M.U.S.T. 2007 summer research project at NASA's KSC MILA facility.

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- **Educational Summary**

As part of the MUST (Motivating Undergraduates in Science and Technology) scholarship program, MUST students are required to participate in a 10-week summer internship at a designated NASA facility. Students receive a stipend, which covers basic expenses incurred while working on their projects.

The internship opportunity bestows upon MUST students a first hand look at the type of challenges in store for them after college. In the NASA arena, such challenges include but are not limited to:

1. Compliance with strict security measures as required by NASA guidelines
2. Integration into a cutting edge, highly technical environment
3. Exposure to industry standards & terminology
4. Experience with industry standard engineering hardware and software.
5. Familiarity with engineering practices & techniques.

By acquiring this set of skills, students will have a better understanding of the fundamental practices in their particular field of choice.

We must also recognize America's investment in her students. In return for these opportunities, our great nation shall benefit by reversing the increasing shortage of professionals in STEM fields, thereby allowing for a more productive and competitive populace.

- **Introduction**

The summer research activity at Kennedy Space Center (KSC) aims to introduce the student to the basic principles in their field of study. While at KSC, a specific research project awaits the student to complete. As an Aeronautical Engineering student, my assigned project is to assist the cognizant engineer, Mr. Troy Hamilton, in the six engineering phases for replacing the Ponce De Leon (PDL) 4.3M Antenna Control Unit (ACU). Although the project mainly requires the attention of two engineers and two students, it also involves the participation of many colleagues at various points during the course of the engineering change (EC).

Since the PDL 4.3M ACU engineering change makes both hardware and software changes, it calls upon the expertise of a Hardware Engineer as well as a Software Engineer. As students, Mr. Jeremy Bresette and I have worked side by side with the engineers, gaining invaluable experience. We work in two teams, the hardware team and the software team. On certain tasks, we assist the engineers, while on others we assume their roles. By diligently working in this fashion, we are learning how to communicate effectively as professionals, despite the fact that we are studying different engineering fields. This project has been a great fit for my field of study, as it has highly improved my awareness of the many critical tasks involved in carrying out an engineering project.

- **Background**

NASA operates 10 research centers around the nation, each center having a specific purpose. The Space program collectively achieves multiple tasks, serving both the public and private sectors. At KSC, our focus is on the lift off and landing of the Space Shuttle.

There is an extraordinary amount of work required at NASA in order for the Shuttle to make it into orbit. The ascent and descent prove to be the two most critical moments in the mission. Since the possibility for damage to equipment and loss of human life during these two periods is so great, computer systems on the ground monitor the data transmitted by the Space Shuttle closely. NASA facilities on the ground receive this data modulated on RF signals sounds and signals via satellite antennas. We define this type of communication as Telemetry.

