College of Engineering
LAMAR UNIVERSITY
Department of Mechanical Engineering

Shell Eco-marathon

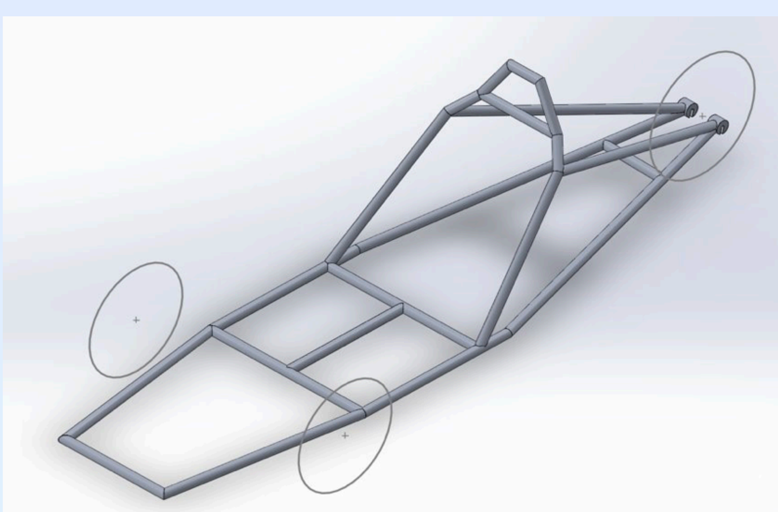
LAMARk, Get Set, Go! - The Cardinal

Shell-Eco Marathon Project Description

The Shell Eco-Marathon Project challenges STEM students to contribute all knowledge towards creating an eco-friendly car that uses the least amount of fuel consumption while obtaining the most output in distance. Throughout the Shell Eco-Marathon Project, students are challenged to design, build, and manufacture a lightweight car following specifications provided by the competition pertaining to the selected vehicle type. There are two types of vehicles that can be built for this project, an Urban Concept vehicle and a Prototype vehicle. 'LAMARk, Get Set, Go!' chose the prototype vehicle based off rules and restrictions. Specifications include weight restrictions, carbon-emission restrictions, material properties, battery selections, steering radius, and much more.

Product Planning and Design

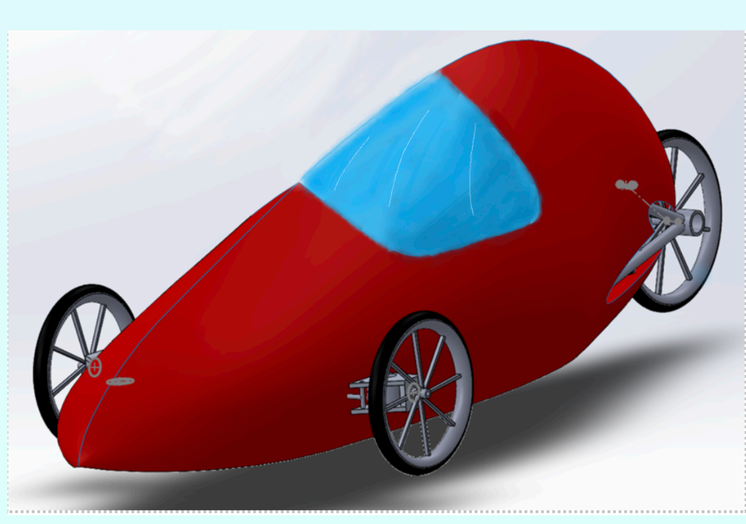
Each type of vehicle has specified regulations that each team must follow. Prototype vehicles cannot exceed a height of 1000mm (3.28ft); the vehicles base must be no less than 1000mm (3.28ft). The vehicles' total length and width must not exceed 3500mm x 1300mm (11.5ft x 4.3ft). The maximum weight of the vehicle without the driver must be less than 140kg (308.6lbs).



Models were designed on SolidWorks and analyzed using FEA analysis to ensure the designed and selected frame would be sufficient for the maximum load applied once completed.

