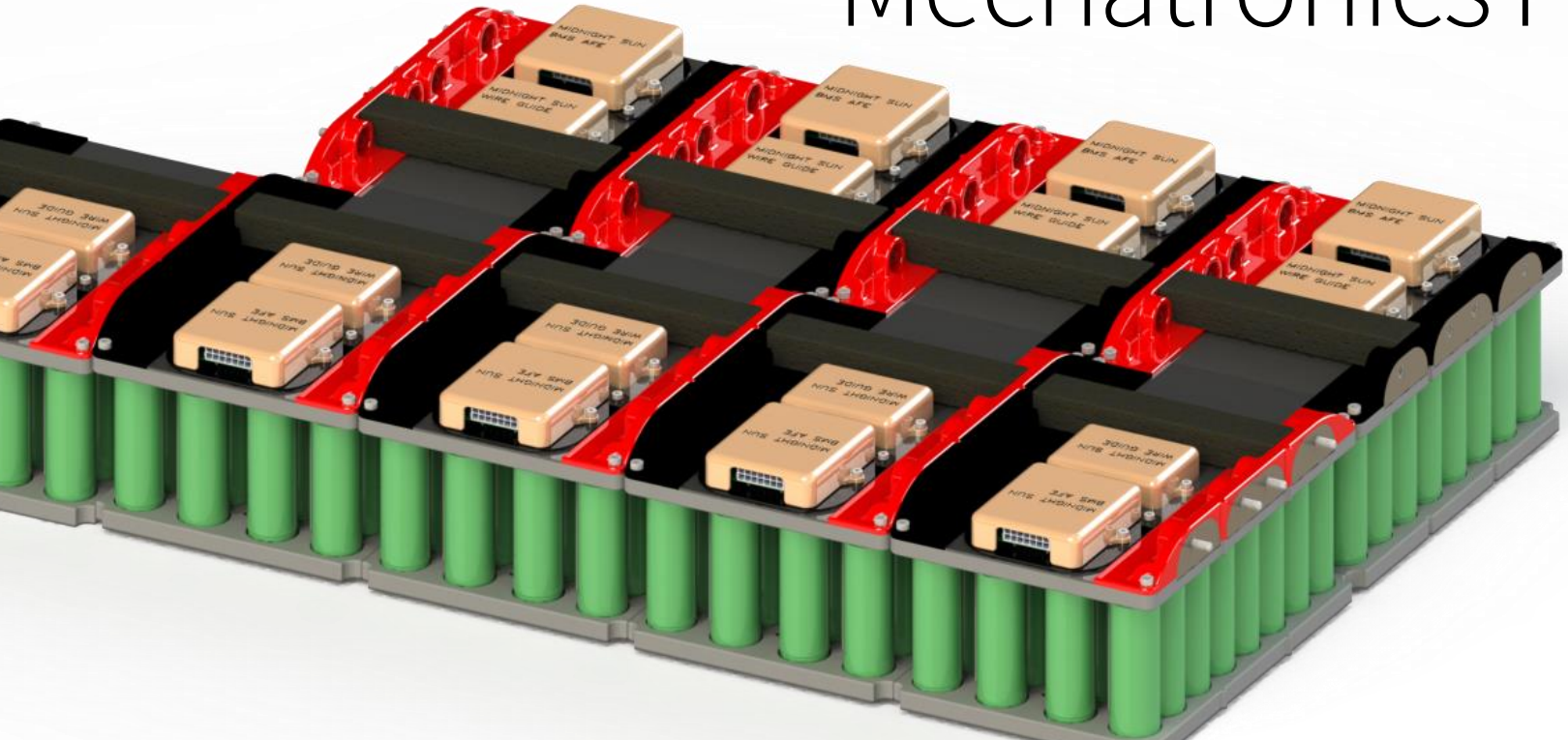
# Eric Zhao
# Mechatronics Portfolio

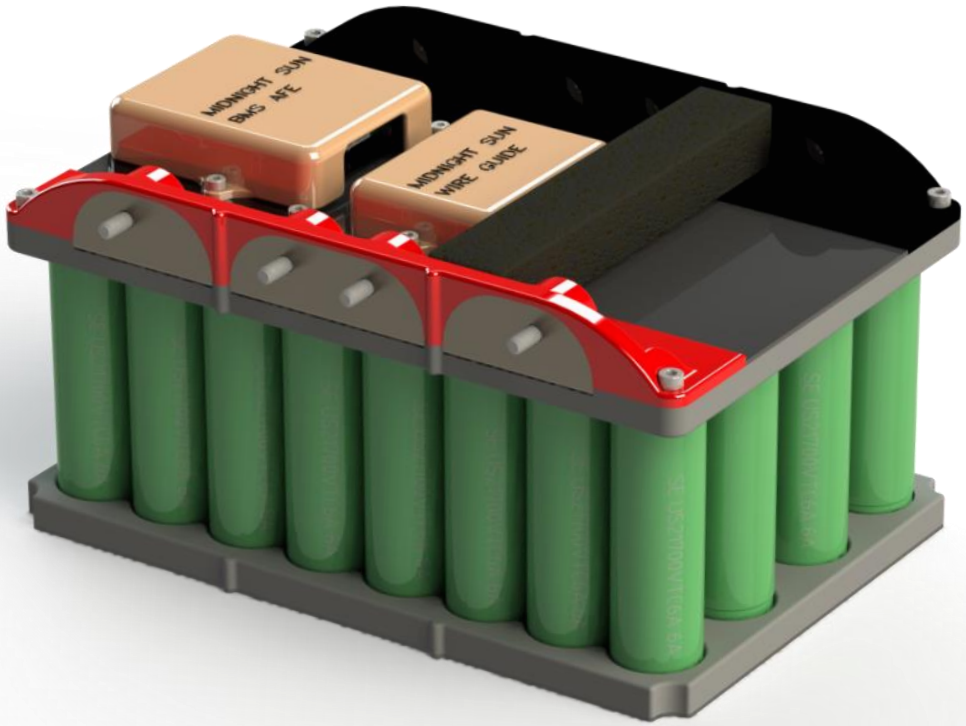


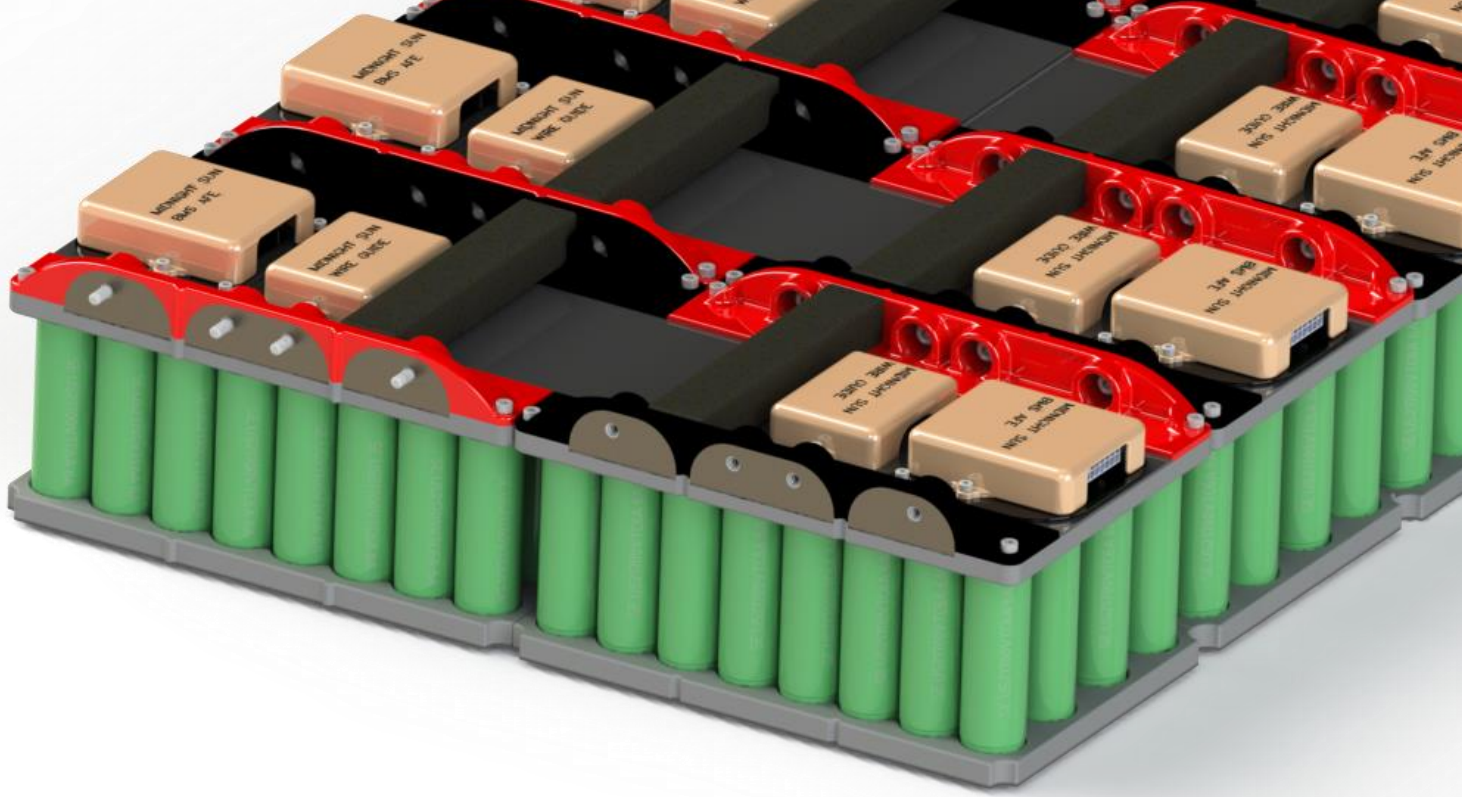
University of Waterloo
May 2021

résumé

# Battery Module Design

Skills used: SOLIDWORKS, Spot Welding, PrusaSlicer



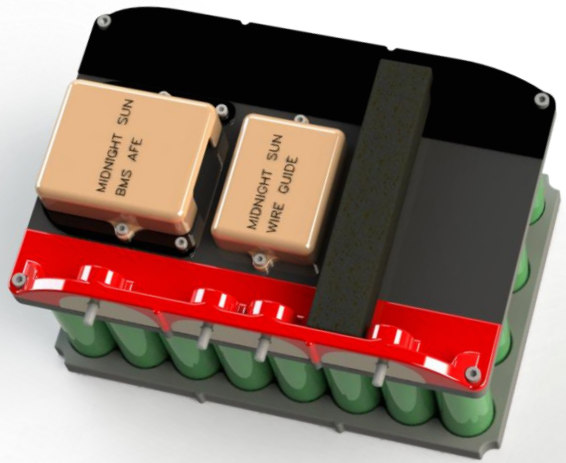
