NASA JSC Spring Intern
Barnes,Sarah_Abstract
Risk & Reliability Analysis Branch (NC4)
Mentor: Roger Boyer
POC: Mark Valentine

Mass and Reliability System (MaRS)

The Safety and Mission Assurance (S&MA) Directorate is responsible for mitigating risk, providing system safety, and lowering risk for space programs from ground to space. The S&MA is divided into 4 divisions: The Space Exploration Division (NC), the International Space Station Division (NE), the Safety & Test Operations Division (NS), and the Quality and Flight Equipment Division (NT). The interns, myself and Arun Aruljothi, will be working with the Risk & Reliability Analysis Branch under the NC Division's. The mission of this division is to identify, characterize, diminish, and communicate risk by implementing an efficient and effective assurance model. The team utilizes Reliability and Maintainability (R&M) and Probabilistic Risk Assessment (PRA) to ensure decisions concerning risks are informed, vehicles are safe and reliable, and program/project requirements are realistic and realized.

This project pertains to the Orion mission, so it is geared toward a long duration Human Space Flight Program(s). For space missions, payload is a critical concept; balancing what hardware can be replaced by components verse by Orbital Replacement Units (ORU) or subassemblies is key. For this effort a database was created that combines mass and reliability data, called Mass and Reliability System or MaRS. The U.S. International Space Station (ISS) components are used as reference parts in the MaRS database. Using ISS components as a platform is beneficial because of the historical context and the environment similarities to a space flight mission.

MaRS uses a combination of systems: International Space Station PART for failure data, Vehicle Master Database (VMDB) for ORU & components, Maintenance & Analysis Data Set (MADS) for operation hours and other pertinent data, & Hardware History Retrieval System (HHRS) for unit weights. MaRS is populated using a Visual Basic Application. Once populated, the excel spreadsheet is comprised of information on ISS components including: operation hours, random/nonrandom failures, software/hardware failures, quantity, orbital replaceable units (ORU), date of placement, unit weight, frequency of part, etc. The motivation for creating such a database will be the development of a mass/reliability parametric model to estimate mass required for replacement parts. Once complete, engineers working on future space flight missions will have access a mean time to failures and on parts along with their mass, this will be used to make proper decisions for long duration space flight missions.

The Mass and Reliability System (MaRS) database was my sole project assignment for the duration of this tour. Within this database many different tasks were accomplished both individually and as a joint venture between Arun Aruljothi and myself. The main objective was to populate the weight for every part on the ISS. To successfully work together, a shared point was created for work collaboration, which established easier access to the branch. Next, a new excel spreadsheet *Mass by Components* was created*;* this database was a simpler method to enter mass data with a few helpful coding aspects (i.e. large sets of data found, created a

unique parts lists to extract the replication of part, added a frequency column part number counter for how many parts found, etc.) The goal of the project was to enter in mass data on a total of 25% of the 81,630 parts on the ISS. This goal was accomplished and even exceeded; I populated over 2000 unique component masses into the database. The total percentage of unique part collected surpassed 27%. The total percentage of overall part numbers exceeded 39%.

Documentation is the step taken, after a mass is retrieved. This verification is key to allow users of the database to track the source of the mass. Space columns in the documentation of both *Mass By Components* and MaRS to input of this information. In the Shared point a folder call *References for Mass Data* was created to consolidate PDF's and JPEG's of reference data. Retrieval of mass data might seem trivial to a user, but is not this way, so we created a process for future interns or users to use that will guide them through the most effective way to find a unit mass. This user manual might be a vital piece of information in this terms completion.

In terms of the VBA coding in MaRS, it can be very cumbersome in places, so some of our time was devoted to simplifying, updating, and debugging the VBA coding by adding arrays and binary coding techniques. Failure data also needed to be updated according to PART database. Lastly, using VBA coding, created a way to efficiently populate the data from *Mass By Components* back into *MaRS*.

In this internship I have experienced team building and intercommunication in ways that have helped me grow as an engineer. Open communications between my point of contact, mentor, and especially Arun have been key to what I believe has been a successful term. At the start of my project our team struggled through some inefficiency. However by working together we decided to create a shared folder and this greatly helped our project to become more interconnected and improved the team's efficiency and communications.

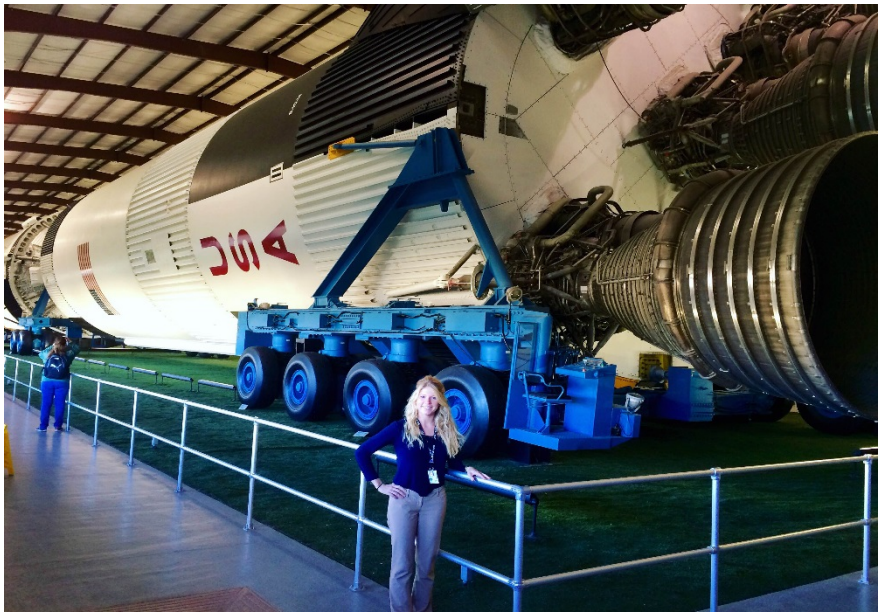
Regarding the technical skills, I was able to advance my capabilities with Excel and Visual Basic Applications. Being a Mechanical Engineering major and not a System or Computer Engineering student, I have less code development experience than some of the other team members. With team assistance I successfully created new MACROs to benefit the MaRS database, and was able to simplify and improve coding techniques.

