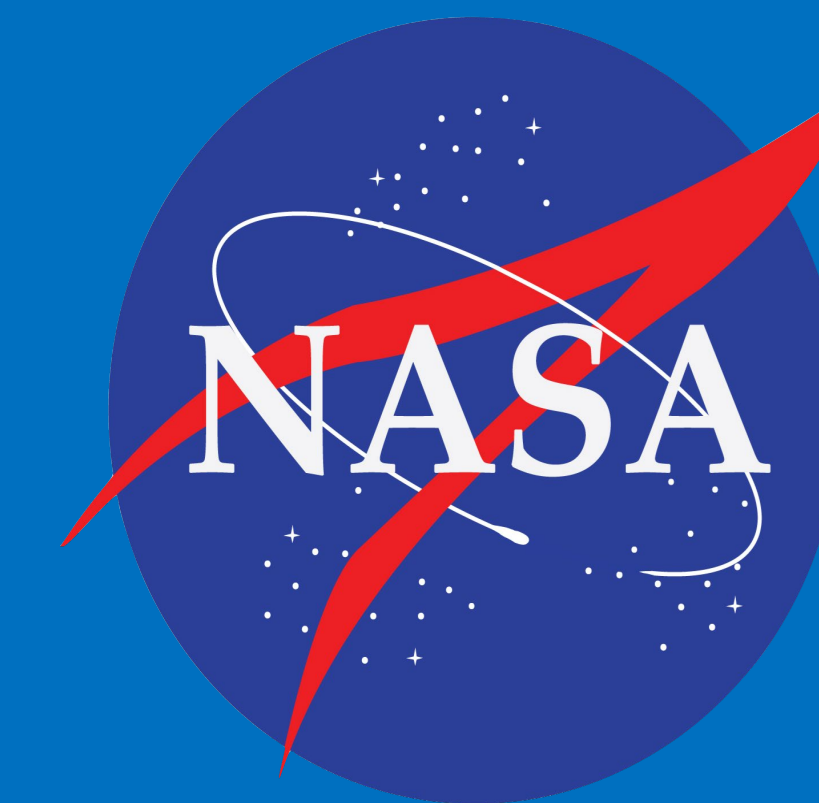


Lunar Operations: Contact Sampling Device

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 2024-2025 TSGC Design Challenge/NASA Micro-g NExT Challenge
 ENGR 1201 Introduction to Engineering Class Project
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Background

NASA is preparing for a return to the Moon, with plans to collect a diverse range of lunar samples during Extravehicular Activities (EVA). A primary challenge lies in acquiring and transporting the top layer of lunar regolith to NASA's space centers while preserving its natural grain orientation for detailed study.

Our team's objective is to design a device that facilitates the precise capture of regolith grains and enables efficient transport and deployment. The tool must be operable in EVA conditions, accommodating astronauts' large gloves to ensure ease of use and functionality.