Summary: I am currently leading the design of new battery modules for Midnight Sun's next solar race car, set to compete in ASC2024.

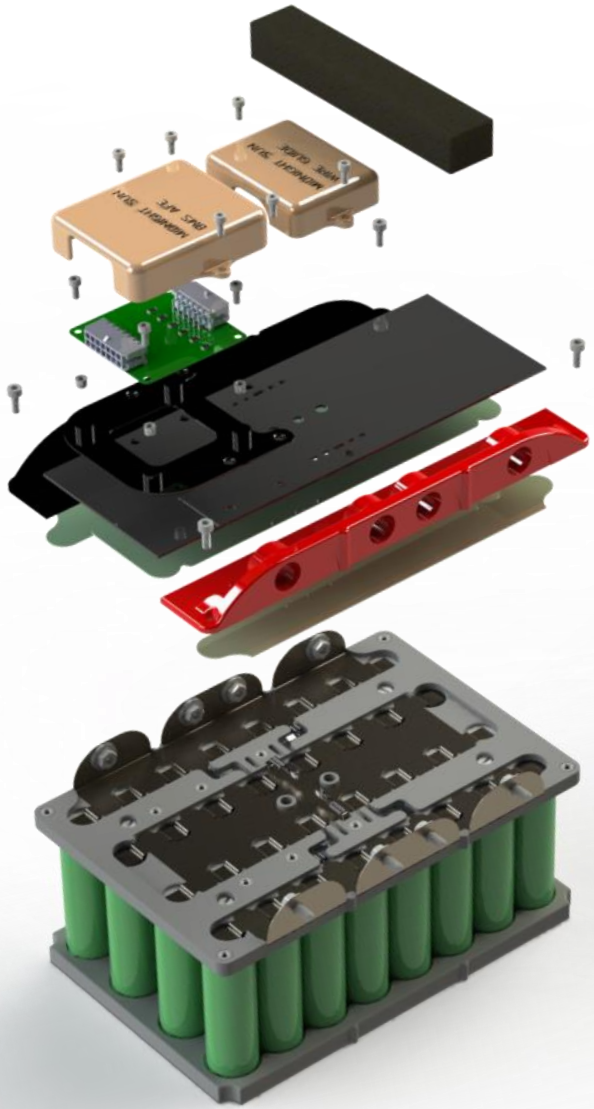
Shown is my current module design, utilizing 21700 sized lithium-ion cells. Each module contains a 4S8P cell configuration. With 9 of these modules assembled in series, the full 36S8P pack will be able to provide up to 5184Wh of energy at 90 to 151.2V.

