Human Powered Vehicle Team

Virtual Design Review 5

Team 20

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MECHANICAL ENGINEERING

Team Members

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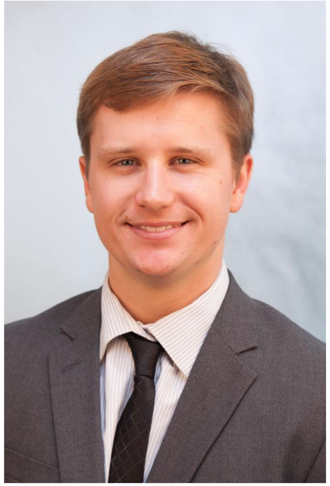

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Analysis Lead

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Team Lead

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Human Powered Vehicle Challenge

- Purpose: Allow students to apply engineering principles to develop feasible and sustainable transportation alternatives
- HPVC consists of the following competitions:
  - Design Competition
  - Innovation Competition
  - Women's Speed Competition
  - Men's Speed Competition
  - Endurance Competition

Project Scope

- Design a Human Powered Vehicle that is:
  - Eco-friendly
  - Swift and versatile
  - Safe and reliable
- Create robust vehicle serving as a foundation for upcoming competitions
- Build prototype
- Market: Megacities (i.e Los Angeles, London, New York, etc.)

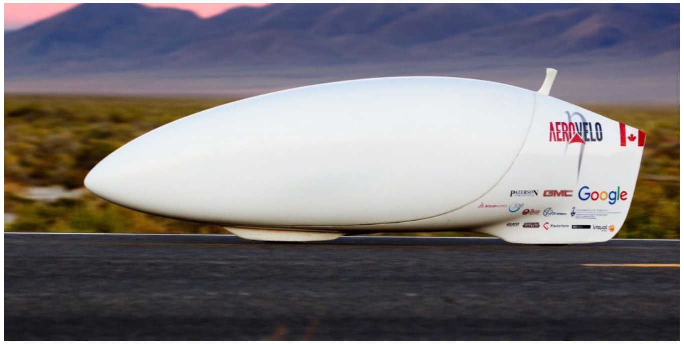
Customer Needs

- The 2018 ASME HPVC Rules outline many of our team's constraints and guidelines
- Some primary needs include:
  - Roll protection system
  - Braking system
  - Turning Radius
  - Structural Requirements
  - Safety Features

Functional Decomposition

Human Powered Vehicle Functions:

- Use human input to create mechanical energy
- Transport operator safely
- Transport operator by rolling on wheels
- Enable operator to detect upcoming obstacles
- Enable operator to steer vehicle in desired direction
- Enable operator to travel on government maintained roads
- Enable operator to alter vehicle's longitudinal acceleration



Target Catalog

Functions	Use human input to create mechanical energy	Transport operator by rolling wheels	Transport operator safely	Enable operator to travel on government roads	Enable operator to steer vehicle	Enable operator to alter the acceleration	Enable operator to detect obstacles
Targets	Wheels: 600 rpm	29 inch wheels	Stops within 6 m for a speed of 25km/hr	Has a head light of at least 300 lumens	Must have a turn radius of 24.6 ft	Each front wheel must have a brake	Driver must have 180 degrees field of view
	Standard bike gear set has 3.25:1 gear ratio	2,3,or 4 wheels	Travel in straight line for 30 m at 5-8 km/hr	Has a tail light of at least 10 lumens			
	CVT has 4.8:1 gear ratio		Has roll protection that can handle loads up to 2670 N				
			Secure driver in the vehicle with shoulder harness				
			Driver is in a recumbant position in vehicle				
			Adjustable Seat				