Figure 1: image of the lunar surface

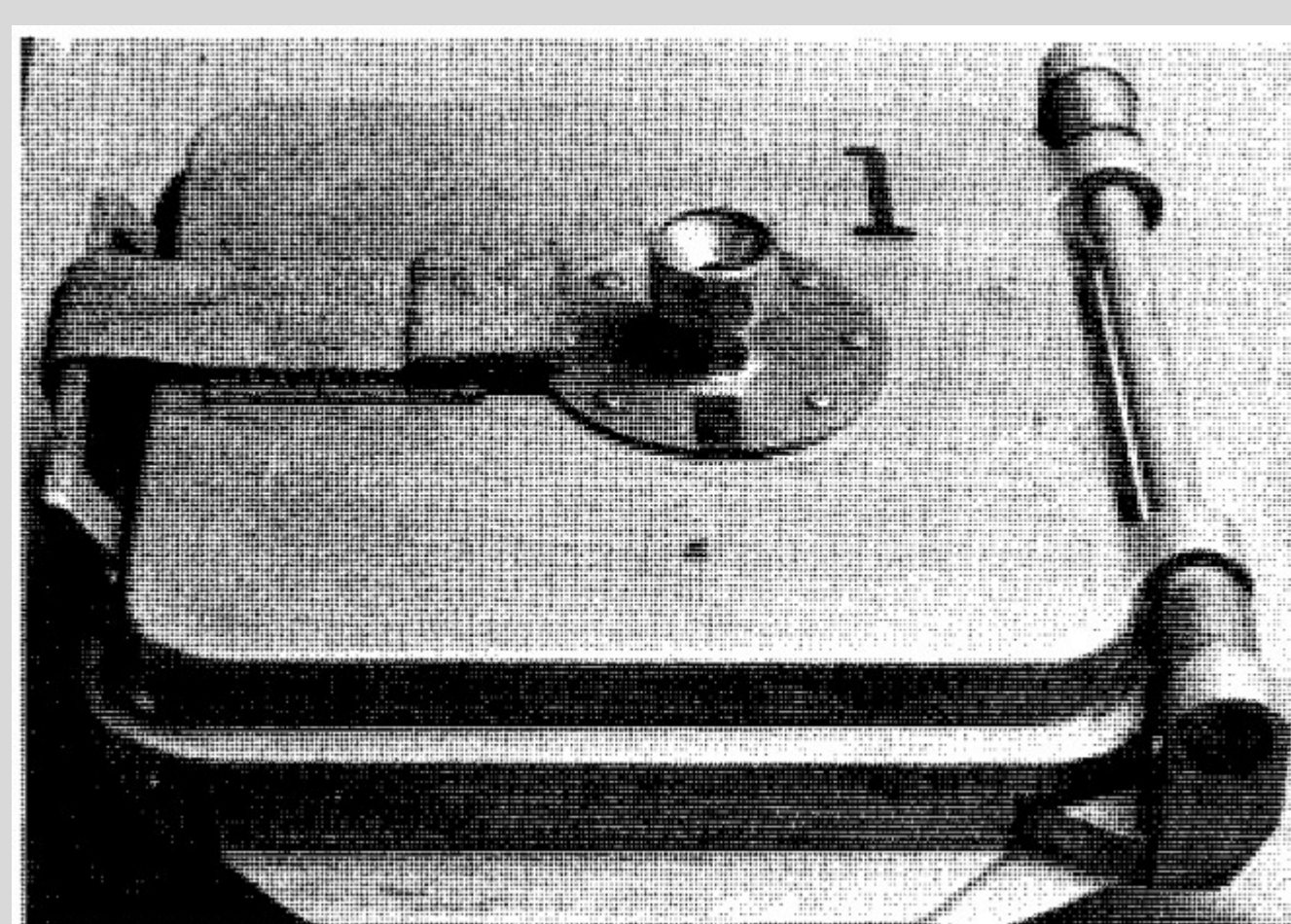


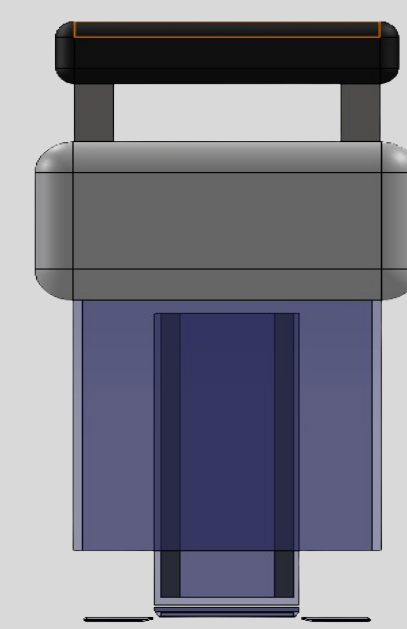
Figure 2: NASA original sampling device used in the Apollo 16 mission. (The device functions, but it does not meet current mission requirements to preserve regolith's grain orientation)

