

**AC 2007-3031: ENHANCING ENGINEERING EDUCATION THROUGH
REAL-LIFE PROJECTS**

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Abstract

The University of Maryland Eastern Shore's (UMES) Engineering Program offered the first two years of an engineering sequence when it began. UMES students were admitted to the University of Maryland College Park (UMCP) College of Engineering with official verification of their enrollment in this program. Students also transferred to other colleges of engineering. Starting Fall 1998, UMES in collaboration with UMCP started offering all four years of Electrical Engineering (EE) on the Eastern Shore. Upon successful completion of the EE discipline, the students receive a Bachelor of Science in Electrical Engineering from College Park. The instructional strategy of the engineering program at the University of Maryland Eastern Shore is to integrate practical experiences with the regular courses, infuse technology into the classroom activities and utilizes interdisciplinary approach to achieve its Mission. It has partnerships with industry that provide students with enhanced learning opportunities through co-op's and internships. This paper discusses some of the challenges in the program and some projects that are being used to enhance engineering education of the students. It discusses the impact the NASA-UMES Summer Internship Program has on the education of the engineering students. It also covers a senior design project arising from this internship program. Furthermore, it discusses First Year Engineering Students collaboration with the Aviation Sciences Program, and a Doppler Radar Study project involving engineering students.

Key Terms – Industry Partnerships, Tri-cycle training device, summer internship, senior design project, Doppler radar

1. INTRODUCTION

The University of Maryland Eastern Shore (UMES), an Historically Black Land-grant University, is a teaching, research, and doctoral institution that nurtures and launches leaders in a student-centered environment, particularly from among ethnic minorities. The mission of the University in the reorganized eleven campuses of the University System of Maryland is that of being one of the four Research/Doctoral Degree Granting Institutions. It is the only campus so designated to serve the Eastern Shore of Maryland

The UMES Engineering Program offers the first two years of an engineering sequence. UMES students are admitted to the University of Maryland College Park (UMCP) College of Engineering with official verification of their enrollment in this program. Students may also transfer to other colleges of engineering. Starting Fall 1998, UMES in collaboration with UMCP offers all four years of Electrical Engineering (EE) on the Eastern Shore. Upon successful completion of the EE discipline, the students receive a Bachelor of Science in Electrical Engineering from College Park. The College of Engineering at UMCP programs lead to the Bachelor of Science degree in Aerospace Engineering, Biological Resources Engineering, Chemical Engineering, Civil

Engineering, Computer Engineering, Electrical Engineering, Environmental Engineering, Fire Protection Engineering, Materials Science and Engineering, Mechanical Engineering, Nuclear Engineering, and Undesignated Engineering. In addition, each of these programs may be pursued through the five-year UMCP plan for cooperative engineering education which combines classroom theory with career-related work experience. Individual counseling is available for students desiring to transfer to other institutions. The Engineering Program is founded on the basic sciences and emphasizes the development of a high degree of technical competence. It integrates these elements: (1) basic sciences, including mathematics, physics, and chemistry; (2) engineering sciences including mechanics of solids and fluids, engineering materials, thermodynamics, electrical and electronic circuits, and transport phenomena; (3) engineering design which applies the above elements into the creation of systems, components and processes while optimizing resources; and (4) humanities and social sciences as part of the general education requirements. The program lays a broad base for continued learning after college in professional practice, in business and industry, in public service, or in graduate study and research.

This paper discusses some industry related activities and projects that are made available to students to enhance their learning experiences in the Engineering Program. These include: NASA-UMES Summer Internship Program (NUSIP), a Senior Design Project, First Year Engineering Collaborative Project with the Aviation Sciences program and the Doppler Radar Study project. Also discussed are the challenges facing the Engineering program at the University of Maryland Eastern Shore.

2. NASA-UMES SUMMER INTERNSHIP PROGRAM (NUSIP)

The NASA-UMES Summer Internship Program (NUSIP) was intended as an outreach program to foster student development in areas critical to NASA's missions and to become a resource pool for prospective engineers, scientists and support staff. Demographic trends in the United States suggest an increase in minority population and that the traditional college-age population for white will expand slowly until 2010 and then decline, whereas the traditional college-age population of racial and ethnic minorities will continue to increase. These trends offer a challenge to the United States to educate students who have been traditionally underrepresented in Science and Engineering¹. Many have recognized the need to step up the training of young scientists and engineers especially the traditionally unrepresented to boost the declining, graying and ultimate retirement of our most experienced scientists and engineers in order for the country to maintain its competitiveness in a global economy and shrinking world. As Dr. Goldin puts it, "..... if we are to discover new worlds, we must break down old barriers. And if we are to replace an older workforce, we must – absolutely must – encourage, recruit and train young explorers: white, black, male and female"². As part of ways of addressing these needs, UMES proposed an internship program to engage minorities and other qualified students from engineering, technology, computer science, science, mathematics, aviation sciences, and business disciplines in practical and meaningful projects at NASA Wallops that will benefit both the students and NASA mission. These students worked at NASA Wallops Flight Facility for a period of ten weeks engaging in

