

INTERNSHIP EDUCATION AS AN INTEGRAL PART OF ENGINEERING EDUCATION: THE NASA-UMES SUMMER INTERNSHIP PROGRAM (NUSIP) EXPERIENCE

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Abstract - A NASA funded summer internship program at the University of Maryland Eastern Shore (UMES) was designed to provide some undergraduate Engineering, Engineering Technology and Aviation Science majors very unique professional experiences by matching them with mentors in the NASA Wallops Facilities. Six undergraduate students worked on several projects during a 10-week summer internship program at the NASA Wallops Facilities. The students participated in several activities, held bi-weekly meetings to report on their activities, wrote a final report and made a final presentation to both NASA staff and the UMES faculty. This paper examines the experiences specific to the Engineering and Engineering Technology students that participated in the program and how the internship at NASA has affected their educational objectives.

INTRODUCTION

Summer internships for students in general have focused on providing students with meaningful experiences that will motivate and refine the students' study habits when they return to their home campuses for continuation of their studies. These experiences in most cases, rarely translate to senior design projects due to the distances between the internship host site and the university and in other instances as a result of the nature of activities the students' were engaged in. With the proximity of NASA Wallops to the University of Maryland Eastern Shore (UMES) (about 20 miles apart) and the need for engineers by NASA, a unique opportunity exists to create an outreach program that will foster student development in areas critical to NASA's missions and to become a resource pool for prospective engineers and scientists to NASA Wallops facility and to the NASA mission in general. The chosen mechanism was to establish a focused internship program with NASA Wallops that required matching students with specific NASA organizations so that by the end of the summer internship period, students can be evaluated for technical competence as well as readiness to join NASA Wallops should they so desire.

As a result of this process, the Engineering and Engineering Technology students were placed in the following NASA Wallops branches:

- Guidance, Navigation and Control Engineering Branch
- Mechanical Systems Center, Carrier Systems Branch
- Microwave Systems Branch
- Observational Science Branch and
- Code Electrical Systems Branch

STUDENT PLACEMENT AND PROJECT ASSIGNMENT

One of the key placement criteria was the level of courses already taken by the selected student irrespective of classification. This was crucial in determining level of responsibility as well as departmental assessment of the student's accomplishments at the end of the ten week period. There is also the issue of task timelines from NASA's end that affect the overall productivity of the group project given that students may be working on an integral part of a larger project.

In the guidance, navigation and control engineering branch, the assigned student was an electrical engineering senior who worked on unmanned aerial vehicles (UAVS) guidance and navigation simulation and control mechanism. This required programming and debugging as well as interface issues which the student found challenging as well as interesting.

In the Mechanical Systems Center, Carrier Systems Branch, the assigned student (engineering technology major) was primarily assigned to research for a replacement of an intercom communication system (ICS) for the NASA Wallops P-3 Orion Aircraft. The objective was to review digital systems compatible with the aircraft and make recommendations based on system performance, reliability as well as cost.

In the Microwave Systems Branch, the assigned student (electrical engineering) was responsible for environmental testing of radio frequency (RF) components in environmental chambers for accelerated component reliability and aging parameters for ongoing projects.

In the Observational Science Branch, the student (electrical engineering) worked on the Ocean-Atmosphere Sensor Integration System (OASIS) development. Primarily an ongoing project, the student focused on the initial stages of the project that dealt with the examination of and

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comparison to Autonomous Drifting Ocean Sensor, battery testing, thermal imaging and motor analysis as primary objectives for the summer.

Finally with the Code Electrical Systems Branch, the student (electrical engineering) was assigned to automation and installation of specific thermal vacuum testing procedure and the integration of hardware software issues.

EXPERIENCE AS A REALITY CHECK

Part of an ongoing reality check for engineers is the ability to communicate their ideas clearly. For these students, it was more than communication. It also involved the ability to understand their assignment, integrate into the work environment as a team player as well as understanding the culture of the workplace. To underscore the importance of documentation of work done, the supervisors were required to authenticate the accomplishments of the students on a weekly basis. The students in their biweekly meetings with the University of Maryland Eastern Shore and NASA coordinating staff examined both progress and obstacles encountered to better assess the progress of the students. The reports and interactions were necessary for continuous assessment as well as mid course corrections in terms of placement if the need arise. As a result of the process, the following are the students' experiences on their assigned projects.

- **Meeting Project Objectives:** Meeting project objectives is a function of time required to understand the project issues as well as the ability to purchase the necessary parts for testing and analysis. While the ten week period was short for some projects, it was adequate for others and the level of expectation is commensurate with the degree of difficulty associated with these issues.
- **Objective Assessment of Progress:** Objective assessment of the assigned work can be done only in conjunction with the supervisor. Meaningful dialog is necessary with group members or other senior employees if they are to progress with their assigned work. It is necessary to research and ask questions if progress is expected.

