

**AC 2008-77: UPWARD-BOUND/JUNIOR ENGINEERING TECHNOLOGY  
SUMMER PROGRAM**

**Asad Yousuf, Savannah State University**

**Mohamad Mustafa, Savannah State University**

**Hope Cranford, Savannah State University**

# Upward-Bound/Junior Engineering Technology Summer Program

## Abstract

This paper will discuss the various factors that contribute to the success of minority students in Science, Technology, Engineering and Mathematics (STEM) disciplines by exploring paradigms that promote success for the underrepresented group of students. Savannah State University (SSU) offered and administered a six-week Junior Engineering and Technology Summer (JETS) program sponsored by the U.S Army Research Office. The primary goal of the JETS program was to provide high school students with interests in mathematics and sciences a preview of engineering studies at the college level. This high quality program nurtured the top 25 academically talented high school students' interests in engineering and science through hands-on activities, team dynamics, faculty and current engineering technology student instruction and a field trip to NASA's Kennedy Space Center. The summer program was supplemented by Upward Bound, an existing summer outreach program at SSU, to attract students who would be able to cope with the requirements of baccalaureate degree programs in STEM disciplines. In this paper we will present the curriculum module, student activities, and an evaluation of student learning.

## Introduction

Recruiting and retaining minority students are major concerns of educational institution across the United States. Furthermore, as technology becomes increasingly important in the global market, there is an ever growing need for minority engineers to support this market<sup>1</sup>. As international participation in advanced science and engineering increases, and as our national population becomes more diverse, it becomes even more important to provide quality education to [minorities]<sup>2</sup>.

Literature review suggests the growing importance of minority recruitment and retention. Presidents of universities and deans of colleges identify minority recruitment and retention as vital issues for higher education. Survey research indicates an increasing percentage of minority students at elementary and secondary school levels. The National Action Council for Minorities in Engineering<sup>3</sup> presented the following data related to minority participation on academic institutions.

Higher education's group of students is increasingly made up of minority youth. African Americans, Latinos and American Indians constitute 30 percent of the nation's undergraduate students today, a proportion that is projected to grow to 32 percent in 2010 and 38 percent by 2025. Corrective actions must be taken to recruit and retain minority students. Several colleges and universities across the nation have implemented minority recruitment and retention programs. Search was made to find out the existing minority recruitment and retention programs. During the fall of 2002, the Student Affairs staff of Minnesota State Colleges and Universities reviewed almost one thousand college and universities web pages describing activities dealing with retention and recruitment of minority students, in order to identify effective methods for recruitment and retention of minority students<sup>4</sup>. Following are some examples as result of the

Minnesota Colleges and University research. These examples illustrate an array of strategies that might help other institution initiate similar programs to recruit minority students.

Purdue University: Purdue University, since its beginnings in 1974, the goal of the Purdue University Minority Engineering Program (MEP) has been to attract, retain, and graduate the very best in African American, Native American, and Hispanic engineering talent from across the country. As they matriculate through their respective programs, these promising scholars may find the rigors of Purdue's engineering curriculum to be quite overwhelming at times. As a result, the MEP constantly searches for ways to improve retention and continually motivate students toward achieving and maintaining greater academic success. These program offerings encompass motivational, recruitment, and retention elements specifically geared toward the above populations.

Virginia Polytechnic University: Virginia Polytechnic University uses a five week summer program to facilitate the recruitment and retention of minority students. This program focuses on increasing skills in academic subjects; developing skills in interactions with peers, faculty and administrators; and learning successful study methods and time management.

The Rochester Institute of Technology: The Rochester Institute of Technology, in partnership with the Rochester City School District and the National Action Council for Minorities in Engineering (NACME) is participating in the NACME Vanguard program to identify potential minority engineers and provide them with academic enrichment and college readiness skills.

