

## Diversity in Engineering Technology: The Community College Perspective

Stephen J. Kuyath, Virgil Cox

UNC Charlotte, Department of Engineering Technology, Charlotte, NC /  
Dean, Engineering Technology, Gaston College, Dallas, NC

### Abstract

Women and minorities are less likely to choose careers in science, technology, engineering, and math (STEM) as noted in a report from the National Science Foundation (NSF). An NSF sponsored consortium including Gaston College, the University of North Carolina at Charlotte (UNC Charlotte) and high schools in the region is coordinating an outreach project, using community college faculty who will focus on mentoring, tutoring, and encouraging underrepresented groups in engineering and engineering technology. Community college faculty will assist in developing hands-on activities, provide lectures, provide guidance in projects, tutor high school students in the preparation of competitions, talk with parents about the rewards of engineering technology careers, and provide information about community college programs and financial aid.

This year, two competitions will be held for high school engineering technology clubs. The first will be an academic and robotic competition between high schools near Gaston College. The second competition will be a combination of the TEAMS (Tests of Engineering Aptitude, Mathematics and Science developed by the Junior Engineering Technical Society: JETS) test and a robotic competition between the twenty participating high schools and hosted by UNC Charlotte. The competitions are designed to encourage high school students to participate in technology clubs and to provide some experience in a hands-on approach to solving engineering technology problems.

This paper will describe the activities of the project from the unique perspective of community college faculty and staff that are directly responsible for the outcomes. We will also detail information about the high school clubs and the impact these activities have had on the students' awareness of engineering technology disciplines and how they differ from engineering, the awareness of career opportunities for students graduating with either an Associate in Applied Science (AAS) in engineering technology or Bachelor of Science in Engineering Technology (BSET) degree, and the educational opportunities for students wanting to pursue an ET degree.

## Rationale for the Project

The United States could face a serious shortage of scientists, engineers, technologists, and mathematicians because the interest level of high school students from underrepresented groups in these subjects remains low<sup>1</sup>. These students are depriving themselves of many technical and scientific career choices, as well as access to high salaried occupations<sup>2</sup>. In 1995, women constituted about 46 percent of the U.S. labor force but only about 22 percent of the scientific and engineering labor force<sup>3</sup>.

The National Science Foundation (NSF) report “Women, Minorities, and Persons with Disabilities in Science and Engineering: 2000” states that, although some progress has been made at all levels of education and employment, women are still less likely to choose careers in science and engineering. Additionally, the numbers and percentages of minorities in engineering related careers are decreasing<sup>4</sup>. A nationwide shortage of qualified high-tech workers will jeopardize the country’s economic future unless something is done to nurture the intellectual development of these non-traditional students so that the pool of scientists and engineers expands to include more women, minorities, and persons with disabilities<sup>5</sup>.

So, what can we do to increase the diversity and quality of engineering and engineering technology graduates? This paper explains the activities taking place at Gaston College, one of four community colleges involved in a larger project with UNC Charlotte to increase the diversity of engineering and engineering technology programs. The larger project is described in detail in a paper titled: *Diversity in Engineering Technology: An NSF Project*.

## Community College Activities

Faculty at Gaston College have been reaching out to students at local high schools to promote engineering, technology, math, and science by supporting engineering technology clubs. The engineering technology clubs were started through a grant from the National Science Foundation as a part of a project titled: **Diversity in Engineering Technology**. Community college faculty are mentoring and tutoring high school students participating in the clubs as they prepare for local and regional competitions. The faculty are also assisting high school teachers in developing engaging and fun hands-on activities that relate to the disciplines in which they teach.

The community college faculty are also reaching out to the community by conducting workshops and seminars to promote science, technology, engineering, and math (STEM) careers and education. Research has concluded<sup>6</sup> that students rely on the advice of their parents, their teachers, career counselors and their peers in making decisions about their future, such as which college program to enroll in (or to help decide if they will even attend college), and what type of career to pursue. Therefore, it is extremely important to ensure that these sources of advice have the correct information.

To determine how students made the decision to enroll in engineering technology programs, we conducted random student interviews. We discovered that many students did not make the decision to pursue a degree in engineering technology while in high school. We also found that many students in the high schools didn’t understand what engineering or engineering technology is or didn’t know the types of careers they could have if they pursued a degree in engineering technology. Therefore, we concluded that we had to get involved with the high school students

and their teachers, career counselors, and parents to increase the awareness of opportunities for the young adults in our community.

