METS: A Collaboration To Assist Students Transitioning Into Engineering From The Community Colleges To The University

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Abstract - The METS project—Maricopa Engineering Transition Scholars—is a two-year pilot collaboration between Arizona State University (ASU) and Maricopa County Community College District (MCCCD) funded by the National Science Foundation. The project is designed to 1) recruit, 2) retain and 3) graduate engineering transfer students. The project targets MCCCD women and underrepresented minority students.

The research-grounded project activities were designed based on analysis of best practices piloted over many years at both MCCCD and ASU. Three of the METS activities include: Be an Engineer event designed to interest students in engineering by allowing them to participate in “hands-on” engineering activities at local community colleges, Pizza with a Professor to allow students to interact with an ASU professor, and METS workshops on survival strategies for students who have transferred from a community college to the ASU Fulton School of Engineering.

The paper discusses what we have learned to date about the METS activities which are the most effective to assist community college students who transition into engineering. METS activities also assist community college students transferring from a two-year community college to a 4-year engineering program at ASU. In addition, the paper provides an analysis of community college students seeking engineering degrees by demographics, motivation, and needs and provides trends in enrollment, retention, and graduation.

Index terms: Collaboration, Community Colleges, Retention, Transfer Students

Background: The Issues and the Project

The United States (U.S.) critically needs more scientists, engineers, and technologists. This need shows in the increasing number of jobs requiring technical education and industry’s reliance on foreign technical professionals admitted under the H-1B visa program [1]. One-quarter of today’s science and technology workforce is age 50 or older and is comprised of 70% white males [2]. However, women, minorities, and persons with disabilities together comprise 70% of the U.S. workforce, but only 30% in science and technology areas [2]. It is a mirror image that bodes ill for the nation’s capacity to fill the ever-growing number of science and technology jobs that power the knowledge economy.

Emerging trends are not promising. Demographers forecast rising minority populations in the United States for decades to come. In fact, the U.S. Census Bureau predicts that by 2050 minority populations will grow so large that the traditional designations of minority and majority will be rendered meaningless [2,3]. Short of relying on foreign workers, women and underrepresented (URM) populations are the nation’s only source of an expanded technology workforce and they are not being successfully recruited and retained in engineering programs.

One solution is collaborations between universities and community colleges. For example, public community colleges enroll about 10% more URM students than public universities [4]. The literature search revealed that there are many models of successful collaborations between universities and community colleges, but only a few involve engineering sciences. The theory of collaborations resides in symbiotic relationships addressing: 1) alignment between partners in purpose and benefits for the students being served, 2) resources and costs to initiate and to sustain the relationship,
and 3) economic benefits to the targeted community (i.e., engineering) [5,6,7].

The Maricopa Engineering Transition Scholars (METS) collaborative project, funded by the National Science Foundation, started in Fall 2003. Five of the ten colleges in the Maricopa Community College District (MCCD) are participating with the Fulton School of Engineering at ASU in the METS project. Strong student enrollments position the Fulton School of Engineering and the MCCD to help meet the demand for the U.S. labor market in engineering fields. On average, the Fulton School of Engineering enrolls about 400 new transfer students every Fall term and 60% or more of these students have come from MCCD colleges. For women and URM students, the MCCD colleges contribute about 85 students each fall term. This number can increase dramatically with appropriate and purposeful recruitment and retention efforts. As for Fulton School of Engineering graduation rates within a three-year period, the estimated degree achievement rate for MCCD women and minorities students enrolled is estimated between 30%-40% [8].

To date, support systems at the Fulton School of Engineering include: 1) the Office of Student Affairs (OSA) that coordinates an orientation track for the Fulton School of Engineering freshmen and transfer students and 2) Student Outreach and Retention Programs (SORP). Each system focuses on the recruitment and retention of students in engineering, targeting women and underrepresented minority students.

The participating five MCCD colleges have academic advisors to assist students with career choice and transition to four-year colleges and universities. In addition, these colleges offer unique and different activities to promote student interest in STEM careers. Chandler-Gilbert offers COOL Engineering Links, the Engineering Learning Community, and ASU Transfer Tuesday. Estrella Mountain focuses on Student Success and Life Skills workshops. Glendale has the STEM Organization, Technical Career Programs, and the ACE Plus Program. Mesa offers the AWARE and Student Technology Assistance programs. South Mountain also has COOL Engineering Links, as well as a number of other programs designed to interest and to engage students in engineering and science.