Targa Resources manufactured the frame used on this vehicle after detailed diagrams displaying all measurements needed were provided. In addition, the team purchased the aluminum round tubing to supply to Targa Resources. The two wheels in the front steer the vehicle meanwhile having a bigger back wheel allows suspension and stability. The front two wheels are attached to the same braking system and controlled by pedal meanwhile, the back wheel is a manual braking system controlled by a lever. The outer shell of the vehicle was designed to have a sleek backed teardrop shape to create the ultimate aerodynamic concept. A rack and pinion style steering system was selected for the vehicle because of its simplicity and minimal parts needed allowing an opportunity to lower product weight. As for visibility, the vehicle was designed to create a cut out from the shell and mold plexiglass to serve as a window and entrance/exit hub.

By having this compartment located above the driver, an entrance and exit time of eight seconds is achievable and secure. Ideally the plexiglass will be heat treated into the desired shape of the shell and allow the driver to have a full 180° view from their seat.



Material Selection

The following material were selected for this project:

- Sch. 80 Aluminum Round Tubing 6061-T6 – Frame
- Aluminum Metal Sheeting – Frame
- Polyurethane (Rubber Foam) – Shell
- Lexan Plexiglass Sheet 9030, 9034 – Shell
- Fiberglass – Shell
- Mophorn Hydraulic Brakes
- Honda GX100 Engine
- 12 Volt Non-lithium Battery
- Fuel Injector Kit
- Starter Motor

Materials listed above each required research prior to selecting and purchasing.

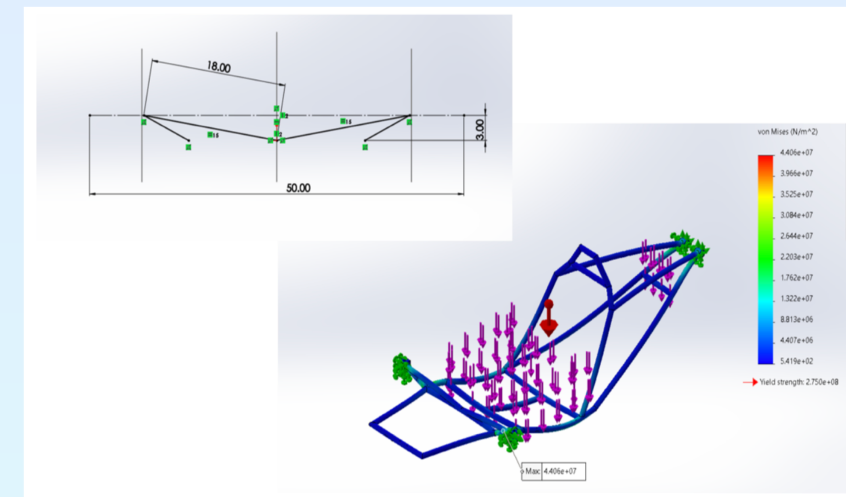
Sponsorships and Funds

D&R Industrial Services, LLC
Tony's Barbecue & Steak House
TARGA
College of Engineering Lamar University
ASME Setting the Standard

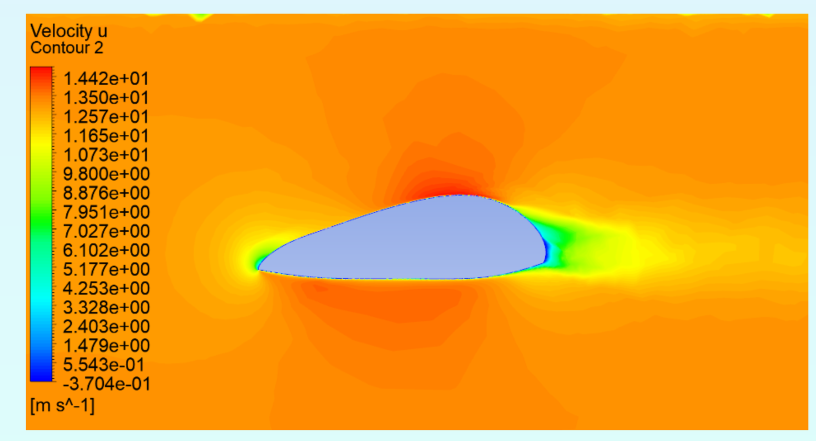
Many expenses were covered by team members.

