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Summary

The Objective

Create a wheeled transportation device that is safe, agile, fast and satisfies the ASME Human Powered Vehicle (HPV) Competition rules.



The team will Emulate the ASME North American E-Fest in Lansing, Michigan in April of 2019.



Competition Requirements

- Stopping distance of 6 m from 25 km/hr
- All front wheels must have brakes
- Vehicle must maintain a straight path
- Vehicle must travel in a straight line
- Vehicle must have a roll protection system (RPS)
- The RPS must sustain a top load of 2670 N
- The RPS must sustain a side load of 1330 N

Objective

Three Events will be Emulated

Design

Methodology
Innovation
Analysis
Documentation

Speed

Top Speed
Timed Race
Safety is Crucial

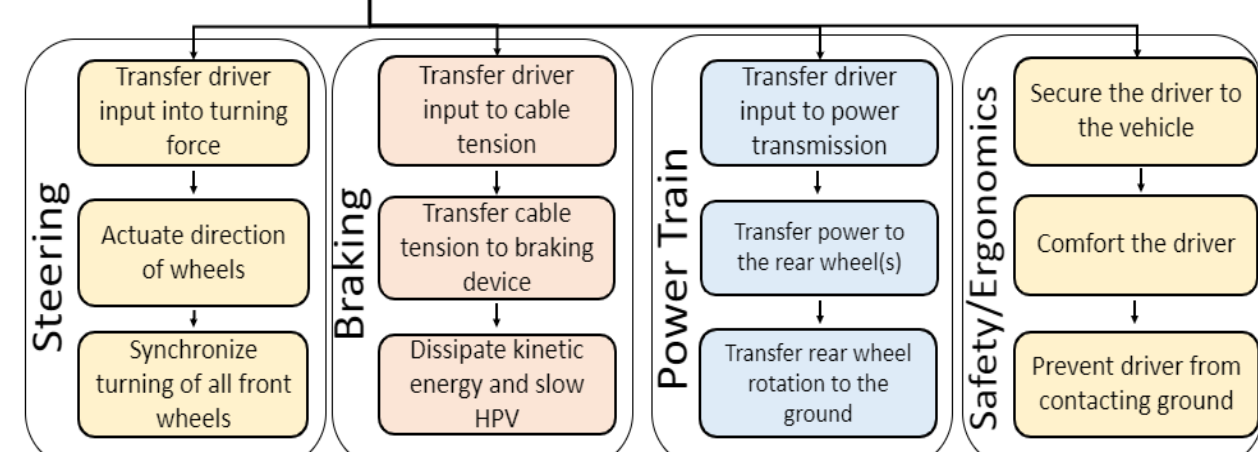
Endurance

Agility
Durability
Stamina

Functions and Targets

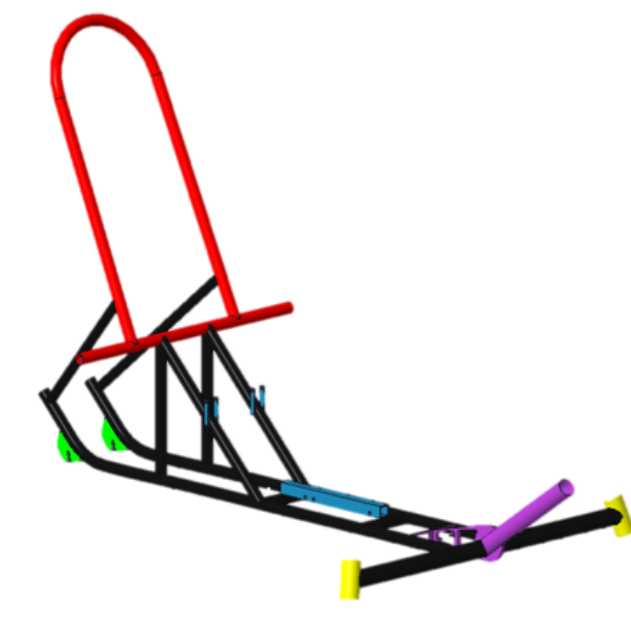
Functional Decomposition

Human Powered Vehicle



- Top speed of 40 km/h or 25 mph
- Brake in 6.0 m at a speed 25 km/h or 16 mph
- Turning radius of 6.0 m or 18 ft
- Roll bar supports 2670 N (600) lbf at 12°
- Vehicle sustains side load of 1330 N (300 lbf)

