Design Visualization Internship Overview

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Abstract

This is a report documenting the details of my work as a NASA KSC intern for the Summer Session from June 2nd to August 8th, 2014. This work was conducted within the Design Visualization Group, a Contractor staffed organization within the C1 division of the IT Directorate. The principle responsibilities of the KSC Design Visualization Group are the production of 3D simulations of NASA equipment and facilities for the purpose of planning complex operations such as hardware transportation and vehicle assembly. My role as an intern focused on aiding engineers in using 3D scanning equipment to obtain as-built measurements of NASA facilities, as well as using CATIA and DELMIA to process this data. My primary goals for this internship focused on expanding my CAD knowledge and capabilities, while also learning more about technologies I was previously unfamiliar with, such as 3D scanning. An additional goal of mine was to learn more about how NASA operates, and how the U.S. Space Program operates on a day-to-day basis. This opportunity provided me with a front-row seat to the daily maneuvers and operations of KSC and NASA as a whole. Each work day, I was able to witness, and even take part of, a small building block of the future systems that will take astronauts to other worlds. After my experiences this summer, not only can I say that my goals have been met, but also that this experience has been the highlight of my experience in higher education.

I. Introduction

In my capacity as a NASA Intern, I had the opportunity to work with the KSC Design Visualization Group during the summer 2014 session. The primary duty of the KSC Design Visualization Group is the production of high quality visualizations and simulations to support NASA customer organizations. Using my previous CAD experience, I was able to quickly adapt to the CATIA software system and use it to aid the DV Group in processing scan data and preparing models for presentation. Having a blended background as both an engineering student and an intern architect, it was exciting to see how the two disciplines come together in a place like KSC. The experience I gained working with the DV Group in such an environment was invaluable, and I feel has more accurately prepared me for a real-world engineering environment than any academic coursework. My objectives for this internship ranged from learning specific technical information about 3D scanning and printing, to simply learning more about how NASA and KSC operate.

II. Background

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Founded in the late 1980s, The Design Visualization Group's primary role at the Kennedy Space Center is providing high-quality simulations and visualizations for NASA customer organizations. The team itself consists of a small group of Boeing contractors, whose individual specializations contribute to the Group's success. With a varied mix of skills in areas such as surveying, mechanical and civil engineering, software development, rapid prototyping and computer-aided design, the KSC Design Visualization Group is able to deliver a wide range of services to customer organizations.

The Group provides detailed 3D, virtual environments that can simulate any number of operations and/or processes with a very high degree of precision and dimensional accuracy. Such visualizations give customer organization's engineers and technicians a wide overview of a process or operation, allowing customers to see

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hardware organizational schemes and facility layouts from positions that are normally inaccessible. In a facility as large as the Vehicle Assembly Building, this proves to be an invaluable tool for customer organization project managers to visually communicate with technicians, such as crane operators, procedures in exacting detail. In addition to visualizations, the KSC Design Visualization Group also provides dynamic, detailed simulations within the visualized 3D environment. This capability is vital to the planning and orchestration of complex operations, as it allows customer organizations to test and visualize "what-if" scenarios. With this capability, the KSC Design Visualization Group enables customers to quickly work through complications, fit and tolerance issues along with other associated problems, in many cases before interacting with any actual hardware. In an environment like the Kennedy Space Center, where time is a valuable and limited commodity, the KSC Design Visualization Group is an invaluable resource.

