue to work with these CCs and attend engineering events on invitation.[4]

When this program ended, we looked for another way to work with CCs. We wanted to know if we could use what we had learned with the local CCs and apply this knowledge to non-metropolitan CCs. We applied for and received a one year exploratory grant to work with three CCs. One CC was only 45 miles away, but the other two were close to 3 hours away. The trips were mostly made by an electrical and an industrial engineering professor. We immediately noted that the same techniques which worked at a local CC did not necessarily work at a non-metropolitan CC. For example, while student role models could accompany us to local CCs, but for schools about 3 hours away, it meant a whole day out of school for a student to travel to the CC. Having a "Be An Engineer" event also did not work well. Usually there were not enough students in appropriate classes during the same hour to hold just one event, even if food was served. Also, CC students tend to work and so usually are on campus just for classes. We quickly learned that having a captive audience in a math, science, or engineering class was the best way to be able to talk with students and to have their attention. The class visits are arranged by a liaison at the CC with the cooperation of the class instructors. Our efforts with this experiment were successful enough for us to receive a five-year STEP grant from NSF (#). The program was called the Motivated Engineering Transfer – STEM Talent Expansion Program (METSTEP). We expanded our efforts from three to five non-metropolitan CCs, one with no formal engineering program and the other with a struggling engineering program.

II. METSTEP Goals

There are three primary goals with the METSTEP program. The first is to encourage and support students to consider a major in engineering. We have discussed that there is a considerable percentage of students at the CC who are unsure of their major. Since we are dealing with non-metropolitan schools, the students may have spent most of their time in a small town with very few role models by major, gender, or ethnicity. The percentage of underrepresented minority students is high among these schools and many of the students are the first in their family to even go to a CC, let alone a university. CC students also report that the Career Services in their school may not be very helpful. In addition, no engineering professors had ever visited any of these schools to talk to students about engineering.

We found that the best way to talk with students about engineering was in classrooms. We try to visit each CC each semester. For schools with more than one campus, we may visit one campus in the fall and the other campus in the spring. In some cases we have visited at one campus and connected with students at another campus through interactive video. In the beginning, some instructors were reluctant to give us much class time. We understand this reluctance and that large amount of material that they have to deliver. However, in most cases, after we had visited a classroom and the instructor heard our message, we were welcomed back and allowed to have more time, often a whole class period. We vary our presentation by the class. When we visit an engineering class, most of the students have already decided on engineering and are preparing to transfer. Therefore we emphasize the need to apply early and certainly by the February 1 scholarship deadline. Often CC students wait until they complete their studies in May and then apply to a university to begin studies the next fall. By the time the transfer is admitted, it is difficult to obtain the correct courses and the scholarship deadline is long gone. Our advice helps the student with transferring, no matter which university they choose.

When we visit with lower mathematics classes such as algebra or pre-calculus, we emphasize the importance of taking all the math and science they can in order to have more choices in a career. We complement them on being in a CC and assure them that they are getting a good education with a good instructor and that they should stay at the CC as long as they can take additional courses toward their major. For these classes, we try to put engineering on the student's career radar. At the beginning of the class, we often ask the students to tell us what career they expect to pursue. Many students do not have an answer. In other cases, we relate an area of engineering or computer science that is related to their interests. We explain that engineering is solving problems to help people and point out the wide variety of problems that are not going to go away soon. As a part of this goal, we are also focused on increasing the number of females and underrepresented minority students in engineering.

We are also interested in helping the students transfer and supporting them after they are at ASU. We hold a transfer orientation each semester. A CC liaison brings a car or vanload of students for a day's visit. The students see our METS Office and Center for transfer students, "a home away from home." They also network with role models, usually from their own CC. They also take a tour of part of the campus and attend a demonstration lab in materials.

Once the student transfer, we encourage them to use the METS Center to network, study, use the computers, use the free printing, and use the transfer students and Director there as supports and resources. We also encourage the transfer students to enroll in an Academic Success and Professional Development class, which is now a two-credit class where the grade counts in the GPA, but does not count in a Program of Study. In this class the students are presented a learning system, the Guaranteed 4.0 Plan; helped with a resume; an elevator speech; and information on how to work a career fair. An emphasis is placed on research and attending graduate school. A large help with interesting transfer students, is the availability of $4,000 scholarships for transfer students. Finances are a major worry for potential transfer students. Only students from the five targeted schools with unmet financial need are awarded scholarships through the METSTEP grant. A requirement of the scholarship is that the student enroll in the Academic Success and

Professional Development class. In this way we keep track of the students at least every two weeks and they are doing class assignments which help ensure their success. In addition, because we do not have enough scholarships for all qualified applicants, we award $300 scholarships from the grant to students who complete the Academic Success Class with an A. In this way, student can earn $300 twice while taking a class that helps them succeed. Many of these students would not have taken the class without the small scholarship incentive and thus we are helping more transfer students. However, some students take the course due to word-of-mouth advertisement and are not even aware of the $300 scholarship.

