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Department: EC2: Crew and Thermal Systems: Design & Analysis

Design Concept for the Interstellar Dust Collector, Remote Sensing Unit,

& WCD Crew Access Panel

Purpose: For this summer 2018 internship at NASA's Johnson Space Center I worked on three projects in the EC2 branch. My primary project was the Interstellar Dust Collector (IDC). My secondary projects are a Remote Sensing Unit (RSU) and the crew access panel for the Water Collection Device (WCD). This abstract will go over each project and my accomplishments, as well as things I learned and the impact to my future career.

Interstellar Dust Collector Project Description:

Interstellar Dust Collector (IDC) is a proposed flight experiment designed to capture space dust on missions involving the Habitable Airlock (HAL) and its Science Airlock (SAL). For operation, the IDC is to be stowed as a payload inside the HAL or to be carried up in a Logistics Module. It will be placed in the SAL on the HAL and be put in place by the HAL robotic arm. It is then to expand to a 1 m^2 area of Aerogel filled panels positioned in the direction of the interstellar dust stream. After a certain amount of time in deep space, the IDC is retracted and returned to the SAL for eventual return to Earth for scientific study.

This has been my main project with help from my mentor and feedback from the scientists. My task was to design and fabricate a mockup to learn more about the concept to capture space dust on missions involving the HAL and the science airlock. This design has panels in Figure 2 folded back and forth on each other. A spring between each panel forces it to unfold. Four strings holds the end in place and keep it from unfolding and will refold it when needed. Figure 1 shows the IDC as designed and built to showcase the idea. Figure 1 is when it is folded for transport in and out of the airlock. Figure 2 is a detailed design of two panels of the IDC. There are 6 panels folded back and forth to be expanded and capture space dust. Figure 3 is the CAD model of the design. The CAD model was used to fabricate the real model and will be used in the simulation of the HAL during the next test session.

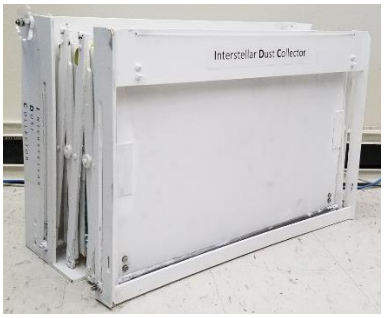

Figure 1: IDC folded

Figure 2: Detailed Panels

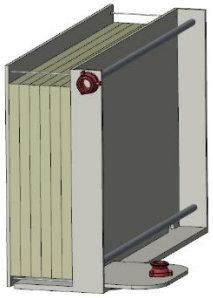

Figure 3: CAD model

Figure 4 below shows the mockup of the IDC when it is fully expanded. This is the side in which the aerogel will be placed and oriented in the direction of the interstellar dust stream.

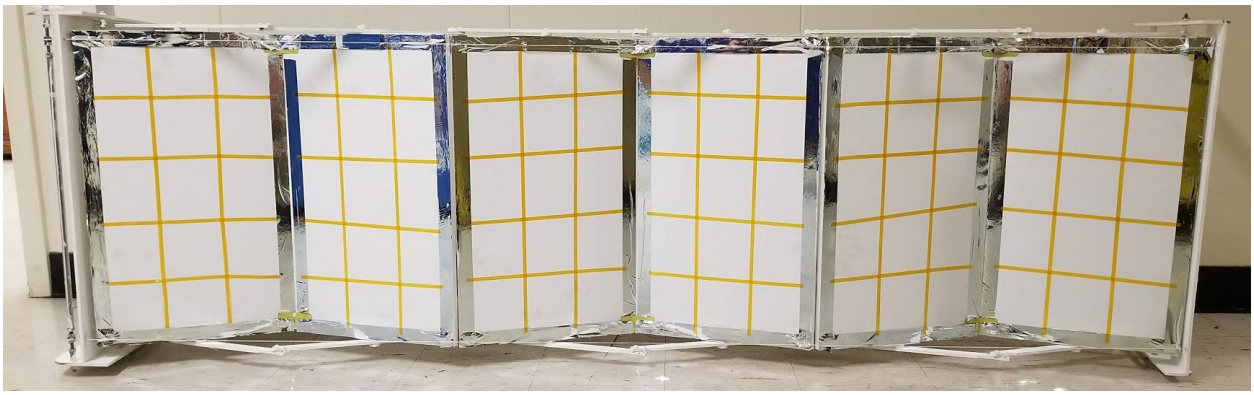

Figure 4: IDC unfolded

Interstellar Dust Collector Project Accomplishments:

- Came up with multiple ideas for the design concept and discussed them with the scientists
- Made a 3D model using Creo to get dimensions and show how it will fit in the HAL science airlock and will be used for a simulation on the next HAL test. (Figure 3).
- Fabricated a fully functional model which expands when the string is unreeled and retracts when the string is reeled in to act like it is working with a robotic arm. (Figure 1,3,&4)
- Painted the assembly to make it more presentable. (Figure 1&4)
- Modeled and fabricated a more detailed Panel model using the 3D printer and laser cutter. (Figure 2).
- Had two presentations with scientists that went very well and going to present my design to the HAL project team with Mike Gernhardt.
- Working on beginning a paper or poster to be presented at the Lunar Planetary Science Conference (LPSC) in May.

Remote Sensing Unit Project Description:

The Remote Sensing Unit (RSU) is a project for our branch chief Vic Untalan. I have been working on this project with another intern, Marika Schubert. This device is designed to measure different environment variables. It measures, C02, 02, pressure, temperature, humidity, color, and audio level of the surroundings. This device is designed for measuring these variables in the HAL for testing currently. It will then log the data to an SD card and can be retrieved either by removing the SD card or through a wireless connection. This project has had 3 different iterations before us. This version will be the first with a fabricated PCB. This version also adds an O2 sensor, audio sensor, and light sensor, and SD card logging backup. I worked on the wiring and coding and PCB design while Marika is working on wireless capabilities.

Figure 5 depicts the current wiring of the device. It is fully functional, however it needs to be compressed, which is what the PCB in figure 6 is for. The PCB in Figure 6 puts all the components in a nice package that's about 2 x 3 x 1 inch. It will be battery operated for at least 8 hours.

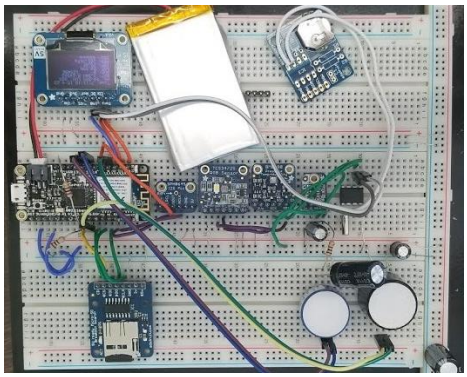

Figure 5: Wiring Prototype

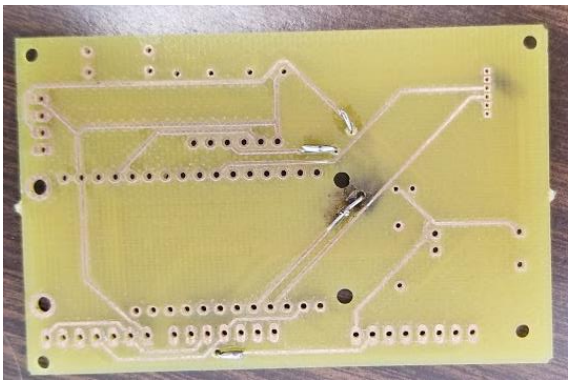

Figure 6: Fabricated PCB on site

Remote Sensing Unit Project Accomplishments:

- Ordered all the components we needed to prototype and program it.
- Wired up the circuit and programmed the chip to read all the sensors. (Figure 5)
- Designed a PCB using EAGLE Designer.
- Learned how to use the PCB mill in our department that had almost never been used before.
- Fabricated a PCB using the onsite mill from the drawings made using EAGLE (Figure 6).

