Design Alteration and Weight Reduction of Micro Satellite Ejection System Components.

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Aim of the Project

The aim of this project was to analyse and improve base and housing components of a microsatellite ejection system in accordance with strict aerospace regulations.

Background

Micro Satellites have many applications and uses. NASA use these miniature satellites to help advance scientific research and understanding of space and earth.(NASA, 2022)

This projects focus was to reduce weight, investigate appropriate aerospace hardware and applicable regulations along with alternative material selection. Two components were to be designed and manufactured, a base and a housing equipped with a lid style opening system.

Strict regulations are applied to these components. Examples being restricted use of materials and procedures, minimal use of electronics and electricity and the use of magnetic materials or magnets in general was strictly prohibited.

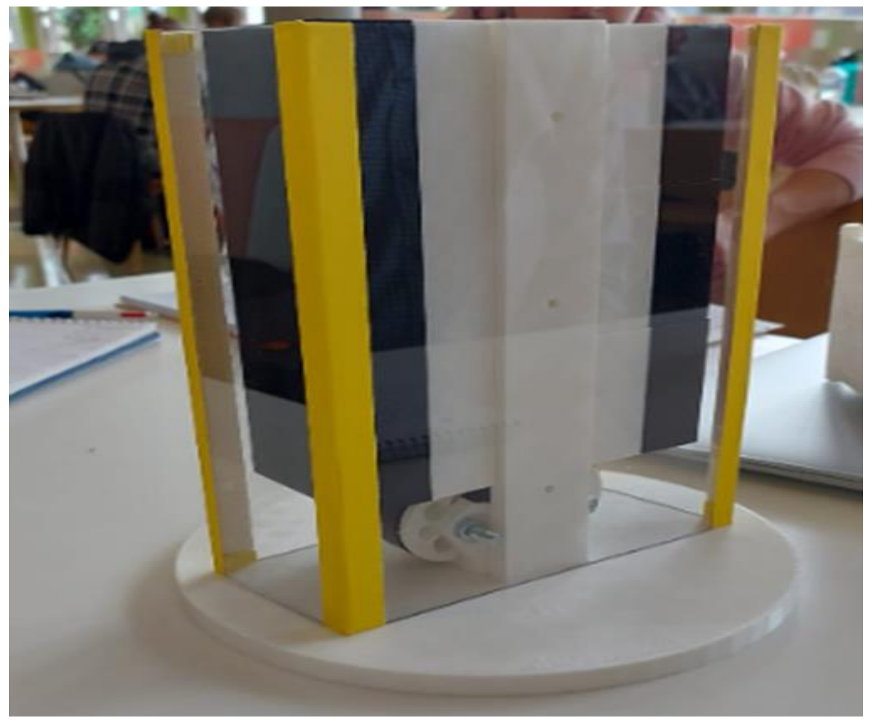

Figure 1: Prototype given to us to advance and improve on and manufacture from Aluminum 6061 primarily