### **The Clubs**

Gaston College serves two counties in North Carolina. Though both counties have a technology magnet high school only one high school currently has a technology club. This club serves the students well, but does not promote the higher level learning in science and math that will be required by students who will pursue engineering or engineering technology degrees. If we are going to promote engineering and engineering technology, we must also ensure that students understand the fundamentals of the higher-level math and science and are prepared to enter the community colleges and the university.

Therefore, we are helping to enhance the existing club, and establish clubs in other schools that will meet these needs. The high school students, through the clubs, will become involved in more demanding, engineering related activities as well as participate in advanced competitions, such as the Junior Engineering Technical Society's (JETS) TEAM+S Competitions (TEAM+S is the Tests of Engineering Aptitude, Mathematics and Science).

### **Mentoring & Tutoring**

As high school students get involved in the advanced activities, they (and their teachers) will require more help. The community college faculty have made the commitment to assist these students and teachers (Figure 1).



Figure 1: Community College Faculty working with High School Club Members

Figure 1 shows one of the faculty members working with club members at one of the participating high schools. In this image, the students are working with a robot that will be used in a local and regional competition. The community college faculty member is demonstrating how the robot may follow a track using an optical sensor. So, what are the students getting out of this? Besides help and support from the community college, they are learning a little about the basics of optical sensors, programming, input and output devices, and engineering principles in designing and building mobile robots.

Additionally, students are interested and engaged in this activity (Figure 2).



Figure 2: High School Club Members

If we are to promote engineering and engineering technology, we must be able to show the high school students some of the benefits of pursuing such a degree. The activities, must be fun, engaging, and allow the students to get their hands on the tools or devices. Students will gain confidence and find, through participation in such a project, that engineering and engineering technology can be fun and rewarding.



Figure 3: Students Participating in a Practice TEAM+S Competition

In Figure 3 many students, both male and female are participating in a practice TEAM+S competition. This will be the first time that this competition is held in this region, so the community colleges hosted a practice competition so that students would gain some valuable experiences with the test.



Figure 4: Students Participating in a Robotics Competition

Figure 4 shows the diversity of the high school students involved in the project. In the region there are a total of 368 students reported by their teachers as attending the club meetings on a regular basis. The demographics of the clubs in the region are shown in Tables 1 and 2 below.

Table 1 Statistics of High School Female Students Participating in the Clubs						
	African American	Asian	Hispanic	Caucasian	Other	Total
Number of Participants	31	6	9	53	5	104
Percentage of Participants	8.4%	1.6%	2.4%	14.4%	1.4%	28.3%

Table 2 Statistics of High School Male Students Participating in the Clubs						
	African American	Asian	Hispanic	Caucasian	Other	Total
Number of Participants	48	34	9	152	21	264
Percentage of Participants	13.0%	9.2%	2.4%	41.3%	5.7%	71.7%

We believe these numbers to be significant. Twenty-eight percent of club participants are female high school students. Currently at Gaston College eleven percent of the students in engineering technology programs are female. Only sixteen percent are African American, two percent are Hispanic and less than one percent are Asian. The clubs in the region have more twenty-one percent African American, almost eleven percent Asian, and almost five percent Hispanic students. If the trend in the club continues, as we would expect, then the diversity at the community colleges and the university should improve due to our efforts. Of course, we are only in the first year of the project and much work remains to be done.

### **Hands-On Activities**

The Maui County High School Technology Survey<sup>6</sup> found that most high school students take math or science courses because: 1) they are required to do so by the school, 2) they are required to do so to get into college, or 3) they are needed to prepare for college. Very few indicated that they enrolled in these courses because they were interested.

When the high school students were asked what changes would make them want to take science, most female students said they wanted to see activities that were more relevant to their lives. Most students, both male and female, indicated that they would want to take science if there were more interesting projects, more team projects, and more hands-on activities.

Another interesting finding was that math was the only subject where females indicated that more encouragement from teachers would help<sup>6</sup>. The girls are trying to tell us that if the teacher would encourage them more, they would try harder in math.

