NASA ROVER CHALLENGE

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ABSTRACT

Trine University Design Engineering students were tasked with building a lightweight human powered rover that would compete in Alabama at the NASA Space Rover competition. Due to COVID-19, the live competition was cancelled, but the team recreated various obstacles of the competition on Trine University's campus and recorded multiple demonstrations of the rover in action. The rover meets a variety of criteria as mentioned below and has undergone many safety protocols including personal protective equipment, stress analysis, and physical safety testing of the wheels and drivetrain. The team also participated in the extra 3D printed tool challenge which would help gain the team leverage in the competition point system.

During the past few months, the team has been in constant communication with NASA HERC staff, completing design review checkpoints. These checkpoints consisted of a report and a PowerPoint presentation where the team discussed challenges and successes. The NASA support staff was impressed with the last report and offered great feedback to improve the rover design.

COMPETITION NEEDS/SPECS

The competition required several design aspects that needed to be met. Table 1 shows these vital features.

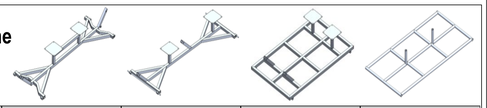
Table 1: Rover Design Requirements

Competition Requirement	Met?
5' x 5' x 5' cube collapsed rover dimensions	Yes
12 inches of clearance between low point and ground	Yes
No chain drive	Yes
Vehicle weighing less than 170lbs.	Yes
15 foot or less rove turning radius.	No
Fabrication of wheels with exception of hubs.	Yes
Seat restraint (seatbelts)	Yes
Free hub safety	Yes
Completely student made	Yes

DESIGN CONCEPTS

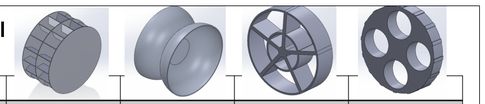
The team went through various design concepts that would initialize the build of the rover. Tables 1-2 show matrix of the different rover ideas the team had and how each was compared. Figures 1-3 show the nearly complete initial rover ideas. Table 3 discusses the task challenge tool.

Table 1: Frame Matrix



Classifications	Concept 1	Concept 2	Concept 3	Concept 4
Weight	4	3	1	2
Strength	4	3	2	1
Easy to Make	1	4	2	3
Space	4	1	3	2
Total	**13**	**9**	**10**	**8**

Table 2: Wheel matrix



Classifications				
Strength	4	2	1	3
Lightweight	3	1	2	4
Durable	3	1	2	4
Capability	4	1	2	3
Ease to Make	2	1	3	4
Totals	**16**	**6**	**10**	**18**

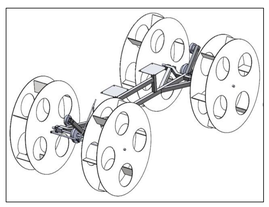


Figure 1: Concept 1 – Back-to-Back

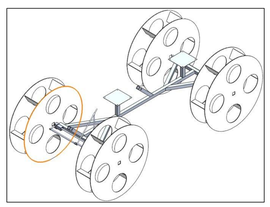


Figure 2: Concept 2 – Tandem

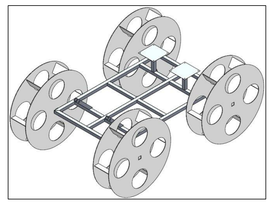


Figure 3: Concept 3 – Side-by-Side

Table 3: Tool matrix

	Printing	Issues	Overall Design
	1. Printing would be slightly difficult with the spaces. 2. More material needed to print.	1. Contamination due to large surface are to clean. 2. Thicker design to support weight.	1. Easy Jar removal. 2. Bulky design
	1. Easier to print model. 2. Print multiples for liquid and solid separation.	1. Threads are dificult to print/ reverse engineer. 2. Ring could become warped.	1. Utilizes thread on collection jars. 2. Simple idea

FINAL DESIGNS

The completed rover is comprised of a single handbrake, a steering system, belt drive, seatbelts, tool and sample collection caddy. The overall weight of the rover is below 80lbs. Figure 4 shows the completed Rover. Figure 5 provided a view of the full 3D printed sample collection tool. The tool was printed in four parts on lab printers.

Figure 4: Completed Rover design

Figure 5: 3D printed tool collector

COMPETITION STILLS

Figure 6: Tool placement on rover

Figure 7: Sample collection caddy placement on rover

Figure 8: Recreation of Obstacle 2- Crater with Ejecta.

Figure 9: Recreation of Obstacle 12: Loose Regolith.

Figure 10: Recreation of Obstacle 13- Pea gravel.

STEM OUTREACH

The team partnered with Waldron and Morristown schools. Students designed marshmallow spaghetti towers with limited resources. The outreach taught students problem solving, creativity, and teamwork. Figures 11 and 12 show students in action

Figure 11: Morristown 6th grade students STEM Outreach

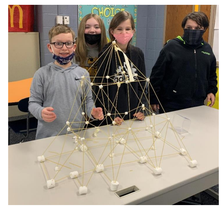


Figure 12: Morristown 6th grade students STEM Outreach

CONCLUSION

The team gained valuable experience and knowledge completing the NASA human exploration rover challenge. The team endured some setbacks, but overall was happy with the final product. The team won the Task Challenge (3D printed tool) award!

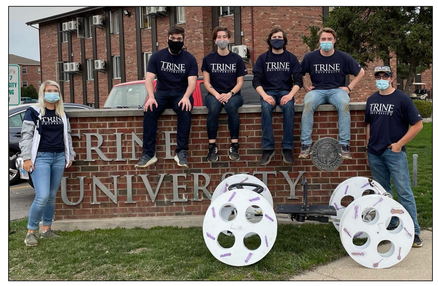


Figure 13: Team with completed rover

LESSONS LEARNED

Throughout this project, the team learned:

- Begin working the small details early in the project.
- Communication with team is crucial.
- Follow the Gantt Chart to ensure time for testing.
- Simulation test models and assemblies before creating the physical model.

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