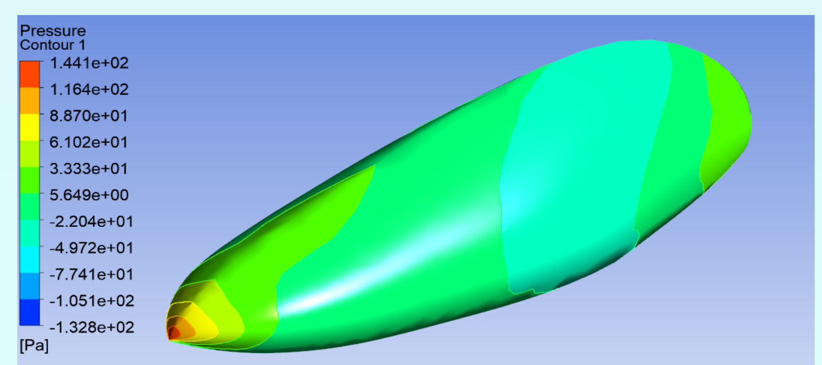
Finite-Element Analysis

Analysis on the frame and shell must be ran before finalizing any design models. While testing, a relationship between the length and the stress was noticeable. In other words, as the length of the piping increased, the Von Misses stress would increase proportionally. Three proper analysis were run resulting in the lowest Von Misses stress of $4.406e^{7}$ (figure shown below) to be found.

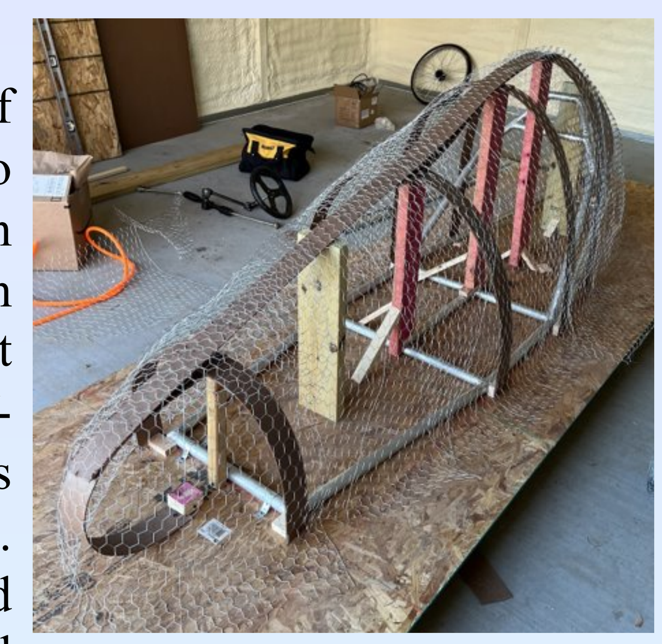


Using ANSYS Fluent, an aerodynamic analysis was run on the shell designs. The very first design produced 8 Newtons of drag (CD=0.188), the second design produced 4 Newtons of drag (CD=0.07), and the final design produced 9 Newtons of drag (CD=0.133). Each test was run at 25mph and to verify the results, an aerodynamic analysis on regular shapes, like a teardrop shape (Cd=0.04) and a sphere (Cd=0.4), were done using the same settings.





Final Product Assembly



The first step of assembly was the manufacturing of the frame. Meanwhile, supports were put in place to mold the desired shape of the shell. The construction of the shell was one of the first milestones the team achieved. Once the frame was finished, the team went in and attached the aluminum metal sheeting with self-tapping screws. Modifications in size and sections took place before completing the floorboard. Throughout the entire process, team members divided to work diligently. The steering system was mounted meanwhile teammates worked on the engine for the vehicle, the brakes, and the stability and appearance of the frame.

Included are photos throughout the process and the most updated version of the vehicles progress.

Conclusions

The Shell-Eco Marathon project challenged the following senior Mechanical Engineering students to utilize skills from many of their coursework as well as develop new knowledge. Each team member had to work efficiently with each other to develop an operating vehicle. There were many unexpected complications such as, stability of vehicle frame, engine fuel injection application, hydraulic brake fluid, additional supports, proper steering alignment, and more. However, the student's problem-solving skills allowed an extravagant hands-on experience.

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