To facilitate the production and delivery of these services, several articles of high-end hardware and software are regularly employed by the Group. While many existing hardware components and/or facilities may be imported as customer-supplied CAD models, accurate simulations many times require the use of measurements from the "as-built" hardware as well as the "as-designed" specifications. Given the unique type of work regularly conducted at the Kennedy Space Center, simple hand-measurements are not always practical or possible. When requiring measurements of large hardware pieces, such as flight components of a launch vehicle, or measurements of a facility or structure, the KSC Design Visualization Group maintains a dedicated array of specialized 3D scanners to obtain usable, precise measurements of "as-built" equipment and facilities. Two such scanners, the TrimbleFX and FARO Focus3D, use a laser to generate a point cloud of data points, which are then registered to a fixed coordinate grid system. The raw data is then processed with special software and converted into a usable CAD format for further processing. Instead of relying on one scanning technology, the KSC Design Visualization Group relies on a range of different scanning capabilities. Each scanner unit serves a specific need, filling a specialized role in the Group's "family" of scanning equipment.

Figure 1. "Family Portrait" of Scanning Hardware.

While the industry standard CAD packages, such as Parametric Technology Corporation's Creo Elements/Pro (formerly known as Pro/E), are normally sufficient for virtual visualization, the sheer volume of data that the KSC Design Visualization Group frequently works with necessitates the use of a software package capable of rendering these immense data sets. Dassault Systèmes' CATIA v5 has been chosen to fill this role, with DELMIA, another product of Dassault Systèmes, assisting in the creation of dynamic simulations and animations. The unique visualization capabilities of CATIA and DELMIA allow for the creation of models and scenes with a staggering level of detail. As mentioned before, a facility as large and complex as the VAB requires thousands of engineering drawings, but with CATIA, the KSC Design Visualization Group can display the entire structure, and then seamlessly move the camera to focus on an area of detail as small as an electrical panel, all in real-time. This ability to incorporate immense data sets into cohesive, singular models is a principle reason for the use of CATIA, though the software has a range of other features that are useful to the Design Visualization Group. Like other CAD packages, CATIA can selectively display or highlight specific systems, sectors, subsystems and selections within singular assemblies. However, unlike other CAD packages, CATIA is able to perform these operations with a model as compound and intricate as an entire launch vehicle. For instances in which many different processes and operations must be

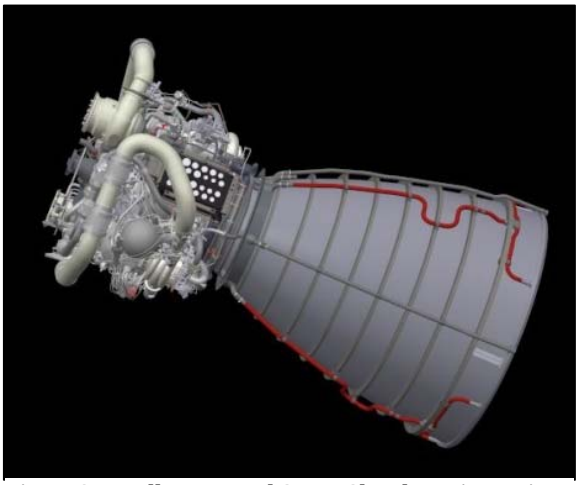

Figure 2. Fully Textured Space Shuttle Main Engine.

orchestrated, this capability once again sets the KSC Design Visualization Group apart as an essential tool for NASA customer organizations.

As a full-service visualization and simulation shop, the Group has a myriad of presentation methods that are used to showcase the data in a way that is both usable and accessible to customer personnel on levels from floor technicians to executive managers. A dedicated video editing studio allows for the production and composition of high quality animations and cinematics, displaying operations and procedures in an easy to follow sequence of events. Full posters and related print materials can also be created for customer organizations, showcasing any stage or step in production or operation. A newer addition to the Design Visualization Laboratories arsenal of presentation capabilities is a Statasys uPrint SE 3D printer. With this addition, physical scale models and mockups of equipment and facilities can be produced for display purposes at customer request.