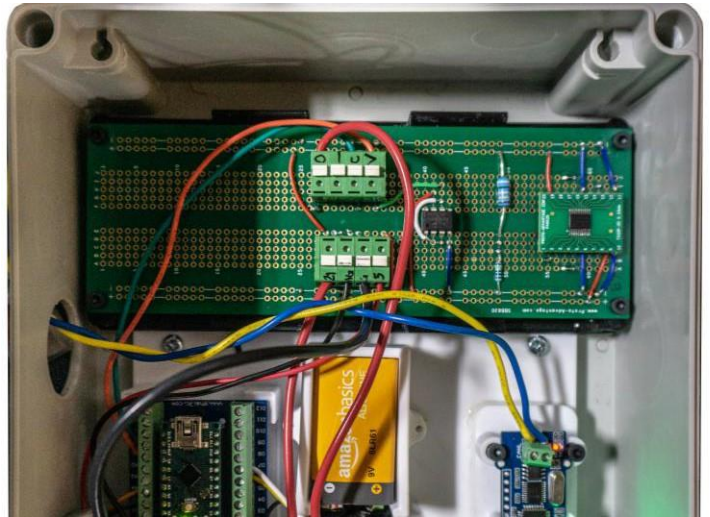
Each module contains 5 thermistors distributed throughout to continuously monitor the temperature distribution of the battery pack.

Nickel strips and Sigma Clad 60 are spot welded together for a balance between weldability and electrical conductivity.

Busbars are designed with two crimp connections to allow for accurate BMS voltage readings utilizing remote sensing.



# Electric Vehicle Battery Status Monitor

Skills used: Fusion 360, C++, Arduino

Summary: I designed and built a circuit to monitor and display the state of charge, voltage, and current draw of a high voltage system. Using a Serial CAN module, I was able to mask, filter, and decipher extended CAN bus messages transmitted by an electric dolly.

I mounted the system with a custom emergency stop box for easy monitoring, reset, and shut-off of the high voltage system.

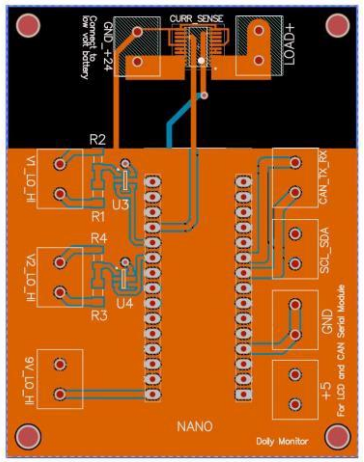
# Status Monitor PCB

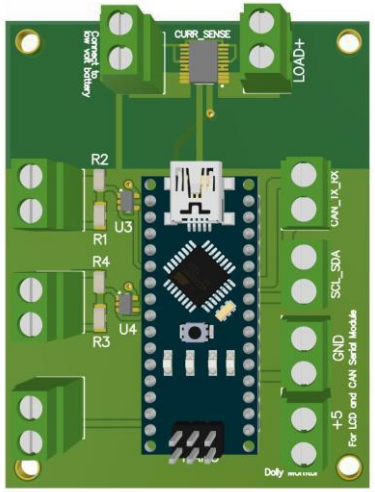
Skills used: CircuitMaker, Soldering

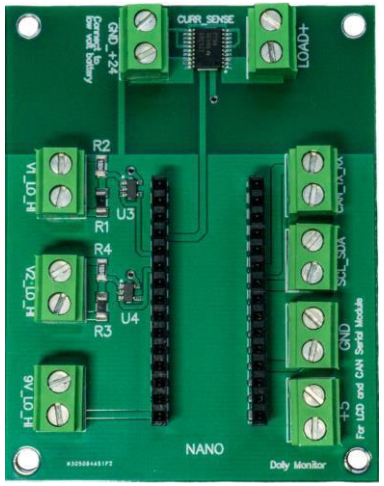
Summary: Utilizing the design of the Electric Vehicle Battery Status Monitor, I was able to create and order a custom PCB to perform the same functionalities at a smaller cost.

The circuit can measure and scale voltages from up to 50V down to appropriate Arduino analog signals with a resolution of 49mV.

I also researched and ordered appropriate current sense amplifiers and shunt resistors to measure up to 12.5A of current with a 12mA resolution



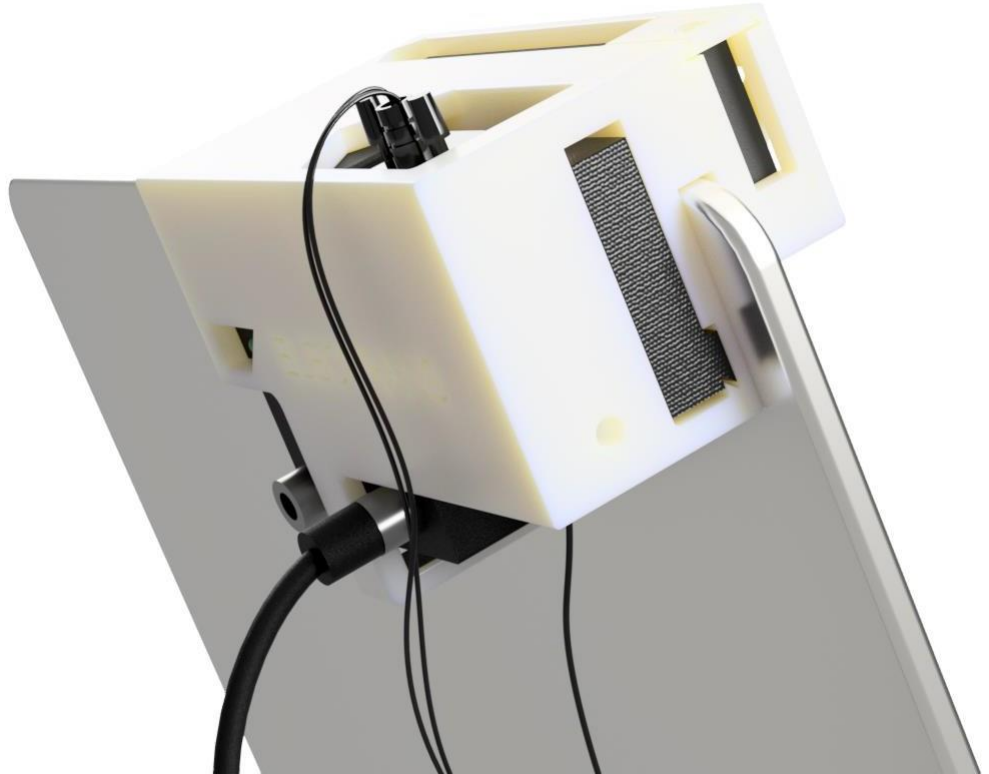



# Mobile Hardware Mount

Skills used: Fusion 360, Ultimaker Cura

Summary: I designed and 3D printed this mount to compactly secure multiple communication devices for mobile testing.