works available in the Applied Engineering and Technology Directorate, Aircraft Office, Observational Science Branch, Management Operations Directorate and Fiscal Office. The diversity and experience acquired by the selected students will form the basis for NASA to evaluate its minority talent pool while addressing the needs of the 21st century.

NASA's funding of this program over the last five years has resulted in thirty-three (33) students gaining experiences at NASA Wallops Flight Facility over a wide range of projects. Eleven of these students were electrical engineering and the electrical engineering technology programs at the University of Maryland Eastern Shore. The students participated in several activities, held bi-weekly meeting to report on their activities, wrote a final report and made a final presentation to NASA staff. There was an exit meeting to access and reflect on the program. One important thing that emerged was the possibility of students, individually and in group working on students' final year projects on on-going projects at the Facility with the help of NASA mentors. It is expected that this approach will make the students' experiences more industry oriented and practical. Through series of reports and presentations, they also worked on their communication skills and record keeping. The students worked on practical projects that helped them better understand some of the materials that they learnt in the class room. Short descriptions of three of the students' projects are included below. More information on the program can be found in these references.^{3, 4, 5, 6}

- **Unmanned Aerial Vehicles (UAVs)**

Unmanned Aerial Vehicles (UAVs) have been around since the dawn of aviation. Much work has been done in recent years to abstract computational models of human control strategy (HCS) that are capable of accurately emulating dynamic human control behaviors. Land-based autonomous vehicles, both in simulation and on real roads, have made successful use of this modeling formalism. The first guided (UAV) was a flying bomb, the Sperry Aerial Torpedo, which was part of an experimental program for the U.S. Navy during World War I. During World War II, Germany launched thousands of V-1 "buzz Bombs" at England. Since that time, the primary use of UAVs has been to serve as aerial targets or drones to be shot down by military pilots and anti-aircraft gunners during training missions and as reconnaissance planes used in Iraq and Kosovo. The UAV flights have helped avoid casualties among pilots. UAVs also fill an important and growing role in the civilian aviation industry. There are many jobs, which are dangerous, monotonous, or very expensive if they are performed by manned aircraft. It has been estimated that over the past five years, on average, eight deaths have occurred annually in the geophysical survey industry, where pilots fly their instrumented aircraft over long routes, close to the ground, and over severe terrain or doing research on active volcanoes, etc. Regardless of the mission, precise guidance is essential for a UAV; therefore, the flight computer performs a major role as a brain to the aircraft and in the success of a UAV. Electrical engineers in Guidance, Navigation, and Control Division of NASA Wallops have begun to develop a flight computer that acts as a brain to the UAV.

Student: Freshteh Agdam

- **Autonomous Flight Safety System**

During the first weeks at NASA, I learned how to read a connector wiring book, count wires within a 422 and RS232 connector, and crimp wires. A connector wiring book details the placement of each wire within a given connector. Counting wires within a RS232 connector is reasonably easy. I began counting from the right corner of the connector and then continued counting from right to left. Learning how to crimp wires was unambiguous. I simply just striped the wire and then placed a crimp over the exposing wire. Afterwards, I seal the crimp using a wire crimper. Thus, the initiating weeks of my internship were straightforward.

While my time progressed at NASA, I embarked on more fascinating things that interested me. I was introduced to Express PCB, circuit board layout software, where I had to create my very own circuit board. I was instructed to use certain types of components and a set amount of them, but the design itself had to be created by me. After learning preliminary knowledge of the software, I was able to design a captivating layout that astonished both my mentor and me. "Wow! This is actually a good layout. It looks like a professional created it," Snow said. Therefore, through practice and consistency I was beginning to find my niche at NASA.