The New Jersey Institute of Technology: The New Jersey Institute of Technology has a Center for Pre-College Programs, designed to attract elementary and secondary students to engineering, science, and math careers and to help them develop the skills to qualify for college admission. The Pre-Freshman Summer Residential Program is a seven-week orientation and transition program providing students academic enrichment in math, physics, communication, and computer science.

The aforementioned examples provide an excellent base work to recruit minority students at majority institutions. However, research shows that African Americans attending historically black colleges and universities (HBCUs) are more likely to complete a degree than those attending predominantly white institutions<sup>5</sup>.

SSU received a grant from the US Army Research Office to conduct the Junior Engineering and Technology Summer program (JETS). This program was supplemented by SSU's Upward Bound program funded by the Department of Education. The program serves as model for recruiting minority students in engineering programs at a minority institution. The following paragraphs will list the best practices that promote recruitment and retention of minority students. The remainder of this paper will present the goals, curriculum, student activities, evaluation of student learning, and future plans.

## **Best Practices for Recruitment and Retention of Minority Students**

The research conducted by the Student Affairs office of the Minnesota Colleges and Universities<sup>5</sup> shows that striking similarities exist in the types of activities undertaken by those colleges and universities that seemed to be the most successful in achieving student recruitment and retention goals. Among these similarities are the following:

- Summer Bridge programs to help students make the transition from high school to college. Some programs are discipline based, especially in STEM disciplines.
- Expressed support for improvements in minority student recruitment and retention at the highest administrative levels and inclusion of recruitment and retention goals in strategic plans and annual work plans, along with accountability mechanisms for achievement of the goals.
- Recruitment activities that go beyond the traditional college fairs and high school visits. Successful institutions recruit minority students in community centers, churches, and other nontraditional settings. Current minority students and alumni are involved in the recruitment effort. Recruiters engage the parents and other family members rather than focusing exclusively on the prospective student.
- Early outreach activities designed to increase college awareness in students at the elementary, junior high and high school levels and enlarge the pool of college-bound minority students. Some of these outreach activities focus on highly talented students in the fields of STEM, while others are more general in nature.

### **Savannah State University Junior Engineering and Technology Summer Program (SSU-JETS)**

The SSU-JETS is funded by the U.S Army Research Office and is coordinated by Junior Engineering Technology Society. The SSU-JETS program is also supplemented by Savannah State University's Upward Bound program. The JETS program serves the top 25 academically talented high school students to promote the development of interests in STEM disciplines through hands on activities, faculty and current engineering technology student instruction and a field trip to NASA. Savannah State University's Upward Bound/JETS-UNITE (The Uninitiates' Introduction to Engineering Program) program is designed to generate in its participants the skills and motivation necessary for success in education beyond secondary school.

SSU-JETS is a six week summer residential program which included the following:

- Instruction and tutorial sessions
- Personal counseling
- Academic advising
- Career counseling
- Parental involvement
- Engineering and Cultural field trips
- Mentoring
- Financial aid and postsecondary admission assistance

The SSU-JETS/Upward has joined hands in a collaborative effort to expose high school students with an interest in STEM disciplines, to the stimulating environment of engineering and

technology. An integral part of this collaborative effort is focused around summer engineering program activities.

### **\*Goals and Expected Outcomes**

The primary goal of the (Junior Engineering Technology/ Upward Bound) UNITE program funded by the U.S. Army is to apprise high school seniors about the importance of STEM disciplines through an immense six-week, residential program incorporating STEM subjects and providing information regarding admission and available scholarship programs. Secondary goals of the program include:

**Goal 1:** To encourage students to select a discipline within STEM as their major in college.

**Expected Student Outcome:** Increase the interest and awareness of STEM disciplines.

**Goal 2:** Academic advisement of STEM programs.

**Expected Student Outcome:** Increase likelihood of the UNITE participants pursuing an academic degree in a STEM discipline.

**Goal 3:** Introduce students to engineering programs.

**Expected Student Outcome:** UNITE participants will gain knowledge of engineering as a program of study, its various disciplines, and of the academic rigor required of engineering students.

