



LunaCats – Mining Subsystem

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Project Overview

Mission Context: For NASA's Artemis missions, manipulating lunar regolith is required to construct protective berms for equipment and habitats.

Objective: The UNH LunaCats designed an autonomous lunar mining robot for the 2026 NASA Lunabotics competition.

Design Philosophy: The mining subsystem was completely redesigned from the previous year to eliminate complex failure points, focusing strictly on consistency, simplicity, and reliability.

Specifications, Metrics, Goals

These specifications were set at the beginning of the design phase to set guidelines for decision making and quantify the success of the completed design. The specifications were based on the NASA Lunabotics guidebook as well as the team's competition goals.

- Must not "Bulldoze" or push regolith into berms
- Should mine and deposit at least 10kg of material for a 30-minute competition round
- Mining system must be under 20kg
- Must not drive over deposited material
- Must fit within size constraint of 1.50 x 0.75 x 0.75 meters

Drum Design

To achieve reliable excavation with minimal failure points and moving interfaces, the team selected a single-chamber mining drum inspired by NASA's RASSOR robot. This features zero internal moving parts, and simple, reliable control.

Internal Mechanics: The drum features internal spiraling geometry designed to excavate regolith while rotating in one direction, and deposit it when the rotation is reversed.

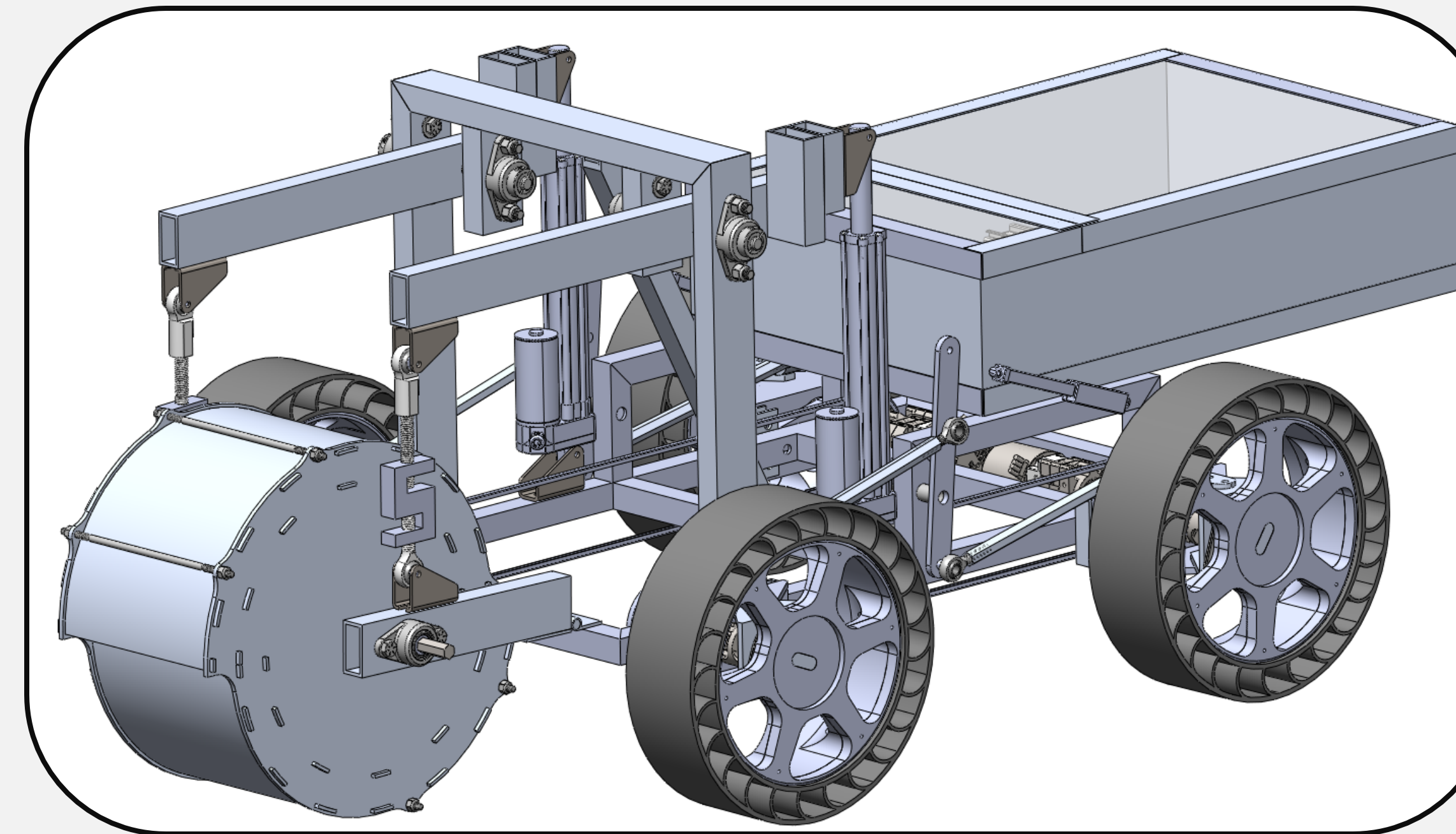
Geometry Optimization: Five scaled prototypes (designated White, Gray, Green, Orange, and Blue) were tested to optimize the internal channels and scoop sizes. The "White" prototype outperformed the others, retaining the most material (508 grams) before spilling.