As I approached my concluding weeks at NASA, I encountered a few challenges. While assembling the Test Umbilical, I included extra wires and I incorrectly crimped the wires within the Ethernet cord. Since I included extra wires, I had to attach a nine pin connector to the Test Umbilical. Because I incorrectly crimped the wires within the Ethernet cord, I had to cut each individual crimp off each wire. Then, I had to re-strip and crimp the wires. So, through inaccuracy I was able to perfect my skills.

Student: Nefretiti Nassar

- **Cosmic Ray Energetics And Mass**

During the past ten weeks I have primarily focused on understanding, improving, and testing many of the hardware components and communications systems used on the NASA CREAM Project. The Cosmic Ray Energetics And Mass (CREAM) project has been a major ongoing NASA supported investigation into the ultra-high energy of cosmic rays through a series of balloon flights. CREAM is designed to explore the supernova acceleration limit of cosmic rays arriving at Earth from outside the solar system. Cream I and II have both been successfully launched from Antarctica using the Long Duration Balloon.

For my first major project, I was directed by the Wallops Electrical Engineering Branch to research and conduct market surveys on Flight Computer Hard Drives, Single Board Computers, and Microcontrollers. The intention of my project was to provide NASA with a comprehensive listing of products needed to replace outdated hardware components used on previous CREAM flight missions. All scientific instruments and hardware situated in the payload of the CREAM flight mission and all other NASA flight missions must first be tested in the thermal chamber. This procedure tests a unit's ability to function over the specified temperature range using a network analyzer and the thermal chamber. For my second major project, I had the opportunity to conduct thermal testing on the Mid-latitude Omni Antenna which has since been approved and sent to Columbia Scientific Balloon Facility for a flight mission.

Student: Mahdi Eydgahi

3. SENIOR DESIGN PROJECT

One of the expected outcomes of the summer internship program is for engineering students to continue work on their initial summer assignments as their senior design projects. One such design project that evolved from this summer internship program is the NASA UAV Project. The project was a portion of the ongoing Unmanned Aerial Vehicle (UAV) project at NASA Wallops Flight Facility. Three students worked on the project. The project detailed the use of a Pulse Width Modulation (PWM) board to control the movement of flight control servos. The project outline was as follows;

- Provide Electrical Engineering support on the UAV Flight Computer
- Research and study the application of a PWM PC104 Board
- Design the software (C code) and electronics interface circuitry
- Present the plan for integration into the PC104 system
- Attend team meetings
- Provide Design Presentation and Testing and Interface procedures
- Provide PC Spice analysis of design circuit, and
- Assemble and test PWM board with circuit and supplied servos.

At the end of the project, the students made a presentation to a team of five NASA Engineers and Scientists and UMES Faculty. The oral presentation was judged based on a form titled **Communication Skills Competencies Evaluation** which covered Content (team), Organization (member), Delivery and Effectiveness (member) and Discussion (member). The students performances were judged as a team and as individual members as indicated. Each segment carried 25 points to give a total of 100 points. The average score for this project was 90 which showed the high quality of work done by the students. In addition, a **Capstone Design Project Evaluation** was done based on the following criteria: Open-Ended Problem Solving, Hands-On, Multi-Disciplinary, Teamwork, and Communication. Each section was ranked according to the following grading system: **L=low**, **M=moderate**, **H=high**, **NA=not applicable**. It is also noteworthy that the students made a presentation of their project in the **IEEE Region 2 2003 Student Paper Contest** held in the University of Maryland Eastern Shore, Princess Anne, Maryland from April 4 -5, 2003⁴.

4. FIRST YEAR ENGINEERING STUDENTS COLLABORATION WITH AVIATION SCIENCES PROGRAM

Early in a student pilot's primary training, a negative transfer of information occurs. From the first flight lesson, Certified Flight Instructors have the new student demonstrate the ability to steer the aircraft (taxi) by means of the aircraft's foot controlled rudder system. This new steering mechanism poses a challenge to most students who rely solely on their automotive driving experience. The result is that initially, students tend to attempt to navigate the aircraft using the yoke (hand input device) and not the rudder pedal. Since the aircraft is not in flight and the ailerons are not effective at taxi speed, no change in aircraft direction is experienced and typically, the aircraft veers off the taxiway centerline only to be recovered by the instructor. To combat this negative transfer,

instructors routinely have students place their hands on their laps or in other positions to reduce the urge to control the aircraft's movement via the control yoke. A solution to this problem was proposed to the undergraduate engineering students at the University of Maryland Eastern Shore. The purpose of the collaborative effort was to involve undergraduate students in the field of Engineering to identify a problem experienced by the Certified Flight Instructors in the Aviation Science Program and to design a tri-cycle training vehicle to help primary flight students transition more fluidly in the usage of the foot controlled rudder system commonly found in general aviation training aircraft.