It was able to hold a DB9 CAN bus connector, a Bluetooth CAN bus transmitter, an USB hub, and a protoboard with soldered terminating resistors to the back of a laptop.

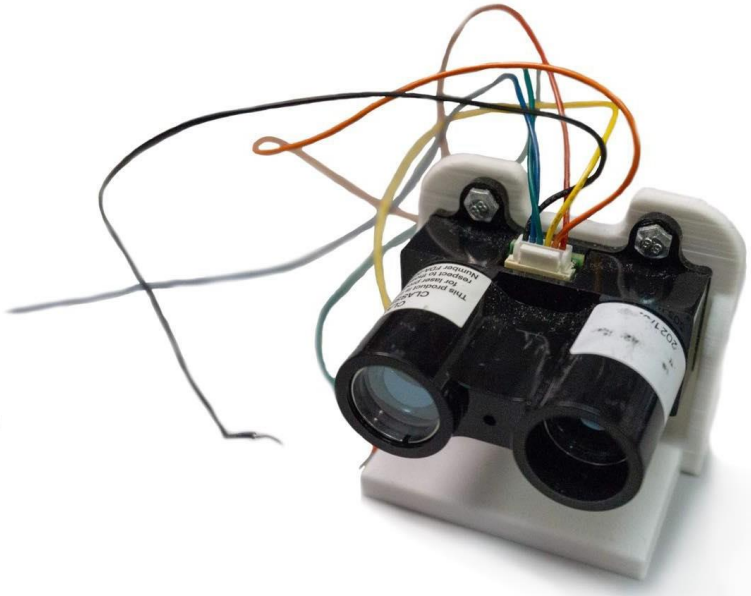


# Distance Sensor Testing Rig

Skills used: Fusion 360, Excel, C++, Arduino

Summary: I constructed a sensor testing rig using two tripods, aluminum extrusions, and 3D printed auxiliaries. The testing rig was used to mount, test, and collect data on a variety of distance sensors from a selection of ultrasonic, infrared, and LiDAR sensors.

The testing rig was able to test sensor orientations with up to 1 degree precision.



# Misalignment Detection System

Skills used: Fusion 360, C++, Arduino

Summary: Using the sensor testing rig, I selected and used two infrared time-of-flight distance sensors to develop and build a system for measuring the misalignment between two commercial vehicles.

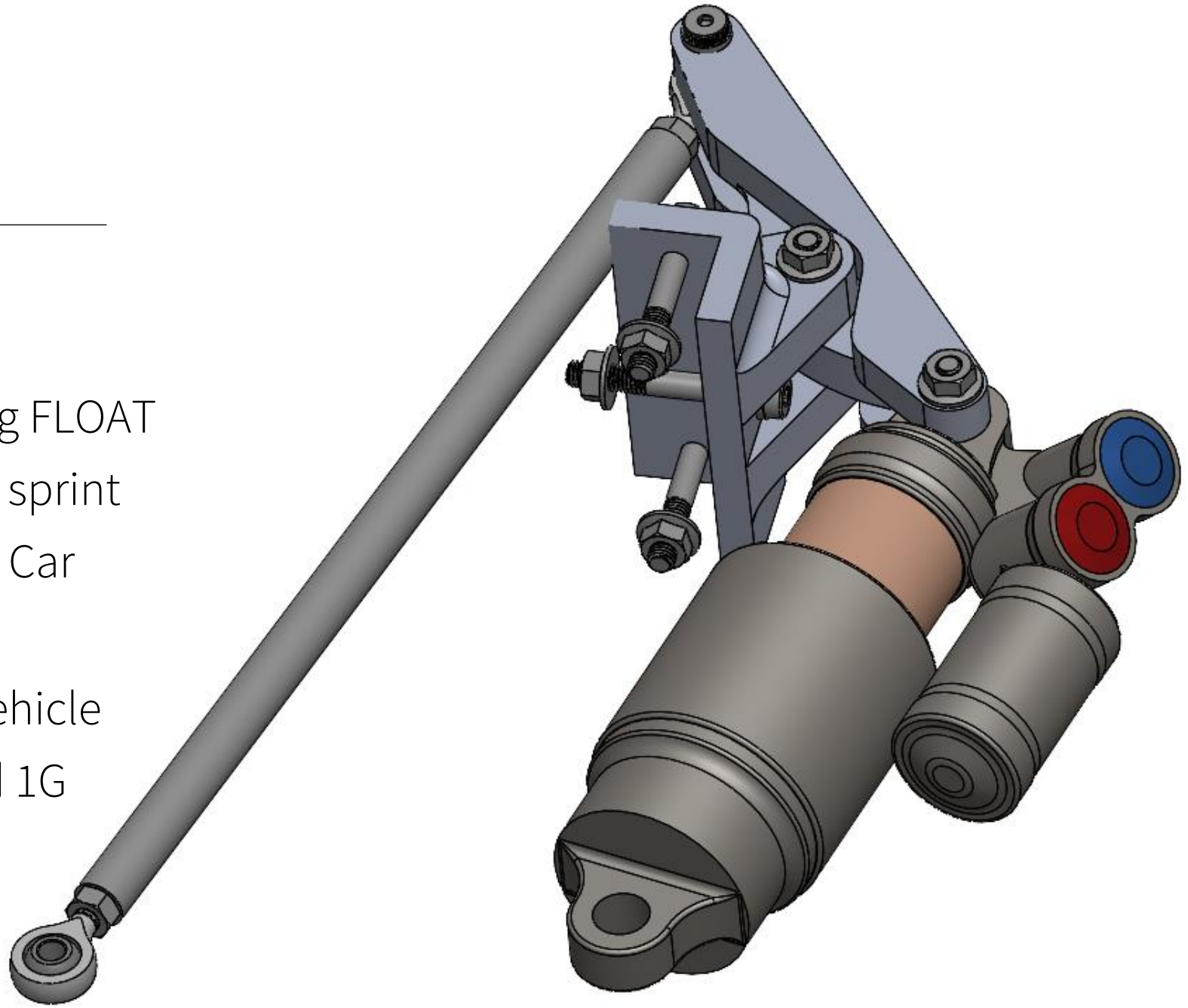
The system was able to detect angles with up to 1.4 degrees of accuracy. A LED display was created to simulate signals showing commercial vehicle drivers how to adjust their vehicles.

