NASA Human Exploration Rover Challenge

Ismail Shah, Emmanuel Castillo, Elda Berhaneyessus, Michael Perez, Lareon Brent III , Hannah Magruder

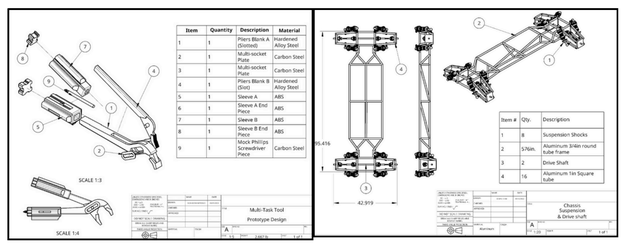
Background

The focus of this project will be to design and optimize a vehicle capable of traversing the terrain of the Moon or Mars allowing for the astronauts to travel further distances before running out of oxygen. The aim is to provide a means of transportation for up to 2 passengers to safely get around on the moon without the assistance of electrical power. The vehicle will need to be omitted from the use of electricity in the case of power failure on the base. One critical flaw during a power outage would be a lack of transportation required for the astronauts to get around the base and solve the electrical issue. Therefore our challenge is to develop a rover capable of transporting two astronauts around the slopes and undulating terrain in order to navigate to the task sites and complete a mission. This entire project will be entered into the NASA HERC competition where the project will be tested to determine if the vehicle is successful or not.

Proposal

The design proposal for the vehicle consisted of the mockup of the initial vehicle design in CAD along with plans for fabrication. The following design choices were outlined in the proposal

- Independent 12 inch dualshock suspension system
- Non-pnuematic wheels with metal inlay and rubber /TPU outer casting
- Belt based drivetrain with a 2:1 ratio
- Comprehensive all in one multitask tool using plier head design



Timeline

Proposal
(Sept. 21st 2023)
Brainstorming of our initial designs

Design Review
(Nov. 16th 2023)
Critique of our finalized designs prior to building the rover

Fabrication
(Jan- Mar 2024)
Welding, Machining, and 3D printing was used to bring the designs into reality

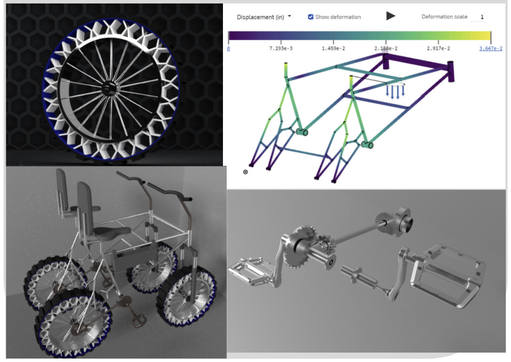
Operational Readiness Review
(Mar. 7 2024)
Post fabrication analysis of the designs for mission readiness

Testing
(Mar-Apr 2024)
Finalizing the changes from the ORR and getting tests with drivers

Competition
(Apr. 20 2024)
The competition with the official Mission Readiness Review and excursion for the final rover test

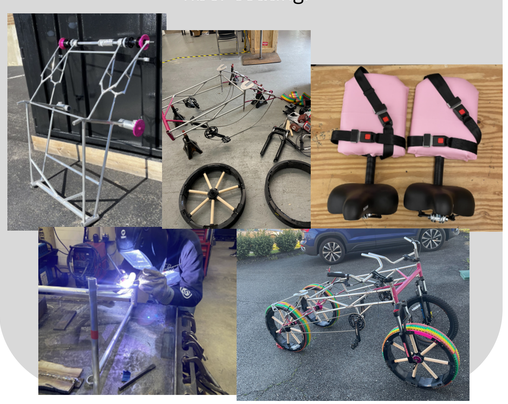
Design Analysis

During the analysis portion of the project we chose to switch to a bicycle inspired rover design which involved MTB shocks, side by side drivetrain design, and linked steering systems. At this point we also chose to pursue a shaft based drive train design and a ratio on 3:1. We did structural analysis on the aluminum 6061 chassis to under stand stresses and failure points



Fabrication

The chassis was welded from aluminum 6061 and had to be taken apart and welded back together several times due to certain issues we faced. The shaft based drive train was prototyped with 3D printed parts but without promising test results the chain based drivetrain was instead implemented. The wheels were fully 3D printed from PETG and TPU with each rim getting a carbon fiber coating.



Competition

During the competition, several adjustments had to be made to the vehicle before we could get to the excursion. The assembly of the vehicle out of the shipping crate took several hours. This involved the final attachment of seats, chains, steering linkage, front wheels, and several other parts. During our on-site testing, we found that the gear ratio of the drivetrain did not produce enough torque. We use the extra chain sprockets to upgrade the gear ratio to 1:1 for stronger torque. We had to use the onsite machine shop to create modified axles for the vehicle. We also had to use onsite welding several times to repair the vehicle after the damage.

In conclusion, the entire HERC competition was an amazing engineering experience for the entire team. We learned a lot about how to complete a full design-build project. We learned how to manage funding and order materials. How to structure ourselves and plan. The team was able to experience manufacturing processes such as 3D printing, welding, machining, carbon fiber, and laser cutting. It helped us learn how to take our CAD designs and bring them into reality. In the competition, our vehicle ultimately did not make it through the entire course. We had a huge failure point in the strength of the aluminum of our chassis. It simply was not a strong enough material to build with. We also had failures with our chain drive system which lost tension and therefore was rendered ineffective. Although we had mixed results in the competition it was a valuable learning experience for all members involved.