So, we can conclude that if students are provided more interesting, hands-on, team based projects and given more encouragement from their teachers, they will become more interested in math and science. This is exactly what the community college faculty are doing. The robots are just one of the hands-on exercises the students are involved in. They are also enjoying building and experimenting with trebuchets and bridges. The community college faculty are there to help, to encourage, but more importantly, they are there to build relationships with these students and encourage them to consider engineering or engineering technology careers.

### **Workshops and Seminars**

A very disturbing finding in the Maui County High School Technology Survey<sup>6</sup> was that 23% of females and 21% of males indicated that they would take science if it would help them get a good job. This is troubling because the other 77% of female (and 79% of male) students were unaware that science classes could help them when in college or in the job market. They don't see how science studies fit in with their everyday life. The students also seem to be unaware of the role science classes take when preparing for job opportunities in engineering.

When students were asked where they developed career ideas, they responded that their own interests were the most important, and that their parents were the next most influential. Teachers, peers, and career counselors also play an important role.

So, what can be done to make the students more aware of the educational and career opportunities in engineering and engineering technology? How can we get the information to the students and those that advise them?

Actually, there is much that can be done. Workshops for career counselors and teachers can significantly benefit the students. Teachers and counselors want to provide the best information they can, but many times the information is either not available or takes too long to research, organize, and put in a form that is easy to disseminate. The community college and university faculty are developing and conducting workshops for teachers and counselors, placing information in one page brochures and providing enough copies so that interested students may have copies, and placing information on a central club website for easy reference.

Seminars for parents and the community will have the same impact, but are more difficult to organize and conduct. Parents will attend if the time and day are convenient, if the seminar is relatively short and informative, and if they know about it. Fliers are given to students announcing times and dates. When necessary, announcements are made by local newscasts; ads are placed in local newspapers, at grocery stores, in church bulletins, restaurants, malls, and quick food shops.

The important thing is to get the information out to the community; raise the awareness of the educational and career opportunities in engineering and engineering technology; and ensure that those people that will provide advice to the high school students have accurate information.

### **Competitions**

The competitions are very important. High school students seem to enjoy competitions and really enjoy beating a rival school. Furthermore, they learn all of this new information about robots, math and science, and careers and college and then they get to put it to good use.

We are hosting several different types of competitions that have several objectives:

1. High school students will be learning and practicing engineering principles while preparing for the competitions
2. High school students will be working in collaborative, team environments
3. High school students will be visiting the community colleges and university campuses
4. And high school students will be applying what they have learned in the clubs.

There are several reasons to host the competitions on college campuses. One reason is that we want to continue promoting engineering and engineering technology. We want to provide meaningful and fun activities for these students in a non-threatening environment. A second reason is that we want to get these students on campus. Research shows that there is a higher probability that a student will return to and enroll in a degree program at your college if the students visit the campus and participate in activities that create pleasant memories.

We are hosting several competitions in robotics, math and science tests (JETS' TEAMS), and in writing and public speaking. The details of the competitions are discussed in another paper (*Diversity in Engineering Technology: The Competitions*), but their importance and impact should be noted.

### **Summary**

So, what can we do to increase the diversity and quality of engineering and engineering technology graduates? All of the activities discussed above are important to increasing the diversity and quality of engineers. We must reach out to female and minority students by creating interesting hands-on activities that relate to their everyday lives, so that the activities have an immediate impact. We must increase the awareness of the educational and career opportunities throughout the community so that those providing career advice to the students know what they are talking about. We, at the community college and the university, must get involved in educating our high school students and create partnerships with the teachers, counselors and parents in our community.

In a recent survey students responded with several encouraging responses (Tables 3 and 4). This survey was conducted after the regional competition and after the students had been involved in the clubs for six months.

Table 3 Results of Student Survey			
Statement:	Agreed	Not Sure	Disagreed
I am enjoying the Jets Club	94.4%	5.6%	0.0%
I have enjoyed working with the robot	95.6%	3.3%	1.1%
I have enjoyed preparing for the TEAM+S Competition	44.4%	36.7%	18.9%
I'm looking forward to the trebuchets	77.8%	22.2%	0.0%
I plan to enter the writing/speaking competition	13.3%	32.2%	54.4%
I will be in the club next year <sup>1</sup>	82.5%	15.9%	1.6%

<sup>1</sup> Responses from Freshman, Sophomore, and Juniors only

Ninety-four percent of the club members have enjoyed being a part of the club. This indicates that there are high school students that are looking for this type of activity in which to be involved. Ninety-five percent of the club members have enjoyed working with the robots. Only forty-four percent enjoyed preparing for the TEAM+S competition (97 students participated in the competition). It may be more significant to note that only nineteen percent (18.9%) indicated that they did not enjoy preparing for the competition. This is not surprising. The TEAM+S Test is a very difficult test. What is significant is that ninety-seven students participated in the TEAM+S Test.