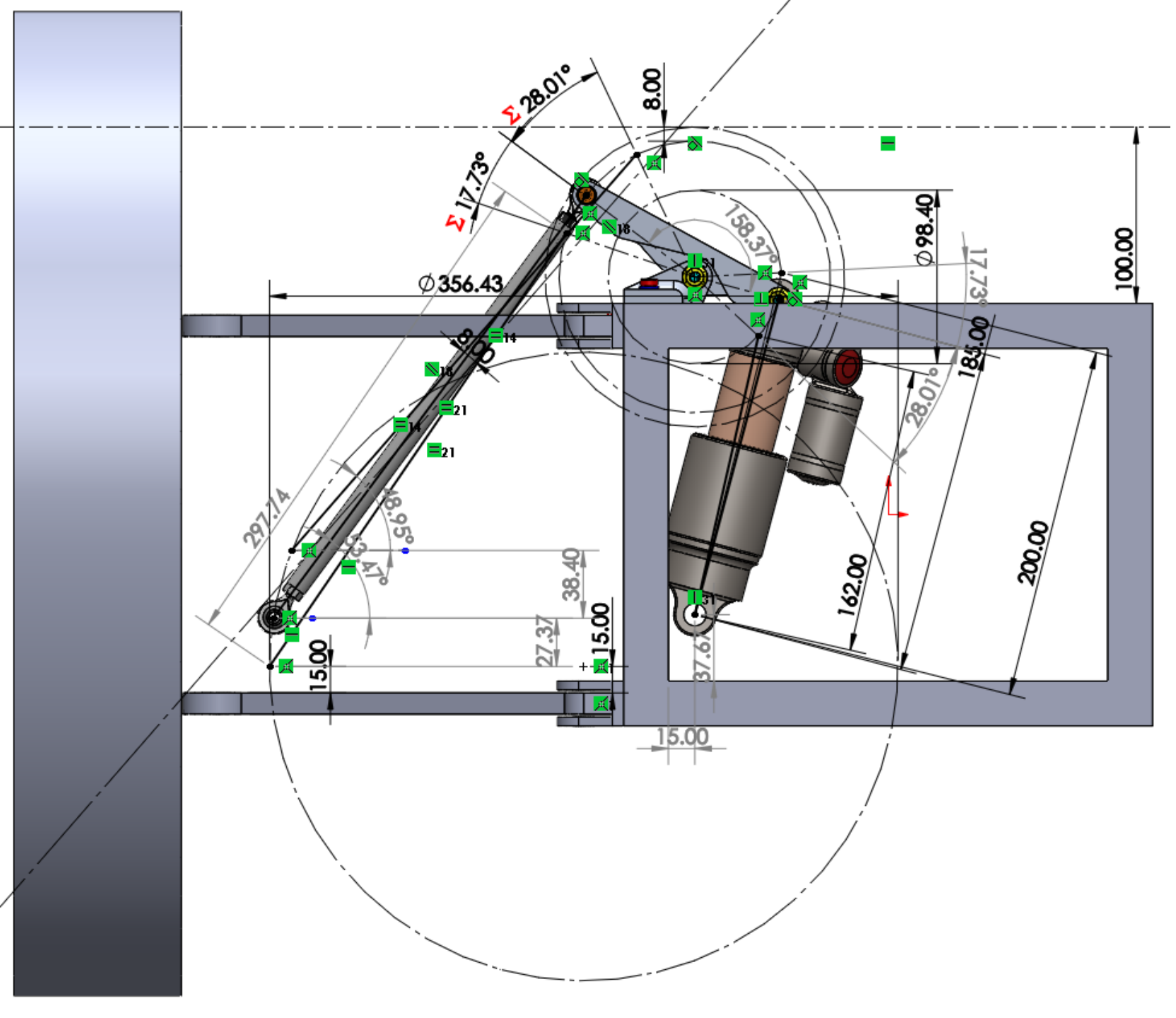
# Basic Pushrod Shock Design

Skills used: SOLIDWORKS

Summary: A basic pushrod suspension assembly utilizing FLOAT X2 shocks, made for a design sprint based on the American Solar Car regulations.

Designed for a 192kg mass vehicle with a 1G turn, 2G bump, and 1G braking force.





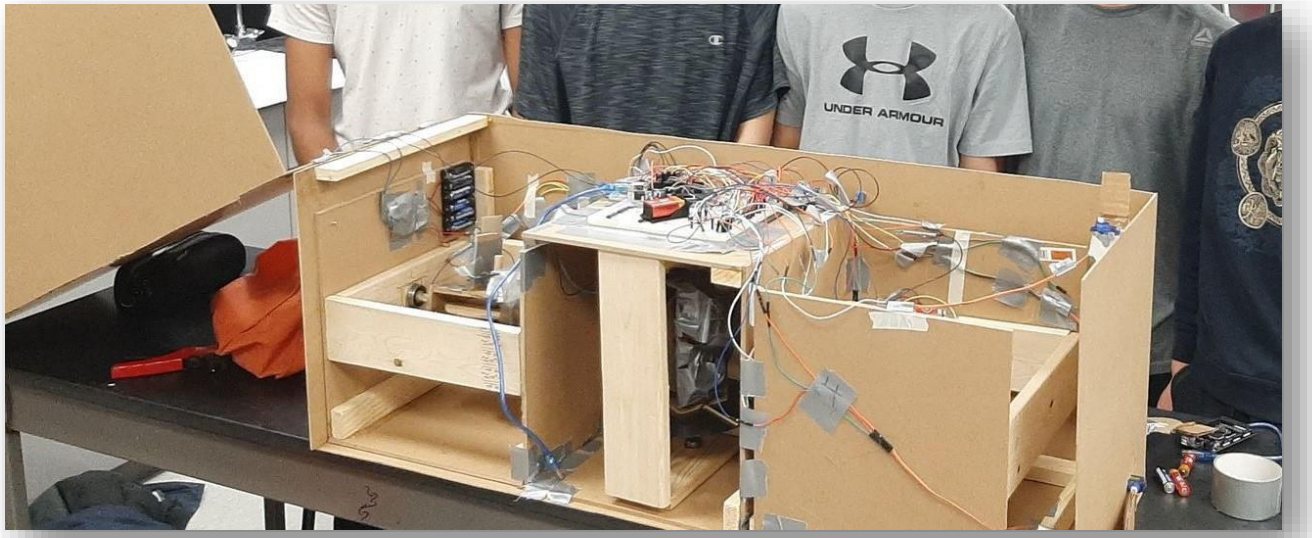

Part of the design process was to define a sketch according to the given parameters to help visualize  the suspension movement at a variety of pushrod lengths.

