College of Engineering
LAMAR UNIVERSITY

Department of Mechanical Engineering

# FDHB HPVC 2: ASME Human-Powered Vehicle

## *Project Description*

FDHB HPVC goal is to create a HPVC design that will provide a reliable form of transportation at an affordable price and provide structural integrity while adhering to safety guidelines put forth by ASME for the 2022 HPVC Event.

Talking to faculty members and recent graduates, the team did more research on trikes. Members read "Build the Warrior Racing Trike," "Essentials of Vehicle Dynamics," and "Vehicle Handling Dynamics Theory and Application."

The team decided to use an unfinished trike from an old team and improve its components and overall performance.

The team employed multiple engineering techniques to design this new trike such as computer-aided drawing, finite-element analysis, MATLAB coding, and general analytical skills.

## *Frame Material Selection Process*

A list of material options was organized after searching what materials are commonly used for bicycle frames and what materials are readily available for purchase. There were two options compared in six categories in the table below. Our biggest concerns was cost and safety, while still having access to the material. We choose steel because we had access to a pre-built trike that we can build upon while aluminum is more expensive and less available.

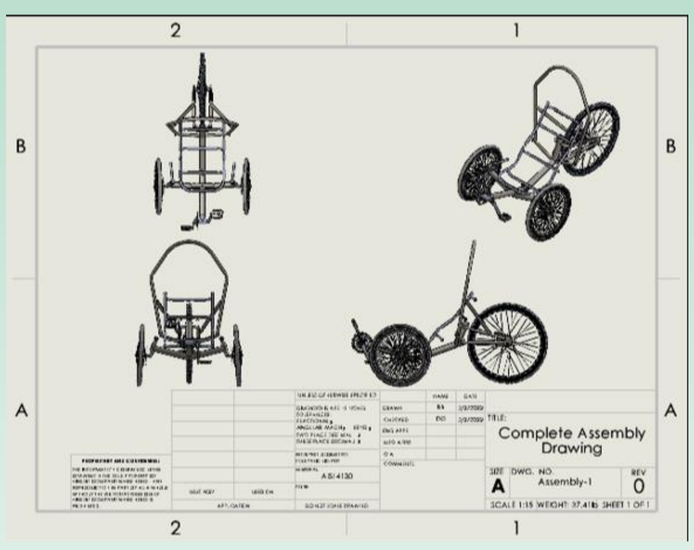
**HPV Frame Design Decision Matrix**

| Criteria | Criteria Weighs | Design Concepts | |
|---|---|---|---|
| | | Steel | Aluminum |
| Weight | 1 | 2 | 1 |
| Strength | 3 | 3 | 2 |
| Durability | 3 | 3 | 2 |
| Cost | 1 | 1 | 3 |
| Ease of Manufacture | 1 | 1 | 2 |
| Availability | 3 | 3 | 3 |
| Totals | 12 | 13 | 14 |
| Rank | | 1 | 2 |

After organized and comparing the points in the design matrix, it became apparent that common steel was the best option for the team to select for the frame material.