At the start of the semester, Aviation Sciences representatives were asked to attend an introductory class with the engineering students where they were interviewed by students to determine the specifications of such a device. On a bi-weekly basis, Aviation Sciences representatives were queried as to specific requirements and ideas where exchanged. The end result will be a motor-powered tri-cycle training device that is foot-pedal controlled in a manner similar to general aviation aircraft.⁷ The finished design will be used for freshman aviation student orientation as well as for Aviation/Aerospace summer education programs. This is an on-going project and Figures 1 and 2 show the early stage of the cycle construction.



Figure 1 GO-CART (TRI-CYCLE) (BEFORE)



Figure 2 GO-CART (TRI-CYCLE) (AFTER)

5. DOPPLER RADAR STUDY PROJECT

The purpose of this project was to take the preliminary steps needed to assess the benefits, limitations, acquisition options and requirements for adding a state-of-the-art Doppler Radar to support launch operations and research, and how such a system might augment launch ranges at the NASA Wallops Flight Facility. In addition, the study evaluated opportunities for the development of educational products and student participation in radar technology and operations. The project was conducted as a cooperative effort between National Aeronautics and Space Administration (NASA), Mid-Atlantic Institute for Space and Technology (MIST) and University of Maryland Eastern Shore (UMES). Two engineering students and two faculty conducted the study. NASA took the lead in identifying desired capabilities and performance attributes that would significantly enhance range capability. The study was funded by MIST and NASA

Eight Doppler radars with different capabilities and characteristics from three companies were considered in this study⁸. Doppler radar capabilities considered were: CW Doppler radars (The continuous wave (CW) Doppler radar has typical low operation and maintenance cost), available at X-, C-, and S-bands, Velocity only, Full angle tracking and Direct ranging. The Doppler radars can interface to range data networks through most range data formats and have Doppler radar hardware/software upgrades with PC based and PowerPC architectures. In addition, the study showed that with a state-of-the-art Doppler Radar system, there will be opportunities for research, student participation and faculty involvement in Doppler radar technology and operations. The possible integration of Doppler radar technology into five existing undergraduate courses in Aviation Sciences and Engineering were identified. Areas of Doppler radar in which experimental undergraduate courses may be designed which may lead to actual course

offerings were also identified. Some student projects as well as possible areas for faculty research were outlined. The study also addressed student summer internships at NASA as well as NASA University Partnerships on Doppler radar.

6. PROGRAM CHALLENGES

The Engineering program at the University of Maryland Eastern Shore is going through a developmental stage and some of the challenges it faces include:

- Having an Engineering Building with full compliment of labs and lecture halls
- Stand-Alone 4 year program in major fields of Engineering
- ABET accreditation and
- Low retention of students

7. CONCLUSION

Some real life projects and activities used to enhance the learning and training of engineering students at the University of Maryland Eastern Shore have been outlined. These activities have given the students the opportunities to apply knowledge gained from their courses to real projects, to acquire new skills on the job and to be better prepared for their college studies. The Engineering Program will be better positioned to achieve its objectives and goals if the challenges faced by the program are addressed and resolved.

8. ACKNOWLEDGEMENT

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Joseph O. Arumala received the B.S. degree in Civil Engineering from the University of Lagos, Nigeria in 1973. He received his M.S. and Ph.D. degrees in Civil Engineering from Clemson University in 1978 and 1982, respectively. For several years after graduation, he taught in the Department of Civil Engineering, University of Port Harcourt, Nigeria. In 1996, he joined the Construction Management Technology Program, Department of Technology, University of Maryland Eastern Shore as a Professor. He is a registered professional engineer (P.E.) and is currently a Professor teaching undergraduate courses in Statics, Strength of Materials, and design courses in Steel, Timber, Reinforced Concrete and Masonry. He also teaches Soils and Surveying classes.

Ibibia K. Dabipi received the BS in Electrical Engineering and BS in Physics/Mathematics from Texas A&M University, Kingsville, Texas in 1979 and MS in Electrical Engineering from Louisiana State University, Baton Rouge in 1981. He received the PhD in Electrical Engineering from Louisiana State University, Baton Rouge in 1987. From 1997 to 2000, he was Professor and Interim Chair, Electrical Engineering Department Southern University. He is currently a Professor in the Department of Engineering and Aviation Sciences, University of Maryland Eastern Shore.