III. Work Performed

During my limited tenure with the Design Visualization Group, I was exposed to an array of new technologies, practices and procedures common to the aerospace industry. With previous CAD experience as support, I was able to gain a layman's understanding of CATIA, though co-workers within the Group would often demonstrate operations that showcased the software's full potential. As my knowledge and experience of CATIA and DELMIA was only introductory, I was assigned simple tasks such as applying textures to a model of the SLS Liquid Oxygen Umbilical structure, which is anchored atop the Mobile Launcher Platform. These tasks allowed me to learn the intricacies of CATIA at a comfortable pace, all while exposing me to real flight hardware. This level of real-world application is seldom seen in most academic curricula, and it was very refreshing to have the opportunity to work with cutting edge equipment. Other modeling tasks I contributed to include applying material textures to a model of the Space Shuttle Main Engine, modeling sections of the East Access Towers used by the Mobile Launcher Platform, as well as components for other structures used to vertically stabilize the SLS vehicle while it is mated to the Umbilical Tower.

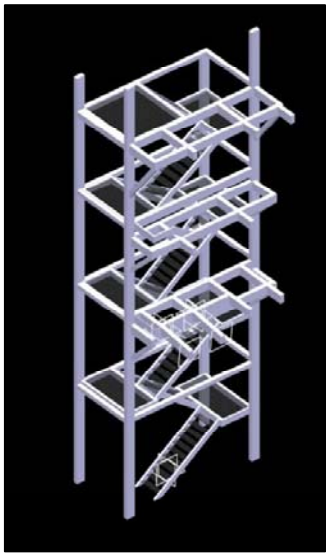

Figure 3. East Access Tower Model.

An additional component to my work with the Group included a scanning operation of the Multi-Payload Processing Facility (MPPF). Key areas of interest during the scan were the exterior and interior dimensions of the main bay door, as well as the measurements of the interior bay itself. The Trimble FX scanner was used to scan the bay door interior and exterior, as well as the bay interior, while the FARO Focus3D was employed to scan the bay interior with a higher degree of accuracy.

Figure 4. Trimble FX Scanner Setup.

Another project I was involved with was the creation of a credibility assessment scale for the Design Visualization Group. The purpose of this document is to serve as a general rating scale by which a particular process or procedure could be analyzed and/or examined to determine the credibility of a given data set. This would be highly useful in the areas of quality control and error reduction, as it provides a standard by which to verify and validate existing and imported measurement data.

IV. Conclusion

As a mechanical engineering student with a working history in the field of commercial and industrial architectural engineering, the opportunity to witness a merging of the two disciplines in a field as dynamic as the U.S. space program was an experience like nothing else. Working with the KSC Design Visualization Group required the ability to work as a specialist and a "jack of all trades", sometimes simultaneously, as many different areas of specialization frequently overlap and are integral to the completion of a project or operation. I was able to expand my knowledge of CAD programs through my almost daily interactions with CATIA, while 3D scanning and printing operations introduced me to entirely new technologies; technologies rapidly gaining prominence in the

modern engineering environment. Working with a Contractor group also afforded me a unique vantage point at which to observe the interactions of NASA and Contractor personnel. Viewing the interactions between the Design Visualization Group's Boeing workforce and the NASA customer personnel provided me with invaluable insight into the complex Contractor/Government relationship, and how this relationship both defines and influences the culture of NASA and KSC.

V. Acknowledgements

None of this would have been possible without the full faith and support of my mentor, David Miranda. Without his decision to select me for this opportunity, I would not have had the ability to engage in such a valuable experience. He has been continually available for questions at every step, and has gone above and beyond to ensure that I gain the most out of my experience at the Kennedy Space Center by connecting me with individuals and events which match both my professional and academic interests. His passion and dedication for his work is inspiring, and transformed this opportunity from a great experience into an unforgettable one. Finally, I must thank the members of the Design Visualization Group. Attempting to integrate into an established working group is difficult at best, but they made the process seamless and enjoyable. Regardless of rank, each member of the team made themselves available for questions and offered advice at every step. No matter where my career takes me, I will always remember the experience I gained here, and I earnestly believe I have become a better engineering student because of it.