Frame

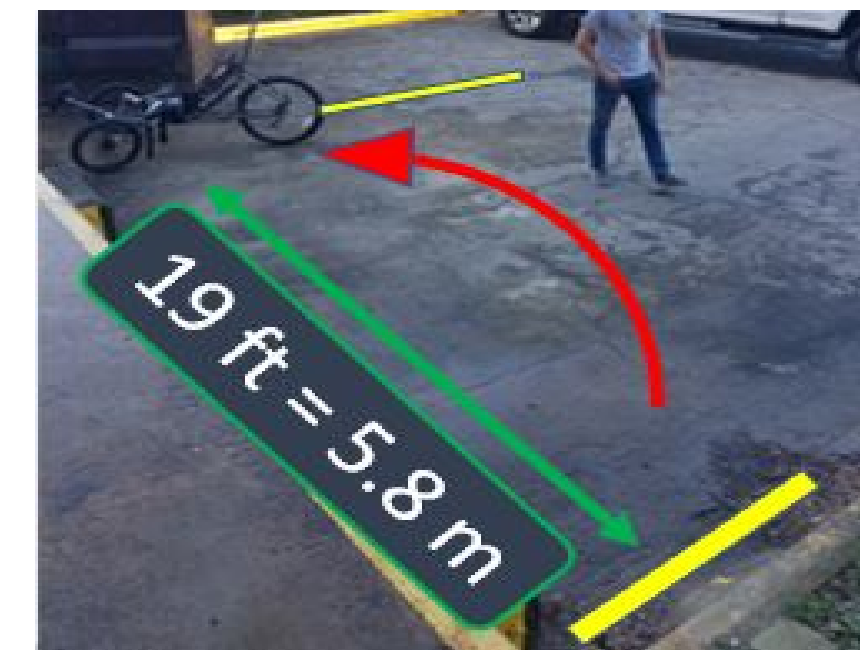


Frame designed to integrate all systems:

- Roll Protection System
- Rear Wheel Mounting Point
- Reclined Seat Mounting Points
- Head tubes for front wheels and direct steering
- Pedal Boom Mount with Reinforcement

Testing

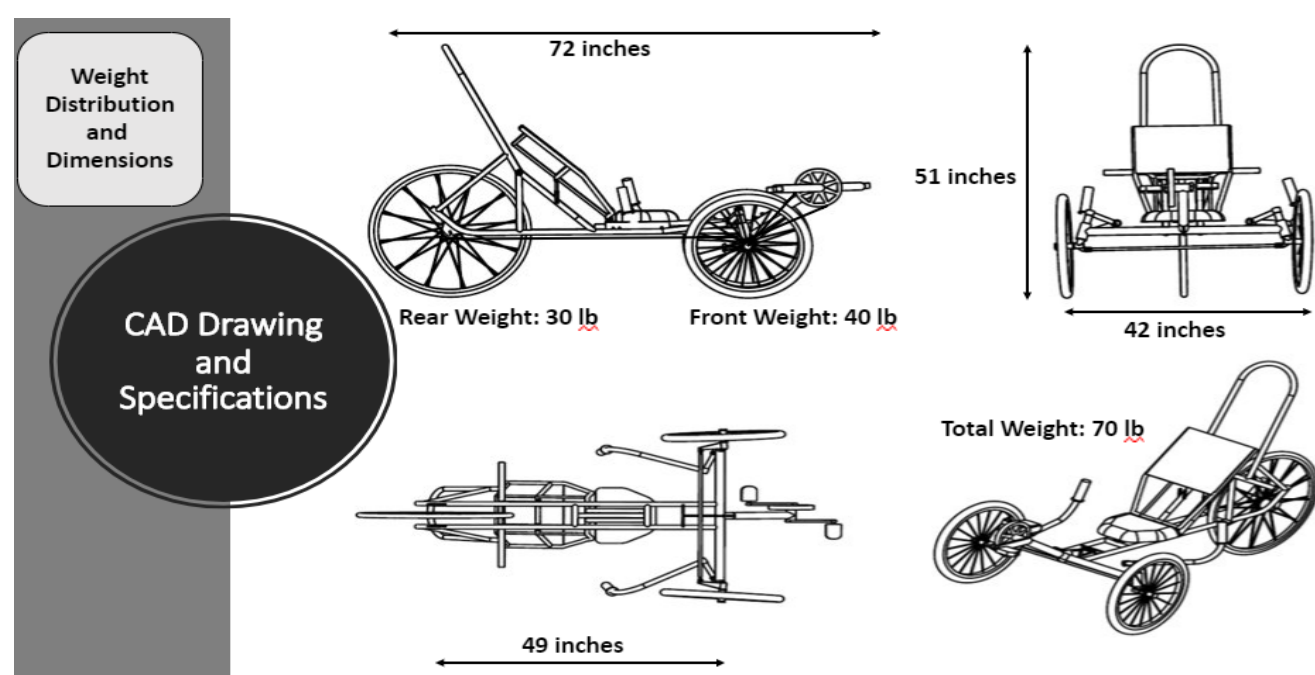
Turning Radius (6m (19.8 ft) Target)



