

Building A Pipeline of Future College Engineering Students

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ABSTRACT

As part of Arizona State University's (ASU) K-12 outreach effort to increase the number of qualified minority students entering the College of Engineering and Applied Sciences (CEAS), the Office of Minority Engineering Programs (OMEP) has developed a collaborative effort with engineering faculty to expose high school students interested in math and science to the excitement of an engineering discipline.

Underrepresented minority students and their teachers from eight high schools that participate in the Mathematics, Engineering, Science Achievement (MESA) Program, supported through OMEP, were invited to participate in a "willing worker" engineering assembly project in the ECE 100: Introduction to Engineering Design class. Their teachers who participated were MESA Program advisors. In Spring 95, forty enthusiastic high school students joined college students to get a first hand look at "life as an ASU engineering student." The comments from all parties involved were so positive that Dr. Barry McNeill, Assistant Professor of Mechanical and Aerospace Engineering, invited 110 students to the classroom in the Fall of 1995.

Throughout the semester, the college engineering teams studied various consumer products. The study required that the products be taken apart. As the final phase of the project, the high school "willing workers" were to reassemble the products using assembly instructions created by the engineering teams. If specifications were well developed, the products were reassembled and operative. If specifications were not adequate, university students had an opportunity to assess weak points in their plans.

Overall, the program provided a win-win situation for both university and high school programs. As a result of the experience, several students have inquired about application to ASU. High school teachers had an opportunity to discuss curriculum strategies with faculty which they hope to implement in their future math, science and English classes.

INTRODUCTION

Arizona State University is the fifth largest university in the United States with a Fall 95 enrollment of 42,040 students. The university is opening a new site in the summer which will expand the campus sites to three, ASU Main, ASU West and ASU East. The entering class in the fall semester can have as high as a 50% representation of lower division and upper division transfer students from other institutions including many from the local community college system. (Note: a lower division transfer student is one that transfers more than 12 credit hours, but less than 35 credit hours, while an upper division transfer student is one that transfers 35 or more credit hours.) The ASU College of Engineering and Applied Sciences (CEAS) represents four schools: the School of Engineering, the School of Technology, the Del E. Webb School of Construction and the School of Agribusiness. The total enrollment in CEAS for the Fall 95 semester was 6048 students including 4087 undergraduate and 1961 graduate students. The female undergraduate students (813) represented 20% of the total undergraduate student population, while the female graduate students (367) represented 19%. The underrepresented minority enrollment in the college was 527 undergraduate students or 13% and 94 graduate students or 5% [1].

The Office of Minority Engineering Programs (OMEP) at ASU was established by the CEAS to aid in the recruitment and retention of underrepresented minority students. Specifically, the goals of the OMEP are to build a community of minority students that are academically prepared to pursue baccalaureate and graduate degrees within the CEAS and to create a climate that develops and promotes academic excellence, technical competence and marketable skills. Furthermore, it is the goal of the OMEP to build the foundation for life-long learning that will sustain students after they leave academia and through the twenty-first century. These goals are realized through comprehensive programmatic support for both recruitment and retention of underrepresented minority students. The recruitment program targets K-12 students through the efforts of the Mathematics, Engineering, Science Achievement or MESA Program. The retention goals are supported through the Minority Engineering

Program (MEP) where students can find assistance in adjusting to the demands of university life and the rigors of the technical curriculum. (For additional information, see Reference 2).

In conjunction with the MESA Program and as part of ASU's K-12 outreach effort to increase the number of qualified minority students entering the CEAS, the OMEP has developed a collaborative effort with engineering faculty to expose high school students interested in math and science to the excitement of an engineering discipline. This collaborative effort is centered around the freshman engineering core course, ECE 100: Introduction to Engineering Design, required in the engineering and construction curriculums.