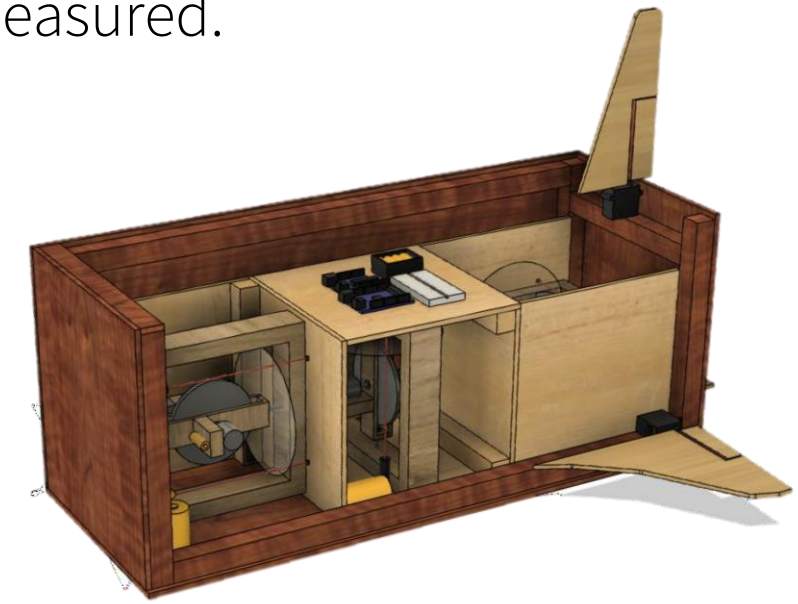
# POLARIS 🔗

## Rudimentary Spacecraft Guidance System

Skills used: Fusion 360, Arduino, machining and hand tools, soldering and wiring

Summary: Three single-gimbal gyroscopes were built to find a model spacecraft's orientation in space. By shining lasers through circular gradients attached to the gimbals of each gyroscope, and analyzing the light intensity of each laser, the spacecraft's rotational position around the 3 axes was measured.



## Flight

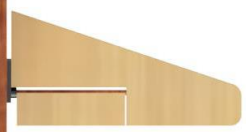
As humanity explores the frontier of space, SAJER continues to demostrate cutting edge innovation and design for spaceflight - the unifying force between the world.

## Control

To go where no one has gone before requires more than just power—it is essential to fly with stability and precision. POLARIS detects rotation in all three spatial axes, to calculate and set appropriate fin positions to correct a craft's path.

## Design

The driving principle behind POLARIS is the use of lasers. Shot through a conical gradient, the perceived intensity on the other side is proportional to the sheet's angle of rotation. By attaching this gradient to a free-rotating gimbal around the gyroscope and shooting a laser through towards a photoresistor, POLARIS accurately determines the system's angle of rotation.

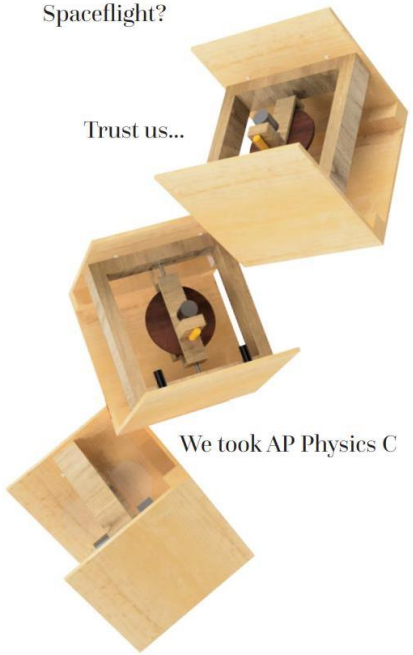


Designed by SAJER in Toronto
sajer.com

POLARIS

Spaceflight?

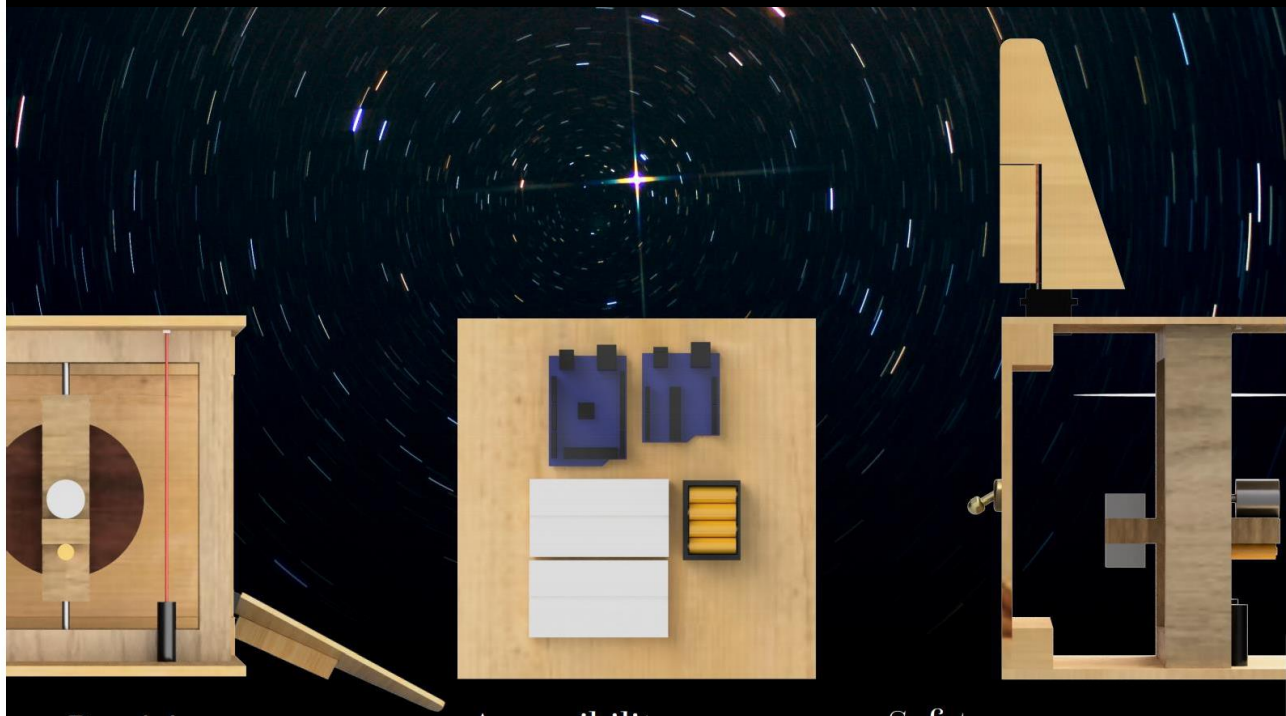
Trust us...