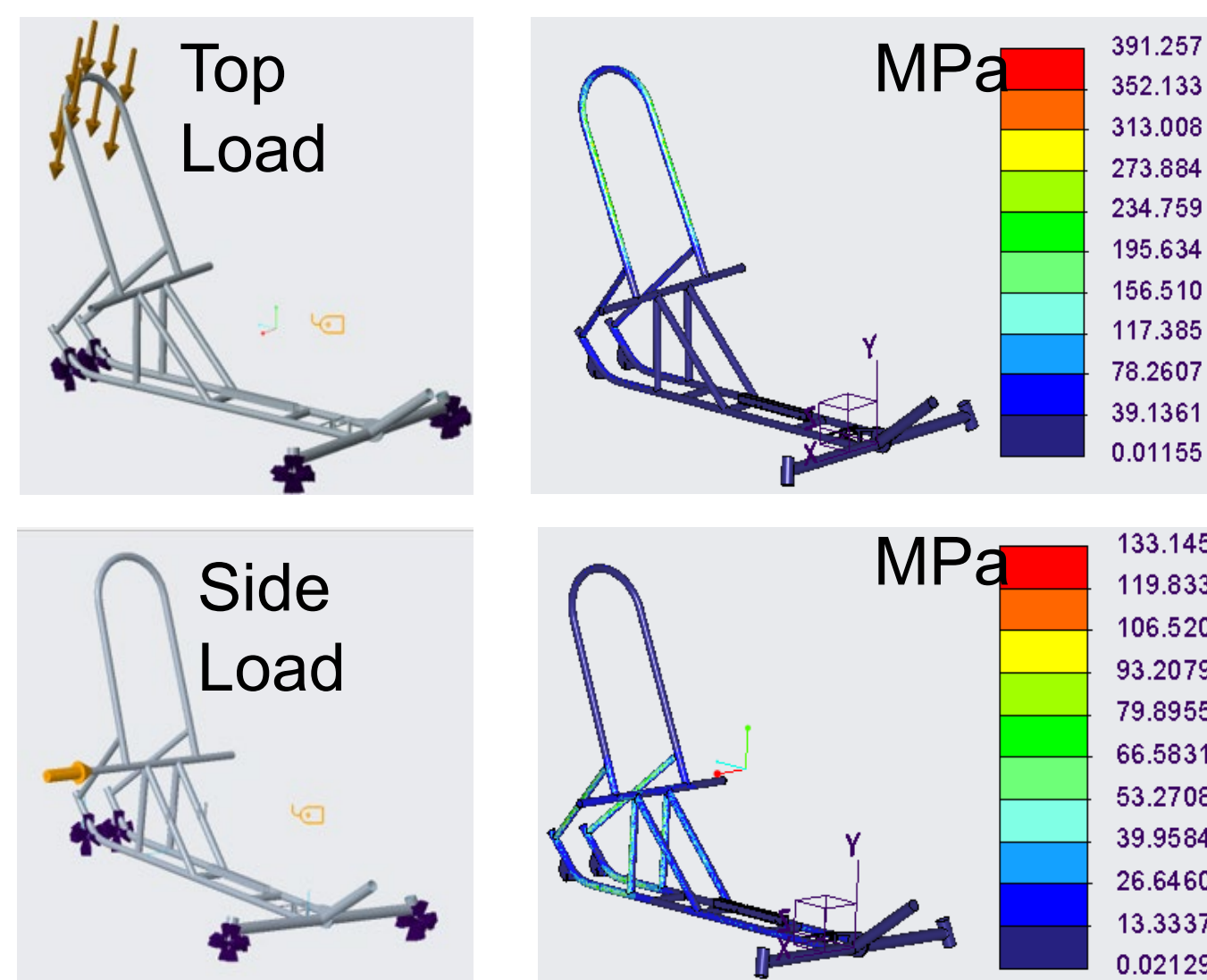
Braking Distance (6m (19.8ft) Target)



CAD Model



Finite Element Analysis



Max Von Mises Stress (Top Load) = **391 MPa**
Max Von Mises Stress (Side Load) = **133 MPa**

The frame can handle the loads required by the competition

Governing Equations

$$\text{Force of Weight} \\ F_g = mg \cos \theta$$

$$\text{Force of Friction} \\ F_{fr} = \mu_N mg \sin \theta$$

$$\text{Force due to Acceleration} \\ F_a = ma$$

$$\text{Force of Drag} \\ F_d = \frac{1}{2} C_d \rho v^2 A$$

$$\text{Energy} \\ = \int_0^t (F_g + F_{fr} + F_a + F_d) v dt$$

Prototype



Features:

- Full body protection during flips on side
- 7-speed transmission for varying conditions
- Disc brakes for fast stopping at high speeds
- Reclined seating position for rider comfort
- Direct steering for simplicity
- 5-point safety harness

Suggested Improvements



Lowering the center of gravity can improve speed and cornering.

Allow for a variable seating position

Reduce weight of vehicle

More ergonomic handles can make it easier to control the vehicle, brake and change gears.

Acknowledgements

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