Goals

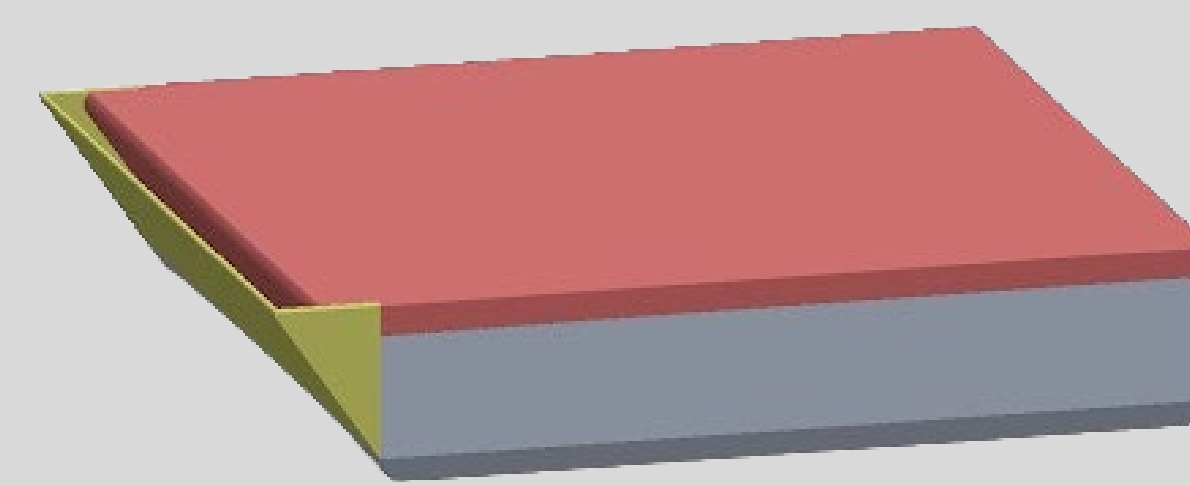
- Tool must be able to collect 1-5 mm of regolith;
- Tool must be able to maintain the grain; orientation of regolith;
- Tool will only use manual power;
- Tool weight must not exceed 10 lbs;
- Tool actuation force must be < 20 lbs.