The design of the Maricopa Engineering Transition Scholars (METS) is based on research-grounded project activities of best practices as well as capacity building on the aforementioned programs already in place at ASU and within MCCD [9]. Three of the METS activities include: Be an Engineer event designed to interest students in engineering by allowing them to participate in “hands-on” engineering activities at local community colleges, Pizza with an ASU Professor, and METS workshops on survival strategies for students who have transferred from a community college.

**Project Evaluation Design**

The methodological framework used to evaluate the first-stage of the METS program addressed the dynamics of symbiotic relationships as well as intended outcomes for student enrollment, retention/graduation. Evidence gathered was from interviews, focus groups, surveys, and ASU student database warehouse.

The questions addressed so far in the METS project were:

- For ASU and MCCD internal stakeholders: 1) What is your definition of a collaborative agreement? 2) What has been desirable or beneficial of the METS partnership and can facilitate this partnership?
- For other ASU and MCCD stakeholders: 1) How many faculty have been involved and what disciplines do they represent? 2) What have been the experiences of Fulton School of Engineering academic advisors in counseling community college transfer students?
- For encouraging community college students to consider an engineering degree: 1) How many students attended each event? 2) What was the general profile of the students attending each event? 3) What did students have to say about each event?
- For quantitative outcomes measuring the project’s effectiveness: How do we measure program success relative to enrollment and retention/graduation at the Fulton School of Engineering? Indices based on those are specified in Table I.

### TABLE I

<table>
<thead>
<tr>
<th>Event</th>
<th>Index</th>
<th>How Applied</th>
</tr>
</thead>
<tbody>
<tr>
<td>Enrollment:</td>
<td>Five-year averaging of academic years from 1998-99 to 2002-03 by non-minority males and combined females/minorities.</td>
<td>First, MCCD enrolling transfers are compared against the 5-yr average The same model is used for a comparison of MCCD METS and non-METS colleges.</td>
</tr>
<tr>
<td>These are MCCD transfers with a transcript from any of the MCCD colleges. The MCCD students are divided by MCCCD college participating in the NSF-METS Program.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Success Index:</td>
<td>Three-year averaging from 1996 to 1998 by non-minority males and females and minorities. All based on percentages.</td>
<td>For all MCCD students from 1996 to 2006.</td>
</tr>
<tr>
<td>The index is based on those still enrolled and those graduated in engineering. The index only targets MCCCD students.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Findings Thus Far**

The findings are presented within the previously mentioned framework focusing on symbiotic relationships and student outcome indices. The questions posed within the framework guide discussions of the findings.

**Key Stakeholders**

Ten of the eleven key stakeholders (project’s PIs, and coordinators and the colleges’ coordinators) were individually interviewed six months after the project was initiated. The interviews not only aimed to gather information about what the key players were thinking, but also to prime them in a
We have many...in many cases they do have special needs...
with them. Their...community college students...experiences may not be the...student has already experienced college level coursework.

In my experience working with first-time freshmen and...in doing so. They still go...community college transfer students compared to first-time freshmen or sophomore, junior, or senior students?

Do you see a difference when you are advising first-time community college transfer students compared to first-time freshmen or sophomore, junior, or senior students?

In my experience working with first-time freshmen and first-time community college transfer students, we still go through common issues: program requirements, residency, and time management even though the community college student has already experienced college level coursework. Their...community college students...experiences may not be the same as groups at ASU, so we try to share that information with them.

[In many cases they do have special needs]... the big need is always ...work and go to school"... and there is always time management issues with that.

I agree with the working comment... it seems to me that the community college students that I've met tend to work more hours than incoming freshmen. There are also some expectations from the community college students that we would hold later hours or Saturday courses for them, because they are used to that at community colleges. They don't understand sometimes why ASU's schedule is not more flexible for the working student.

Do you find that community college students are interested in working on campus as opposed to off-campus?

In my experience, students are looking for something that will pay a good amount of money. On campus jobs do not traditionally fall into that category... only a small percentage of community college students ask for work study.

In my experience, most of them arrive already employed with the job or have in mind of looking for a job that is closer to home than at ASU.

Sometimes they are working in industry related to engineering but most are working in a related engineering area and are making just above minimum wage. I don't think it is a good thing that a student has to work and go to school.

For those students that tell us that they're working and they are going to go full-time, I think that it is a little scary. But, maybe some of them are use to doing it at a community college. We tell them that it is not a good idea.

Do those particular students succeed?

I don't know, I have not looked at every student but I can tell you that a lot of the petitions we get, one of the major number reasons given to take a class for the third time is "I was working too many hours and now, I cut back". [Thus, they meet]... the minimal requirement but... are still not... completely in the top groups.

Some of them have to have a bad semester to understand that they can't do both, some of them will tell us immediately "Oh, I am going to cut my hours, I was planning to that."