Prototype	Full (g)	Empty (g)	Material gathered (g)
White	849	341	508
Gray	810	356	454
Green	806	379	427
Orange	752	338	414
Blue	742	330	412



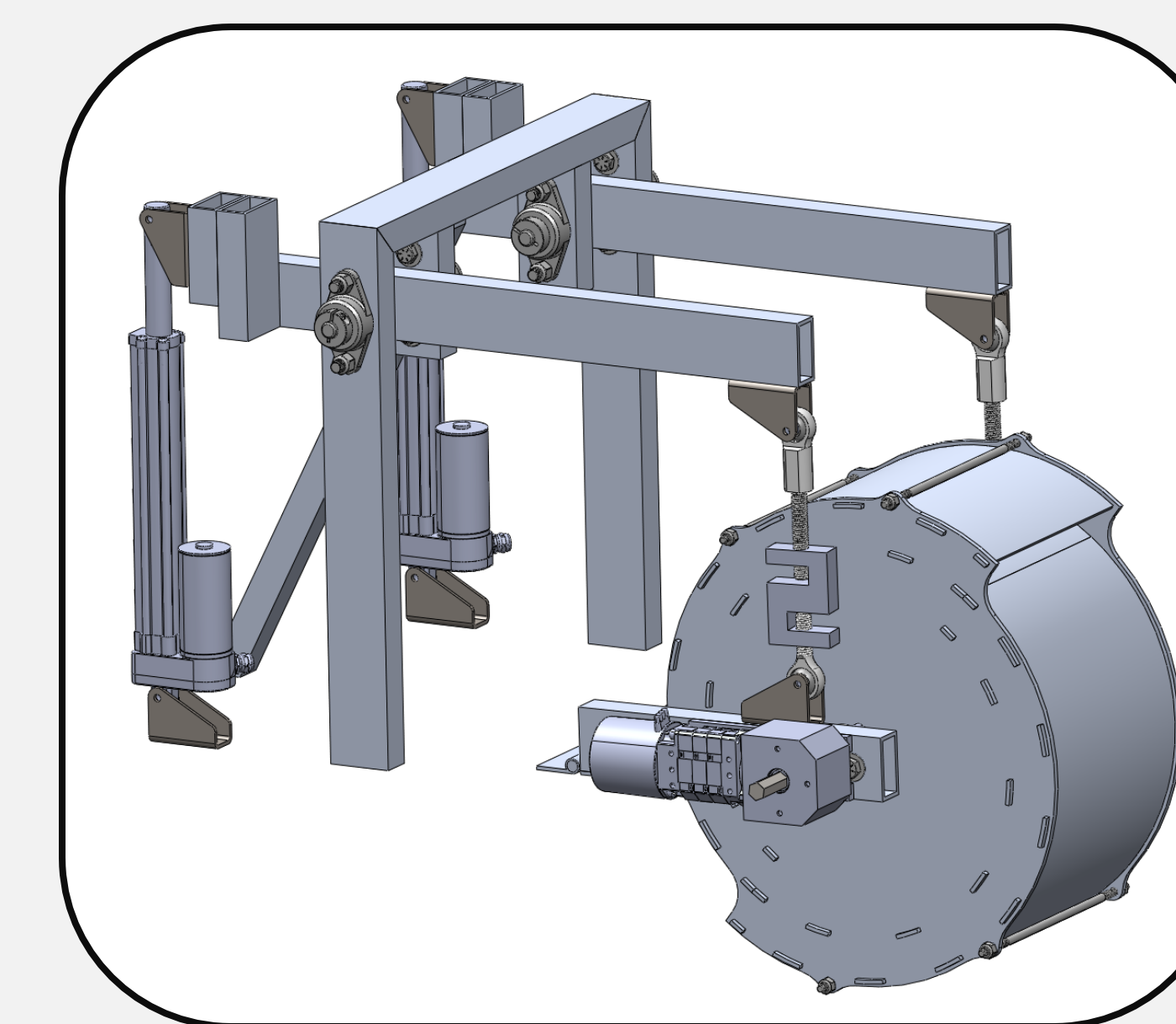
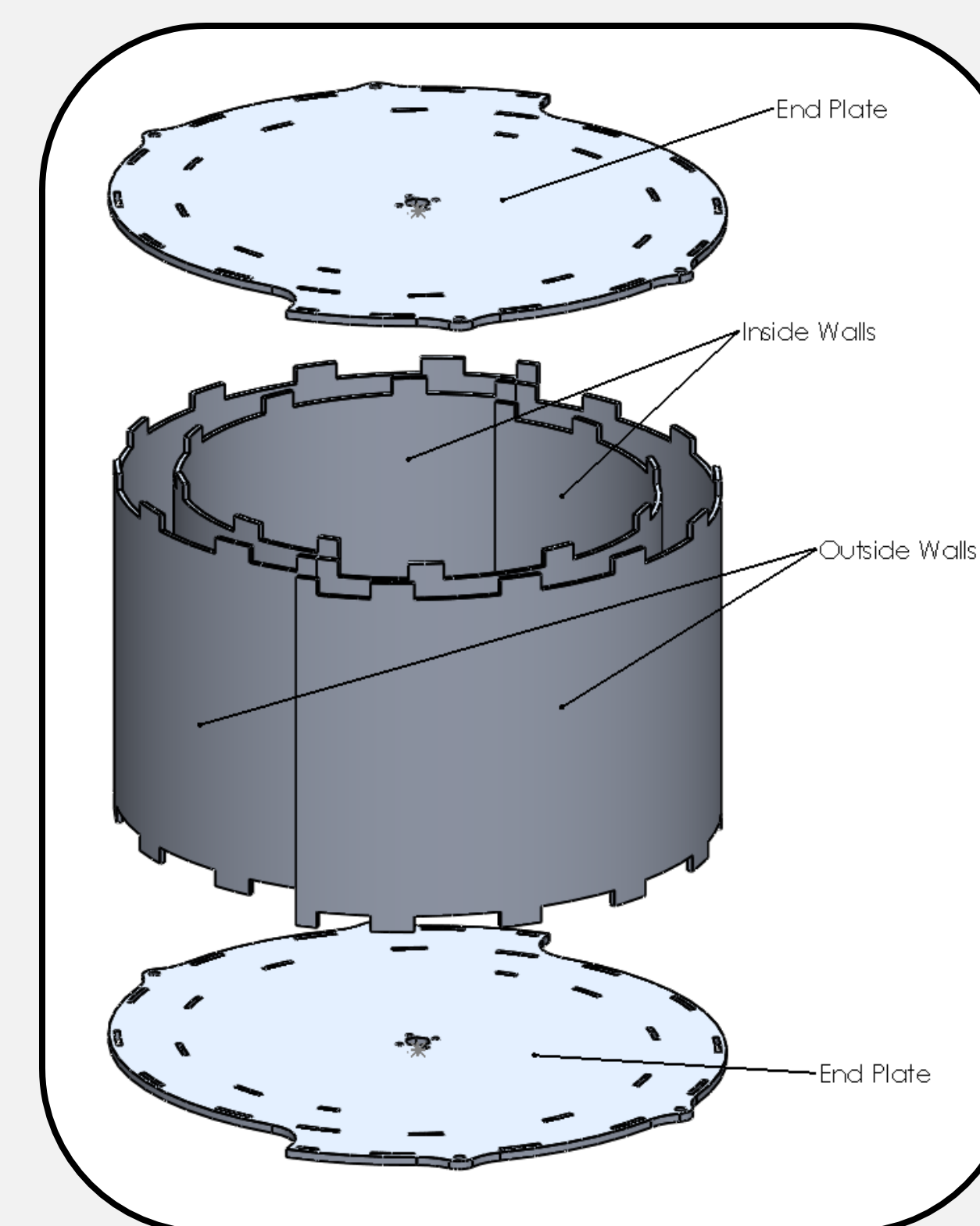