We took AP Physics C

# POLARIS

Precision Optical
Laser-Based Aeronautical
Rotation Information System



## Precision

POLARIS reads rotation up to a resolution of 5 degrees in all three axes of rotation. In complete, implemented, and calibrated systems, this value is expected to become even more precise. Four sets of servo controlled fins react to every read movement, ensuring your path stays true.

## Accessibility

The POLARIS system relays rotational and technical data to an external display, allowing you to easily ensure the system is functioning at the proper level. This information can be conveniently displayed using the given software, providing graphs to visualize your every need.

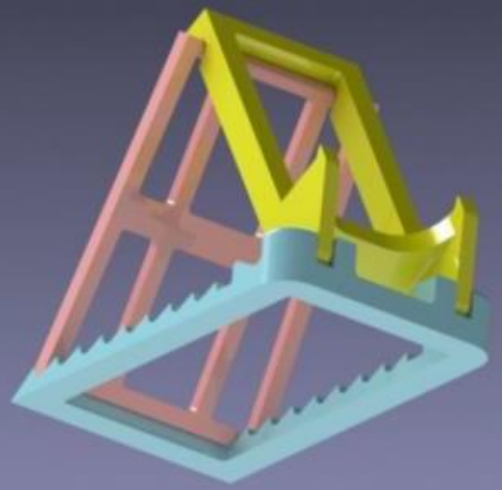
## Safety

Designed with safety in mind, the entire POLARIS system may be turned on and off with ease, using externally accessible switches. The use of individual, modular circuits rather than a large combined circuit minimizes the risks of laser diode burnouts or dangerous high voltages.

# Pamphlet Design

uPhone Stand XX Plus

Stability. In every way.



Eric Zhao
November 24, 2020

# Foldable Phone Stand

Skills used: SOLIDWORKS, GrabCAD Print

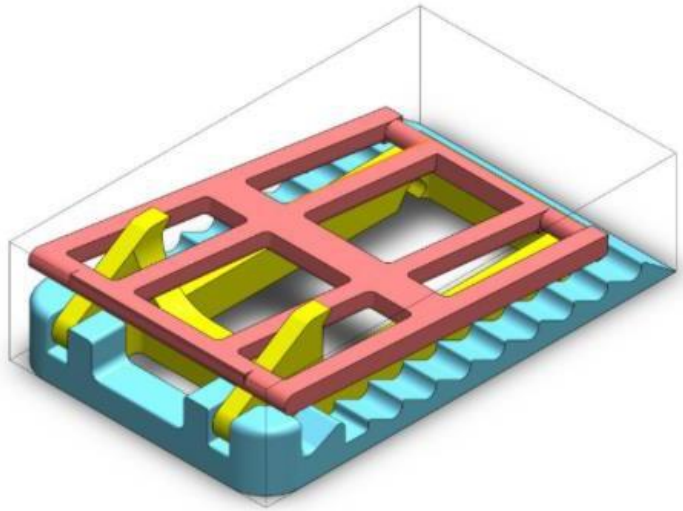
Summary: I designed a 3D printable phone stand that can hold a phone at 8 different angles with room for a charging cable. I optimized the design for 3D printing in GrabCAD Print and was able to make a 3D print which I still use today.

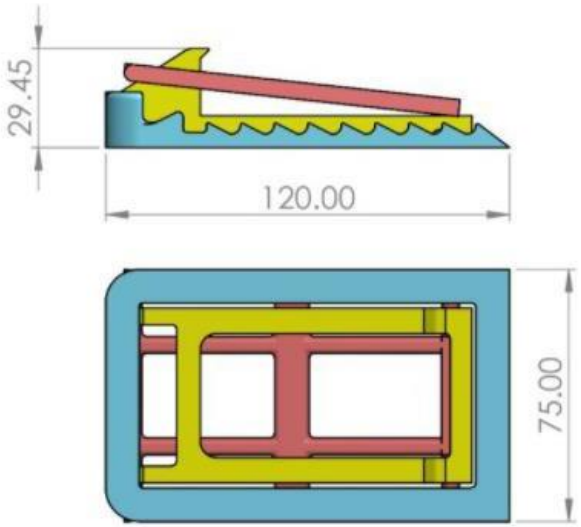
The assembly can be collapsed to fit into a 75x120x30 mm box for shipping or storage.

Easy to use.

Simple to disassemble.

Small to carry.