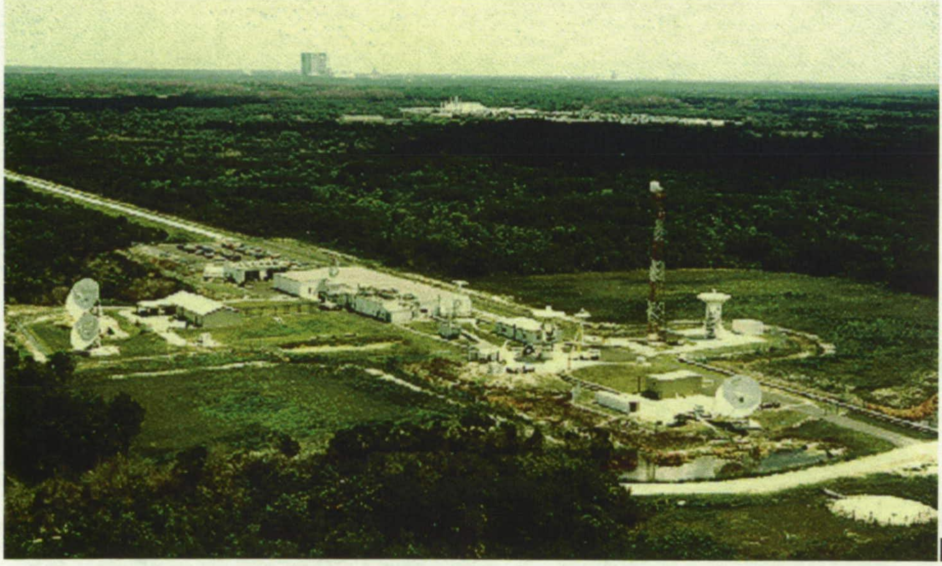

Figure-1

Located one mile west of KSC gate H is the Merritt Island Launch Annex (MILA) space tracking and data network station (**Figure 1**). MILA is the main facility of three, responsible for successfully receiving and distributing the telemetry during a Shuttle launch. It is composed of a wide variety of electronic equipment and personnel, all finely tuned and polished to the highest level of their capability. MILA does a terrific job at assisting the Space Shuttle program in reaching its space exploration mission.


Figure-2

Located 30 miles north of KSC is the Ponce De Leon (PDL) space tracking and data network station (**Figure 2**). PDL is the second of the three responsible for receiving and distributing the telemetry of a shuttle launch, during the event that MILA cannot successfully do so. This generally happens during the first two or three minutes of launch when the plume generated by the Shuttle interrupts the radio frequency signals to MILA. This summer we have had the opportunity to work at both facilities.

Within MILA and PDL, are 4.3-meter (dish diameter) antennas that point to and track the shuttle as it lifts off. The operation of these antennas requires a computer called the "Antenna Control Unit" (ACU) (**figure 3**). In order to sustain operations, MILA and PDL needed to replace their existing ACU's, with new and more capable ACU's. Due to the urgency of this change, the NASA Education office in collaboration with the MUST coordinators paired us up with MILA and PDL.

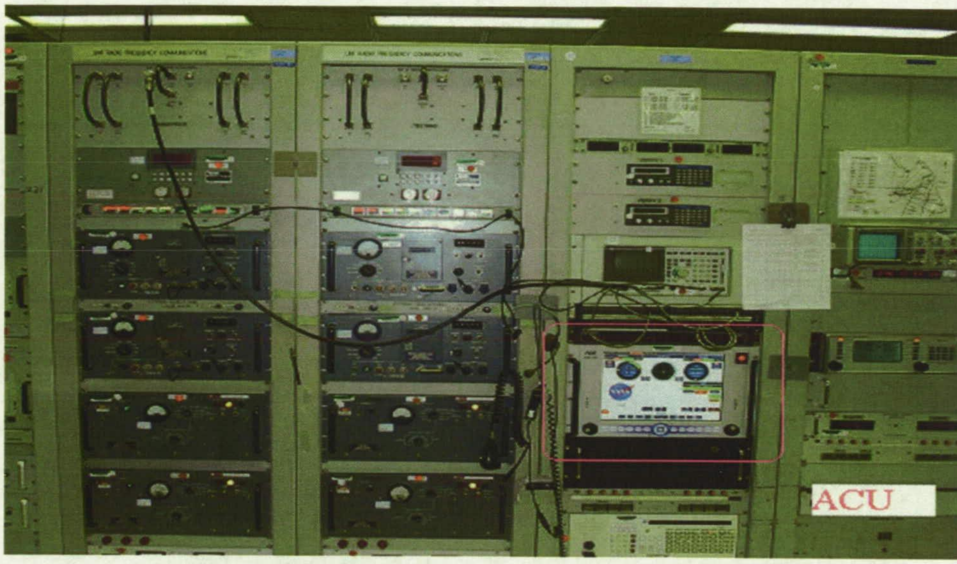

Figure-3

- **Procedure**

Our main objectives as interns have been to design, develop, verify, implement, test, and transition to operations the replacement of the ACU at PDL. We achieved this objective by following a systematic guide called "Near Earth Network Services Engineering and Configuration Management Process" (**Figure 4**). Although with some variations, this type of process is common in the industry for many types of engineering projects. Ours in particular is the NENS-GN-LOP-0124, which consists of 6 phases.