Preliminary Designs

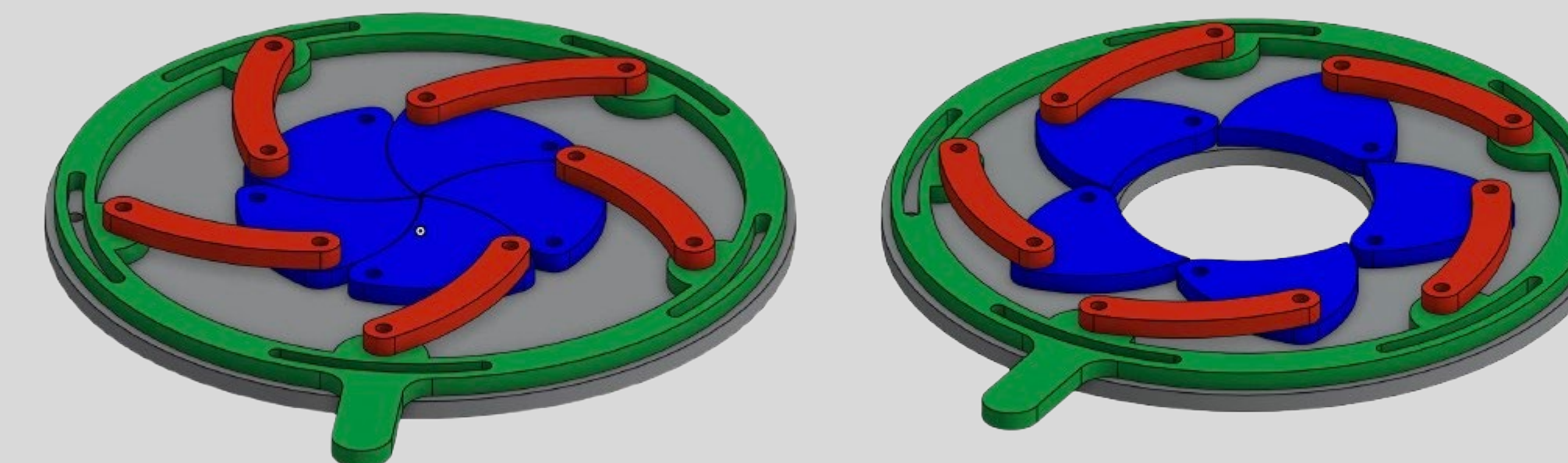
1. Stamp



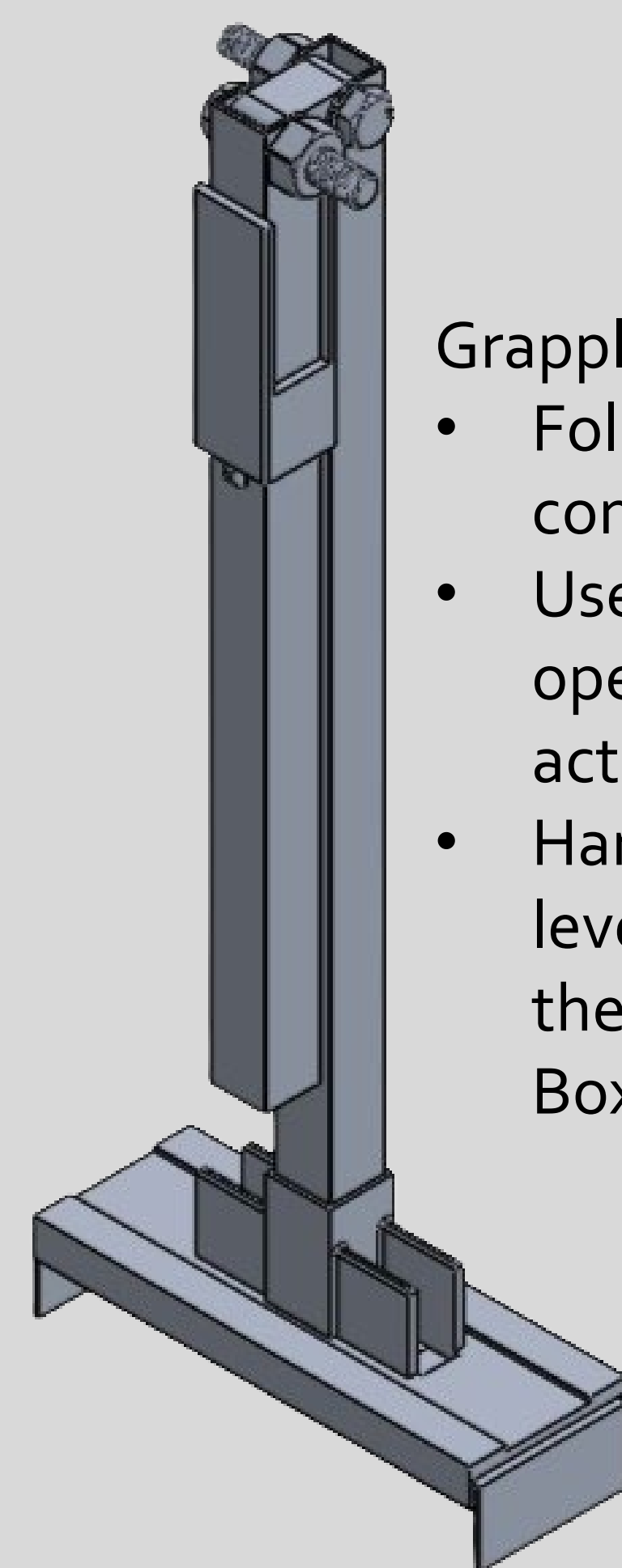
2. Rego Collector



3. Iris



Final Design Decision



Grappling Cane:

- Foldable for compact shipping
- Use lever to operate clamping action
- Handle at top uses lever to operate the Containment Box Separator

Containment Box:

- Containment Box Separator travels through box slot to isolate and collect sample.
- Foam (brown Layer) to compress sample securing grain orientation during transportation
- Has removable lid (red Layer) for sample extraction on Earth