Design

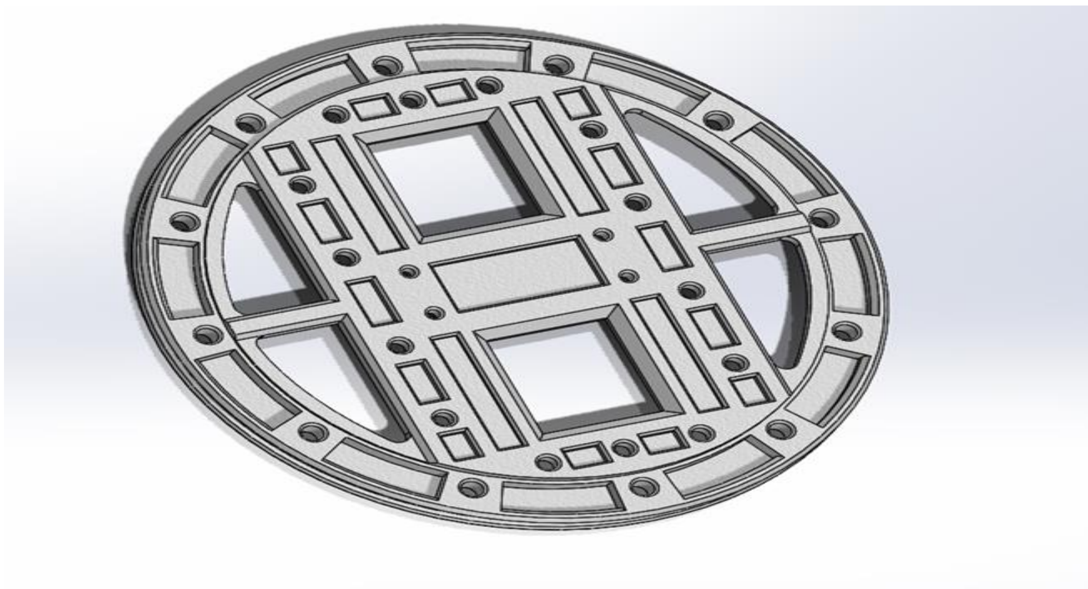

Figure 1:Final Base Design

The above design shows the final design of the base component. It features a weight reduction of 816.23 grams over the original solid design. The option to manufacture the base from PEEK (Polyether ether Ketone) was also an option which would save another 208 grams from the weight without compromising strength. Weight reduction is vital throughout this project as 1KG of payload to be ejected into space costs a total of €90,000. The final weight of the component was 417g.

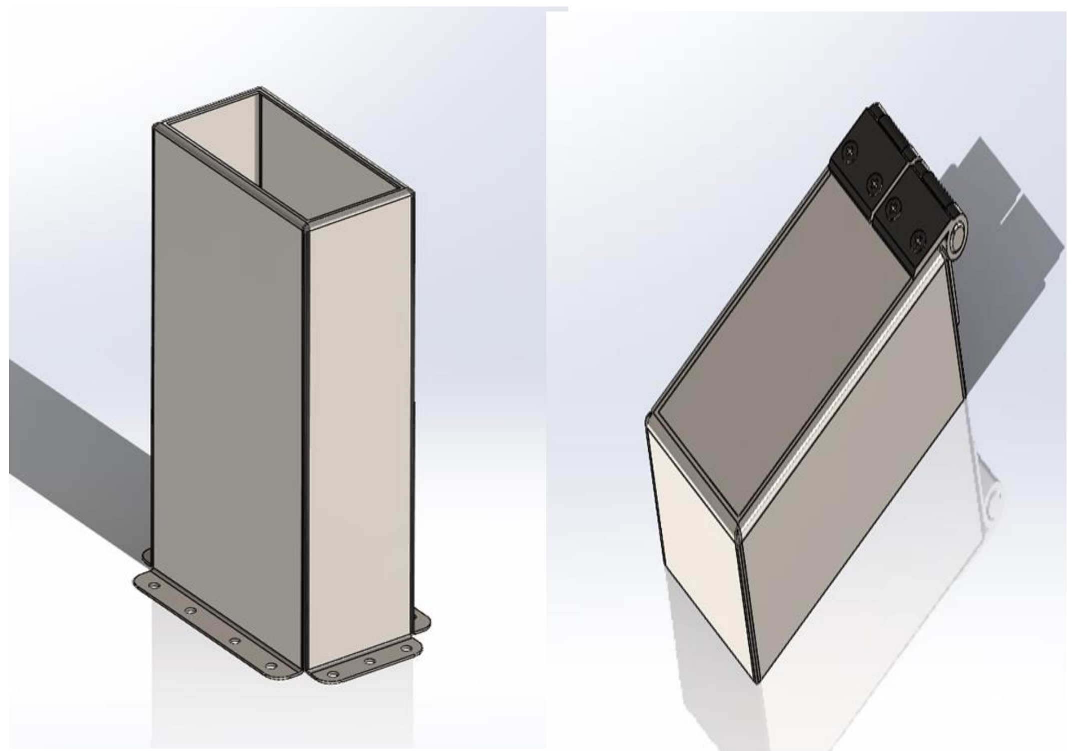

Figure 2: Final Housing Design

The above images show the housing and separate lid system. The concept behind this design is to allow for development of different opening systems. The housing is to be made from 2mm sheet aluminium 6061. Spring hinges will be used in the door latching mechanism along with a nitinol releasing system.