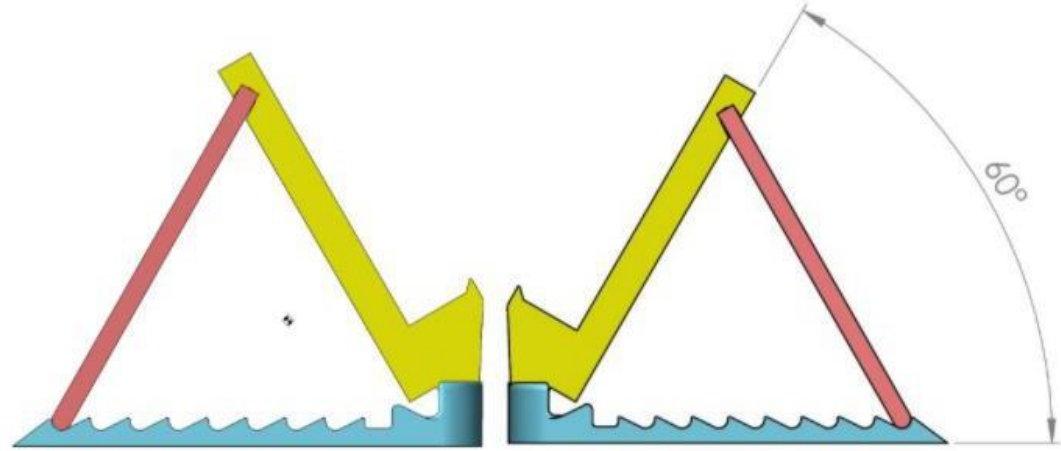


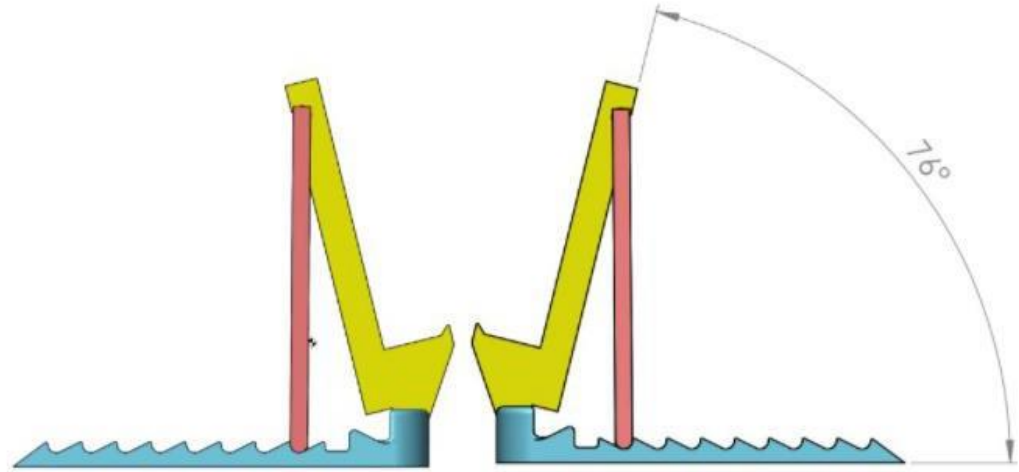



8 angles.

16 degrees.

1 Phone Stand.



# Connection Port

Skills used: SOLIDWORKS, Confluence, GrabCAD Workbench

Summary: The connection port of Midnight Sun's 14th solar race car required a redesign, as the original hinged lid did not work. I created an entirely new port housing and cover, converting the hinged design into a 3D printable sliding cover.

The port housing prints in 3 separate pieces: The port housing, the sliding cover, and a glue-on piece which secures the cover, ensuring it doesn't completely slide off the housing.

The design process for the lid included a back-and-forth feedback cycle between the Interiors team lead and me to optimize the design for 3D printing and assembly. I documented the entire design process onto a Confluence page for the Midnight Sun Solar Car Team.

Part of the design includes a “soft lock” mechanism which ensures the lid stays closed through the vibrations of the car. There is just enough clearance for the rail to slide over the hump, providing a soft click when the cover has been pushed to the end.

# CC Connection Port

EZ

Created by Eric Zhao
Last updated less than a minute ago • 7 min read • 2 people viewed

**Intro**

The side of the catamaran cover will have a port that houses the connectors we need such as USB-C fo
phone charging and CAN debug outputs. @Renzo Villanoy originally designed a port housing and c
be 3D printed but the design for the hinge had some issues that needed to be improved upon. The go
this mini project was to find a redesign for the port cover and housing that is able to meet all the
requirements and is easy to use.

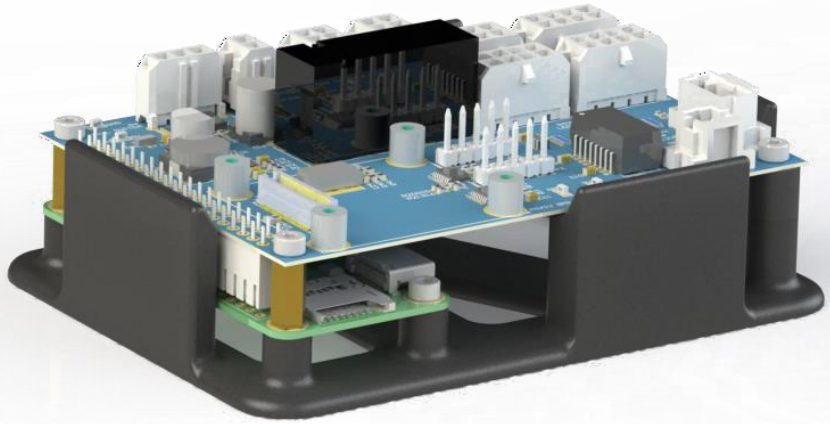
**Requirements:**

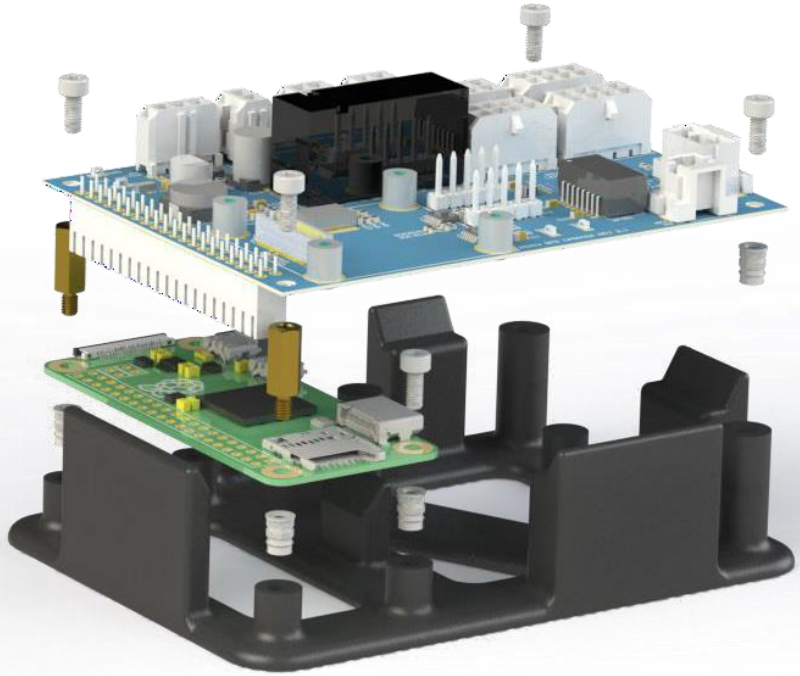
- Outer dimensions do not ch
- Must be 3D printable, the simpler

# PCB Mounts

Skills used: SOLIDWORKS, Altium 365, GrabCAD Workbench

Summary: In order to secure the newly designed printed circuit boards for Midnight Sun's 14th solar car safely, I was responsible for designing mounts for 9 different boards. Altium 365 was used to pull the most recent board versions into SOLIDWORKS, where personalized board mounts were created for each of the new boards.





I also performed research into heat inserts, designing the mount standoffs so that heat inserts can be used to provide threads for fasteners.

GrabCAD Workbench was used to sync up my designs with the rest of the project, allowing for easy collaboration of work on the Midnight Sun solar car.