The majority of my project involved the International Space Station, and this has given me insight into the operations and maintenance involved, especially the system hardware. Learning about the Johnson Space Center and NASA as a whole has been a significant learning experience. I have gained insight into the future of space flight and the aerospace technology that supports it. I had the privilege of attending many tours, lectures, seminars and networking events. This has been both exciting and educational.

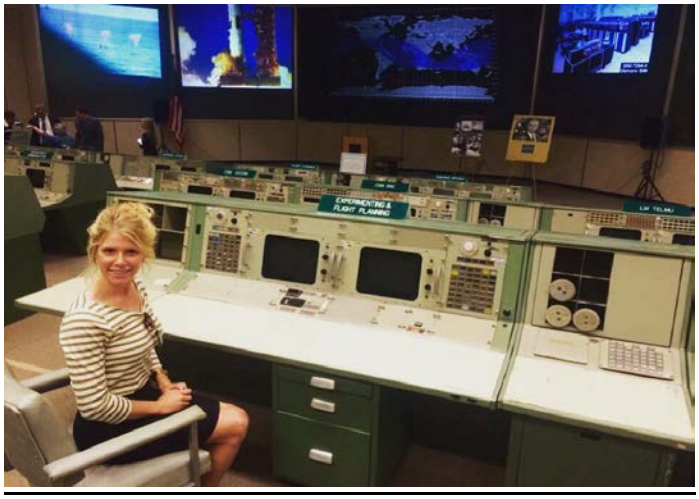
This internship, at Johnson Space Center, has impacted my career tremendous. I was able to implement and see firsthand some aspects of my aerospace classes. This term finalized

my ambiguity to obtain a Master's degree and helped me refine the area of study to Aerospace/Space Systems engineering. The atmosphere of Johnson Space Center is what gave such a positive experience: the thirst for knowledge, the passion for Space Flight, and the willingness to educate the younger generations shines through here at JSC. I hope to rekindle my career here, or with other NASA centers, later down the road.

Pictures of Tours and Lectures during Term:



Visiting the Saturn V Human-rated expendable Rocket at Rocket Park. This three stage (363 foot) rocket supported the Apollo missions for Moon explorations.



Historic MCC- Controlled Gemini, Apollo, Skylab, and Shuttle Missions.

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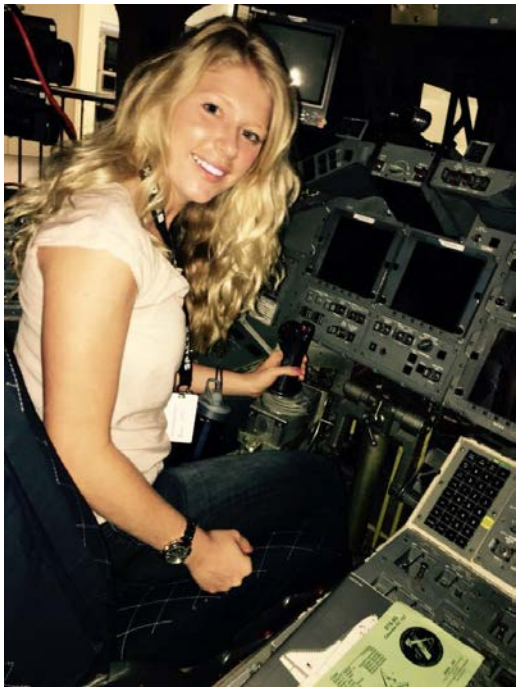

Sitting in the Commander seat in the Shuttle Avionics Integration Laboratory (SAIL) cockpit. This facility, for shuttle program, was where actual orbiter hardware and flight software could be integrated and tested in a simulated flight environment. It supported the entire space shuttle program to perform integrated verification tests.

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Appendix:

Initial Project Schedule:

Project: Mass and Reliability Source (MaRS)

	Objectives	Dates(Two week Intervals)							
		1/25-2/5	2/8-2/19	2/22-3/4	3/7-3/11	3/14-3/25	3/28-4/8	4/11-4/22	4/25-5-6
1	*Become familiarized with ISS Database and Documention*								
2	*Update MaRS Programming and Documentation*								
3	*Find Mass Data of Components*								
3.1	5% of Total Component Masses Input								
3.2	10% of Total Component Masses Input								
3.3	15% of Total Component Masses Input								
3.4	20% of Total Component Masses Input								
3.5	25% of Total Component Masses Input								
4	*Update Failure Data of Components*								
5	*Complete Exit Documentation*								
6	*Presentation and Report for Project*								

Completed
Projected

References:

- NA/Safety & Mission Assurance Office Welcome Package
- 2014 NC4 Annual Report
- MaRS Hand Off Document
- MaRS Manual