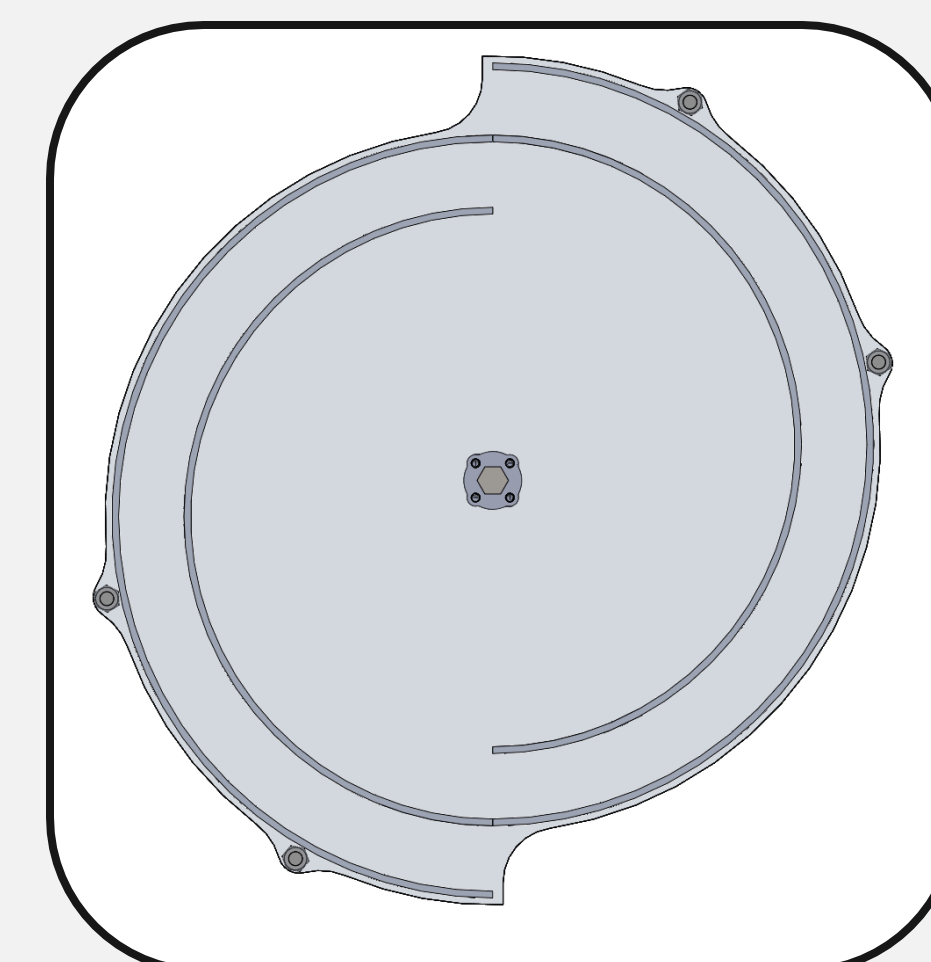
LunaCats 2026 – ATLAS 2.0 (Mining Subsystem)