WCD Crew Access Panel Project Description:

Figure 7 is the crew access panel is a part of the Water Collection Device (WCD). The water collection device is a science experiment to determine whether a fixed complex geometry helix can separate water from air without having to use separate spinning part to separate the water from the air. I was tasked with designing an access panel for crew operations of the device. This will house all the connections to the station, to different parts of the device, and to the test article. It also houses a refill well to inject water into the air stream for testing.

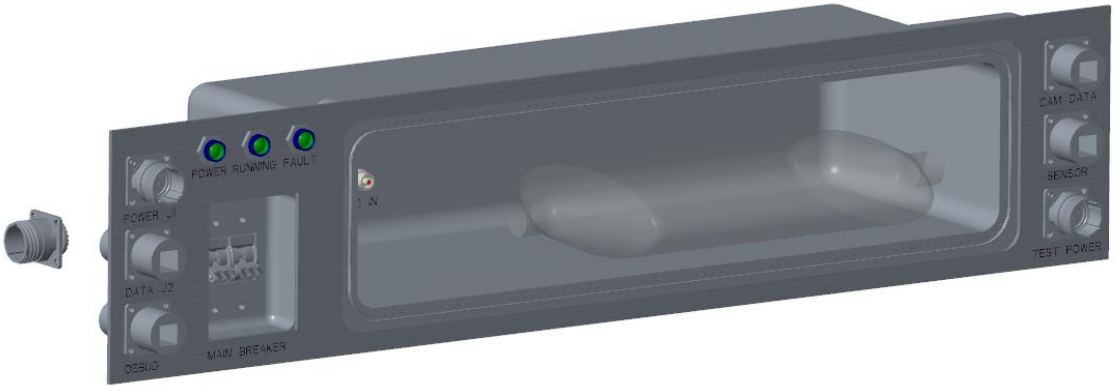

Figure 7: Crew access panel for the WCD

WCD Crew Access Panel Project Accomplishments:

- I looked up all the connections that we knew and found CAD drawings, or dimensions to model.
- I designed the Front panel for all the connections using the drawings found for the parts.
- I designed a well to hold the refill bag and picked hinges and an O-ring size to seal the well.

- I am updating and modifying as more connections are defined as the project progresses.

Things I learned:

For the IDC I learned a lot about systems integration with the vehicle as a whole. I had to work with many other projects and got a chance to see the process it takes to add a new device to a project. I worked with robotics, simulation, science airlock, and other parts of the HAL to make sure this device would work. I also had to work with the scientists to make sure the device met their requirements. This taught me what it takes to work with a large group of people working together on a single large project to make sure everything fits together. I also learned this in a smaller way with the WCD. I had a part of the larger project I had to integrate my part into and work with the other people on the team.

I learned a lot about HAL and the Gateway project since some of my projects are related to that potential mission. I also learned a lot about robotic arms since the IDC has to be controlled and placed by the HAL robotic arm. I also got a chance to work in the soft goods lab and composites lab. I learned a lot about those labs and how soft goods makes most all of the fabrics on station and composites does almost all the painting, surfacing, and finishing jobs for space parts at JSC.

The rest of the things I learned were project design based. I learned how to use Creo to design my parts for the WCD and The IDC. I learned how to use EAGLE to design a PCB. Lastly, I taught myself how to use the PCB mill in our department which had only been attempted in a limited capability by a previous intern.

Internship Impact on Career & Educational Goals:

This has been a great summer at NASA and I would like to come back again. The EC2 department fits my interests much better than any previous internship and I would be happy to work here or in a similar department full time. Although, I am currently planning to start grad school at Georgia Tech this fall. I am pursuing my Ph.D. in Aerospace engineering. Since I am just starting, I am unsure when I will have a semester open to come for another tour. I would like to continue with the Pathways program next to hopefully be hired full time when I earn my Ph.D. If I don’t end up at NASA, I would definitely like to end up in somewhere in the space industry, in the leading edge of spacecraft design, breaking new and exciting barriers!