NASA Rover Team

Emily Atwell, Tyler Blanton, Carma Cherry, Sandeeb Kurian, Alex Munger, Ian Price
Design Engineering Technology
Advisor: Timothy Jenkins, Ph.D.

MISSION STATEMENT

Figure 1: Team Photo 2019-2020

"The Trine University NASA Rover Team works towards fabricating a lightweight yet durable rover vehicle design while maintaining user safety and the ability to overcome course challenges."

The team photograph is shown in Figure 1.

NASA ROVER CHALLENGE

The National Aeronautical and Space Administration (NASA) Human Exploration Rover Challenge aligns with the mission to return to and explore the Moon in the next decade. The competition emphasizes designing, constructing and testing technologies, including tools, mobility devices and traversing in unique environments.

The challenge in Huntsville, Alabama is conducted annually but requires teams to make at least 50% modifications from the previous year designs. This keeps teams innovative and creative and gives NASA the opportunity to review how up-and-coming engineers are thinking. Trine University has participated in this challenge for the past 5 years.

CUSTOMER NEEDS & SPECS

The team gathered requirements set forth by NASA as well as needs discussed with the team and team sponsor to create a list of customer needs. The customer needs were then translated to specifications for the team to meet in the rover vehicle design. Some important ones are in Table 1.

Table 1: Customer Needs & Specs

Needs	Specifications
Safe	0 Protrusions, 2 seat belts
Lightweight	< 170 lbs
Fit in Cargo Space	5'x5'x5' Constraint
Robust for Many Terrains	12'' clearance from the ground
Unique	50% modifications from previous year

DESIGN CONCEPTS

Subproblems for the team designs include the frame, seating, steering, and wheel designs. Figure 2 shows a 3-wheel concept where riders are back to back, with a hinge in the middle to fold the vehicle to fit within the volume constraint. Figure 3 shows a 4-wheel design with wood wheels, where riders are side by side, which is unique to the past designs from the university. Figure 4 shows a forward-inclined design with the same wheels, where riders are lifted and both facing forward, with the seat turned forward for riders to be in a power position. Figure 5 shows a v-structure frame with steel and aluminum wheels. The team used these concepts to create a final design.