Target Catalog

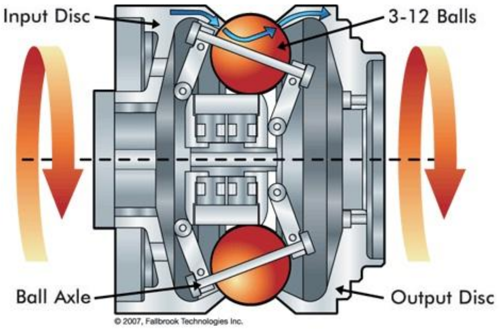
Transport operator safely	Enable operator to travel on government roads	Enable operator to steer vehicle	Enable operator to alter the acceleration
Stops within 6 m for a speed of 25km/hr	Has a head light of at least 300 lumens	Must have a turn radius of 24.6 ft	Each front wheel must have a brake
Travel in straight line for 30 m at 5-8 km/hr	Has a tail light of at least 10 lumens		
Has roll protection that can handle loads up to 2670 N			

Concept Generation

Component Options:

- ➢ Drivetrain: Chain vs. Belt
- ➢ Full rotation pedal vs HANSCycle vs CVT
- ➢ Vehicle configuration: 2, 3 or 4 wheeled vehicle
- ➢ Steering: Steering rack vs linkage
- ➢ Fairing: Full vs partial vs none

Full Rotation Pedals



CVT

HANSCycle

Concept Generation (Aerodynamics)

