SpudNik-1 CubeSat Ground Support Equipment (GSE)

Faculty of Sustainable Design Engineering, University of Prince Edward Island

Background

CubeSat

- A CubeSat is a miniature satellite used for research purposes that is made up of cubic units.
- The SpudNik-1 is a CubeSat that is being designed and manufactured by the Faculty of Sustainable Design Engineering (FSDE) at UPEI.
- The SpudNik-1 is a 2U CubeSat meaning it is made up of two 10cmx10cmx10cm cubes end to end.
- The FSDE plans to have the CubeSat completed by April of 2021.

Ground Support Equipment (GSE)

- The GSE consists of three components: the Mechanical Ground Support Equipment (MGSE), the Electrical Ground Support Equipment (EGSE), and a cleanroom.
- The MGSE is the portion of the equipment that holds the CubeSat secure while it is being integrated and tested.
- The EGSE is the equipment that keeps the CubeSat and all its components safe from static electricity during integration and testing of the electrical components.
- A cleanroom is a room that is kept free of airborne contaminants and particles using filtration and pressurization.

Market Options

- There are several market options available for MGSE however they are all in the thousands of dollars range.
- There are many options available for cleanrooms however they are all in excess of $10,000.
- The EGSE requires many separate parts, many of which are already owned by the FSDE.

Problem Definition

Mechanical Ground Support Equipment (MGSE)

- Design, develop, and manufacture the MGSE prototype which will be capable of transporting and securing the CubeSat during the integration and testing phase.

Electrical Ground Support Equipment (EGSE)

- Research and make recommendations on the EGSE needed to effectively carry out the integration and testing of all electrical subsystems of the CubeSat.

Clean Room

- Design and, if time allows, build a clean room or clean bench where all assembly, integration, and testing of the CubeSat during the integration and testing phase will be carried out.

Timeline

- All tasks listed above commenced in October 2019 and were to be completed by April 2020.

Idea Refinement

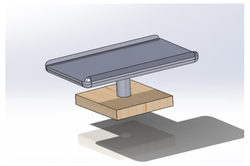

Fig. 1: Initial Design

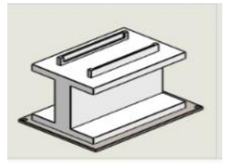

Fig. 2: Initial Design

Horizontal MGSE

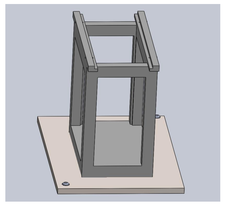

Fig. 3: Second Design

Vertical MGSE

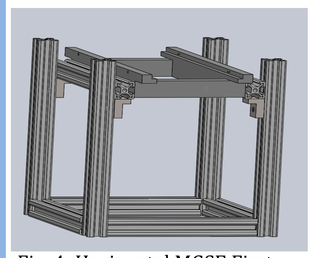

Fig. 4: Horizontal MGSE First Iteration

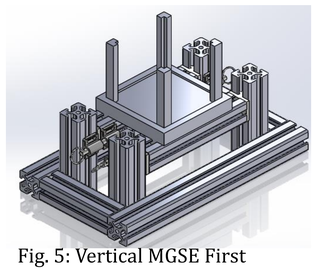

Fig. 5: Vertical MGSE First Iteration

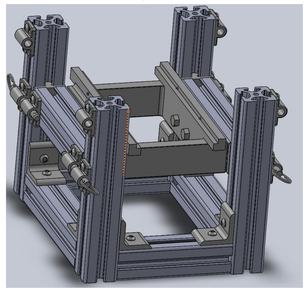

Fig. 6: Horizontal MGSE Final Design

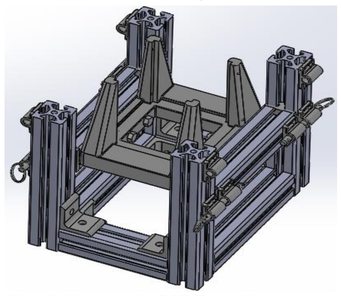

Fig. 7: Vertical MGSE Final Design

Key Features of Vertical & Horizontal MGSE

- Adjustable in height
- Common main base
- Removable sliding components
- ESD safe
- Dimensioned to CSA Nano-Racks Deployer specifications
- Lightweight and easily transportable
- Allows access to underside

Analysis & Decision

Functional Analysis

- Both jigs dimensioned to CSA specifications for the Nano Racks Deployer.

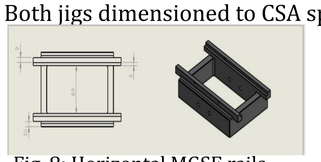

Fig. 8: Horizontal MGSE rails

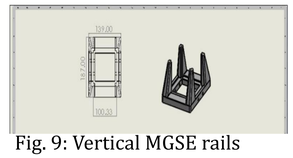

Fig. 9: Vertical MGSE rails

Strength Analysis

- Both jigs designed to hold the CubeSat along with additional weight.

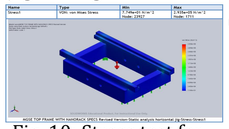

Fig. 10: Stress test for horizontal MGSE

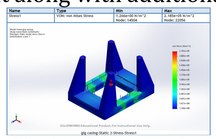

Fig. 11: Stress test for vertical MGSE

Human Factors Analysis

- Jigs were designed to meet the physical requirements of the AIT team.
- Jigs were designed to a small scale to allow for ease of transport.

Market Product Analysis

- Production expense for both MGSEs was approximately $550 CAD, which is well below the price of standard jigs on the market.
- Jigs were constructed to meet specific needs of the client.

Physical Description Analysis

- Physical aspects of both jigs, including length, width, and volume, were analyzed.

After considering all the analyses and consulting with the client and various technicians the team decided to move ahead with the implementation of the final MGSE designs.

Implementation

- The main frame for the MGSE was manufactured with 40mm 80/20 aluminum (Fig. 12).
- The rails for both the horizontal and vertical components were 3D printed with acetal copolymer, an ESD safe plastic (Fig. 13, 14).
- Remaining steps include securing the frame and the 3D printed components together and testing the functions.

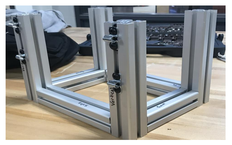

Fig. 12: MGSE main frame

Fig. 13: Horizontal Rails

Fig. 14: Vertical Rails

Acknowledgments

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