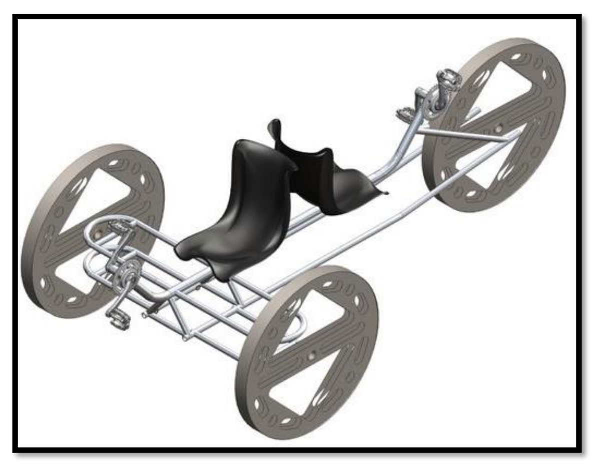

Figure 2: Back-to-Back

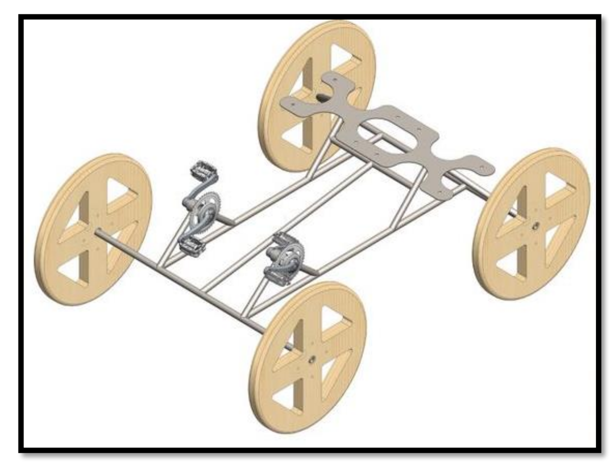

Figure 3: Side-by-Side

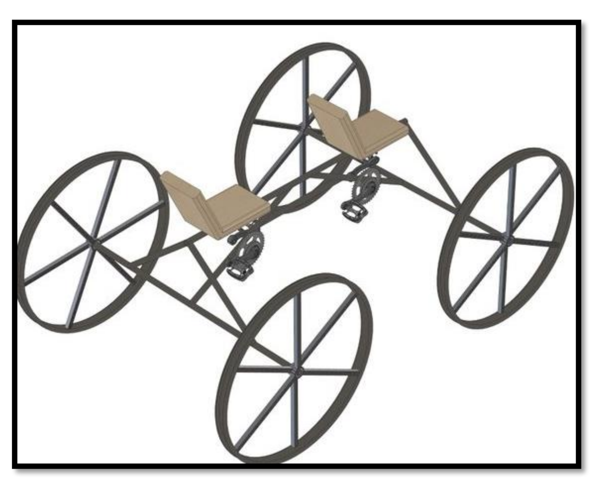

Figure 4: Forward Incline

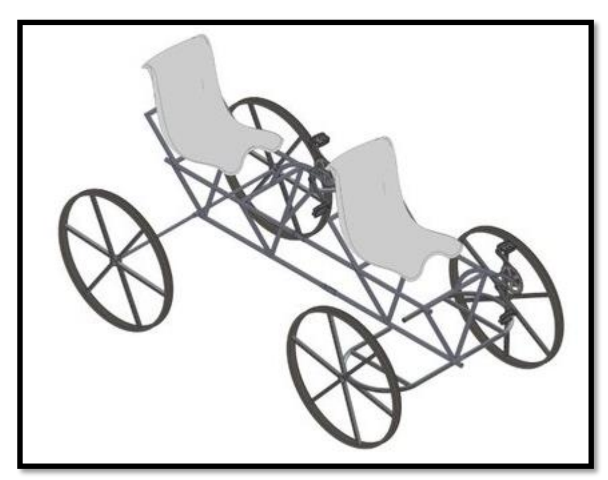

Figure 5: V-Frame

TESTING

Testing was done using Finite Element Analysis (FEA) on SolidWorks of models designed by the team. These assessments helped the team test and gather important information such as model weights, strengths, and how much material the team would need to order. Figure 6 shows good results after applying 1,500 pounds on it. In Figure 7, the wheel has a high Factor of Safety and weighs only 6 pounds.

