HUMAN POWERED VEHICLE @ UCI

Team Members: Phillip Choi, Alexander Santiago, Edmund Feng, Kazi Hasan, Aldo Khiev, Christian Mason, Christian Ortiz-duarte, Alex Plascencia, Gabriel Sackinger, Daniel Stoll, Peter Tran, Darren Aguilar, Daniel Jang, Anisha Jayaserkara, David Lozano, Sophia Shannon, Amanda Lieng

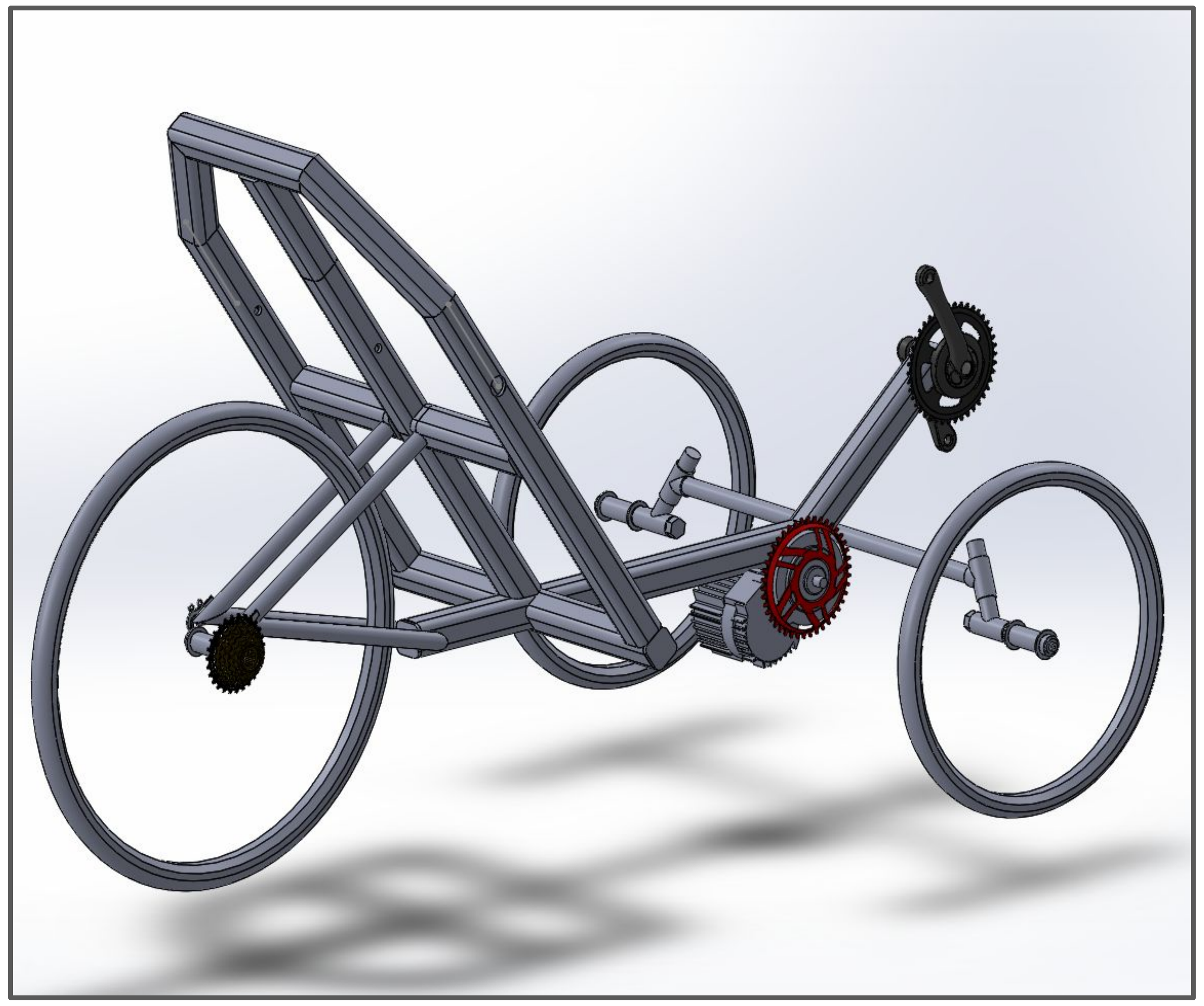
SUMMARY

RATIONALE

- Currently the world is facing the accelerating problem of climate change and today's methods of transportation all use large amounts of fossil fuel energy to operate.
- A human powered vehicle is a low energy, environmentally friendly vehicle which can serve as a new form of transportation in a decarbonized world.
- The American Society of Mechanical Engineers runs a yearly competition for engineering students across the country teams which determines which team creates the best human powered vehicle.
- The leadership of the local branch of the American Society of Mechanical Engineers wanted to create a senior design project which acts as an introduction for new engineers.
- For these reasons, the American Society of Mechanical Engineers at the University of California Irvine created the Human Powered Vehicle Project.