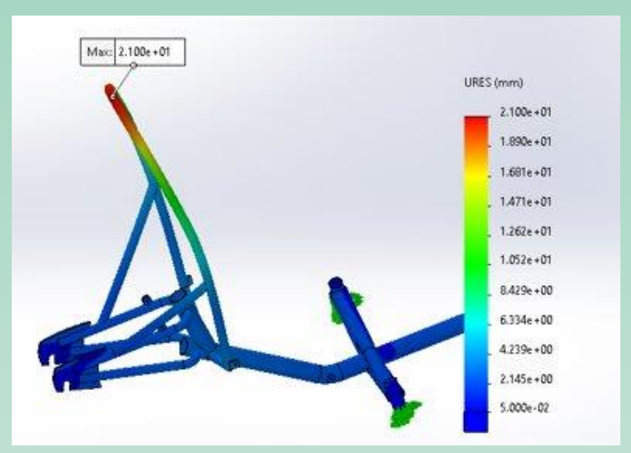
## *Modelling of the HPV Frame*

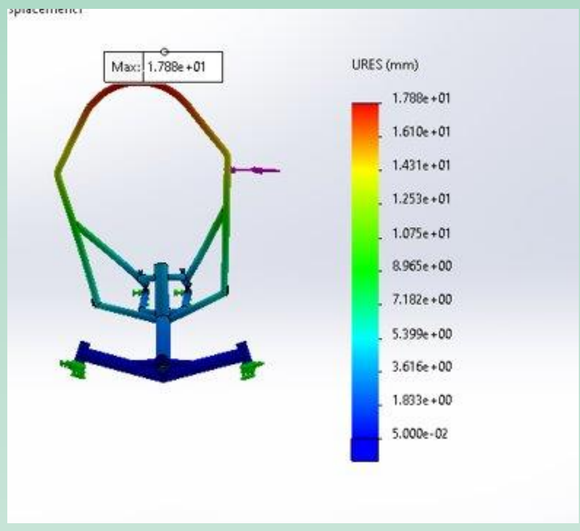
The frame was designed and modelled in SolidWorks around a team member's body dimensions to ensure an ergonomic design. A large effort was put into minimizing frame weight while still maintaining reasonable safety factor values under loading. Because of this, the team made the main "spine" of the frame out of 1-1/2-inch pipe and the rear forks as well as the roll-protection system (also called RPS) out of half-inch pipe. This helped reducing the weight of the trike.

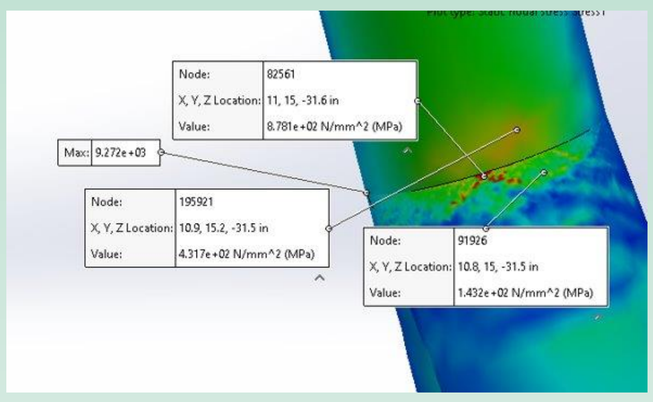


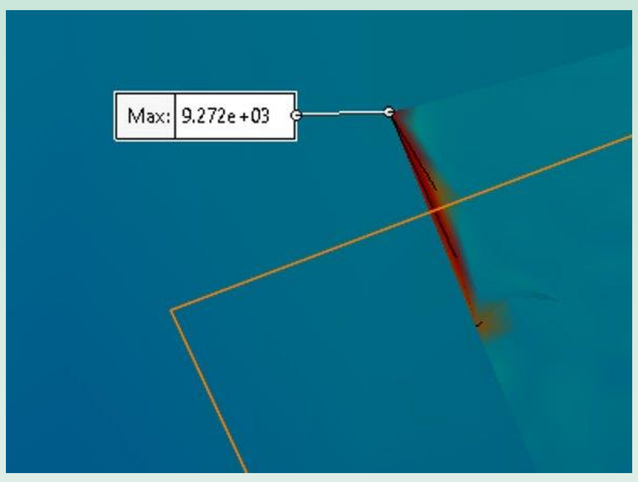

## *Frame Finite-Element Analysis*

Most of the stresses in the trike are in the blue/green region. There is a very high stress concentration at a vertex. This makes our maximum stress inaccurate. We believe that limitations due to solidworks or a small geometry error in the model caused these results however we can simply ignore it as it is very small. The maximum displacement is 2.1 cm which is acceptable since our maximum allowable elastic displacement is 5.1 cm.




## *Performance Testing the Final Product*

Even though the team was unable to attend the 2022 ASME HPVC in person, we still put our build through rigorous testing. Utilizing simple tools such as GPS speedometers, stop watches, and measuring tape to simulate the tests that would normally be conducted in the competition, the team showed the performance of the bike. The table below shows the performance specifications set forth be ASME as well as how the bike performed in all the cases.

| Test | Requirement | Results |
|---|---|---|
| Hold 250 lbs | Yes | Yes |
| Brake Distance at 25 km/hr | <6.0 m | 2.34 m |
| Turn Radius | <8.0 m | 5.9 m |
| Stable at 8 km/hr | Yes | Yes |
| RPS Roll Testing | Pass | Pass |
| Max Speed | >20 km/hr | 32.4 km/hr |
| Weight | <200 lbs | 67 lbs |

As a result of all the tests, team FDHB HPVC build met all the performance requirements set forth in the 2022 ASME HPVC rule book.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Lamar University of Mechanical Engineering Department