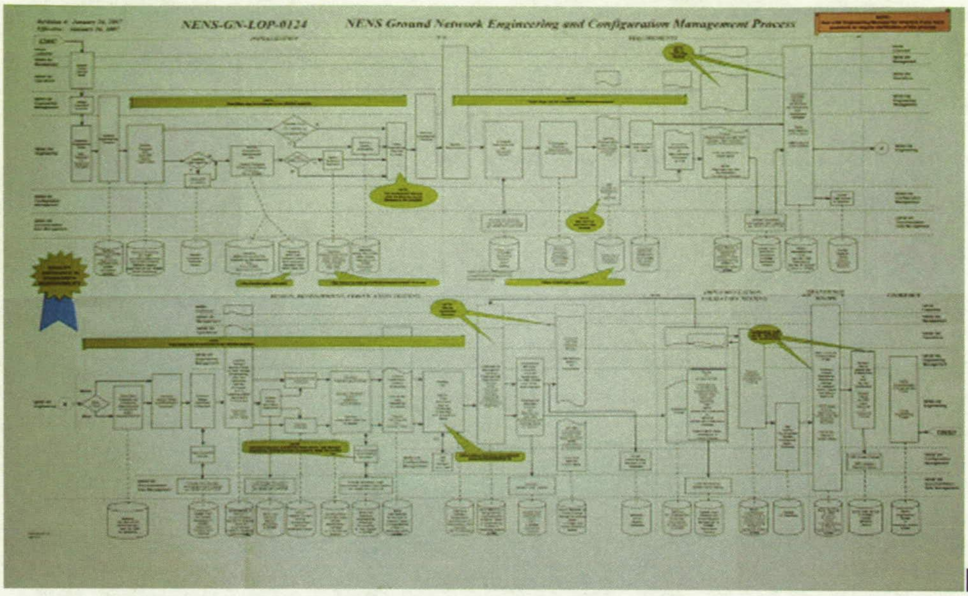

Figure-4

- Phase 1: Initialization process:

  This phase is where we identify the change needed, select the engineers, and review technical information.

- Phase 2: Requirements:

  This phase is where we come up with an initial course of action to carry out our EC. We also go over the proposed EC with the Committee Review Board, and make any changes as necessary in order for the change to stand the test of stress and time.

- Phase 3: Design, Development, Verification Testing:

  At this point, we are ready to make or buy products required for the design. We develop the strategy and test for all what if scenarios.

- Phase 4: Implementation, Validation testing:

Once having all necessary hardware, software, firmware and work force, we can implement the change and perform the validation to make sure that the change is an engineering success.

- Phase 5: Transition to Ops:

  A key step in the true success of the EC is Phase 5. It involves a configuration audit form peers and operators (the people who will actually use the equipment), and a NASA federal strict guideline safety and operation test.

- Phase 6: Closeout:

  Upon successful completion of Phases 1-5, Phase 6 is then completed. This phase will submit a FMCR to the Committee Review Board upon removal of temporary change, and will verify the completeness of all related EC documentation. Once all steps are complete, we can close the EC and archive the EC folder for future reference.

In order to complete our assigned project, NASA provides access to all resources required to finish the job. Resources such as existing samples of previous engineering changes, internet access, peer reviews, etc...

- **Accomplishments & Analysis**

At the beginning of the summer internship, our assigned mentors worked diligently to get us up to speed in the basic concepts and methods of working with telemetry. Soon after, we began to execute each individual phase of the EC process on a variety of Engineering Changes. Due to the logistics of making and delivering the new ACU, we were not able to see the Closeout of that particular EC. However, we have managed to complete every phase of the "Engineering Change and Configuration Process" on multiple EC's. This derivation of the existing plan actually proved to be much more beneficial to obtain real world experience. In a real world scenario, sustaining engineers frequently work on multiple EC's at any moment in time.

In the Aerospace industry, time is of the essence. Every launch requires the perfect function of every piece of equipment involved. This NASA guideline puts a 3-week freeze on the equipment that MILA and PDL work on. With two shuttle launches during the internship program, it has been especially challenging to do work at the facilities. Nevertheless, we have managed to utilize the available time as effectively as possible by learning the importance of planning.

In addition to the successful completion of the "Engineering Change and Configuration Process", we also had the privilege of learning and growing with some of the brightest and best engineers in the NASA Space program. Furthermore, we have had the opportunity to participate in countless research presentations, enrichment activities, and social events specifically designed to help ensure our success in our pre-engineering careers.

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