NASA HP ROVER CHALLENGE

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ABSTRACT

The project aims to create a human-powered rover for the NASA Human Exploration Rover Challenge, piloted by one male and one female astronaut. The intent was to create a lightweight, human powered vehicle that could traverse a series of obstacles that simulated terrain on earth's moon or other planets. All of this had to be completed in a short time frame as "oxygen was limited" in space and the pilots would only have so much time to complete the mission. The team split the rover assembly into subcomponents for design and construction so each team member could focus on a smaller chunk of the project. The overall project was broken down into phases to allow the team to work in a systematic way to complete the rover on time. Figure 1 shows the team for this year and Figure 2 is the course layout for this year's competition in Huntsville, Alabama.

Figure 1: Team Photo

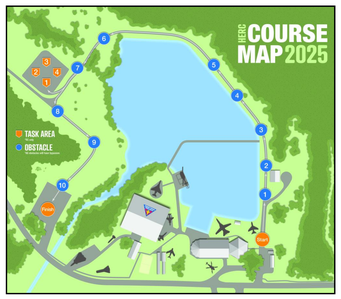

Figure 2: Course Map

CUSTOMER NEEDS/SPECS

Table 1 shows the customer needs and specifications the team and group sponsor identified.

Table 1: Customer Needs/Specifications

Needs	Specifications
Vehicle shall be human powered	Weight under 170 pounds
Non-pneumatic and custom-built wheels	Assembly time under 1 minute
Traverse the 0.5-mile course with 10 obstacles	Lowest Driver Appendage 12" above ground
Fully designed and built by team	Must fit into a 5'x5'x5' box
Lightweight	Minimum 10' Turning Radius
8-minute time limit	Brake on 30 – degree incline
Safe	

DESIGN CONCEPTS

Several design concepts were developed but the ones in Figs 3 and 4 most heavily affected the final design and build.

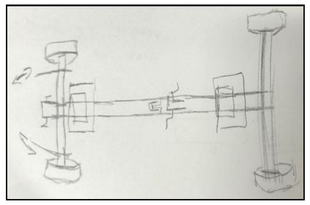

Figure 3: Concept Sketch 1

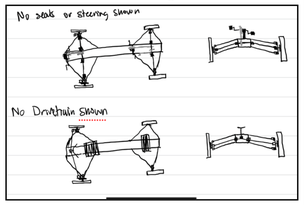

Figure 4: Concept Sketch 2

SIMULATION & LIVE TESTS

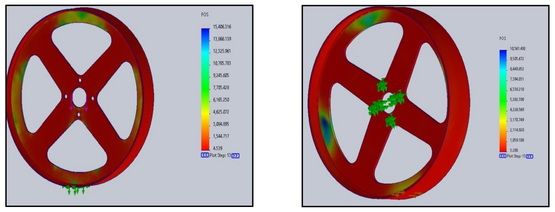

Figure 5a-b: Wheel FEA Analysis Results

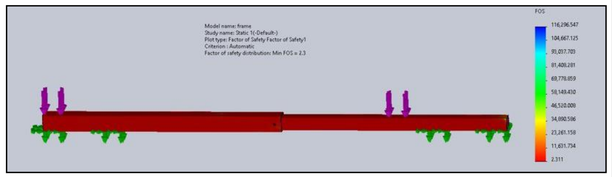

Figure 6: Frame Post FEA Analysis Results

The team developed testing plans for the rover to ensure its proper function and safety during the competition. These plans focused on identifying structural weaknesses using FEA (Figs 4-6) and live of observation (Figs 7-8), especially the welds and connections, to ensure functionality and verify performance, and to protect the pilots while in use.

Figure 7: Testing Rover at Trine

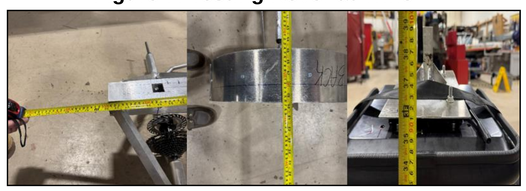

Figure 8: Testing Rover Length, Width, and Height

FINAL DESIGN

The final rover design (Figs 9-10) had a lightweight frame that follows the team's goal of keeping the overall weight below 170 pounds. During testing, the steering displayed too many degrees of freedom and would lay parallel to the floor, so the team added needed control arms to limit degrees of freedom for the rover to steer properly.

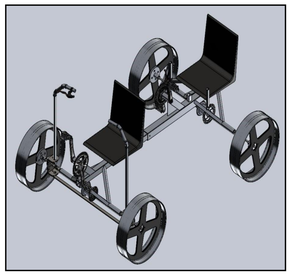

Figure 9: Final CAD Model

Figure 10: Final Rover

COMPETITION RESULTS

The team finished 11th at the competition in Huntsville, with a recorded weight of 129 pounds (Fig 11), resulting in the lightest in the 12 years Trine has competed. The rover was able to collapse into the required 5-foot cube (Fig 12). It attempted or completed 5 obstacles with a time of 5:48.

Figure 11: Final Weight

Figure 12: Final Size

Figure 13: Pilots with Finished Rover

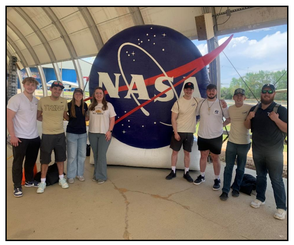

Figure 14: Team photo

Pilots at the start (Fig 13) and a team photo (Fig 14) at Space and Rocket Center.

CONCLUSION

The team has gone through the extensive engineering design process to create a functional rover to participate in the competition at Huntsville, Alabama. The team followed a specific phase-based schedule to have a sound plan during the development, build, and testing of the rover. Working with NASA timelines has also pushed the team into making sure that the rover was competition ready including verifying safety and mission ready requirements. Making sure the drive-train chain was stretched to compensate for slip and the steering design was sound proved instrumental to the team's success for the competition. Figure 15 shows rover on the course and Figure 16 is the team at the finish line.

Figure 15: Rover on Course Obstacle

Figure 16: Competition Completion (Finish Line)

LESSONS LEARNED

One lesson that was learned through the process of the project and the development of the rover was the importance of research and design concept construction through the design process. The team performed extensive research regarding previous and current rovers and subcomponents which heavily influenced and encouraged many design ideas. Seeing all the different rovers at the competition was also inspiring.

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Campus Operations, Trine University