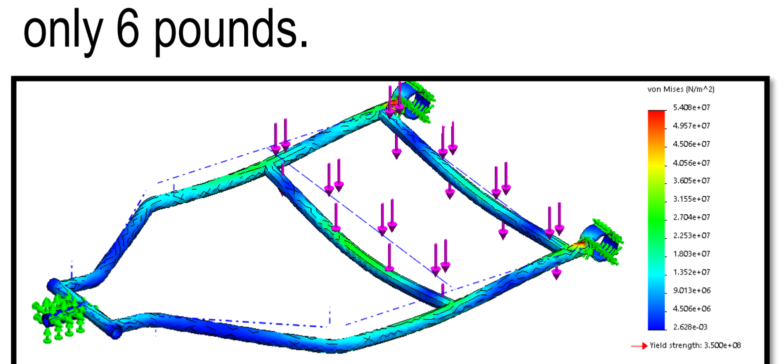

Figure 6: Rover Frame Testing

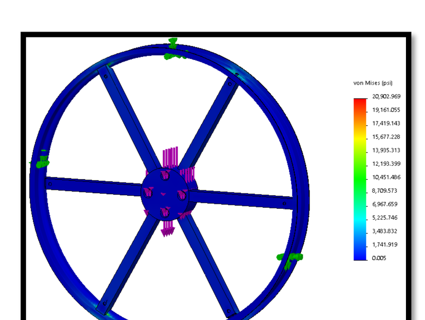

Figure 7: Rover Wheel Testing

FINAL DESIGN

The final design for the rover vehicle to be constructed is a combination of the 4-wheel, side by side concept with the steel and aluminum wheels as seen in Figure 8. The frame, is constructed of 1" diameter steel pipe, Figure 9. The rover also features a belt driven drive train, cable steering, and disc brakes. The total weight of the rover is around 102 pounds. The wheel design, see Figure 10, consists of a steel rim with a unique profile, aluminum bars as spokes, and small steel adapters to bolt the spokes to the rim. Cut up, rubber floor mats will serve as the tread and provide traction as well as protection for the rim and spoke connections.

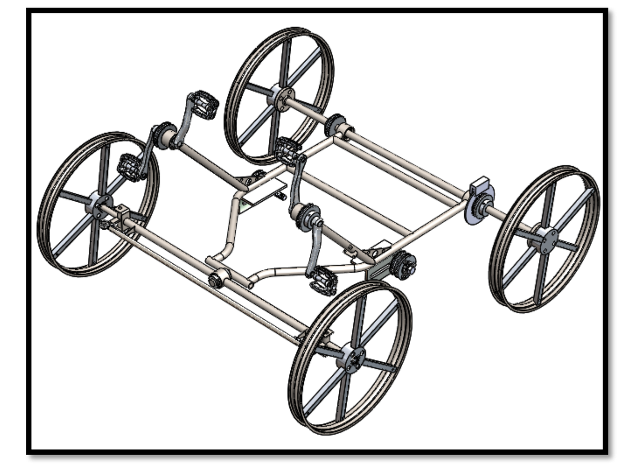

Figure 8: Final Model

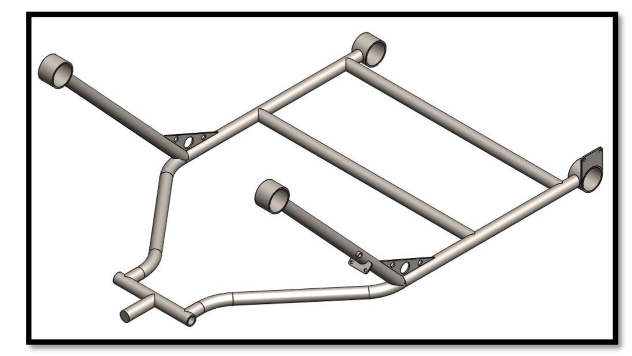

Figure 9: Frame Model

Figure 10: Wheel Model

FABRICATION

Fabrication of the rover took place at the Student Design Center at Trine University. The team began with cutting, bending, and coping steel pipes to weld. Pedal bars were welded on, and angle iron was welded for added strength once riders applied force. The frame with and without seating can be seen in Figures 11 and 12. The wheels can be seen in Figure 13. The wheel rims were fabricated, and holes drilled for the spokes to be bolted to it. Due to unforeseen circumstances, the team could not complete fabrication this year.

Figure 11: Frame with Seat

Figure 12: Fabricated Frame

Figure 13: Fabricated Wheel

CONCLUSION

Although the team will not be able to complete fabrication of the rover vehicle or travel to Alabama to compete with other teams, the team is proud of the work completed. The team still had time to complete testing and make refinements if construction was completed. Other challenges were overcome throughout the project. The team had to find solutions to add adjustability to the drive train, add a freehub to the pedal assembly, and face other challenges with tools and training. Despite the difficulties encountered, all members feel confident that the rover vehicle would perform well if completed.

LESSONS LEARNED

Throughout the project, the team faced challenges and learned lessons about project development and collaboration. Helpful lessons were learned in time management such as the benefits of setting milestones and using phases to stay on track. Other lessons learned include the importance of teamwork and communication. The team made the difficult decision to cease fabrication, however these decisions happen every day in the workplace and was also a learning experience for the team. Along with other lessons learned, students were able to gain training and hands-on experience with tools and machinery at Trine University.

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