Fall 2012 Graduate Engineering Internship Summary

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In the fall of 2012, I participated in the National Aeronautics and Space Administration (NASA) Pathways Intern Employment Program at the Kennedy Space Center (KSC) in Florida. This was my second internship opportunity with NASA, a consecutive extension from a summer 2012 internship. During my four-month tenure, I gained valuable knowledge and extensive hands-on experience with payload design and testing as well as composite fabrication for repair design on future space vehicle structures.

As a systems engineer, I supported the systems engineering and integration team with the testing of scientific payloads such as the Vegetable Production System (Veggie). Verification and validation (V&V) of the Veggie was carried out prior to qualification testing of the payload, which incorporated a lengthy process of confirming design requirements that were integrated through one or more validation methods: inspection, analysis, demonstration, and testing. Additionally, I provided assistance in verifying design requirements outlined in the V&V plan with the requirements outlined by the scientists in the Science Requirements Envelope Document (SRED). The purpose of the SRED was to define experiment requirements intended for the payload to meet and carry out.

At the conclusion of writing the V&V plan, qualification testing of the payload was conducted. The purpose of qualification testing was to run the Veggie under strict system guidelines in order for the payload to operate safely on-board the International Space Station (ISS) as well as operate without interference to other payloads or systems on the low-earth orbiting laboratory. I primarily created event work orders (EWOs) for qualification testing, which are task plans created for the testing of system capabilities to verify their specific performance criteria. Qualification testing encompassed several different testing requirements, such as measurement of acoustic levels, vibration loads on the payload during launch configuration, electromagnetic interference (EMI) measurements from the sub-systems within the payload, off-gas testing, and full system functional testing conducted prior to and after the aforementioned tests. I participated in pre-EMI functional testing on the Veggie, recording light intensity measurements from the light-emitting diodes (LEDs) of the payload on the light measurement fixture, which is connected to the bottom of the lightcap assembly that I designed in Pro-Engineer (Figure 1). Upon completion of qualification testing, development of the Acceptance Data Package (ADP) began. The ADP summarizes the testing results for which NASA was responsible during qualification testing and verifies that the measurements recorded during the tests are acceptable to the levels intended according to requirements from both the design and science requirement documents.

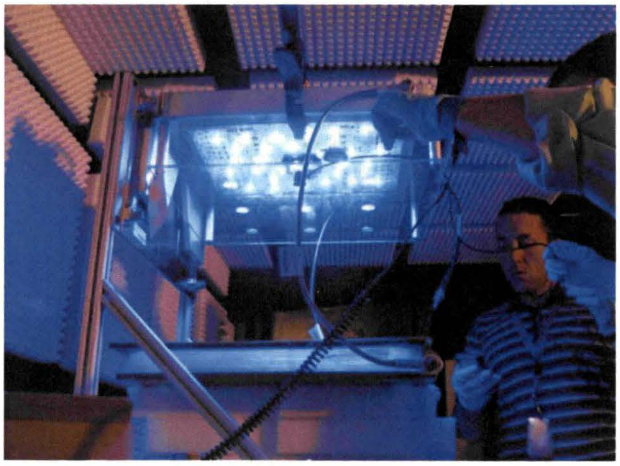

Figure 1 – Conducting LED measurements for functional testing of VEGGIE prior to EMI testing.

Additionally, I served as a secondary systems engineer for the Plant Habitat (PH) payload, a self-sustaining biological growth chamber that will be the largest biological chamber to house and test a scientific payload on the ISS. The team worked towards the Preliminary Design Review (PDR), which serves as a 30% completion checkpoint over the course of the entire design of the payload. However, the PDR was suspended due to a design discrepancy between the height of PH and the internal dimensions of the largest Cargo Transfer Bag (CTB) available, which is used to deliver the payloads to ISS via transfer vehicle. A call for re-design was released to address the issue of reducing the volume of the payload without compromising the criticality of the height of the growth chamber so that the plants can grow to their full potential. This opportunity allowed me to propose a design option, which was presented to the team and discussed. It was agreed upon that by extending the growth chamber below the outer shell of the PH structure, thereby incorporating an additional uninhabited area of PH within the EXpedite the PRocessing of Experiments to the Space Station (EXPRESS) Rack, full functionality of the growth chamber would be preserved without significant impacts to design, costs, or schedule (Figure 2).