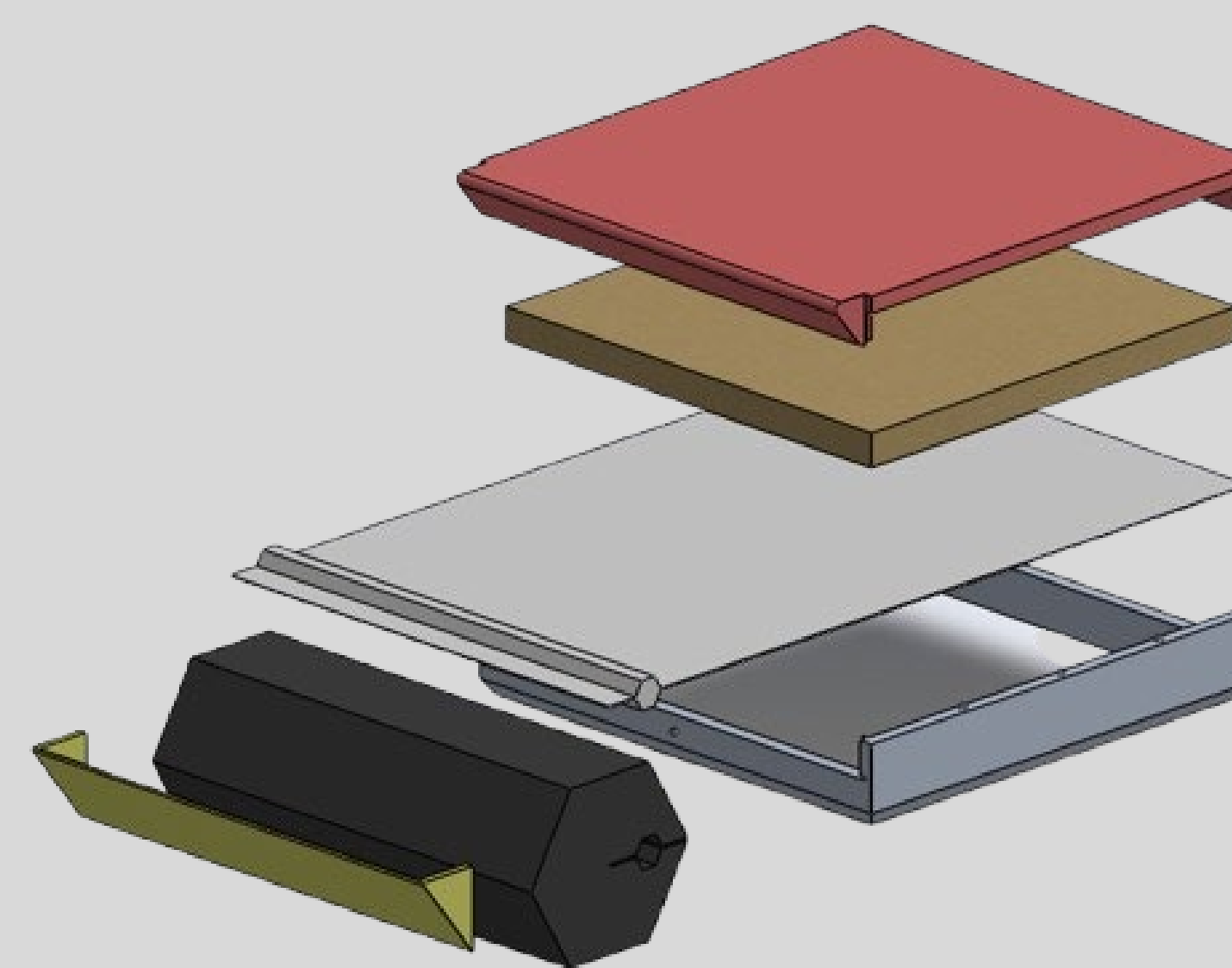