Positioning: Forward biased system positioning Prevents deposition inside wheelbase without compromising center of gravity.



Positioning: Creates room for other systems and sensors

Assembly: To avoid the warping and melting associated with welding, the drum was built using a tab-in-slot method. This also allows for easy internal repairs if needed. It utilizes water-jet cut 6061 aluminum for the flat end plates and machine-rolled 5052 aluminum for the walls.



Lifting: Actuated lever arm for a high range of motion. Safety factor of actuating strength calculated at 2.02

Lifting Mechanism Design

The lifting and rotation mechanism is the system that articulates the drum up and down as well as enables it to rotate in both the clockwise and counterclockwise directions for mining and deposition.

Competition Optimization: The drum is located outside of the wheelbase to avoid driving over deposition piles, maximizing point generation by preserving pile integrity. Integrated load cells give live feedback of drum weight, allowing for easy automation of mining and deposition sequences enhancing our competitive advantage.

Designed for Reliability: The design was prototyped against several different options and selected based on its structural rigidity, overall mechanical simplicity, and adequate safety factor (N = 2.02). The design features linear actuators and dry run bearings which can withstand the dusty environment of the regolith arena. A high torque gear box (125:1 gear reduction) with a custom protective dust cover allows the drum to effectively cut through the dense regolith simulant.

Early Lifting mechanism prototypes:



Conclusions

- Final system weight: 13.36 kg
- Drum capacity: 9.3 liters (14.46 kg of regolith)
- Mitigates dust on critical robotic components.
- Achieved consistent and reliable operation

Acknowledgements

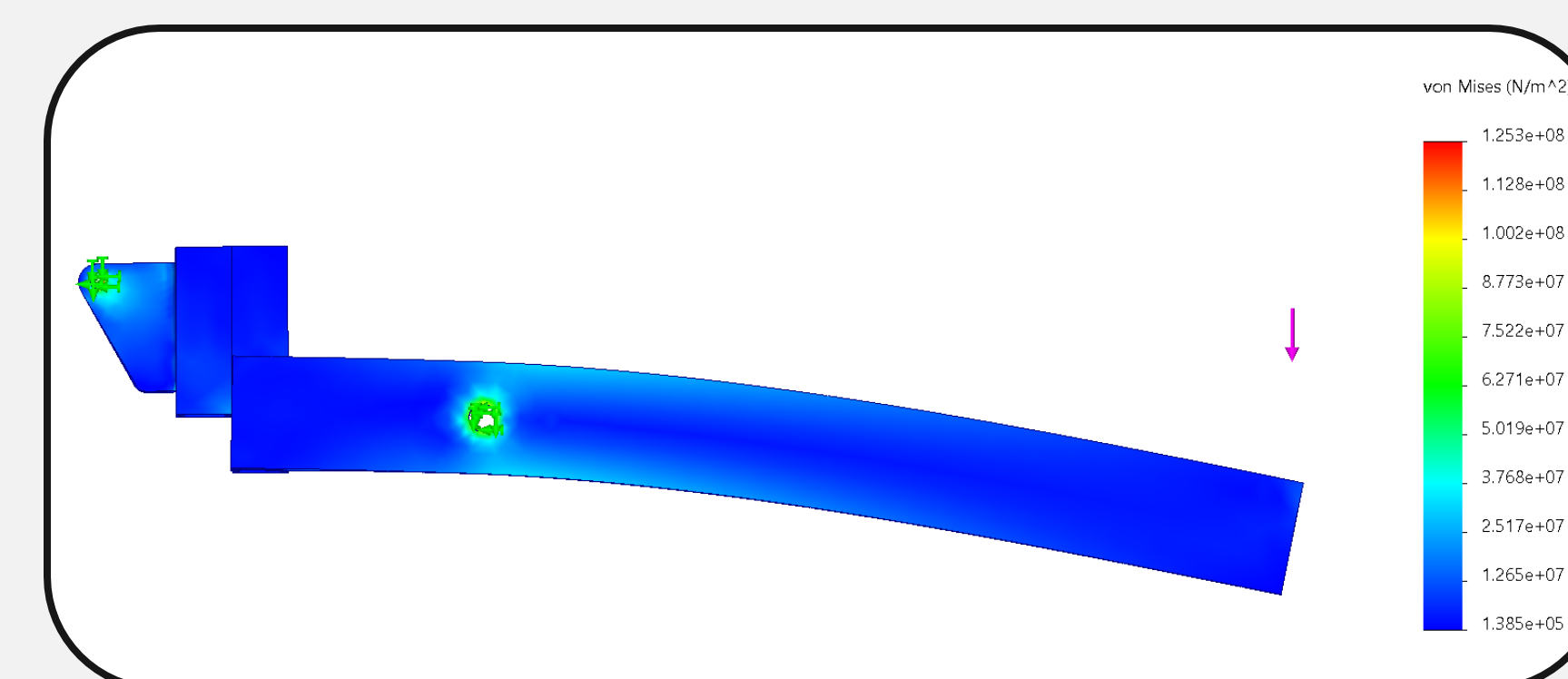
- **Faculty Advisor:** Dr. May-Win Thein
- **Graduate Advisor and Sponsor:** ChanLing Beswick
- Subcom
- John Olson Advanced Manufacturing Center
- Sylvester Sheet Metal
- CEPS Makerspace

