Formula SAE

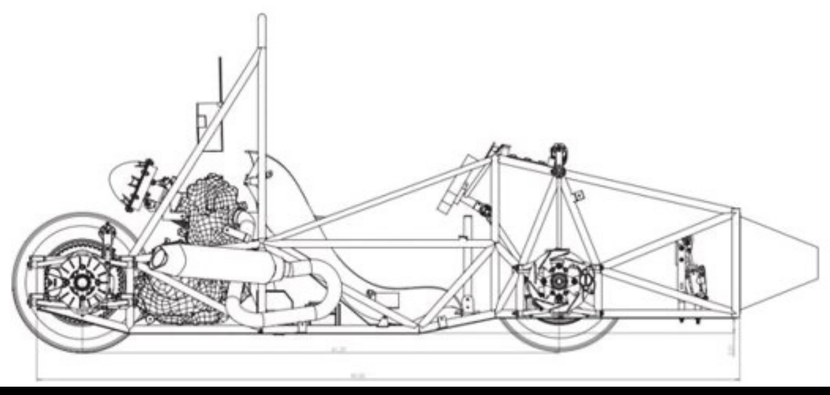
Team Members: Henry Amador, Steven Lim, Kyle Misa, Uriel Perez Mora, Jessica Plascencia Magdaleno, Cesar Ramirez, and Leonardo Sanchez
Faculty Advisor and Liaison: Dr. John Chris Bachman
Departments of Mechanical Engineering and Electrical & Computer Engineering
College of Engineering, Computer Science, and Technology
California State University, Los Angeles

Introduction

Formula SAE is an international competition requiring students to design and build an open-wheel race car. The vehicle design and build was separated into the following subsection: drivetrain, powertrain, rear suspension, and electrical, with a team lead focusing on system integration. The engineering design process was undertaken to complete the project. The final design consisted of a 4-wheel vehicle powered by a single cylinder KTM 690 engine, independent pushrod suspension, chain driven differential rear wheel drivetrain, plenum and air stack air intake, data acquisition system measuring engine's speed(RPM), transmission's gear position, and engine temperature.

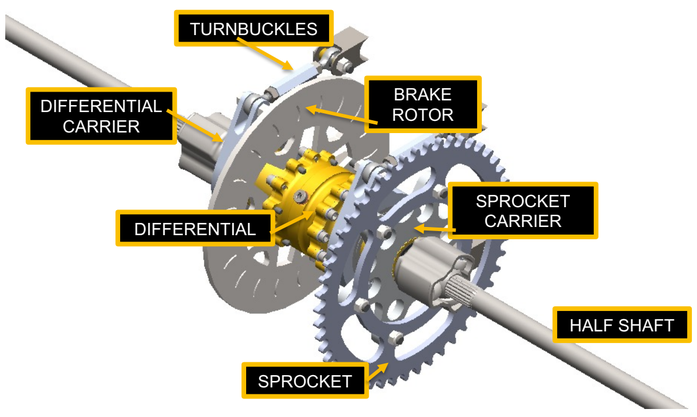
Objective

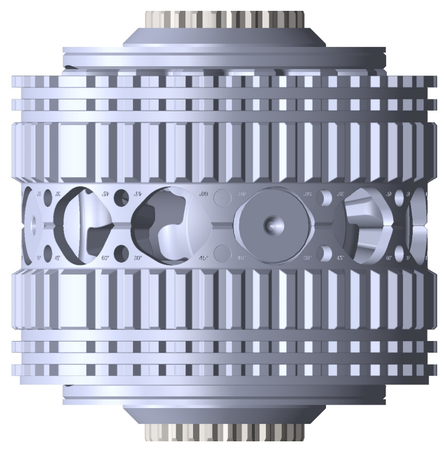
The Senior Design team worked alongside the Cal State LA Formula SAE team to whose goals are design and manufacture a vehicle that will weigh under 450 lbs, have a weight distribution of 45/55 and finish in the top 20 for the 2021-2022 competition.



