Completion of Launch Director Console Project and Other Support Work

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Abstract

There were four projects that I was a part of working on during the spring semester of 2018. This included the completion of the Launch Director Console (LDC) project and the completion and submission of a Concept of Operations (ConOps) document for the Record and Playback System (RPS) at the Launch Control Center (LCC). As well as supporting the implementation of a unit in RPS known as the CDP (Communication Data Processor). Also including my support and mentorship of a High School robotics team that is sponsored by Kennedy Space Center. The LDC project is an innovative workstation to be used by the launch director for the future Space Launch System program. I worked on the fabrication and assembly of the final console. The ConOps on RPS is a technical document for which I produced supporting information and notes. All of this was done in the support of the IT Project Management Office (IT-F). The CDP is a subsystem that will eventually be installed in and operated by RPS.

I. Introduction

During the spring semester of 2018 I was officially brought on as a Mechanical Engineering Intern under the NIFS program to work on the development and implementation of a new Launch Director Console (LDC) for the IT Project Managers Office. While working on this project I was also tasked with creating supporting documentation for the writing of a CONOPS (Concept of Operations) for the Record and Playback System (RPS) and eventually sent to shadow and support a lab working on a subsystem that would eventually be integrated into RPS. This work required a versatile set of skills to be implemented daily. These skills included verbal communications, physical strength and dexterity, a knack for problem-solving and designing, and an open mind to continue to learn new concepts and ideas. Completing these primary tasks and maximizing my personal skill required me to work with different subject matter experts located around Kennedy Space Center (KCS), including civil servants and contractors. This was a very rewarding opportunity which gave me the chance to work with many talented individuals. I worked on two projects with incredibly different deliverables, and the rest of this paper will work to explain the importance of each of these projects, and the nature of the work that was required to accomplish each.

II. Launch Director Console (LDC)

The Launch Director Console is an innovative workstation that is being built for the Launch Director to use during launches of the Space Launch System (SLS). This console is only a single piece of what will be the final configuration of hardware used in Firing Room 1 of the Launch Control Center (LCC) at KSC. The final configuration is to include a console for the assistant launch director, and a custom video display workstation. The SLS program will be helmed by Charlie Blackwell-Thompson from this console. This project is intended on being a legacy product, intended to be used for at least the next 30 years. For this reason, factors like ergonomics, adaptability, and versatility were crucial in the initial design phase of the project. The console houses two computers displaying 3 monitors, Voice over IP (VOIP), a telephone, and an OIS-M unit that are all capable of being adjusted. These are key factors that were considered during the early design work of the project.

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This project is unique because this has been a project that has been almost exclusively been done by interns. From the initial establishing of design requirements to early prototyping to the installation of the final product, this project has been handled with the utmost care by a long line of highly skilled interns.

A. Personal Responsibilities and Deliverables

I was brought onto this project in the final stages of its implementation. My responsibility was to perform all of the tasks necessary to complete the final installation and implementation of the workstation. That included assembly of the physical work station, the integration of all of the mechanical and electrical subsystems used in the workstation, and the installation of computers and monitors. It was expected of me to understand every single component and how they interact to ensure that if there were any problems, that I would be able to identify the problem and immediately implement a repair or modification. This required the use of many mechanical and electrical engineering principals to problem solve. I was also tasked with implementing and tracking minor changes that needed to be made during installation. These kinds of changes included the design and fabrication of a handle for the headset door, custom signage, and many more.

For many of the mechanical and electrical problems that arose I would design and fabricate new components using the invaluable resources made available to me at the Prototype Development Lab. Working with their experienced technicians I was able to solve all of the outstanding issues with the console in a timely fashion. Being able to debug and repair these systems quickly led me to being an expert on all of the consoles different subsystems. I was made to be responsible for ensuring the quality and long term functionality of the console. This included verifying the different design specifications that had been outlined were adhered. This required that I familiarize myself with all of the documentation that had been produced to ensure that all of the user needs were either met or exceeded.

In completing my role on the project our team had finished the installation of the workstation, computers, mechanical and electrical subsystems, and Electromagnetic shielding. While working on this I also supported the corresponding documentation on the project. This was used in the TRR (Test Readiness Review) and ORR (Operational Readiness Review) verification and validation of the project.