➤ These issues are exemplified in the project summaries submitted by the students as paraphrased below:

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 identify 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 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 piloted 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 difficult 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.

ENVIRONMENTAL TESTING OF RF COMPONENTS

Network Analyzers can be used to measure the transmission and reflection of signals. Environmental chambers can simulate different atmospheric conditions. By combining these two equipments, we can easily test for the durability of microwave equipment under several environmental conditions. The results from these tests can help in diagnosing the possible failure in components before carrying out a mission. Although these components have manufacturers' specification on them, it is sometimes found that the components still experience failure. The satisfaction of testing one's components personally to guarantee that they are functional under the conditions in which they are required is irreplaceable. The Environmental chamber is one of the many types of equipment that can be used to simulate mission requirements. There are other technologies/equipments such as the vibration table, spin balance, network analyzer, spectrum analyzer and much more. This paper will demonstrate how a network analyzer, vibration table, and environmental chamber can be used to save a mission from possible failures.

OCEAN-ATMOSPHERE SENSOR INTEGRATION SYSTEM (OASIS) DEVELOPMENT

This report focuses on the continued development of an Ocean-Atmosphere Sensor Integration System (OASIS) to perform dynamic, autonomous, synergistic *in situ* measurements and observations of air and sea processes. OASIS is a low-cost, self-navigable, easily recoverable and reusable ocean sensor platform consisting of unmanned sea surface vehicles (USSVs) interfaced with scientific oceanic and atmospheric instruments. Pre-purchasing of equipment, examination of and comparison to an Autonomous Drifting Ocean Sensor, battery testing, thermal imaging, and motor analysis are various objectives to which OASIS has been and is being subjected.

INTERCOM COMMUNICATION SYSTEM (ICS)

ICS (Intercom Communication System) is an electronic device used in an aircraft by pilots, copilots, mission managers, crewmembers and passengers to communicate within and near the aircraft. My project this summer was to research a replacement for an existing ICS with an advanced digital and wireless feature for the NASA Wallops P-3 Orion Aircraft. The P-3 is a four-engine turboprop, which supports the NASA LAASP (Low Altitude Airborne Science Program). It is one of 3 aircrafts owned by NASA Wallops Flight Facility. The P3 was used in the Soil Moisture Experiment (SMEX '02) in Iowa in June of 2002. The Aircraft Office I work in provides services such as maintenance, configuration control, airborne science and mission support for assigned aircraft. It develops and implements rules and procedures to ensure the safety of aircraft operation. Other services provided include, aircraft scheduling services, launch range requirements and budgetary management. The primary reason for the replacement of the existing ICS system is that the company that manufactured the current ICS is out of business and its parts are costly and difficult to find. Another reason is that since it's not wireless, its long cords can be a safety hazard. The new ICS system will be more user friendly, cost efficient and safer than the current one.

AUTOMATION AND INSTALLATION

The thermal vacuum testing procedure used in building F7 is a slow and arduous process that requires the user to write down numerous numbers after calibrating a series of temperamental pieces of equipment to specific values from hundreds to thousands of times. Updating the procedure using more modern hardware and software is the most logical solution to increase productivity and accuracy of the procedure. Learning how to use the new hardware and software is the major battle because the test procedure from component to component is different and the ability to integrate the systems is crucial. I have learned the hardware and software and feel confident that I could integrate them with most tests involving the thermal vacuum test procedure in building F7. The transmitter site building U 55 has five command destruct transmitting amplifiers, five antennas, and four dummy loads that need to be connected in various ways depending on what mission they are setting up for. In order to do this in an easy and sane way the use of a patch panel network was devised as a solution. On the network, each component would be represented by a connected spigot. The two panels that were previously bought for this task have spigots that are routed to each other in a geometric fashion. I was put in charge of the layout of the ports and the installation of the two panels that make up the network and all the activities involved with the task. Given the available materials I was able to finish approximately 60% of the job.

INTERNSHIP PROGRAM STRUCTURE

The summer internship program was designed to give students unique hands-on experiences by matching students with NASA Scientists and Engineers. The pre-summer activities involved sending out notices announcing the project and requesting students to apply. Once the applications were received a preliminary screening was done to ensure compliance to the conditions stipulated. Following this, an interview date was set in which the students were interviewed by a team of NASA Scientists and Engineers some of whom were likely to be mentors to the students in the program and UMES faculty. At the end of the interview, the successful students (based on their performances and interests) were matched with mentors in NASA with similar interests. This matching process was key to the success of the program. It was somewhat difficult because the mentors had to consider several factors like the kind and level of courses already taken by the student etc and the availability of on-going projects at NASA.