Manufacture

Figure 3: Base Stock

Figure 3 shows the stock used for the machining of the base component. A waste piece of 250x250x12 Aluminium 6061 plate was found in the stores. This suited the piece perfectly as it could be secured to the vice easier and would be easier overall to work with.

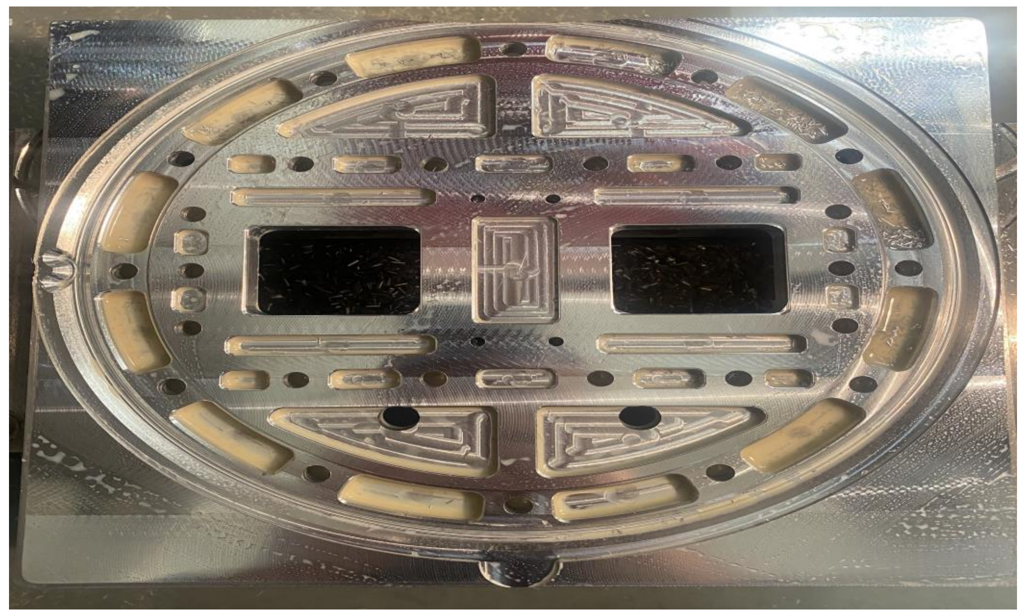

Figure 4: Completed Mac 1

Figure 4 shows the completed top side of the base. It was machined using a Cincinnati Dart CNC Mill using primarily pocket and profile operations to generate the weight reduction features.

A fixture was created to do the underside of the component. The holes for mounting the unit to the space shuttle were utilized to machine the underside. The piece was then mounted on the fixture in a unique way for every underside operation.

References

- NASA, 2022. *CubeSats overview.* [Online] Available at: https://www.nasa.gov/mission_pages/cubesats/overview [Accessed 23 09 2023].