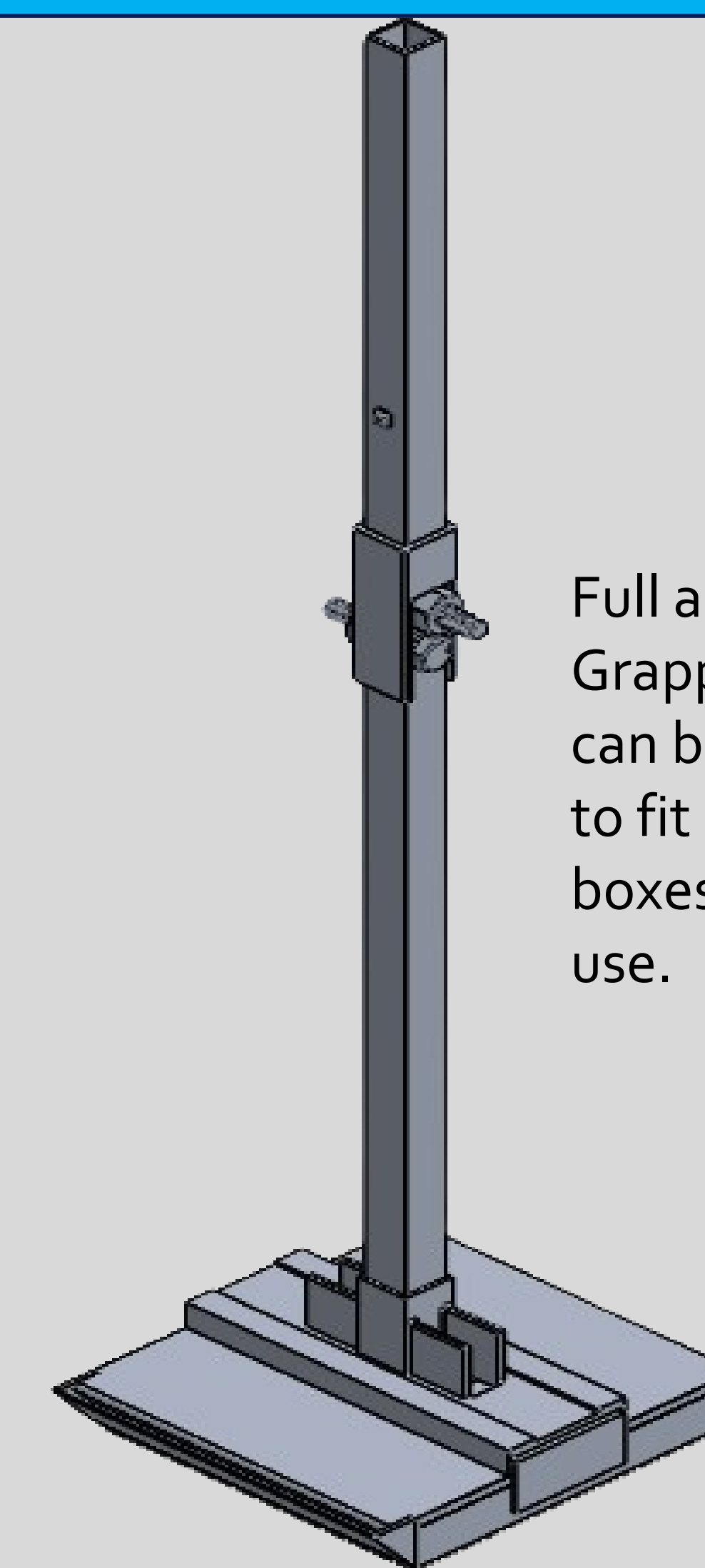