When students reported for the program, they were expected to regularly attend a set of pre-designed activities which included orientation meetings, visits to some NASA facilities and bi-weekly meetings to discuss the progress of their primary assignments and other issues. A schedule of activities was designed for the 10-week summer program. This schedule is in two parts: **Orientation** which included the following: Wallops Mission Overview, Intern Program Handbook Overview, Program Schedule Review, and Technical Report Overview and **Program Activities** which included biweekly staff meetings, tour of Wallops, trips to Goddard-Greenbelt and Virginia Air and Space Museum, Hampton, Virginia. The students made presentations of their work to Wallops Senior Staff and to the UMES community at the end of the period. The bi-weekly meetings offered opportunities for the students to meet with the coordinators of the program and to discuss their progress with their primary assignments. They made presentations on their primary assignments and discussed difficulties. They also submitted a written report and made available their log books for review. In these meetings the students had opportunities to make presentations and had guidance to improve their communication skills.

Towards the end of summer internship, the students made two presentations of their work to Wallops Senior Staff and to the UMES community. At the end of the presentation at UMES, the students were presented with certificates of participation and NASA Tee Shirts. The NASA mentors were also presented with certificates.

On the last day of the program, the coordinators met with the students. The students gave a feedback on their perception of the program. There was a general consensus that the program was very beneficial to them in learning more about NASA's operations and to their career goals. They were appreciative of the opportunity to participate in a program of this nature. Students also provided feedbacks on

ways of improving the program in the future. Some of their recommendations are as follows:

- It will be desirable for students to be given picture IDs
- It will help if mentors provided specific projects/topics
- Some students will like to continue their projects as senior projects
- It will be helpful to match students with mentors during placement
- Can students use the Navy dormitories for the program period?
- It will be helpful if students are provided with an office space and some basic office equipment.
- Provision of better accommodation.

The project went well and accomplished the objectives for which it was designed. The students by the end of the summer through series of presentations, tours and participation in specific projects were quite familiar with the operations and facilities of NASA. 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 learned and are learning in the class room.

REFLECTIONS

The authors believe that this summer project was highly successful because of some key factors that were addressed in the planning and execution of the project. These are:

- a. **Pre-Summer Planning.** In this period, there were a series of meetings between the UMES Coordinators and the NASA Equal Opportunity Officer to map out the format for the activities for the 10-week project period. All the details about each activity were planned and thoroughly reviewed. Timelines and Milestones were set and requirements for meeting targets were examined and clarified.
- b. **Orientation.** This was used to introduce students to the operations of NASA as well as to present to them the expectations for every activity in the summer. The students were given logbooks and discs for recording daily activities in their primary assignments. Their NASA Mentors/Supervisors signed off on these activities every week in the logbooks. The format for biweekly and final reports was presented to the students at this time and these were also included in the disc provided to the students. The students were encouraged to record their daily activities, presentations and reports on the logbooks and discs. The logbooks were

inspected by the coordinators in the biweekly meetings. It was made clear that the discs and the logbooks were to be handed over to the coordinators at the end of the project.

- c. **NASA On-Going Projects.** These projects were real life projects and the students were excited about being part of the team implementing the execution of the projects.
- d. **Biweekly Meetings.** These meetings were very successful and proved to be quite helpful to the students. The discussions and lessons emanating from the meetings helped them to refocus their energies on areas that needed more attention and work. It also helped to clarify details of the projects as they answered questions and discussed the projects.
- e. **Reports and Final Presentations.** The students were aware of these activities early in the program and worked hard to prepare and refine them with every successive meeting. Owing to the strong and continued emphasis on these activities, the students' works were of high quality.
- f. **Exit Meeting.** This meeting was held on the last day of the project and enabled the students to give an overall feedback on their experiences in the entire project. Useful comments and suggestions were made which will lead to enhance the planning of the project in the future.

CHALLENGES

Although students were generally satisfied with the level of stipend they received, there were certain issues that the students raised. These were listed in the section on Program Overview. Some of the challenges encountered were:

- I. Providing adequate accommodation, office and cafeteria for the students.
- II. Issues of reassigning students a few weeks into the program to new projects. This caused some delays and anxiety and the possibility of establishing an appropriate evaluation criteria given the timeframe within which the new assignment is achieved.

OUTCOME FROM INTERNSHIP EXPERIENCE

One of the expected outcomes of the summer internship program is for 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 is a portion of the ongoing Unmanned Aerial Vehicle (UAV) project at NASA Wallops Flight Facility. Three students worked on the project. The project details 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, 2003.

CONCLUSION

The conclusion of this experience is that NASA Wallops had an opportunity to evaluate the product from University of Maryland Eastern Shore and had expanded the program to include other disciplines such as business and computer science in the upcoming summer internship period. As a result of the experience, three students were able to do their senior design project at NASA on real projects with meaningful experience being gained. It has also provided for further collaboration among NASA scientists and University of Maryland Eastern Shore faculty. We see this as an ongoing relationship to provide NASA with quality students as well as fostering educational enhancement in students' learning and growth.

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