OVERVIEW

- Main Goal: To design an electrically assisted human powered vehicle from scratch that meets the safety and performance criteria of the Human Powered Vehicle Competition. Additionally, the project will serve as a stepping stone for new student engineers to experience the application of engineering principles in a collaborative environment.
- The design of a human powered vehicle can be broken down into three major aspects: Statics, Dynamics, and Electrical. To overcome the overall challenge, each aspect has a dedicated subteam for members to focus on tasks of their expertise.
- As some tasks dip into two or more aspects of the challenge, collaboration and coordination between subteams is paramount to the completion of these tasks and the quality of the results.



CURRENT DESIGN

DYNAMICS

OVERVIEW

- Main Goal: Design and implement an effective drivetrain, steering, and braking system that meets or exceeds HPVC requirements
- Drivetrain components have been selected and will be ordered shortly
- A rear chain drive system will be used with a pedal assisted motor
- Front wheels will be fitted with mechanical disc brakes and a synchronous actuator

Future Plans

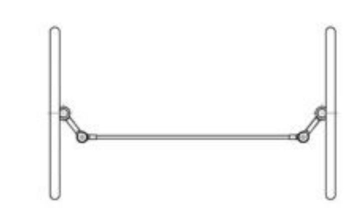
- Create a rig to test and verify drivetrain components
- Test braking system to ensure compliance with HPVC guidelines
- Finalize steering system design
- Implement optimal wheel camber
- Work out any interference with statics and electrical subteams

Steering and Drivetrain

- The drivetrain assembly consists of a front crankset, two intermediate chainrings, pedal assisted motor, and a rear cassette and derailleur.
  - 24/34/42T front crankset
  - Intermediate gears 38/30T
  - 11-32T rear cassette
- Dual 20" x 1.5" front wheels
- Single 700c x 30mm rear wheel
- Indirect steering mechanism consisting of tie rods connecting the wheel to the steering rack

	30.4	41.7 %	43.067	23.5 %	53.2
11	6.0		8.4		10.4
18.2 %					
13	5.0		7.1		8.8
15.4 %					
15	4.4		6.2		7.6
20.0 %					
18	3.6		5.2		6.4
16.7 %					
21	3.1		4.4		5.5
14.3 %					
24	2.7		3.9		4.8
16.7 %					
28	2.3		3.3		4.1
14.3 %					
32	2.0		2.9		3.6

Gear development in meters, intermediate GR = 1.267
Source: Sheldonbrown.com



Tie rod mechanism
Source: Mark Archibals, *Design of Human-Powered Vehicles* (2016)

Braking System

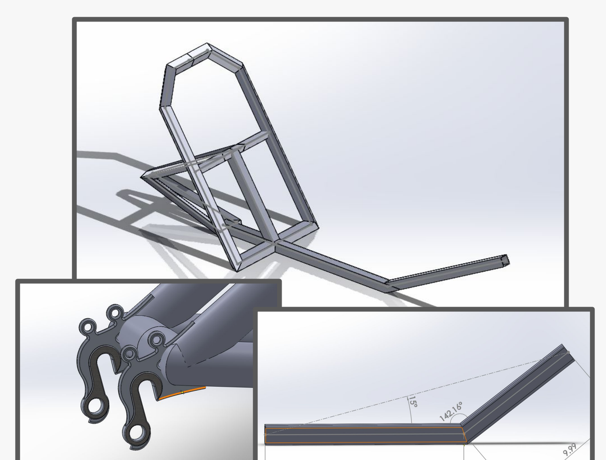
- Mechanical disc brakes (MDB) provide the ideal combination of cost effectiveness, low maintenance requirements, and performance.
- Mechanical disc brakes will be fitted to both front wheels and actuated by a synchronous lever.
  - This provides greater performance and stability while balancing brake force between wheels.