No Fairing

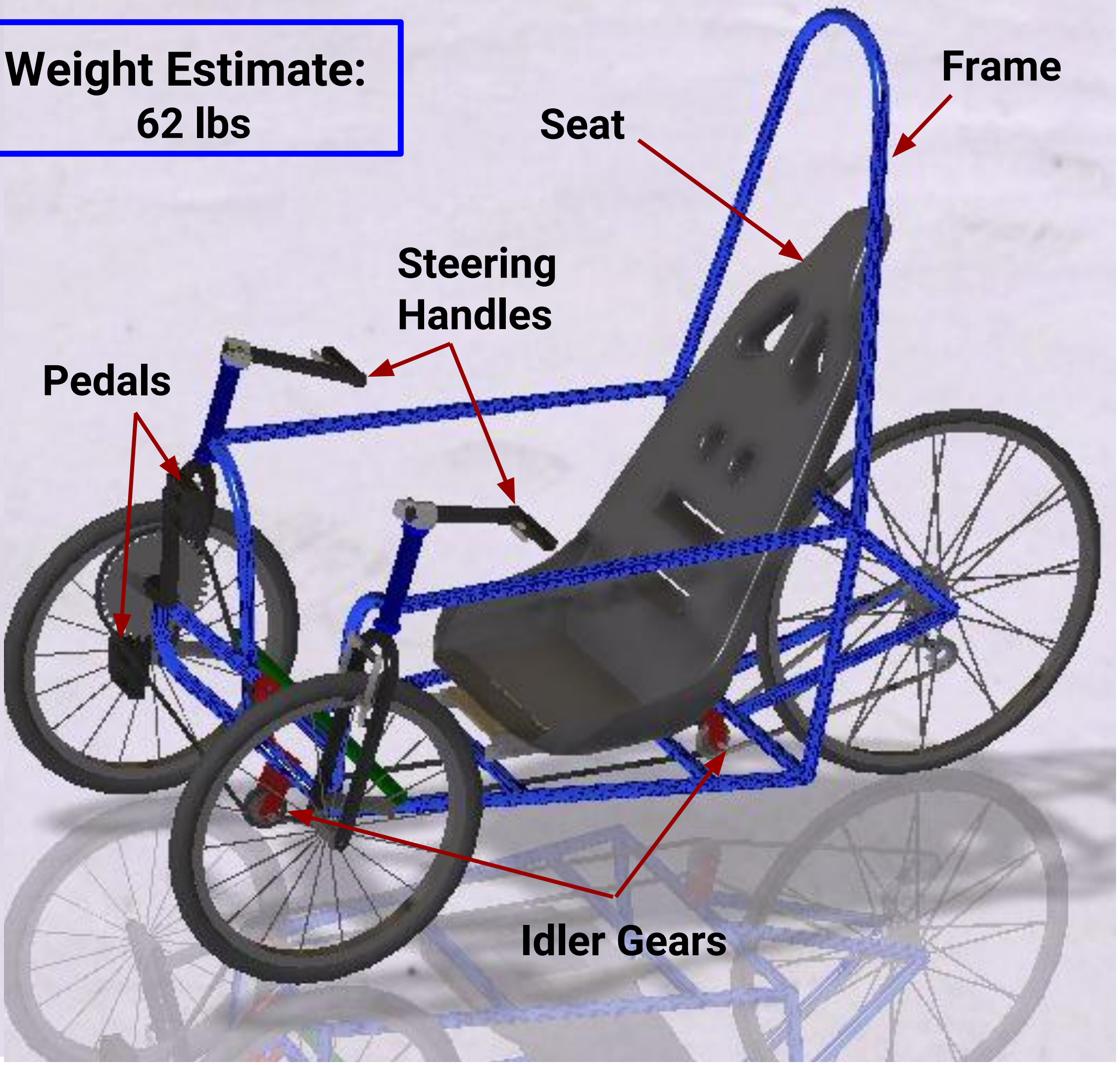
Small Fairing

Full Fairing

Current Design

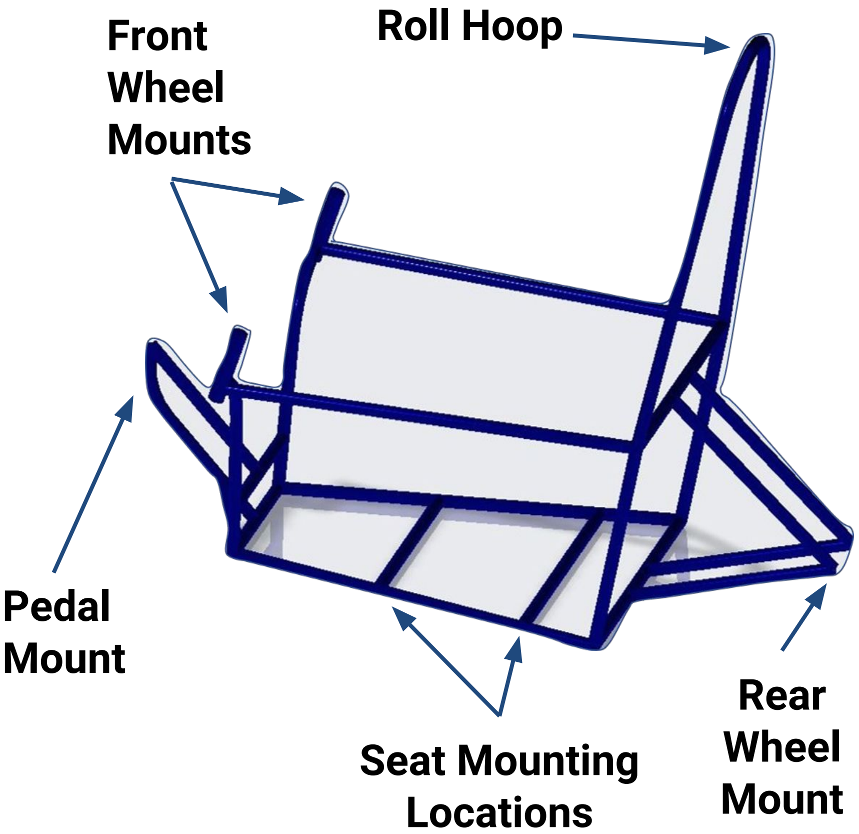
- Frame
  - 4130 Steel
  - Yield strength: 70,000 psi
- Drivetrain
  - Interchangeable pedal configuration
  - Rear wheel drive
  - Idler gears underneath frame
- Steering
  - Wheels pivot within frame similar to the front end of bike
  - Both connected with a tie rod
  - Steer in side-to-side motion
- Recumbent Seat
  - Adjustable seat for different riders
  - Positioned for comfort and maximum power output potential

Weight Estimate:
62 lbs



Chromoly Frame

- **Frame Characteristics**
  - Requires:
    - 24’ tube of 1” OD, .083” WT
    - 18’ tube of 1” OD, .049” WT
    - 3’ tube of 1.25” OD, .095” WT
    - *(OD: Outer Diameter)*
    - *(WT: Wall Thickness)*
  - Cost: $399.25 w/ shipping
  - Weight: 29.1 pounds
  - Vendor: McMaster Carr

