NASA HERC ROVER

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ABSTRACT

The NASA Human Exploration Rover Challenge (HERC) requires student teams to design and build a man-made human powered vehicle to be driven on a half-mile course with 10 obstacles and 5 tasks. Figure 1 shows the course.

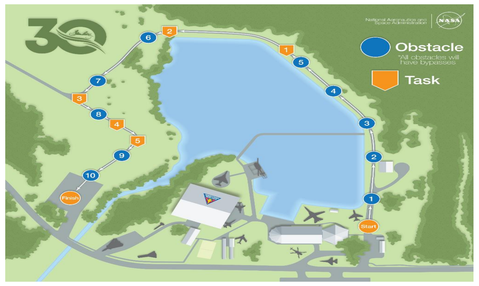

Figure 1: NASA HERC Course

This challenge engages students in hands-on engineering design which contributes to NASA's Artemis mission. The team designed each sub-system and a task tool to traverse the course and complete tasks. The rover was assembled within the second semester of the 2023-24 school year. Figure 2 shows the rover from the previous year.

Figure 2: 2022-23 Rover Design

CUSTOMER NEEDS/SPECS

After consulting the handbook provided by the competition holders and previous year's problems, the team create the following customer needs and specs shown in Table 1.

Table 1: Customer Needs

Customer Need	Target Specification
Rover expenses need to stay under budget	Expenses do not exceed $6000
Rover needs to be safe to ride and handle	All sharp edges need to be filed and rounded
Build envelope needs to be within competition guidelines	Rover build envelope should not exceed 5'x5'x5' cube
Center of gravity needs to be relatively low to prevent tipping	Lowest human appendage must be at least 12" above ground
Ensure pilots are comfortable while piloting rover	Seats are tilted at 20°-recline for ease of pedaling
Rover must be completed in a timely manner	First build complete by 2/9, final build complete 4/6

DESIGN CONCEPTS

The team generated several concepts for this project before narrowing it down to 4 concepts that were shown to the department for further deliberation. Figures 3-6 display the various concepts the team create, with Figure 6 being the chosen concept to move forward into the build phase.

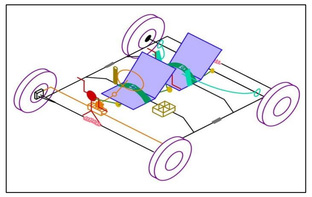

Figure 3: Split Frame Concept

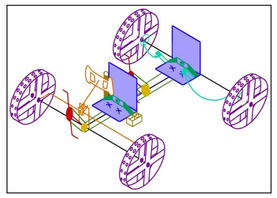

Figure 4: I-Frame with Sway Concept

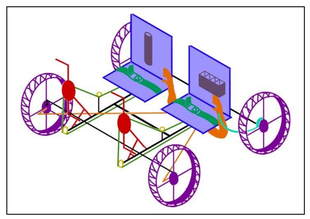

Figure 5: Bed Frame Concept

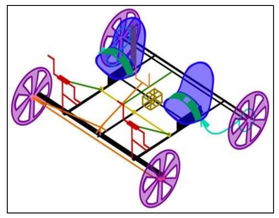

Figure 6: H-Frame Concept

ARTIFACT BUILD

A variety of manufacturing processes, from welding to 3D printing, were used during the build phase to create the prototype and final artifact. Pictured in Figures 7-10 are various processes used to create the team's design.

Figure 7: 3D Printed Carbon Fiber Bushings

Figure 8: Pedal Stand Welding

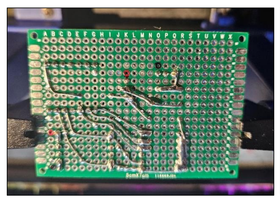

Figure 9: Task Tool Circuit Board Soldering

Figure 10:Aluminum Wheel Rim Rolling

TEST RESULTS

The team performed various simulations, an example seen in Figure 11, of critical components to ensure failure will not occur while operating the rover. The team also performed on-the-ground testing of the rover by piloting it around campus and over various constructed obstacles, seen in Figure 12.

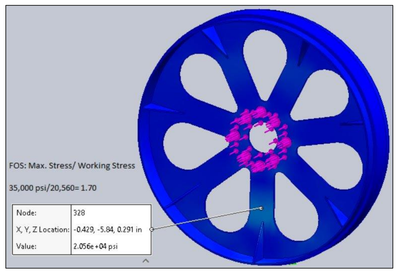

Figure 11: Front Wheel Thrust Analysis

Figure 12: On-the-Ground Testing

FINAL DESIGN

The team developed a final solution concept, manufacture, and competed with the final design. Figure 13 shows the initial final artifact 3D model. Figure 14 shows the final artifact after completion of course requirements for the NASA HERC Competition in Huntsville, Alabama

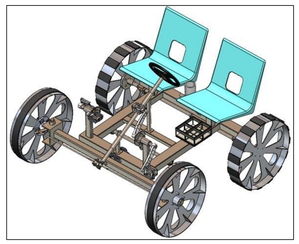

Figure 13: Initial 3D Model

Figure 14: Final Artifacts

CONCLUSION

The team was able to complete its overall goal of competing in the NASA HERC competition in Huntsville, Alabama (Figures 16-18) with its various obstacles and task challenges. This was accomplished through utilizing the engineering design process of initial concept creation, product and customer research, small and large-scale prototyping, and testing of the final artifact.

Figure 15: Team Members Assembling Artifact

Figure 16: Artifact Going Through Inspection

Figure 17: Team Pilots Prior to First Excursion

Figure 18: Team with Artifact After Second Excursion

LESSONS LEARNED

At the conclusion of the project, the team learned:

- Problem-solving skills to unforeseen challenges
- Team coordination of various tasks
- Evidence documentation

ACKNOWLEDGMENTS

The team would like to acknowledge the following people for the help through the completion of the project:
Tom Trusty, Department Chair, Design Engineering Technology
Roberta Gagnon, Assistant Professor, Design Engineering Technology
Jarred Finnerman, Assistant Professor, Design Engineering Technology
Higbee Welding