Mechanical disk braking system with dual actuators

STATICS

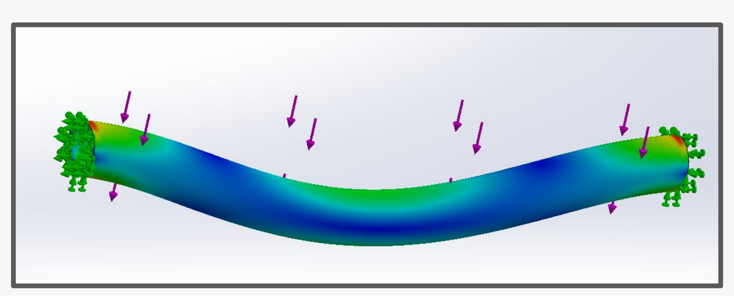
OVERVIEW

- Main Goal: The Creation of a Vehicle frame that can safely protect the rider and integrate electrical and dynamic components.
  - Frame must include a Rollover Protection Bar to protect the rider in case of any falls
- Frame design from the beginning has incorporated human anatomy to maximize rider energy output.
- Planning Phase is extremely close to completion, only minor decisions need to be made.
  - Major Frame choices have been selected, small fine tuning remain such as placement for mounting locations to minimize bending
- Throughout design force analysis were done to ensure safety requirements were met

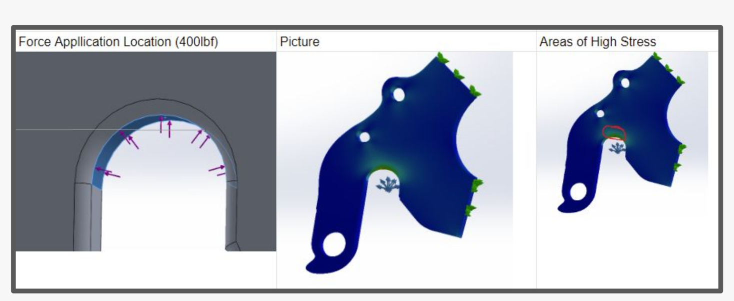


Various portions of the frame in SOLIDWORKS

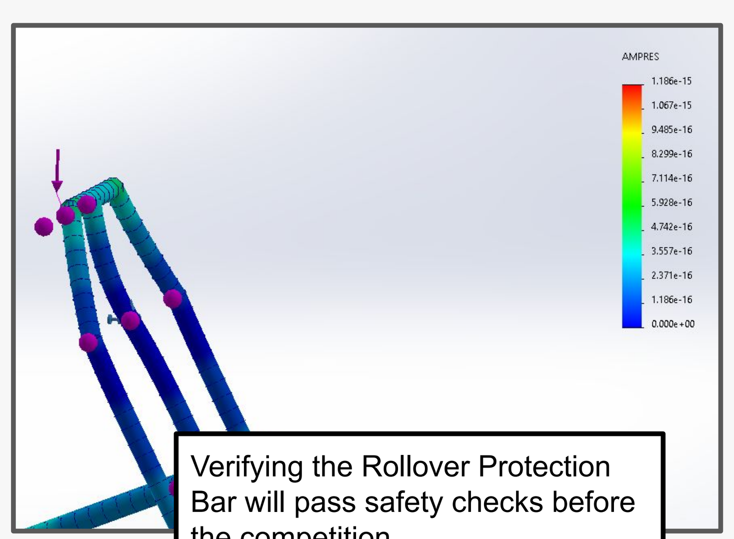
Various Finite Element Analysis Performed by the Statics Team to Test Safety and Design Integrity



Testing the strength of different bar Geometries to find out best shape and size to use for the frame



Verifying dropouts can hold the worse case load on the frame

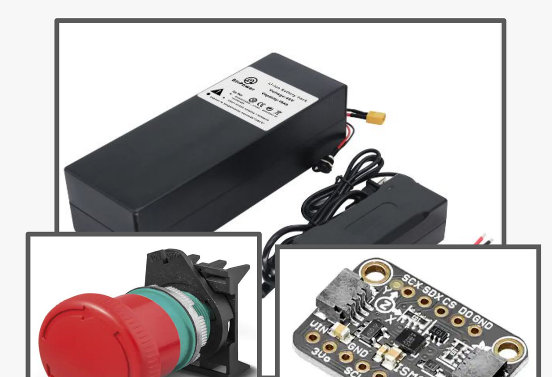


Verifying the Rollover Protection Bar will pass safety checks before the competition

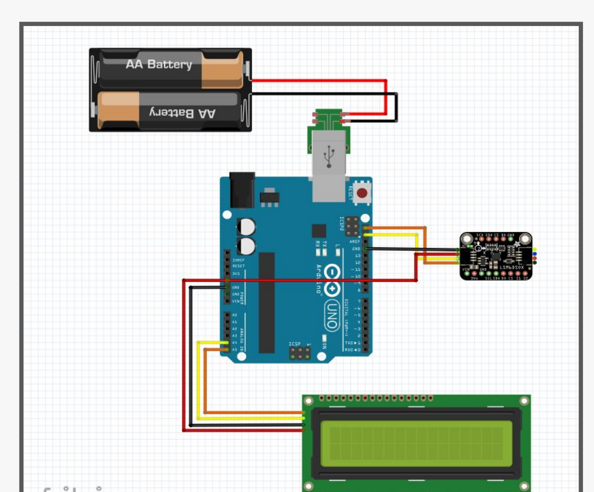
FUTURE PLANS

- Work with Electrical Sub-Team to integrate their components into the design
- Begin Manufacturing the Frame
  - Ordering Materials
  - Verify Part Geometries
  - Create a RPB with PVC to certify our design meets the ASME requirements
  - Decide the seat and create mounts on the frame
  - Run FEA on any new additions
  - Build the Frame in real life

