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# Lunar Surface Recycling-Scavenging and Reuse of Discarded Mission Hardware

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## Abstract

Team Gamma Rays is tasked with the development of a design capable of scavenging and recycling previously discarded mission hardware. Additionally, the design must have conceptual tools, robotic attachments as well as be sustainable.

## Objectives

Develop a lunar rover tow vehicle with the capability to collect payloads from the previous missions, specifically rovers

## Key Requirements:

- Energy Efficient
- Semi-Autonomous
- Payload Handling

## Project Background

Resources from previous lunar missions have been left on the Moon. Mission hardware ranging from structural frames to electronics [1].

NASA is investigating methods to recycle and reuse materials from previous or future lunar missions [2].

Currently, there aren't any methods or standards to recover, recycle, nor repurpose these components.

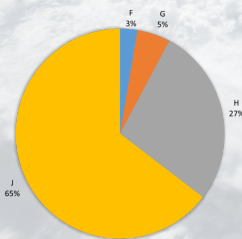


Figure 1. Breakdown of Apollo Missions Payload

## Design & Analysis

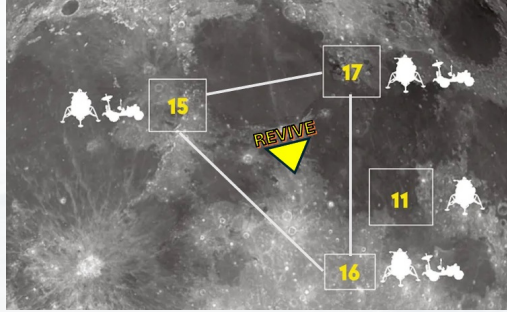


Figure 1. Triangle Distance

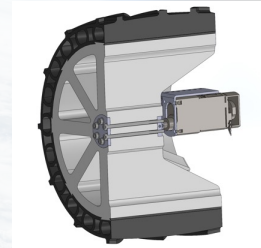


Figure 2. Cut View of Wheel



Figure 3. Concept Model ISO View

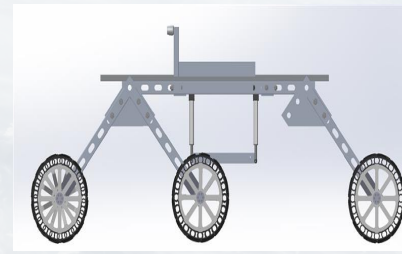


Figure 4. Concept Model Side View

Table 1. Pi Theorem

Nominal load – Primary sinkage driver	$\pi_1$	$\frac{W}{\rho g L^3}$
Cohesion ratio – controls cohesive	$\pi_2$	$\frac{c}{\rho g b}$
Friction	$\pi_3$	$\tan\phi$

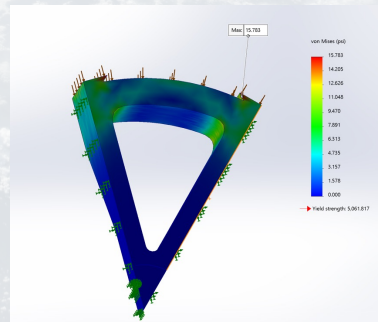


Figure 7. Displacement analysis

## Future Works

- Increase autonomy of rover via "go-home" function integration and removal of hand controller
- Replace angle iron with hooks

## CONCLUSIONS

The Gamma Rays have created a hypothetical 1:3 lunar rover which would be able to haul the Apollo Rovers to repurpose their materials. To determine the most optimal path and approach, triangulation was used to gain insights into the distance needed to travel—as well as a center point between the three rovers. To ensure accuracy, a scaled down prototype will be created by leveraging the Pi Theorem. Additionally, FEA was performed to validate the design and material selection.

## References

- [1] Thomas A. Sullivan. "Catalog of Apollo Experiment Operations." <https://www.nasa.gov/wp-content/uploads/static/history/alsj/RP-1994-1317.pdf?>
- [2] Bullard, Savannah. "NASA Seeks Innovators for Lunar Waste Competition." <https://www.nasa.gov/news-release/nasa-seeks-innovators-for-lunar-waste-competition/>
- [3] Photo by NASA on Unsplash
- [4] How to See the Apollo Landing Sites. BBC Sky at Night Magazine. <https://www.skyatnightmagazine.com/advice/skills/see-apollo-landing-sites-moon>

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