References

- NASA's Lunabotics Mining Competition 2025 Guidebook, 2025 Kennedy Space Center
- Design of an Excavation Robot: Regolith Advanced Surface Systems Operations Robot (RASSOR) 2.0

Structural Analysis

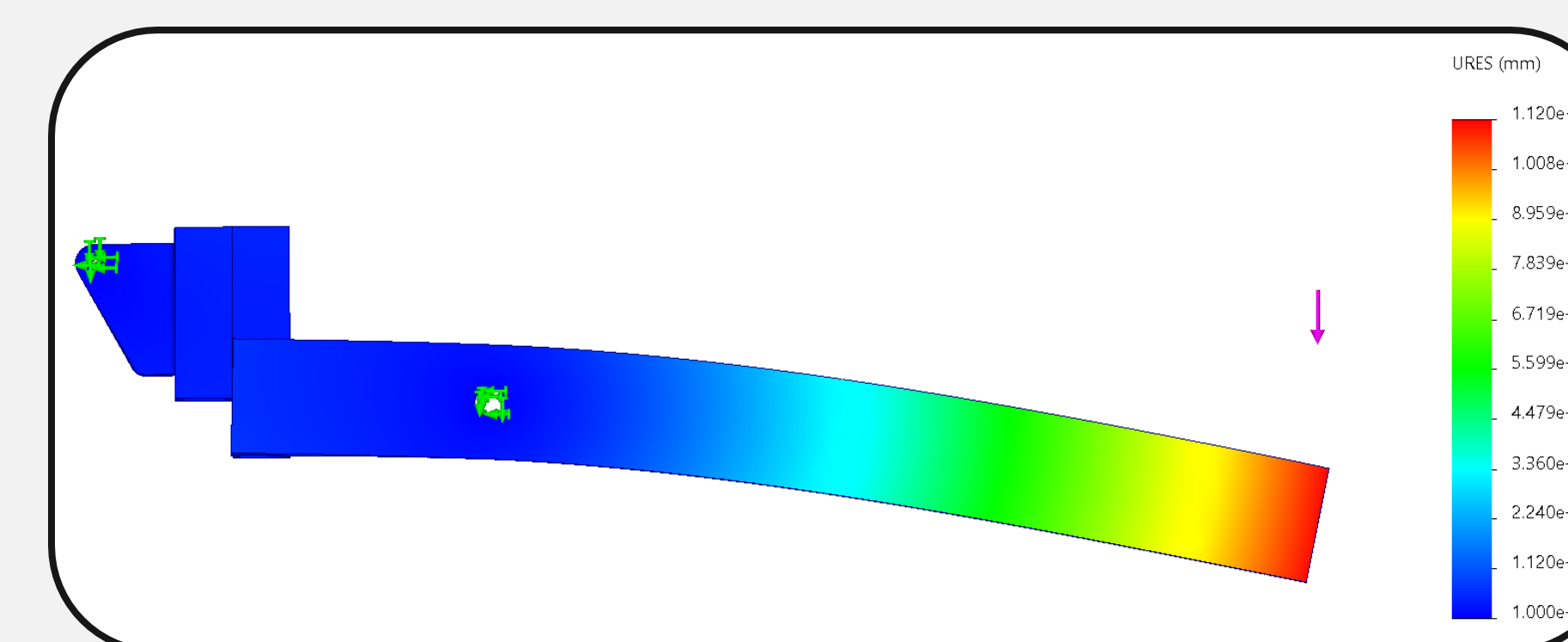
Simulation #1: Stress of the lever arm under a 100 lbf load (Extreme load case)



- 6161-T6 Al Yield Stress= 276 MPa
- Max Stress Experienced = 37.68 MPa

Ensures shaft hole will not round out under load

Simulation #2: Displacement of the lever arm under a 100 lbf load (Extreme Load case)



- Max Displacement = 1.12 mm

Negligible Displacement for our application