A third goal of the grant is to help build and strengthen the engineering programs in the CCs. The CC liaisons exchange information at meetings held once a semester. The CC liaison, dean over engineering, or chief academic officer of the school has changed in all five schools during the past six years. However, through it all, the program continues with renewed commitment by the newcomers to this program. An engineering program has been established at the one school which did not have engineering and the engineering programs at the other four schools have increased with more students and additional engineering faculty.

III. Lessons Learned

A primary lesson learned is that a program is as good as its people. We have been fortunate to have worked with excellent, passionate liaisons from each college. When we have come across CC representatives who were not committed to engineering, the CC has quickly recognized the situation and made a change for the better. This collaboration has been a true "win-win" and there has been complete trust from the beginning. We are not trying to take CC students away from the CC. We urge the engineering students to stay at the CC as long as they can continue to take math, science, and engineering courses which count in their ASU program of study for their major. On the other hand, when they are ready to transfer, we want to help them, and hopefully they will transfer to ASU where we know they will be well supported. At the same time, Fulton Engineering is seeing an increase in transfer students from these five schools – the number of transfers has doubled since we began our efforts through the NSF grants.

Complete articulation agreements exist for all Arizona CCs and the three public universities in the state. This helps the students and advisors help the students to not take extraneous courses. Much work has recently been done to provide major pathways for CC students in the local Maricopa County Community District. Work is still being done on these pathways for the non-metropolitan schools where transfer is more difficult because these schools do not teach as many of the required courses for the first two years of an engineering major. Work is also being done to make it easier for CC students to transfer without an Associate Degree and to be able to complete this degree with reverse transfer while also earning their Bachelor's degree at the university. Working together, the students "wins" because they are less likely to take extra courses that do not count toward an engineering degree, the CC "wins" because we encourage transfer students to complete their Associate's degree after they transfer, and ASU "wins" with more transfer students, which is a university goal.

Another major lesson is that high expectations will make better students. We now have about half of our scholarship students going on to graduate school. We have learned that 70% of these students would not have gone to graduate school if they had not been in our program where they were encouraged and expected to go to graduate school. In general less than 20% of graduating engineers go right on to graduate school and only about 12% of upper division transfer students in engineering go on to graduate school.

IV. Results

We have now doubled the number of transfer students from the five targeted CCs. See Table I.

	FA 08	FA 09	FA 10	FA 11	FA 12	FA 13	FA 14
Institution	**Enrollment**	**Enrollment**	**Enrollment**	**Enrollment**	**Enrollment**	**Enrollment**	**Enrollment**
AZ Western	32	38	40	34	30	35	41
Central AZ	15	11	16	21	29	40	50
Cochise	16	17	19	27	31	29	33
Eastern AZ	7	14	15	20	26	29	30
Mohave	10	11	20	22	22	30	40
Total	80	91	110	124	124	163	187

Table I. Transfer enrollment in ASU's engineering and computer science programs for the past seven years from the five non-metropolitan CCs targeted by the NSF STEP grant.

In general, we are graduating 95% of the transfer students who receive scholarships through the METSTEP grant of the S-STEM programs. In general, only 70% of upper division transfer students graduate in the Fulton Schools of engineering and an even lower percentage of females graduate. We also have about 50% of our scholarship students going right to graduate school after their Bachelor's degree. In most cases, the few students who have withdrawn from the program and school have gone to work full-time to support their family and have been unable to keep up with their studies.

V. Challenges and Conclusion

The primary challenge to keep transfer students in good standing is to convince them to take a reasonable class load while working 20 hours or more. A few students are able to take 18 credit hours and work nearly full-time for a semester, but to do this more than one semester in a row takes its toll. A second challenge is to convince the transfer student that they need to have a detailed time management system to help organize their time. This time management is part of the Guaranteed 4.0 Plan. Students who take this system seriously have been helped greatly in their academics. For some students, it is difficult to engage them in any type of research. We have now broken down the assignments into small steps to make a research paper appear less daunting.

Our largest challenge is to be able to continue to give scholarships. The university is now giving $4,000 to students with top grades from the CC. While we have recruited and support talented students, we have never tried to just recruit the top scholarships with high GPAs. Many of the students that we have brought into our program have had GPAs between 3.0 and 3.5. With

encouragement and support, these students have succeeded and gone on to graduate school. These students have responded well to high expectation.

We believe that we have built a successful program and made good use of government money through NSF. We hope to continue our program and add three additional CCs, two of which are non-metropolitan and all are minority-serving institutions.

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5. Note: additional publications on the METSTEP program will be added to the final paper.