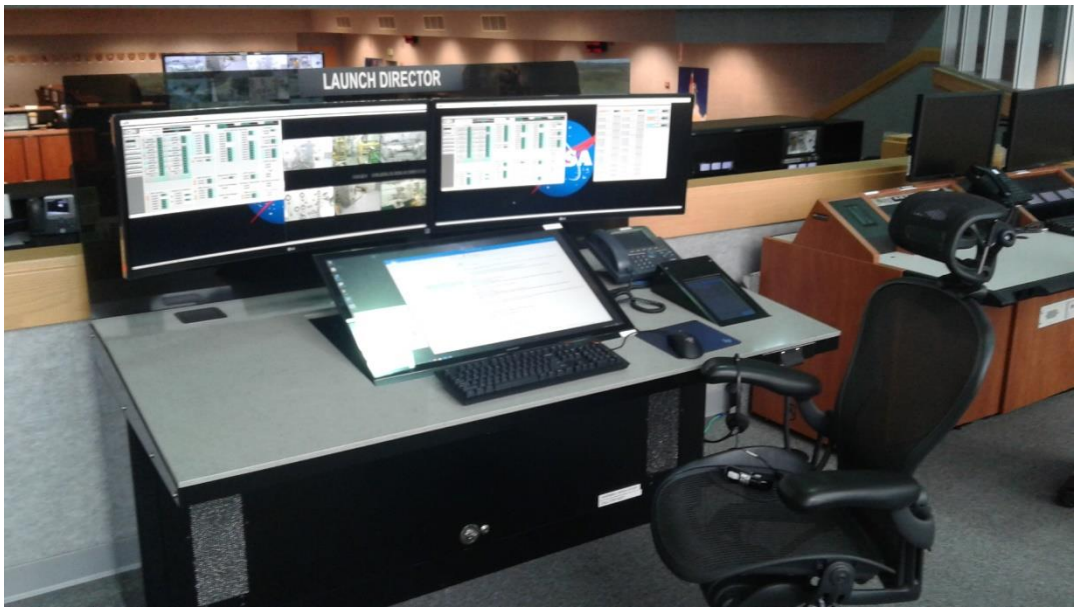

Image 1. Operational Launch Director Console *Pictured above is the completed LDC, including its 2 ultra-wide monitors, adjustable touchscreen, telephone, and OIS-M unit.*

B. Future of the Project

With the near completion of the first workstation it only needs to be validated and then work on the second one would begin. The idea that was originally pitched for this revamped manager's row of the firing room included many pieces to be built. One of those pieces was the Assistant Launch Directors Console (ALDC). This workstation would be identical to the first, and act as an alternative workstation in the event of a failure to the LDC.

The next large scale item that will be added is what is known as the "Glass Wall". It is a large touch screen display capable of hosting many live video feeds from the launch pad. These video feeds are critical to the launch director's

decision making process in situations where time is a factor, and mission success at jeopardy. These live video feeds can reveal problems that traditional telemetry data does not. It is expected to be completed by August. It is a subsystem that requires a massive backend server supplying over 50 live video feeds streaming simultaneously to a single display.

The final unit to be installed will be a separate, isolated communication unit known as "Point to Point". This unit is used to communicate with the flight director in Houston, the Range at the air force base and other important people of interest. These are parities that the launch director must be able to communicate with at all time as a matter of safety. For that reason, this unique unit will have the capability of sending and receiving messages in any emergency or environment. This unit utilize a highly robust communication hardware that will be housed in a custom, freestanding unit that will be located between the LDC and ALDC.

III. Record and Playback System (RPS) Concept of Operations (ConOps)

The Information Technology Project Managers Office, like most offices, requires the use of paperwork to document and verify that projects are being completed and reaching their goals. In developing these documents, sometimes a project manager will need to sit down with subject matter experts and collaborate on the writing of these documents. I was asked to provide assistance in writing some notes for a project manager to refer to while they wrote one such document. For working on this document, I was able to sit down and interview experts in RPS and document their work flow process. This included all of their capabilities, which resulted in roughly ten pages of notes which I provided to my supervisor.

A. Concept of Operations (ConOps)

One of the other projects that I supported was the writing of a ConOps for a lab known as RPS. A ConOps, or Concept of Operations is used to define the capabilities and expected baseline operations for a project. This can include some technical functionality, but is typically written to capture the functionality of a project at a high level, outline the major tasks that will be accomplished, not each step needed to accomplish them. The ConOps is typically written before a project is started to identify the expected scope, and to reach an understanding of what will be accomplished with the project. The ConOps that I helped support was slightly different in that it was looking to capture the functionality of a lab that was already operational. The goal of the document was still to identify the functionality of the lab, but it was not going to act as a template for the project, but an understanding of the expected long term capabilities.