**Goal 4:** Introduce students to team work.

**Expected Student Outcome:** To foster teamwork, the groups will participate in a number of activities that will acquaint them with their teammates, orient them to the university campus, reward them for collaboration, and introduce healthy competition.

**Goal 5:** Introduce students to the work environment of engineering and technology.

**Expected Student Outcome:** Students will interact with engineers in their place of work. Such an activity will provide the students with an opportunity to meet engineers from various disciplines and to see them in assorted work environment.

**Goal 6:** Instruction/Tutorial sessions in Engineering, Mathematics, English/reading, Science, and PSAT/SAT.

**Expected Student Outcome:** Students will have the ability to apply mathematical, scientific and engineering principles to the identification, formulation, and solution of engineering problems. Students will also learn about reading comprehension. Students will be better prepared for the SAT.

### **Assessment Process:**

The program coordinators established an assessment process and tools to ensure that the JETS participants achieved the expected program outcomes. The data related to each outcome was collected from various resources such as student surveys, team project assignments, and field trips; ASSESS test from JETS, and an SAT practice test. Table 1.0 shows which tool will be used to measure the expected outcomes stated above.

Table 1.0: Assessment of Outcomes

Assessment Tools	Outcomes
Survey	Increase the interest and awareness of STEM disciplines
Survey	Increased likelihood of UNITE participants pursuing an academic degree in STEM discipline
National student clearing house database	UNITE participants will gain knowledge of engineering as a program of study, its various disciplines, and academic rigor required of engineering students
Team Project	To foster teamwork, the groups participate in a number of activities that acquaint them with their teammates, orient them to the university campus, reward them for collaboration, and introduce healthy competition.
Field Trip	Students will interact with engineers in their place of work. Such an activity will provide the students with an opportunity to meet engineers from various disciplines and to see them in their various work environments.
Assess and SAT Test	Students will have the ability to apply mathematical, scientific and engineering principles to the identification, formulation, and solution of engineering problems. Students will also learn about reading comprehension. Students will be better prepared for the SAT.

The aforementioned goals were achieved to a great extent. However, in goal 5 the students only attended one workshop at NASA. Future plans are to visit at least two more companies which will provide our students an opportunity to interact with engineers from different disciplines in the work environment. We also plan to include the following activities for the UNITE/JETS students:

1. More hands-on learning and problems with practical applications, and opportunities for creative solutions.
2. More active, open-ended learning situations to replace drilling students on “correct” textbook answers.
3. Active career guidance, stressing the importance and usefulness of Science, Technology, Engineering and Mathematics as future career choices.
4. Interactive learning activities in the classroom

### Criteria for Admission

Students were recruited based on their grade point average and interests in mathematics and science. The application form can also be accessed through our website link [http://www.savstate.edu/scitech/engtech/ssu-jets/JET\\_Application\\_Form\\_2007.doc](http://www.savstate.edu/scitech/engtech/ssu-jets/JET_Application_Form_2007.doc)

## Curriculum

The UNITE/SSU-JETS/Upward Bound students that participate in the JETS Summer program at SSU are thrust into a six week long itinerary that consumes their time from 7 A.M. until 11 P.M. each day with activities that are designed to achieve the aforementioned goals. A general description of UNITE/SSU-JETS/Upward Bound curriculum is given below in Table 2.0:

Table 2.0: UNITE/SSU-JETS/Upward Bound Curriculum

UNITE/SSU-JETS/Upward Bound Curriculum		
Math (Core)		
Courses/Instruction	Description	Weeks
Algebra I Algebra II Geometry Pre-Calculus	The math component offers algebra I, algebra II, geometry, and pre-calculus. Algebra I and algebra II focus on the basic concepts of Algebra emphasizing computation and application. The Geometry and Pre-Calculus courses also emphasize computation and applications within the specific subject matter. Instructors utilize computer-assisted instruction PLATO with an emphasis on preparing for the PSAT, SAT, ACT, and Georgia End Of Course Test (EOCT).	6
English/Literature /Reading (Core)		
English Composition Literature Library Science Workshops	The purpose of this component is to engage participants in the process of writing that involves: thinking, brainstorming, outlining, free-writing, editing and re-writing. Classes also explore the connections between literature and the present world with emphasis on the lives of several authors and their relationships with their respective culture, society, and time period. Participants are expected to write articles in the UB newsletter, essays for college admissions and compositions about field trips. Participants also conduct dramatic presentations about literary works and make oral presentations at recruitment and other group meetings. Instructors utilize computer assisted instruction PLATO and Kaplan with an emphasis on preparing for the PSAT, SAT, ACT, and Georgia EOCT.	6
Reading (Core)		
Reading	The purpose of this component is to develop basic, advanced, or speed reading skills based on the participant's need. The curriculum focuses on vocabulary building, reading comprehension, and spelling skills. Participants are encouraged to read as often as possible. Newspapers, program correspondence, and library books are all made available to participants with encouragement to read.	6

<b>Foreign Language (Core)</b>		
Spanish French	Classes in Spanish and French encompass basic conversation with an emphasis on pronunciation and grammar. In addition, emphasis is placed on exposing participants to other cultures to help them gain a global perspective and appreciation for people of other countries. Activities include games, worksheets, oral reading, listening to music and computer exploration.	6
<b>Social Studies (Core)</b>		
U.S. and World History Geography American Government	Social Studies classes emphasize types of government economic systems, history, geography, and the social, cultural and political position of America from the pre-colonial period to the present. Participants conduct library research on current events and review videos and books on current social topics.	6
<b>Science (Core)</b>		
Physical Science Biology Chemistry Physics	The sciences include introduction to geology, structures and functions of the organs, introduction to nuclear energy, major gas laws, and molecules. Activities include lab experiments requiring: preparation, observation, measurement, discussion, and writing lab reports.	6
<b>Engineering and Technology</b>		
Introduction to Engineering and Technology	This course will introduce the student to engineering disciplines. Students will develop an understanding of various engineering programs and how these programs relate to the work environment. This course will emphasize on hands-on activities in areas of Civil and Electrical Engineering.	6
<b>Electives*</b>		
Computer Technology	This course is a general introduction to the world of computer technology. Students will learn hardware, software and computer terminology. Students will receive hands on opportunities to operate software and formulate spreadsheets and databases.	6

\* Electives include computer technology, dance, drama, chorus, senior seminar, entrepreneurship and art.

### **Strengths and Weakness of the Program**

The strengths of this year's program are:

**Recruitment** - The Upward Bound program at Savannah State University assisted in recruiting UNITE/JETS students.

**Hands-on-activities**- The utilization of hands-on activities (fabrication of solar car and bridge model) in the engineering classes allowed the students to be active during the entire class period.

**Software simulation** - The utilization of 3-D simulation software of bridge construction and design allowed the students to see their idea put into simulation construction and testing prior to

building the physical model. This concept allowed the students to modify their projects and improve on their initial designs.

**Team building exercises** – The UNITE participants represented the rising underrepresented high school seniors from the Chatham County area schools. The team building exercises allowed them the opportunity to develop the necessary skills to enable them to work with others. Examples of successful activities included design, fabrication and testing of bridges and solar cars.

**Minority in engineering** - UNITE/JETS program student populations were 100% minority with 50 % of the UNITE/JETS students being female African Americans. UNITE/JETS program increased the awareness of engineering programs in the underrepresented communities.

Weaknesses of this year's program are:

**Time limitations to recruit students**- Since this was the first year of the program, we had time limitations involved in the recruitment process of our upward bound program

**Field trip** – This year the UNITE/JETS students only visited NASA. Next year's plan is to increase the number of visits to include companies in the city of Savannah and its surrounding areas.

**Role model** – There is dire need to hire engineering students from Savannah State University to serve as role models for the underrepresented minority and female students.