Conclusion

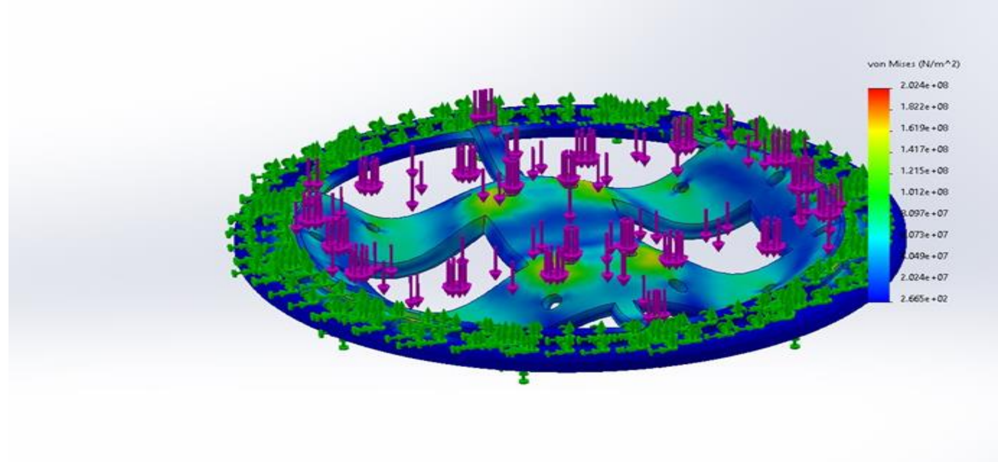

Figure 5: Base FEA

The figure shown above is the FEA analysis on the final base design. As the operation of this unit is critical a factor of safety of 3 was applied. The component was fixed as regulated by NASA and a load of 30,000N down and 15,000N on the X-Axis was applied to simulate that of a launch. Due to having no rocket spec sheet for this project, the forces had to be estimated. The component displayed a minor displacement of 0.004m under the large stresses.

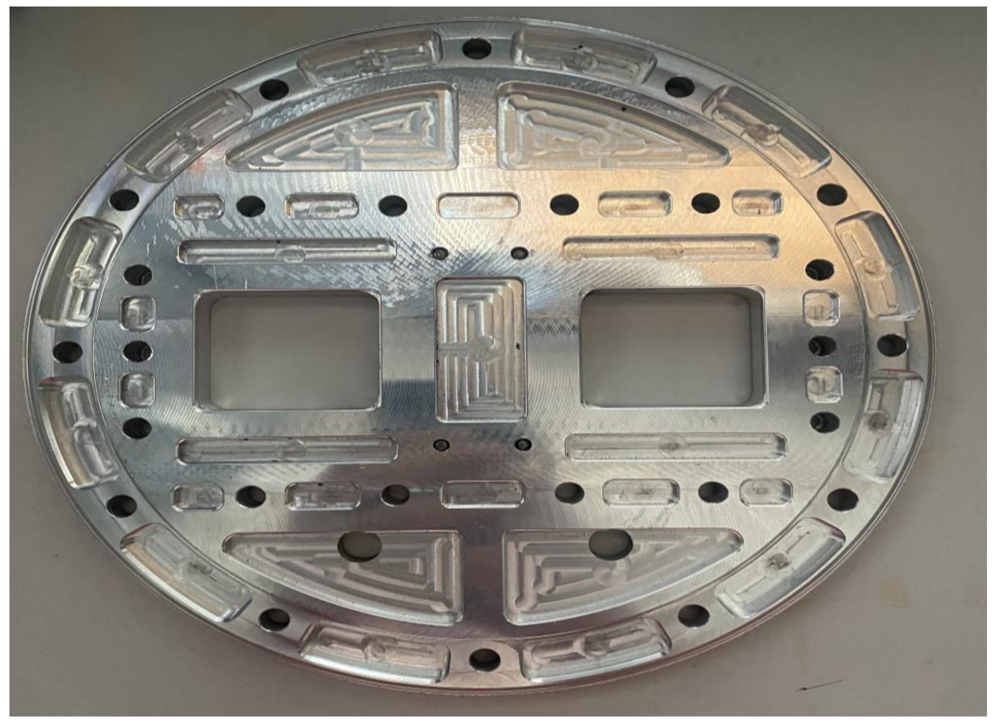

Figure 6: Completed Base Component

The above figure now shows the final manufactured model of the base that will be attached with the space shuttle. After manufacturing was completed, the base weighted 323.2g in Aluminium 6061

As of now the housing is being manufactured by “Andec Stainless Steel” in Little Island, co. Cork. It is due to be finished Thursday the 11th of April.