Figure 4: Rego collector box



Full assembly. Grappling Cane can be detached to fit different boxes for repeated use.

Figure 5: Full Assembly

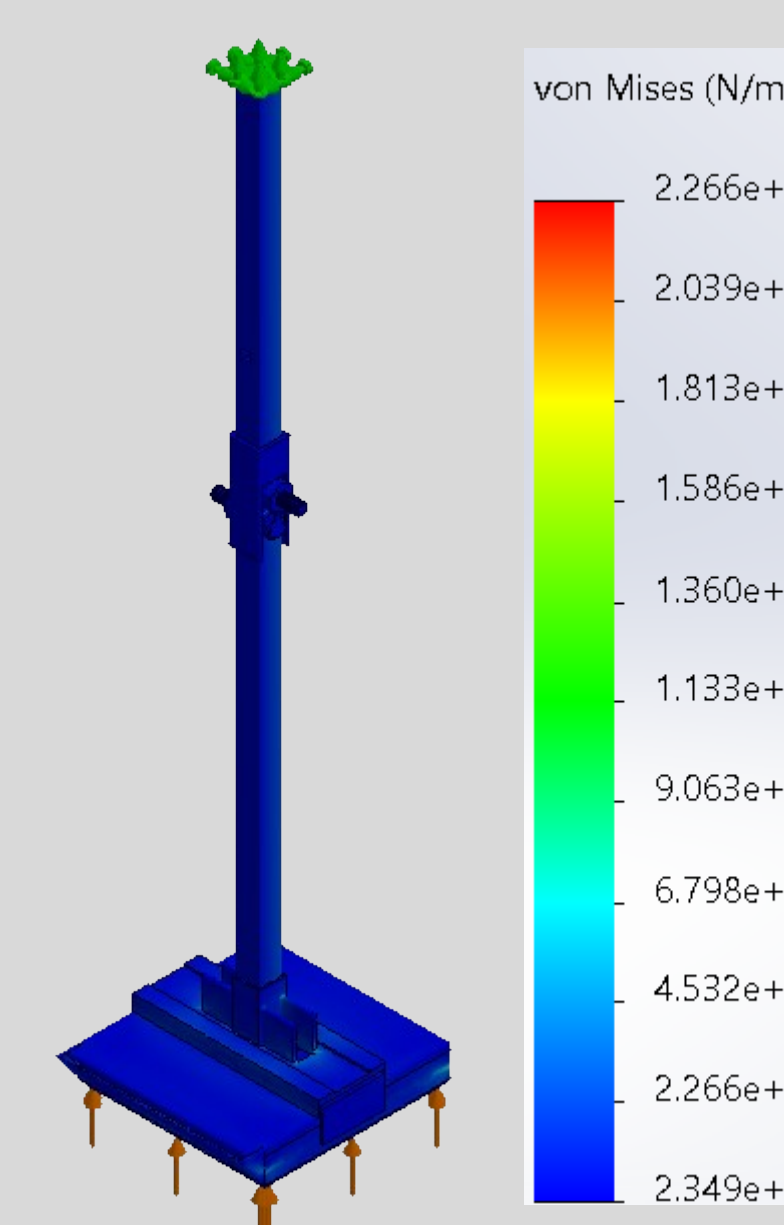
Pugh Chart

Using a Pugh Chart, the Rego Collector was chosen for the final design decision.