**Interest** – Students in the program expressed interest in Business/engineering, nursing, psychology, and etc

### **Pre- and Post-Test Results and Discussion**

To assess the engineering knowledge acquisition of the participants in the JETS program, pre- and post-tests were administered. The pre-test was conducted on the first day of classes to test and document students' knowledge in structural engineering concepts, three dimensional coordinate systems and solar power. The post-test was administered after instructions in those specific areas were delivered in the form of classroom instructions and hands-on activities.

Pretest results indicated that although the students were able to identify whether the structure system was man-made or natural, they could not classify the structure as a frame, truss, shell or mass structure. Based on this result, various types of structural systems, their classification, and practical applications were discussed in the classroom throughout the project period. In addition to the classroom discussion, ModelSmart3D, a 3-D modeling software, was given to the students to design the least weight bridge truss geometry for a set of control design parameters. This project allowed the students to experience hand-on activities related to three dimensional coordinate systems and their applications to real life structures. It also, allowed students to critically critic their design and strive for better outcomes.

From the post-test results, 65% of the students were able to identify the force members as tension or compression in a bridge truss correctly. This was a great improvement from the pre-test results as a very small percentage was able to identify them correctly. Overall, the post-test results indicated that about 75% of the students improved their understanding of structure classification systems and three dimensional coordinates. Similar improvements were obtained in other topics investigated throughout the project's period.

### **Future Directions**

To further assess the success of the UNITE/JETS program at SSU, the program coordinators will continue to monitor the enrollment and progress of its participant through their high school and acceptance at the college level. The program coordinators plan to develop a dynamic data base in conjunction with the high school counselors and instructors to keep track of the UNITE/JETS participants. Student mentors at SSU will assist the program coordinators to update the database on a continual basis. Next year's program will focus on self-improvement of strengths with the feedback provided by the student evaluation. As part of the continuous improvement plan, efforts will be made to revamp the curriculum, program objectives and student assessment tools. Capitalizing on the strengths of the program the UNITE/JETS program curricula at Savannah State University will focus on improving the technical skills and the general science, technology, engineering and mathematics (STEM) preparation of each student. Program coordinators will work in conjunction with the Upward Bound personnel to develop a robust recruitment model. The recruitment model will consists of the following recruitment activities:

- Selection process (Criteria will be based on high school GPA, statement of interest, and membership in engineering clubs at SSU) High school students will be encouraged to join the engineering clubs at SSU free of cost.
- Quarterly sessions to discuss the recruitment process with high school counselors and instructors.
- Invite high school counselors, instructors and students. High school engineering program will be held in February during the engineering week.
- Parents, students, instructors, and high school counselors will attend engineering night at Savannah State University. The intention of this effort is to increase engineering awareness. Engineers from industry will make a presentation at the engineering night.
- Program coordinators of the UNITE/JETS program at Savannah State University will work with the industrial advisory committee to arrange field trips to various companies in Savannah and other surrounding areas. Engineering and Technology students who have completed their junior year of studies or higher will be employed as student mentors, serving as consultants and role models to guide the students through the engineering experience and related projects. They will also help the teams stay on task; locate resources around the engineering and technology complex and the university campus in general.

This year's students entering the program had strong potential academically. However, as a natural phenomenon they expressed interest in other fields and were not sure if they wanted to pursue engineering. Program coordinators will work in conjunction with the MAGEC-STEM program funded by the National Science Foundation at Savannah State University to conduct engineering seminar series for the underrepresented high school students during the academic year so that the awareness of engineering programs will be increased. Students showing an interest in engineering/business is positive from the real world aspect.

To capitalize on this concept, the program coordinators' plan for next year is to assign a group project that spans the entire program incorporating engineering, innovation, business, and entrepreneurial components. Through the group project students will be involved in business concept development, product design engineering, rapid prototyping, business plan formation and a group presentation. The students will conceive a novel product, design and build a prototype, and give presentation and demonstration on the last day.

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