What about curriculum alignment with Maricopa community college? In your division how would you characterize or rate curricular alignment of your basic freshmen courses with those also taught at the Maricopa Community Colleges? Has there been any major attempt to do curricular alignment, like ECE 100? What is taught at, let say at Mesa (for example), is that comparable to ECE 100 here?

The effort is, technically or formally, defined by tabulation that we have had for many years and continue to have. So, there is a lot of effort put into aligning the courses. But we have no control over what actually they do at the community colleges other than keeping students informed every year through these meetings, discussing what is done and what the issues are. But we have no jurisdiction over there... So, it is a very difficult thing to do but formally, yes there is a process.

Faculty from community colleges with the faculty here worked to develop a course and that is statewide. So any community college that wants to expand offerings, we give them a contact person to work with or they find one by themselves to develop a course and then they submit the course through the formal channel or through their evaluations. Once [the course] is developed it is not just a done deal; there is an additional formality of actually having our evaluators evaluate the course. For example, for ECE 100, we have an additional process that involves a set of standards and course outcomes for working with NAU, U of A, and the community college.

In my experience, students from the Maricopa system are academically prepared to perform as well as students who take the same courses at ASU. However, they swirl. We have many students that are taking courses at both institutions at the same time or swirling out for summer school and back in fall.

Do you think that swirling is a good thing?

I think it depends on what classes you’re taking. For example, our computer science classes build on each other,
which makes swirling not a good thing. Also, at some community colleges we notice that they don’t enforce prerequisites that we enforce. So, if students have to take CSE 200, 210, and 240 as a sequence, we notice that there are a lot of colleges that allow students to take 200 and 210 at same time. I think it creates problems depending upon the sequence.

I would like to say, for different reasons swirling is good and not good. The ideal [solution] would be if everyone could come here as a freshman and take their full course load. But in reality, we don’t have the capacity to accommodate the needs of all students. So, we often refer students to a local community college to take a class.

I just want to add one last comment about students needs in terms of advising, we have taken advising to the community colleges. We go once a semester. Students at community colleges know what questions to ask and they are much more aware than freshmen who are really still not in tune to what the system is like.

Recruiting Students

Since September 2003, over 350 community college students have attended “Be an Engineer” events at their colleges or at the ASU main campus. By on-site surveying we have been able to obtain the demographics and background of 41% (Table II) of the attendees and 50% of attendees’ opinions about the events (Table III).

### Table II

<table>
<thead>
<tr>
<th>Variable</th>
<th>White &amp; Asian Males</th>
<th>Women &amp; URMs</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of responses to interest in becoming an engineer</td>
<td>102</td>
<td>43</td>
</tr>
<tr>
<td>Barriers to obtaining a BA in Engineering</td>
<td>Top Barriers</td>
<td>Top Barriers</td>
</tr>
<tr>
<td>Support while pursuing a BA in Engineering</td>
<td>Top Support Areas</td>
<td>Top Support Areas</td>
</tr>
<tr>
<td></td>
<td>Work off campus</td>
<td>Work off campus</td>
</tr>
<tr>
<td></td>
<td>Financial Aid</td>
<td>Financial Aid</td>
</tr>
<tr>
<td></td>
<td>Scholarship</td>
<td>Scholarship</td>
</tr>
<tr>
<td>Encouragement from immediate family to be an engineer</td>
<td>Very Supportive 74%</td>
<td>Very Supportive 68%</td>
</tr>
<tr>
<td></td>
<td>Supportive 18%</td>
<td>Supportive 31%</td>
</tr>
</tbody>
</table>

Retention Efforts

Retention efforts are supported by another NSF grant named CIRC/METS. This grant targets women and underrepresented minority students (24 students in ’03-’04: 10 URM, 9 white women, and 9 students who were neither female nor underrepresented minority) who range from sophomore to seniors. The students receive $3,125 per year. Five events are held per term and cover survival skills including resume, letter writing, and interviewing; guest speakers addressing various engineer careers and the overall benefits of pursuing a master’s degree in engineering. Overall, 82% of the students’ rankings of the CIRC/METS sessions were very good to excellent.

### Quantitative Measures of Effectiveness

To measure the outcomes of project efforts over time, two baseline indices were established to measure changes in enrollment and success rates at the Fulton School of Engineering. The baseline indices can be compared to subsequent years of project activities.

### Enrollment Index

The enrollment indices are a five-year averaging of entrants for academic years from 1998 to 2003 by gender and ethnicity. The indices are constructed for MCCD and then sub-indices are constructed for METS and non-METS colleges by gender and ethnicity (Tables IV and V). For each year the cohort group should be compared to the five-year average. Table V shows the number of METS transfer students exceeds the number of non-METS transfer students. This is partially due to the 17% greater enrollments and engineering curriculum in the METS compared to non-METS colleges.