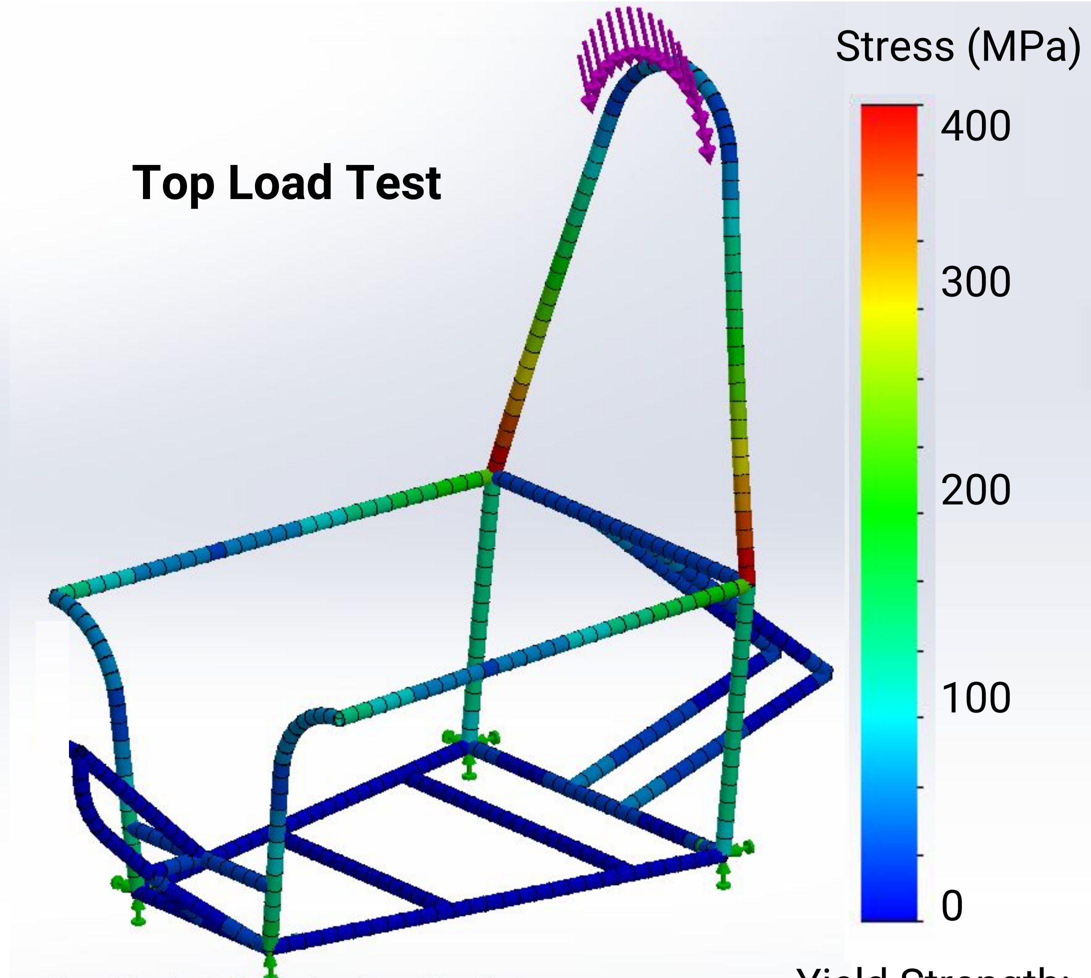


Chromoly Frame (cont.)

Top Load Test:

600 lbf at 12° offset from vertical

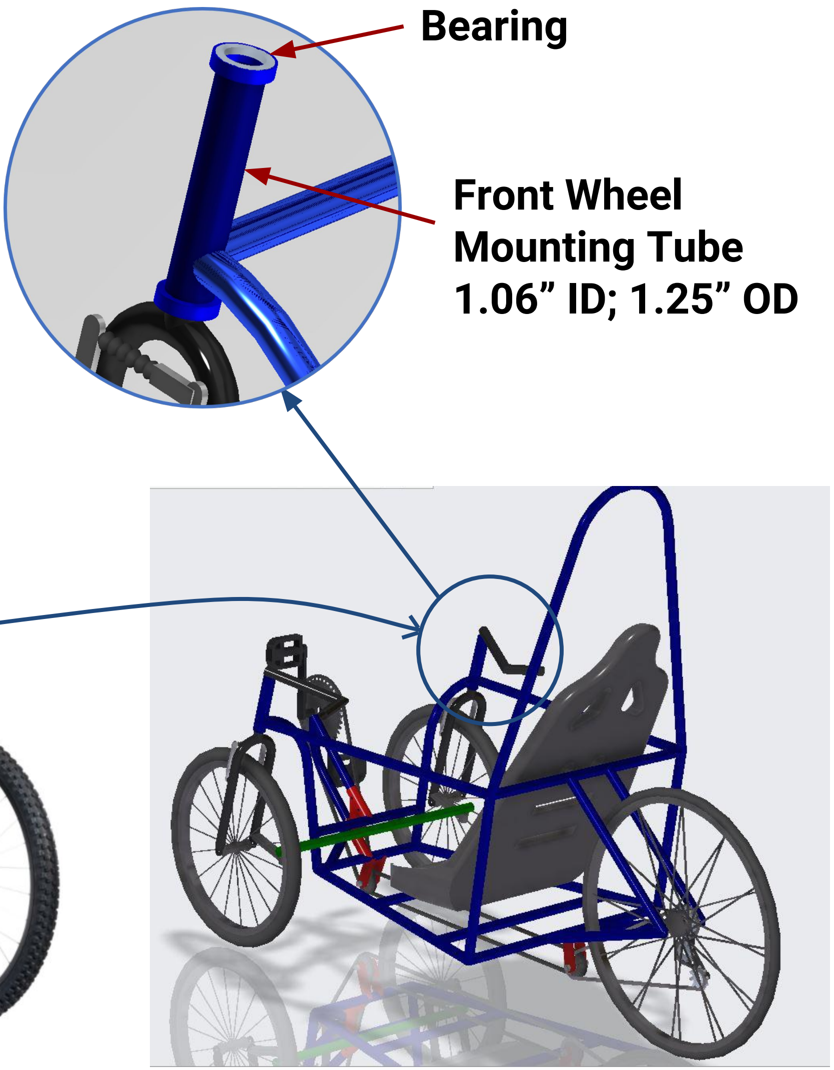
- Maximum stress: 396 MPa
- Safety factor: 1.16