Drivetrain

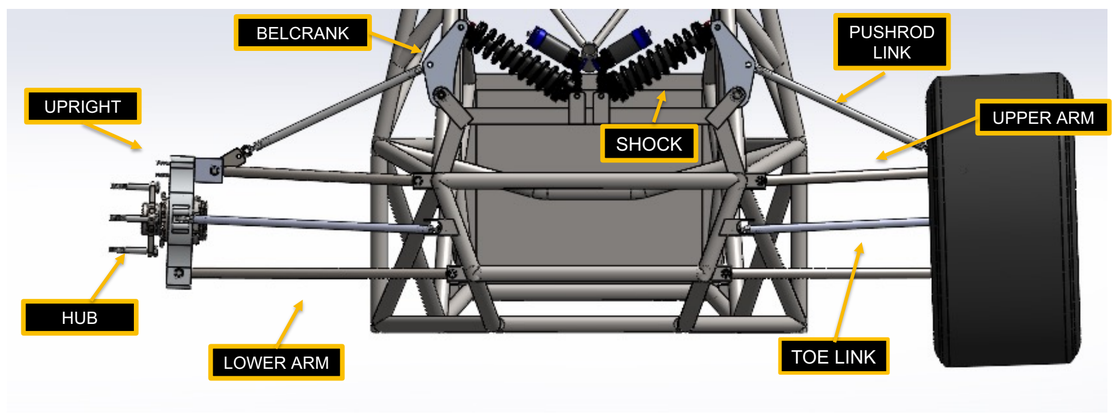
The drivetrain system connects the output of the engine to the rear wheels through a chain and sprocket. This chain and sprocket transmission uses a chain connecting the output sprocket to the rear sprocket which is attached to the differential and connected to the wheels via half shafts. The differential being used is the FSAE Drexler Differential V2, this differential allows for torque to be transferred to the rear wheels while they rotate at different speeds.





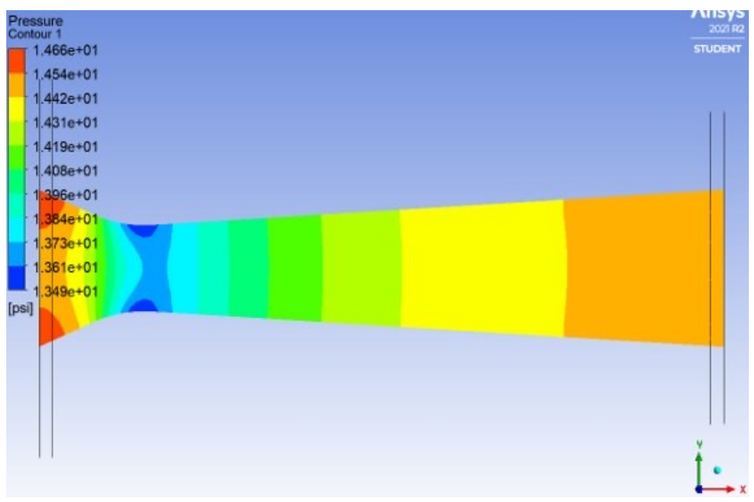
Rear Suspension

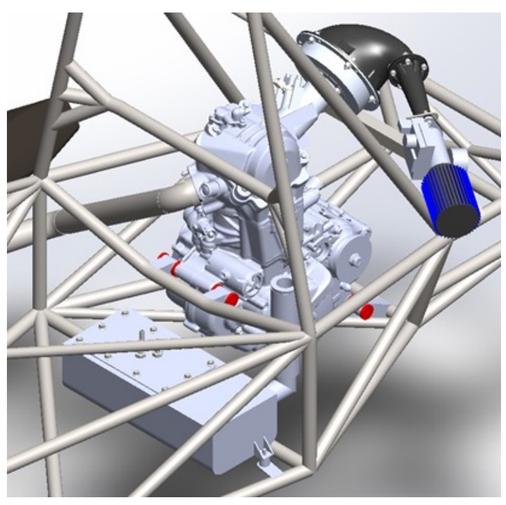
The suspension system keeps the tires' contact patch on the road by providing vertical wheel movement when impacting bumps on the road and controls the vehicle's weight transfer when accelerating, braking, and cornering. The implemented pushrod suspension system is composed of a pushrod link that pushes upwards against the oscillating bell crank transferring vertical, longitudinal, and lateral forces into lateral forces compressing the shocks. The control arms, upright, and hub connects and transfers forces from the tires to the chassis.



Powertrain

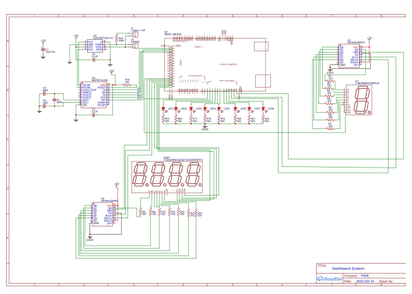
Powertrain is composed of the fuel, exhaust and cooling system. The fuel tank and fuel lines were designed to meet the dimensions and needs of the engine. The intake system restrictor is designed to optimize air flow with an ideal mass flow rate of 0.0931728 lbm/s, which will create 100% volumetric flow rate.