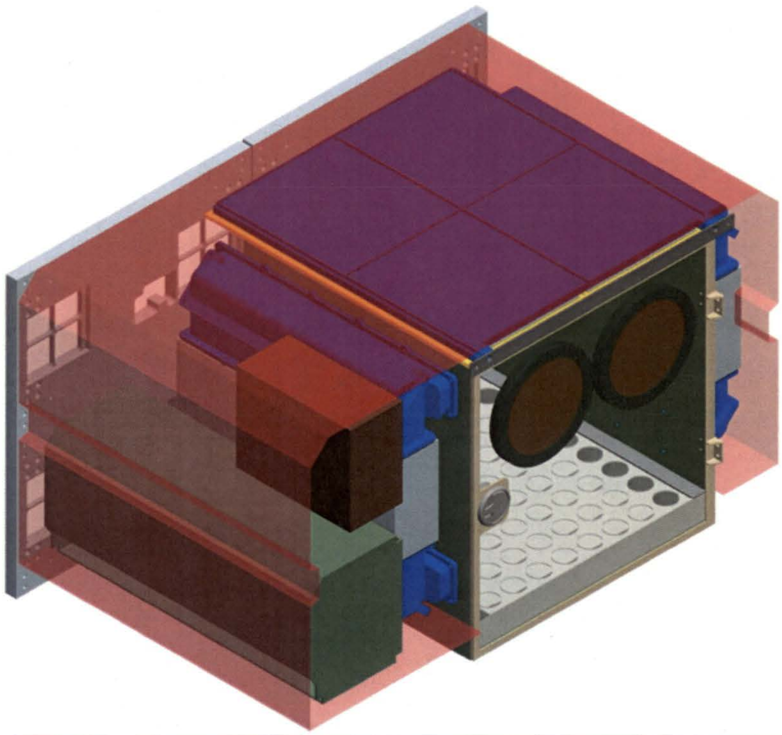

Figure 2 - PH payload with newly designed growth chamber

Finally, I continued to serve as a composite materials analyst providing support with the construction of the growth chamber for PH. In order to minimize weight, composite materials were selected as the primary material for the structure of the growth chamber. Standard practices and procedures required that the materials be tested for flammability, off-gassing, and bio-compatibility. This precaution is to prevent materials from being installed on the ISS that can propagate a fire, produce toxic fumes that could threaten the crew, and to test whether plants can grow symbiotically within the chamber with the materials chosen. Additionally, I conducted tensile testing on composite material samples (Figures 3 and 4). Intermediate modulus 7 (IM7) carbon fiber material and bismaleimide-2 (BMI-

2) resin were integrated through vacuum-induced high temperature resin infusion to create a high-stiffness 5-harness satin composite. Fiber layups orthogonal to the direction of the resin infusing into the material showed the smallest strain (inch/inch) per unit area while those fiber layups lined up rectilinearly with the resin flow was subjected to the highest stress values (Figure 5). I am completing a technical paper on an evaluation of the infusion processes of specific carbon fiber material and resin I conducted during the course of my internship at KSC, which I plan to present at the Society for Advancement of Materials and Processes Engineering (SAMPE) Conference in Long Beach, California, in May 2013.