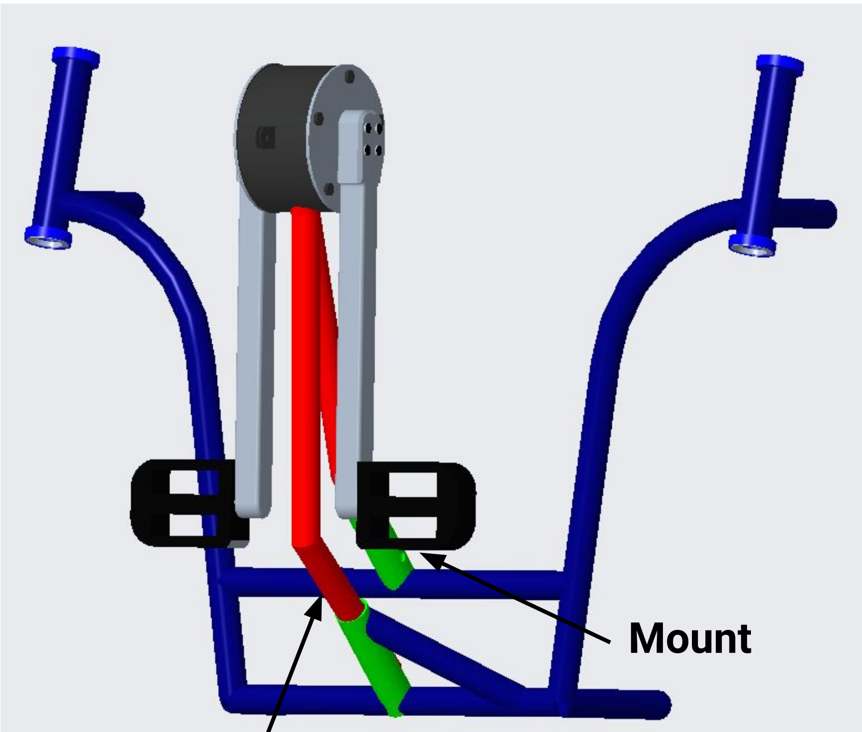
Yield Strength: 460 MPa

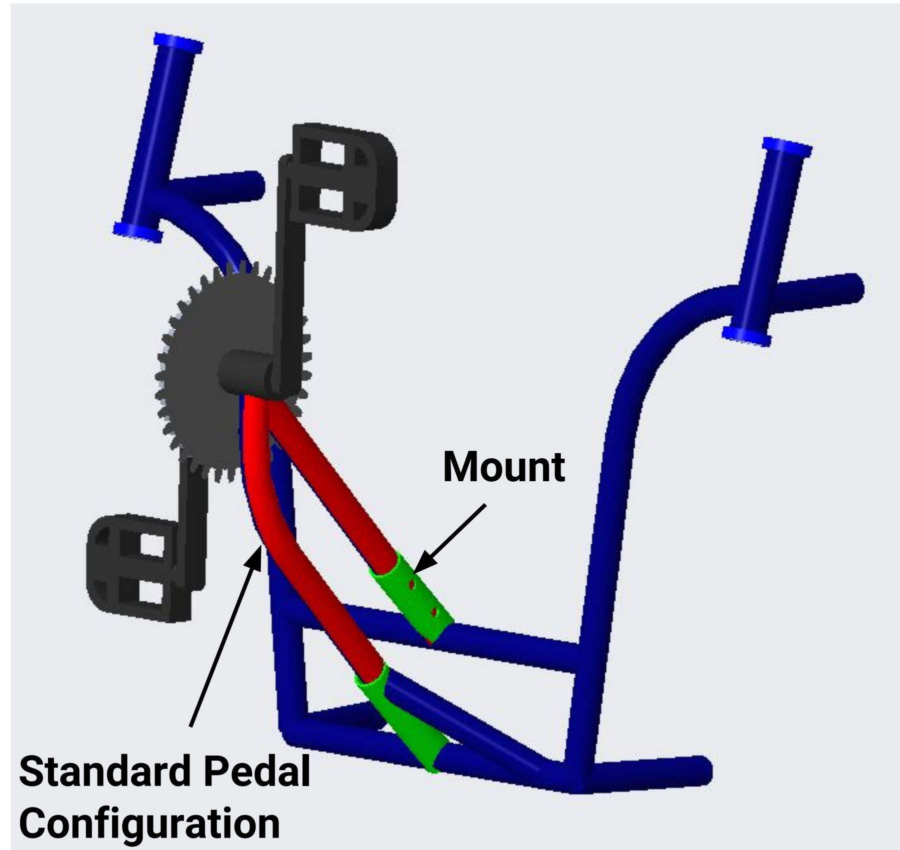
Steering

- Front Wheel Mounts
  - Same dimensions as front pivot tubes of standard bikes
  - Manufactured using 1.25” OD tube with .095” wall thickness
  - Bearing mounts welded on either end
- Tie Rod
  - Creates stability
  - Input from either handlebar can steer vehicle
  - Linkage is 2D and will only require pin joints