DISCUSSION

The MESA Program

The MESA Program is a K-12 outreach program supported by local industry and the CEAS for the purpose of increasing local technical talent within Arizona. The ultimate goal is to produce engineers, technologists and scientists for the future workforce. This program exists in eight high schools and four middle schools stretching from nearby schools in the valley to schools located as far northeast as Window Rock on the Navajo Indian reservation and as far east as the Apache Indian reservation. The students that participate in this academic program are exposed to careers in the mathematics, engineering and science fields and encouraged to pursue curriculums in high school that will academically prepare them to pursue baccalaureate degrees in these areas. In some cases, the MESA students may be the first generation of the family to complete a high school degree or to pursue higher education. In this respect, it is of vital importance to expose these students to the university setting and prepare them culturally and socially for the rigors they will face in the pursuit of a technical degree.

Students from the eight high schools that participate in the MESA Program, supported through OMEP, were invited to participate in a "willing worker" engineering assembly project in the ECE 100: Introduction to Engineering Design class at ASU. While the MESA Program serves middle and high school students, the program described in this paper facilitates high school students visiting a university setting to preview the engineering curriculum. High schools in Arizona are required to provide courses with a career focus. ASU and OMEP are helping to meet this objective by providing direct access into a university class for a first hand look at the engineering curriculum. This is where the collaboration with the MESA Program began. In Spring 95, forty enthusiastic high school students and their MESA advisors joined college

students to get a first hand look at "life as an ASU engineering student." The comments from all parties involved was so positive that Dr. Barry McNeill, Assistant Professor of Mechanical and Aerospace Engineering, invited 110 students to the classroom in the Fall of 95 and over 60 in the Spring 96 semester.

ECE 100 Course Requirements

As a result of the recent curriculum redesign, the engineering core requirements were reduced from 136 to 128 credit hours and a new introductory engineering course was created. The new course is a requirement for the entering freshman students in engineering and construction and replaces the former engineering core requirements of two courses each having three hours of credit. This new four credit hour course entitled ECE 100: Introduction to Engineering Design includes two hours of "Concepts", two hours of "Modeling" and two hours of "Projects". The three elements of the course result in a total of six contact hours and the students meet with three different instructors. The course has many important elements for freshman engineering students that include modeling with Microsoft Excel, teamwork, collaborative learning, project documentation and problem solving skills. In addition, ECE 100 is the only engineering core course in which freshman students participate and therefore, can be the basis of their decision to continue to pursue engineering as a career. For this reason, OMEP and the faculty members felt that exposing MESA students to university students and the curriculum in ECE 100 would help them formalize their interest in engineering at ASU.

The ECE 100 course requires students to work in groups of four to five on various projects throughout the semester. One of the projects that extends over seven weeks of the semester has students working for a fictional company called "Kopy Kat Are Us Kompany." The students or "employees" study various consumer products and require the team to take their particular product apart. This provides students an opportunity to study "process management" as they define their product specifications. The products can include telephones, fruit juicers, food processors, etc. The culmination of the project is the reassembly of the product using the pieces they took apart and the assembly instructions that the team has developed. In order to properly test the assembly instructions, the teams need "willing workers" that have not participated in the project to this time that can objectively read the assembly instructions and utilize them to reassemble the product. If these "willing workers" could not reassemble the product using the directions that were provided to them, the "willing worker" students would help the team locate weak points in the assembly plan and give the team a place to work from for improvement. The MESA students were invited to be these "willing workers". Dr. McNeill

encouraged feedback for possible solutions from both the university and the MESA students.

In addition to their participation in the assembly project in the classroom, the MESA students were hosted by the OMEP for lunch and toured by the student society members of the American Indian Science and Engineering Society (AISES), the National Society of Black Engineers (NSBE) and the Society of Hispanic Professional Engineers (SHPE). All three of these organizations have come together to create the Coalition of Engineering Minority Societies (CEMS). In particular, the MESA students from the Apache and Navajo Indian reservations enjoyed meeting the CEMS members from AISES. Students were made aware of other resources on campus such as Financial Aid and the American Indian Institute. While the students were participating in the classroom, the MESA advisors also had an active role. They were encouraged to interface with the faculty members in the classroom about the high school academic preparation students interested in engineering should pursue.