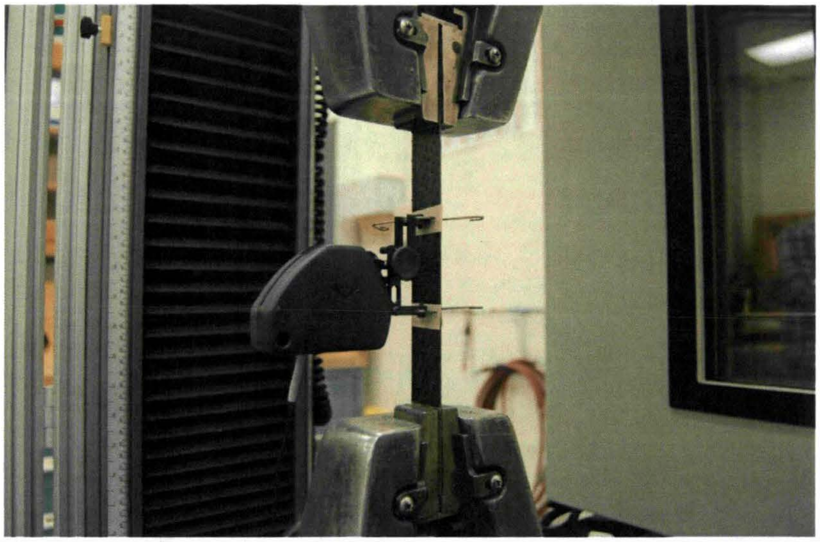

Figure 3 - Tensile testing of IM7 carbon fiber composite with $[90]_4$ layup

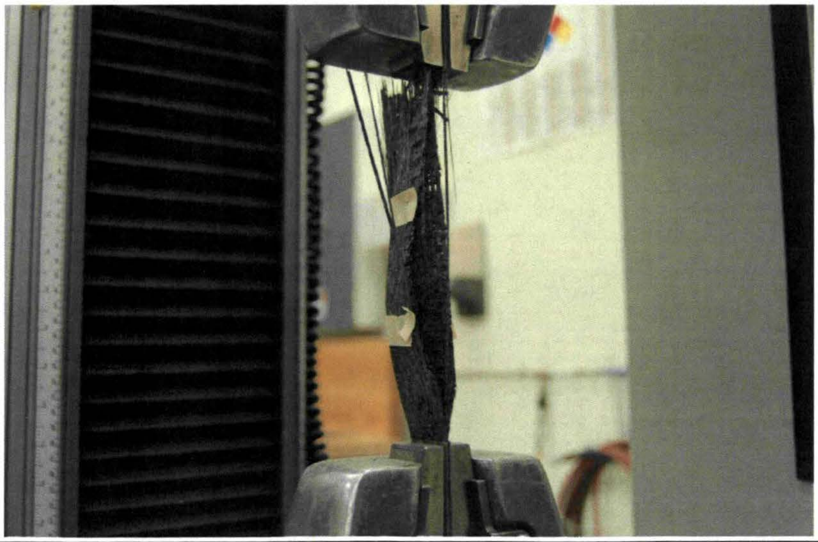

Figure 4 - Delamination inbetween plies due to excess yield strength of IM7 carbon fiber

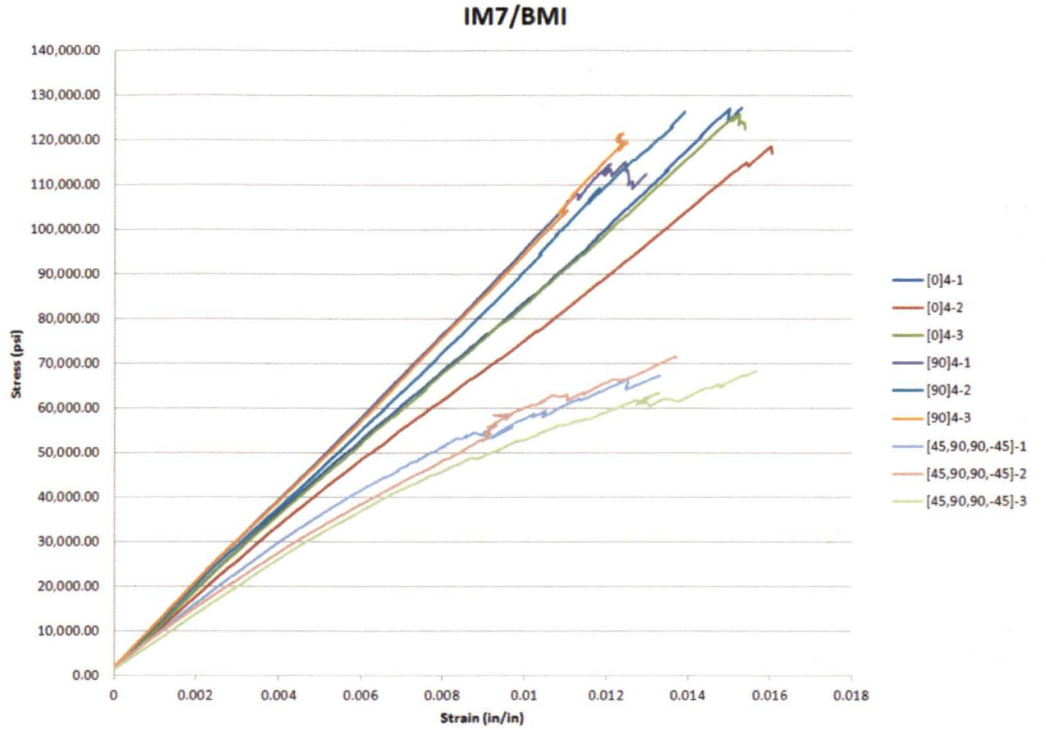

Figure 5- Modulus test results for all three composite panel tests

My tenure as an intern with NASA continued to be a rewarding and jaw-dropping experience. I was continuously presented with opportunities to step outside my bounds to not only prove to fellow engineers and project managers my abilities and skill sets, but also to make a significant impact on the tasks and projects that were assigned to me. As an intern, I was able to propose an idea and have it incorporated into a multi-million dollar piece of hardware; not many people can say that. I was proud to not only serve NASA but also the American people; the title of 'civil servant' goes beyond what anybody can expect when not experienced firsthand. My mentors and supervisors were highly impressed with my work ethic and drive to learn and succeed, which will benefit me as an engineer. My time spent at NASA has highlighted both my undergraduate foundation from the University of Florida and graduate-level skills obtained at Embry-Riddle Aeronautical University. Incorporating the systems engineering aspects from my coursework in SYS 500 and SYS 405 helped me tremendously in the field. I hope to encourage future engineers to follow their dreams and never give up on their passion for success. I have never strayed away from my goals, and I have and will continue to meet those challenges as they are presented to me.