B. Record and Playback System (RPS)

The Record and Playback System (RPS) is a unique lab located in the Launch Control Center (LCC) that processes telemetry data. Historically RPS was used to record all of the telemetry data from launches, including the Shuttle program to Apollo. With the new Space Launch System (SLS) there is more information being produced than ever before. This telemetry data will be delivered from SLS via the umbilical connections until liftoff and then through radio frequency communication. All of this telemetry data is used by Launch Control System (LCS) to use during the launch, and is subsequently needs to be reviewed after launches. RPS is tasked with recording all of this information and supporting the post processing of the data. RPS holds a wide range of capabilities to support pre and post launch operations. They also prepare the data for transmission to other centers such as Marshall Space Flight Center.

Currently most of RPS is being used to support the verification and validation of the firing room's software packages. They are in the early stages of shifting their focus to more align with supporting SLS in the same way they supported the Shuttle program. They are doing this by increasing their scope, and adding capabilities that reflect the digital age. Including moving from older analog and copper connections to carry data signals to using Ethernet and fiber connections. Recording these data signals is vital for the validation process of many systems.

IV. CDP Support

The CDP or Communication Data Processor is a system that is currently being developed by the Telescience Lab. The lab is working to develop and implement this new subsystem into the greater information network used to process critical flight data during a launch. I spent my time shadowing James Dumoulin as he worked on the project. When I joined, he had already implemented an early iteration of the CDP, and was working to develop the final product and prepare it for installation in RPS.

A. CDP Function during Launch

During the launch of the future Space Launch System, the rocket will send telemetry data to the ground, which is needed to determine the functionality of the rocket and ensure launch success. The CDP is going to be a major

component in the RPS lab, and is used to manage and route telemetry data to different customers. These customers include Firing Room 1, Marshall's Mission Control Center, and The Range (Cape Canaveral Air Force Station). All of these customers need the telemetry data for different reason, so the CDP is capable of taking all of the incoming telemetry data, packaging the required portions for each customer, and then delivering that data. This is done to decrease the load on the networks which this system supplies.

B. CDP Progress

The CDP has been going though development for over a year before I began to work in the lab, and is expected to be delivered in August. Most of the work being done on the CDP currently debugging and modifying the software to meet customer needs. This requires communicating and coordinating with a vendor to implement software changes that support the specific function for the final product while also allowing them to develop a more robust software package.

V. Robotics Mentor

During my time as an intern I was able to act as a mentor for a high school robotics team which Kennedy Space Center sponsors. This robotics team includes students from three local high schools and mentors from KSC. Together, we built a robot to compete at regional events. These competitions are hosted by an organization known as FIRST Robotics, and it includes thousands of teams and hundreds of events around the world. Our team competed at two different events this year. Over the 3 month season we constructed a robot from the ground up utilizing the support from a few different groups around the center.

This year the robot had to be able to accomplish a few different tasks. An example of one of those tasks included being able to grab crates off the ground, and to place them on different platforms up to seven feet off the ground. I worked and helped design and fabricate different mechanical components and subsystems used on the robot. This was a massively powerful robot capable of moving up to 12 feet per second and lifting its own body weight of 120 pounds.

VI. Conclusion

This spring semester was very eventful and I was able to see the completion of two major projects that I was able to participate and the groundwork for more projects to be done in the future. The LDC was an area in which I was able to continually use my critical thinking and problem solving skills to find effective solutions to complex problems. Having the opportunity to use my skills in design and fabrication was key in completing the LDC project by our deadline. We managed to complete the project and hand it over to the LCC personnel two weeks before our project's deadline. This project was rare in its requirements, and the number of disciplines that it touched. Ensure that all of these pieces created a cohesive final product was imperative to its success. I look forward to seeing the console be used in the future, and only wish that I would be able to help in the completion of the rest of the units to be used in the manager's row of Firing Room 1.

For the ConOps of RPS, it is a less dynamic and technically involved project, but that does not mean it is not still important. The ConOps of RPS will be a document used to guide procedure and expectation for years to come. It also helped me develop critical skills in technical document writing and a deeper understanding of how technical documents are written. These documents are key in maintaining a solid record, and understanding of a project, that can be referenced later. Communication is one of the most important factors when it comes to maintaining a high quality working environment.

Then working with the CDP, a system covered in the ConOps I worked on, was an amazing connection between working on the documentation of a project, and seeing the implementation and work it takes to develop that kind of system. This is a system that is mission critical, and watching the amount of care and patience that must be put into it is astounding.

Finally working as a mentor with this high school robotics team was an amazing experience, learning how to work in a completely different environment, doing important outreach work to help reach a whole new generation of future engineers. It was an enriching experience, and even though we were not able to win, we had fun learning and building together.

Acknowledgments

I would like to thank everyone in the IT-F office for the opportunity to work on these two fascinating projects. I would also extend my thanks the Prototype Develop Lab for their continued support on this project, and all of their experienced technicians and engineers that facilitated the completion of this project.