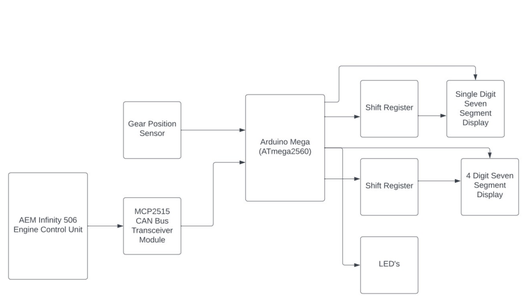


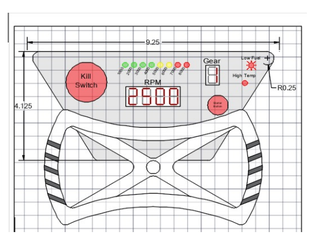


Electrical DAQ

Data acquisition is the process of digitizing real world data for it to be analyzed, processed, and displayed. The electrical data acquisition's primary goal consisted of implementing the FSAE team's dashboard design. A dashboard is crucial in any vehicle as it acquires and displays vital vehicle data/information to the driver. Throughout the year the DAQ subsystem has implemented an MCP2515 CAN bus transceiver and a gear position sensor using an Arduino mega to acquire the engine's speed and transmission's gear position to display them to the driver via seven segment displays.

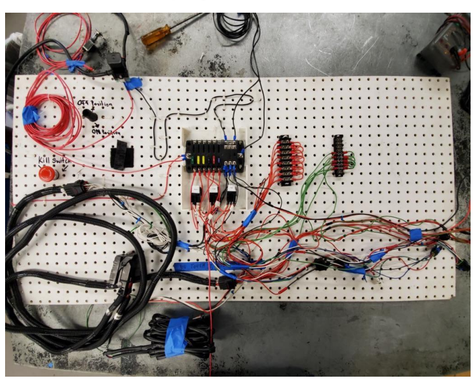


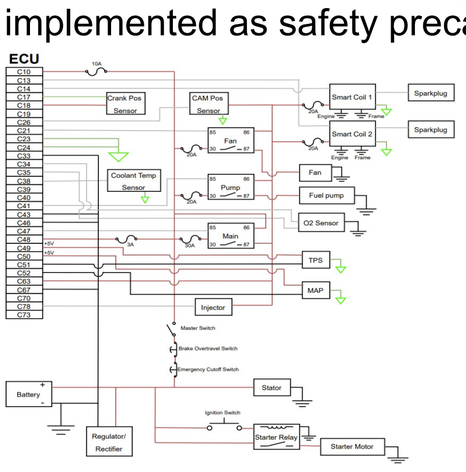




Electrical

An electrical system was designed and implemented to deliver precise fuel quantities and spark during engine operation. Fuel and spark delivery were controlled through electrical components such as the ECU, crankshaft position sensor, and throttle position sensor. Sparkplugs and fuel injectors are controlled by the ECU which are vital for the engine to run. Emergency cutoff switches were implemented as safety precautions and to comply with FSAE rules.

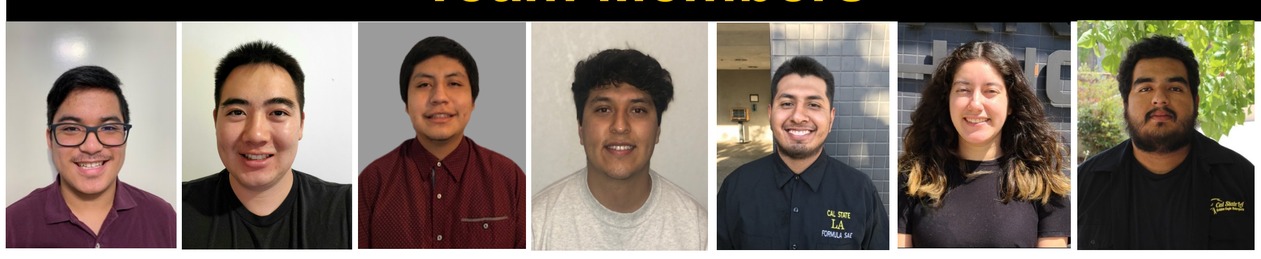




Conclusion

The design and manufacture of the vehicle was completed using Solidworks, ANSYS, Mastercam and various manufacturing equipment with a focus on system integration.

Team Members



Left to right: Kyle Misa-Electrical, Steven Lim-Electrical, Cesar Ramirez-Electrical, Uriel Perez Mora-Suspension, Leonardo Sanchez-Suspension, Jessica Plascencia Magdaleno-Powertrain, Henry Amador-Drivetrain