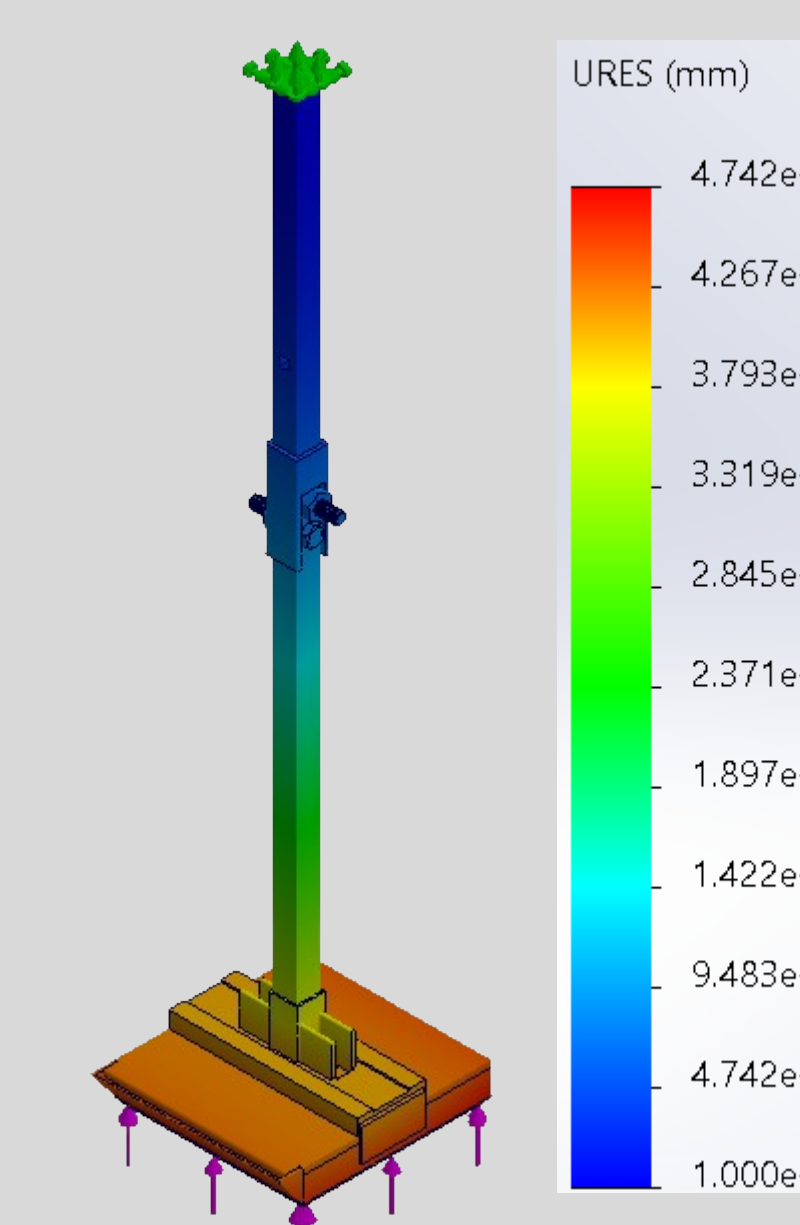
Criteria	Datum NASA device	Preliminary Designs		
		"STAMP"	"REGO"	"IRIS"
Collect 1-5 mm of regolith	0	+	+	+
Retain grain orientation	0	+	+	0
No sharp edges	0	-	0	-
Fit in an 8" x 8" x 16"	0	0	+	0
Weigh 10 lbs or less	0	0	0	0
Use only manual power	0	+	+	0
Must sink in water	0	0	0	0
Ergonomic ease of use	0	-	+	0
Score:		1	5	0
Rank:		3	1	2

Testing/FEA Analysis

Stress Test



Displacement test



The strength of the design was validated by FEA analysis

Compliance Table

Table 1 is an excerpt from NASA Micro-g NExT Challenge's Requirement Compliance Table, highlighting the most important requirements. Our design meets all requirements specified.

Requirement	Yes / No	Comments
Provide a device that can collect and stow a sample of the top 1-5mm of regolith.	Yes	The Rego-Collector collects a 5 mm sample of regolith.
The device shall allow the sampling surface to be removed.	Yes	The top of the Body-Box can be removed in order to access the sample.
Mass of the tool or suite of tools shall not exceed 10 lbs.	Yes	The device weighs less than 10 lbs.
The stowed device shall fit within a volume of 8 in. x 8 in. x 36 in.	Yes	The device will fit in an 8" x 8" x 16" space.
Using only mechanical power, the force required to actuate shall not exceed 20 lbf (89 N).	Yes	The device does not take much force to operate. The device is powered manually.
The device shall pass stress analysis, meeting or exceeding a factor of safety of 2.0 for ultimate stress.	Yes	Passed the stress test based on the FEA analysis on Solidworks.

Table 1: Excerpt from Micro-g NExT Compliance Table.

Future work

Future work includes optimization and the refinement of the designs, then manufacturing of a full-sized, fully functional device using various materials such as tough PLA (3D printed), metal (machined), and commercial-off-the-shelf hardware and parts. Team Aquila looks forward to bringing a fully functional prototype to test at NASA-Neutral Buoyancy Lab during the next phase of NASA Micro-g NExT Challenge.

Conclusion

Team Aquila successfully designed and validated a preliminary design of the Contact Sampling Device that met all the design objectives specified by NASA Micro-g Next Challenge.

Acknowledgement

Team Aquila thanks TSGC Design Challenge and NASA Micro-G NExT Challenge for the opportunity to participate in this project. We also thank team advisor, Dr. Yiheng Wang.

References

- [1] 2025-micro-g-next-challenge-descriptions.pdf
- [2] Catalog of Apollo lunar surface geological sampling tools and containers