ELECTRICAL



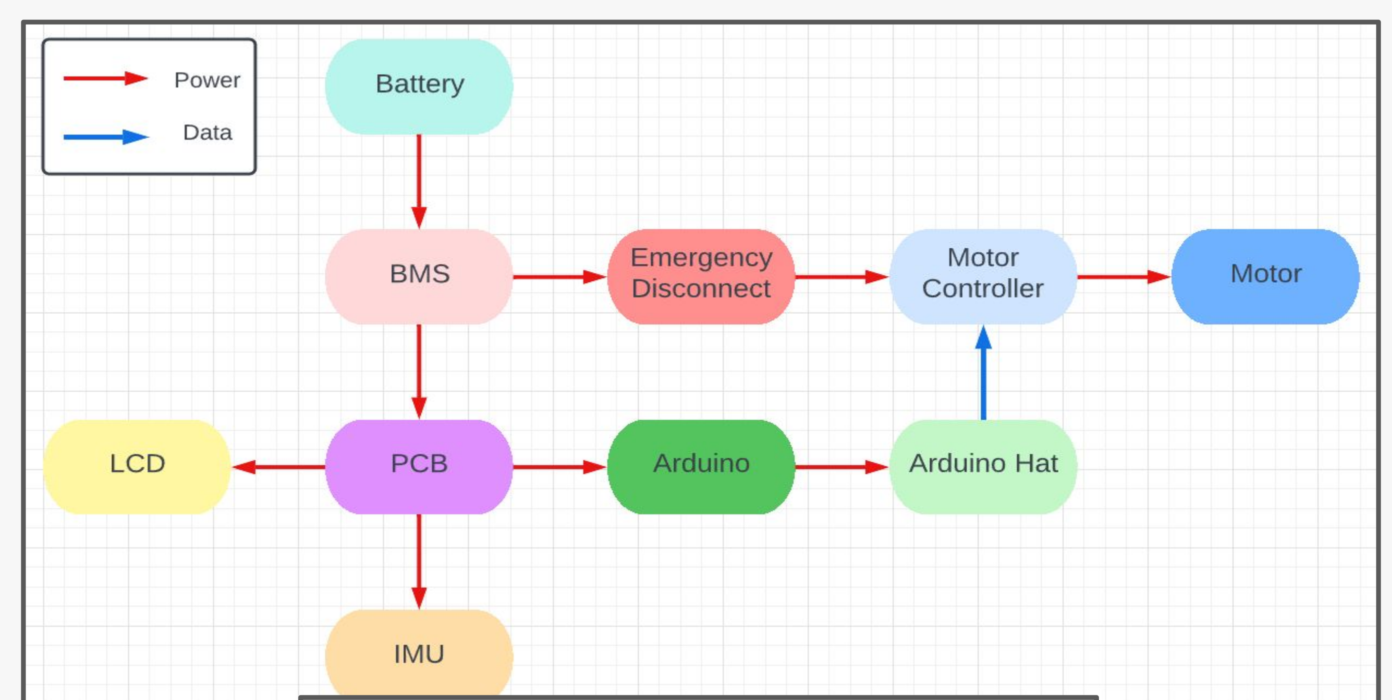
Battery for powering electronics (top) Switch for emergency disconnect (left IMU for positional information (right)



General wiring diagram for auxiliary components. (IMU and LCD display)

OVERVIEW

- Main goal: Safely power and control the bike's motor. Provide useful sensor data to rider on LCD display.
- The electrical subteam has primarily focused on components research and selection.
  - Arduino Uno, Emergency Disconnect Switch, Inertial Measurement Unit (IMU), Battery, Motor, LCD display, PCB
- The planning phase has been completed with component research, selection, wiring diagrams, and layout.
- The key objective for this quarter was to communicate and coordinate with Statics and Dynamics subteams' design decisions.
  - Battery choice depends on selected motor, LCD size dependent on frame design, etc.



High level connection diagram of Electrical Subsystem components

FUTURE PLANS

- Completing the 'Detailed Design' is the goal.
  - Incorporating components into other subteam designs.
  - Begin prototyping and testing next quarter.
- Ordering and receiving parts, beginning testing peripheral components.
  - Focus on auxiliary components until more information on motor implementation is known.