CONCLUSION

The MESA student feedback following the "Willing Worker" Project was very positive. Students were impressed by the fact that the introductory engineering course incorporated technical writing, team work and communication. MESA students felt that they had a better understanding of what freshman engineering students do in their curriculum. They also felt less intimidated by the engineering faculty and classroom. The students found the interaction with the university freshman very valuable and they enjoyed the insight into the demands of the engineering curriculum and what engineering entails. They also indicated that the opportunity to meet with the associate dean of the college and to investigate the university on a more day to day level assisted them in making the decision to come to ASU and pursue an engineering curriculum.

The MESA students found that university students were extremely helpful and willing to give them information about how they choose the engineering field, what really happens once you are in class, what study habits are important, and what faculty expect. Several of the university students offered to take the students to lunch and to show them around campus. For those MESA students who have come back to ECE 100 more than once, we are hearing comments about wanting to be on the "team where my friends are working". The MESA students are identifying the freshman in the ECE 100 class as role models, and concluding that they too could "make it in engineering". There appears to be a comfort level and confidence level developing in the high school students that college and engineering is a attainable goal.

The interaction also provided feedback to the MESA students regarding all the potential options in various engineering careers, paralleling the career decision process the university students are also following. The university students had the opportunity to serve as role models and validate their position as an engineering student. The CEMS students developed an Engineering Advocates group to try to reach other students who may not be involved in the project to encourage them to consider engineering. They enjoyed the opportunity to meet the MESA students and "host" them for the day. In addition, the OMEP provided lunch for the CEMS students so they could continue dialoguing with the MESA students.

Each participating MESA advisor was encouraged to observe classroom interaction and ask questions of the faculty members regarding essential classes that students should be taking at the high school level to best prepare them for success once they entered engineering. One teacher's feedback was that she was familiar with EXCEL, but had not understood it's application to engineering modeling concepts. She has decided to integrate this into her MESA classes. Other teachers found that their MESA projects paralleled some of the projects found in ECE 100, but at a less sophisticated level.

For the first time in Spring 96, we invited a high school principal from one of the MESA schools to attend with the MESA advisor. The principal circulated around the room, sat with university students, dialogued with faculty and met with the Associate Dean of Student Affairs of CEAS. He expressed his enthusiasm at what he observed in the classroom and the interaction between students. He intends to encourage his peers to visit the class in the Fall 96 so they can see the positive impact the program is having on students. He indicated that students from the community where the school is located rarely have technical role models. Many of the students do not have a clear vision of what options are available least of all an engineering career. He has committed his support to encourage additional student involvement in MESA.

Overall, the program provided a win-win situation for both university and participating MESA students. After one year, we have seen five Navajo students apply to ASU into the CEAS. We have seen the valedictorian from Dysart, a Hispanic student, who had only hopes of going to a community college apply for five scholarships so he could attend ASU. He has since been accepted into the Mechanical Engineering department and has requested Dr. McNeill as a faculty advisor. We have had an African American student from the agricultural community of Peoria begin a mentoring relationship with another female engineering student who attended the same high school. She too has applied and been accepted to engineering at ASU. Students also commented that they would not be intimidated to

approach a faculty members once they got to ASU. They described Dr. McNeill as a "cool guy".

REFERENCES

1. Arizona State University Main. "Fall Enrollments 1995". Office of Institutional Analysis, Arizona State University, Tempe, Arizona, 1995 Affairs.
2. Anderson-Rowland, Mary R., James, Darrell, Medicine, Camille, and Reyes, Maria A. "Re-Engineering the 'Pipeline' for Minority Engineering Students". ASEE 1994 Conference Proceedings.