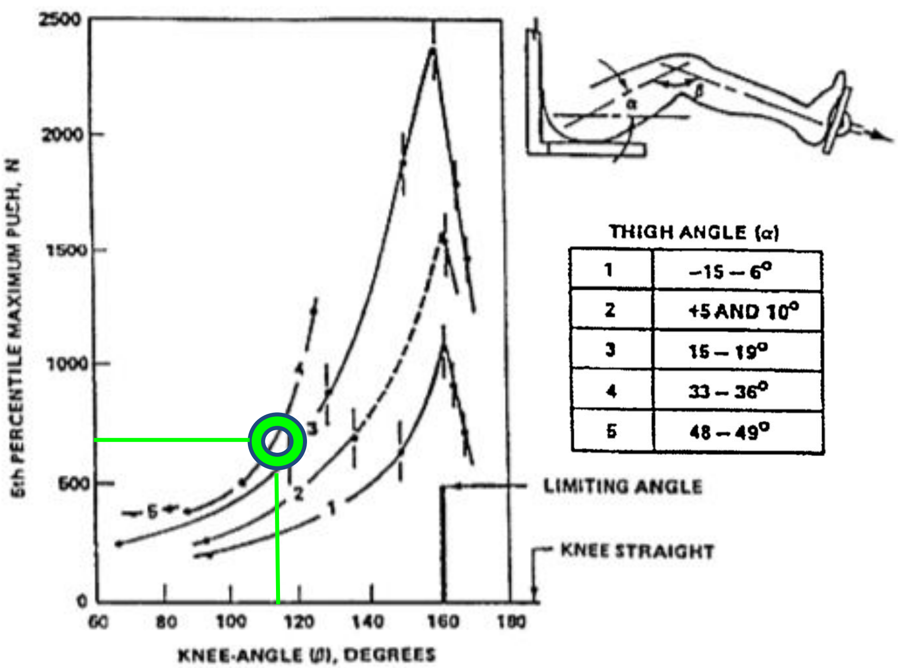
Interchangeable Pedal Mount





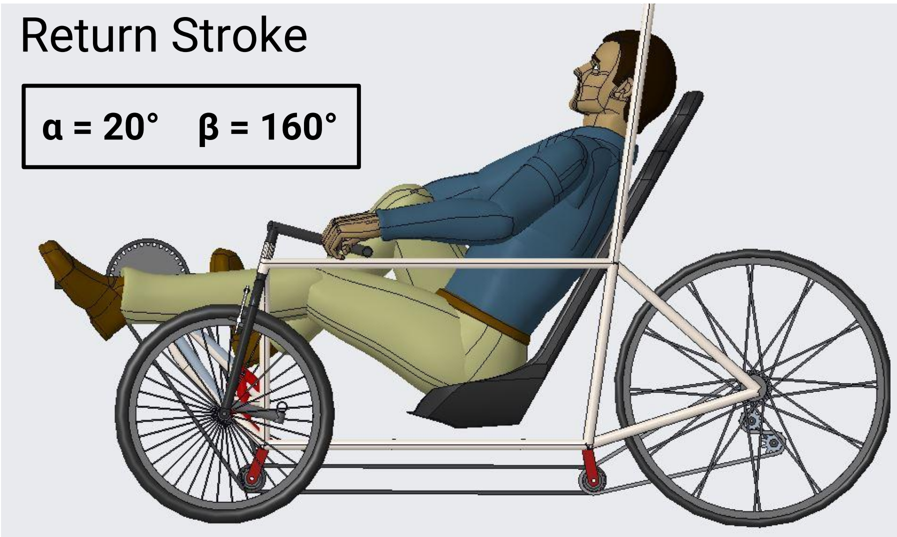
Seat and Rider Positioning

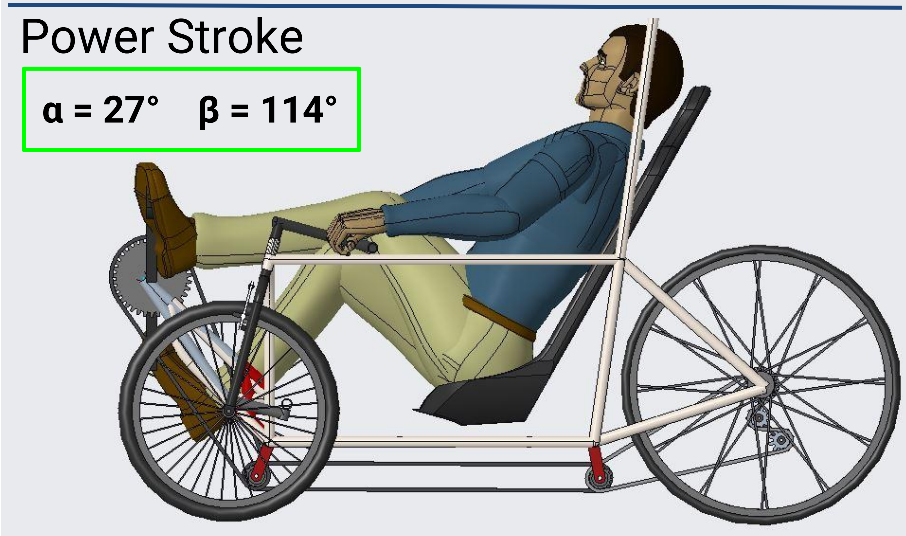
Leg Strength at Various Knee and Thigh Angles
(5th percentile male data) [1]