Approximately seventy-eight percent of the students indicate that they are looking forward to the trebuchets. High school teachers assured us that this statistic would increase once the trebuchets are built and tested and students have a better understanding of what the trebuchets will do. Only thirteen percent suggest that they are interested in the writing and speaking competition. This does not surprise us. In fact, a large number of students competing in this contest is not our goal, nor our expectation. We are using this contest, in part, to increase the awareness of engineering and engineering technology careers and education programs in our region and to get students involved in researching information about engineering and engineering technology.

The most encouraging statistics are shown below, in Table 4.

Table 4 Percentage Of Each Group Reporting That They Agreed With The Statement							
Statements: Because of the club:	Female	Male	African-Am.	Asian	Hispanic	White	Other
I have been working harder in math	55.6%	65.1%	83.3%	42.9%	85.7%	61.8%	53.3%
I have been working harder in science	48.1%	58.7%	66.7%	28.6%	85.7%	56.4%	46.7%
I have more interest in science	66.7%	57.1%	50.0%	28.6%	71.4%	60.0%	73.3%
I have more interest in math	55.6%	66.7%	50.0%	28.6%	42.9%	69.1%	73.3%
I know more about the university and community college programs	48.1%	47.6%	50.0%	14.3%	57.1%	50.9%	46.7%
I plan to go to a CC for an ET degree	3.7%	28.6%	16.7%	0.0%	0.0%	27.3%	20.0%
I plan to go to UNC Charlotte	11.1%	31.7%	16.7%	0.0%	42.9%	27.3%	26.7%
I plan to get an engineering degree	11.1%	65.1%	66.7%	28.6%	71.4%	47.3%	46.7%
I plan to get an ET degree	7.4%	41.3%	33.3%	14.3%	28.6%	34.5%	26.7%



Many students are working harder in math and science and have more interest in math and science. They know more about the community college and university programs and plan on going to their local community colleges or UNC Charlotte for degrees in engineering or engineering technology. This is significant because during an interview at the beginning of this project only 1% of the students (all white males) were planning on an engineering degree and understood the difference between engineering and engineering technology.

We are only in the first year of the project, but we feel that we are seeing encouraging trends. The statistics above are encouraging. The number of students typically underrepresented in engineering and engineering technology participating in the clubs is encouraging. Although these statistics are encouraging, we still have much to do in the next few years and look forward to the opportunity to return and provide an update on this project.

### **Bibliography**

- [1]. Clark, J.V., *Minorities in Science and Mathematics: A Challenge for Change*, Virginia Parent Information and Resource Center, 2000
- [2]. Clark, J. V., *Minorities in Science and Math*, ERIC Clearinghouse for Science Mathematics and Environmental Education, ED433216, May, 1999
- [3]. Milbourne, L. A., *Encouraging Girls in Science and Math*, The ERIC Review, Vol 6, Iss. 2
- [4]. National Science Foundation, *Women, Minorities, and Persons with Disabilities in Science and Engineering: 2000*, Arlington, VA. 2000 (NSF00-327)
- [5]. Kowalenko, K., *Increasing Diversity in America™s Science, Engineering, and Technology Fields*, The Institute, IEEE, Dec., 2000
- [6]. The Maui County High School Technology Survey, *Women in Technology*, Maui Economic Development Board, 2001

### **Biographical Information**

Stephen Kuyath is an Assistant Professor of Engineering Technology at the University of North Carolina at Charlotte. He has taught engineering technology courses at the college level for over 20 years. He has a strong interest in and dedication to improving both traditional and distance engineering education and to encouraging those students typically underrepresented in STEM fields to consider engineering technology as a career.

Virgil G. Cox graduated from MIT in 1962 and 1972. He spent 20 Years in the Navy in nuclear submarines and ship repair as an EDO followed by eleven years at Maine Maritime Academy and then to Gaston College where he's been Dean of Engineering and Information Technologies. Virgil has served ASEE in the ERM and the ETD divisions and at large for ETC.