### Table IV

<table>
<thead>
<tr>
<th>Index and Total Entrants from MCCD</th>
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<tbody>
<tr>
<td>Males non-Minority</td>
</tr>
<tr>
<td>Males non-Minority 5 yr average</td>
</tr>
<tr>
<td>Females &amp; Minorities</td>
</tr>
<tr>
<td>Females &amp; Minorities 5 yr average</td>
</tr>
</tbody>
</table>
Success Index

Table VI shows the success of all MCCD transfers by gender and ethnicity into ASU Main engineering programs. The indices are of those still enrolled or graduated in engineering and are constructed from the academic years 1996-97, 1997-98, and 1998-99. For the next two years the percentages from 1999-00 and forward for each gender and ethnicity group will be compared against its respective index.

### TABLE VI

<table>
<thead>
<tr>
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<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>METS females &amp; minorities</td>
<td>86</td>
<td>84</td>
<td>78</td>
<td>91</td>
<td>89</td>
<td>94</td>
</tr>
<tr>
<td>METS males non-minority</td>
<td>162</td>
<td>171</td>
<td>177</td>
<td>188</td>
<td>171</td>
<td>144</td>
</tr>
<tr>
<td>METS males non-minority</td>
<td>174</td>
<td>174</td>
<td>174</td>
<td>174</td>
<td>174</td>
<td>174</td>
</tr>
<tr>
<td>NONMET females &amp; minorities</td>
<td>41</td>
<td>41</td>
<td>37</td>
<td>38</td>
<td>37</td>
<td>30</td>
</tr>
<tr>
<td>NONMET females &amp; minorities</td>
<td>39</td>
<td>39</td>
<td>39</td>
<td>39</td>
<td>39</td>
<td>39</td>
</tr>
<tr>
<td>NONMET males non-minority</td>
<td>79</td>
<td>76</td>
<td>63</td>
<td>75</td>
<td>67</td>
<td>52</td>
</tr>
<tr>
<td>NONMET males non-minority</td>
<td>72</td>
<td>72</td>
<td>72</td>
<td>72</td>
<td>72</td>
<td>72</td>
</tr>
</tbody>
</table>

### CONCLUSIONS AND RECOMMENDATIONS

We are still in the formative stages of collecting and analyzing data. However, it appears that efforts for generating interest in engineering with the “Be an Engineer” events has been successful thus far based on student responses in Table II. It will take another 14 months to determine the effectiveness of all of the METS components. In the mean time, we are discovering significant operational and policy issues that should be addressed by the METS team, the Fulton School of Engineering, and MCCD colleges.

How successful can community college students be at a university? A disturbing finding in constructing the METS data base for MCCD students who enrolled in the Fulton School of Engineering was that an estimated 10 to 15% had attended more than two MCCD colleges. In other words, they resigned to being “freeway flyers” to amass the credits needed to transfer to ASU. What this implies is that they do not stay in an institution long enough to become engaged students. Thus, they sacrifice important socialization aspects of academic life that can later lead them to research work at a university, degrees beyond a bachelor’s, or important job connections in their study fields. The formative findings also highlighted the fact that community college students choose to work off campus and the academic advisors stated many of the students in off-campus jobs receive just above minimum wage. The academic advisors also stated that community college transfer students work far too many hours that prevent them from achieving higher grades. The last condition that has a negative impact on transfer student success at a university is their course taking patterns. Many of the students swirl - taking courses out of sequence because of convenient offerings.

The next question is how involved are the faculty and advisors in the METS program? At this point, faculty and advisors are still being recruited and/or engaged. Yet, there was never any formal plan in the METS as to how faculty and advisors engagement would occur outside of faculty coordinators at the MCCD colleges. However, the formal plans included a mentoring program that is being begun this semester. Transfer students who have done well in transitioning to the university have told us that they had a mentor, someone they knew at ASU that they had known in their community college. They declare that that person helped them make their transition very smooth.

Recommendations that should be considered at this time include:

- Design a formal recruitment plan for faculty and academic advisors.
- Hold meetings every three months for community college and ASU faculty.
- Hold meetings every other month for the PIs, Directors, co-PIs, and Evaluation Director.
- Establish a formal mentoring program for community college students wanting to transfer to ASU and those already at ASU.
- Continue to work on true collaborative efforts between the Fulton School of Engineering and the Maricopa Community College District by focusing on goals and modifying them where necessary.

### ACKNOWLEDGMENTS

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REFERENCES