Goal: Determine seat angle and position for optimum force output during operation.

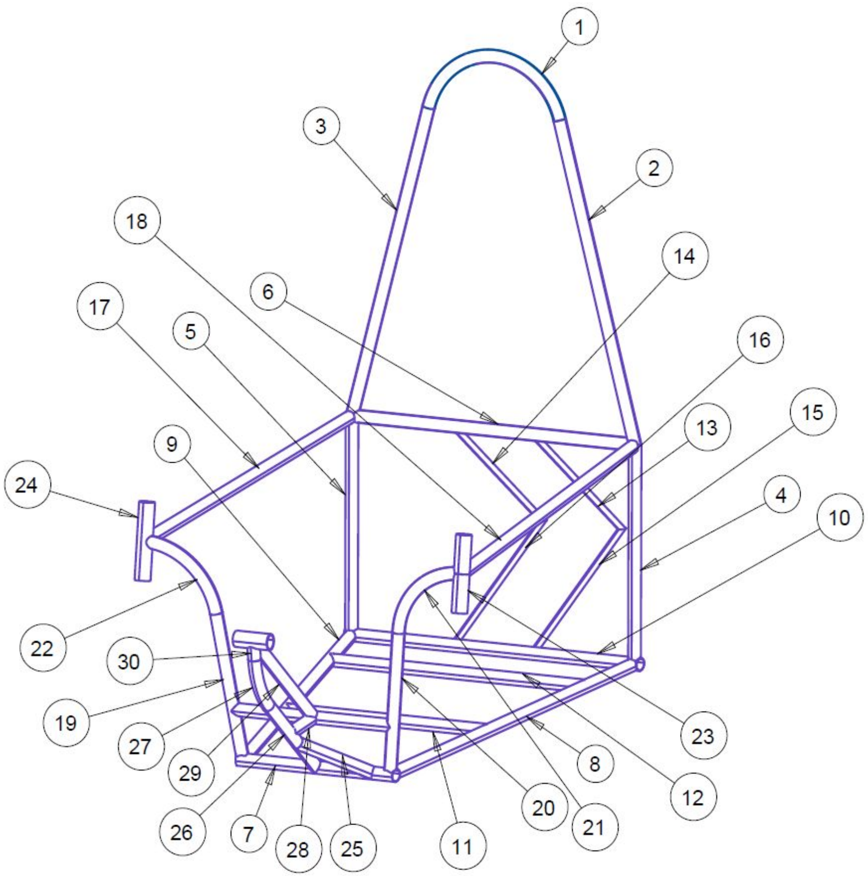
- With an alpha of 27° and beta of 114°, the force output is about 700N (*150lbf*)





Current Progress

- ➢ Ordered and Purchased Parts
- ➢ Generating Drawings
  - ▪ Frame
  - ▪ Tie rod
  - ▪ Wheel mounts
  - ▪ Idler gear assembly
- ➢ Manufacturing Parts
  - ▪ Cutting and welding tube members for frame assembly
- ➢ Budget
  - ▪ Remaining: $125



In The Future

- ➢ Organize Work Performed
  - CAD documents
  - Component FEA analysis
  - Force calculations
  - Evidence book
  - Machined parts
- ➢ Establishing a Legacy
  - Continue to generate interest from EDM students, ASME and SAE club members, etc.
  - Create a solid framework for future club and or recurring senior design project

References

- [1] https://www.product-lifecycle-management.com/download/MIL-STD-1472F.pdf
- [2] https://www.mcmaster.com/#standard-metal-structural-tubes/=1bkgu1k

Questions?