Design and Optimization of a Formula SAE Vehicle

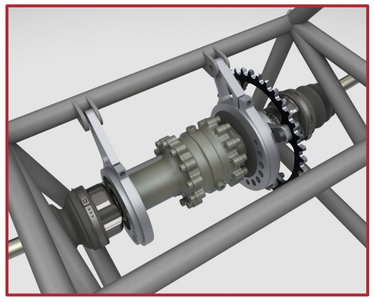
Andrew Casella, Alex Deneault, Patrick Donaghey, Mark Lightbody, Jeffrey Robinson and Cote Taylor

Advisors: Professors David Planchard and John Hall

Abstract

The purpose of this MQP was to design a vehicle for use in the 2018 Formula SAE Michigan competition. The major goals for this MQP were to improve competition performance and to reduce the weight of the vehicle from previous years. The suspension, steering, and drivetrain subsystems were considered to have the most room for improvement, and received the most attention during the design process. Weight was reduced by nearly 100lbs versus the 2016 design, and engine performance shows potential for 10% improvement.

Drivetrain



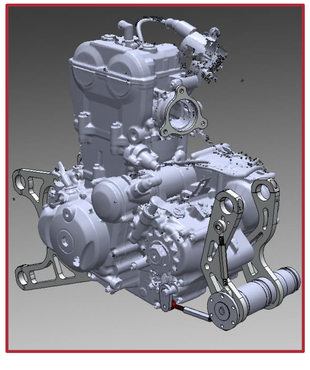
- 450cc single-cylinder motorcycle engine
- Chain drive with limited slip differential
- Eccentric Cam chain tensioner integrated into differential mounts

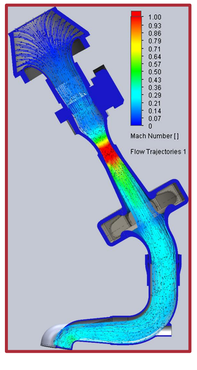
Shifting

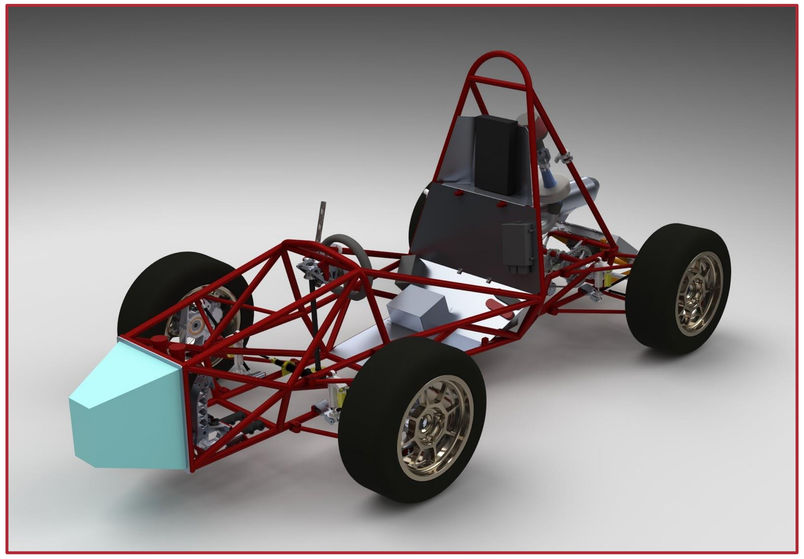
- 5-speed, paddle actuated sequential shifting
- Mechanical linkage driven by electric motor actuates transmission
- Raspberry Pi motor controller

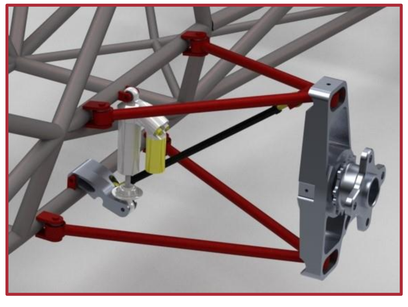
Air Intake

- Developed time-dependent flow simulation method to calculate performance data
- Iterative design for max. efficiency with min. size
- 3D printed components reinforced with fiberglass





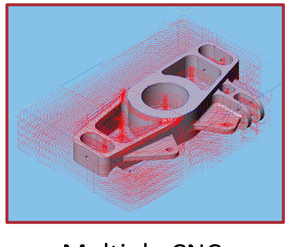


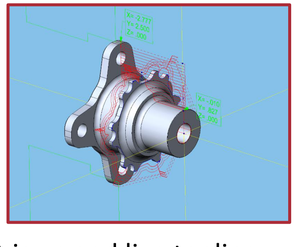


Suspension

- Pullrod actuated double wishbone linkage
- Dynamic motion analysis & Finite Element failure analysis
- Parallel pullrod and shock absorber design saves space

Manufacturing





- Multiple CNC operations utilizing soft jaws and live tooling
- Many complex CNC and welding operations
- Water jet and laser cutting used to make many 2D parts
- 3D printing used for some key components

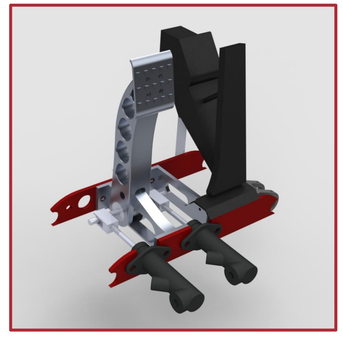
Competition

- Team acts as fictional manufacturing company designing and marketing a small car for weekend autocross racing
- Extensive design regulations
- 120 teams & 2300 students attending this year
- Judging by auto industry experts

FORMULA SAE MICHIGAN	
Static Events	
Presentation	75
Engineering Design	150
Cost Analysis	100
Dynamic Events	
Acceleration	100
Skid-Pad	75
Autocross	125
Efficiency	100
Endurance	275
Total Points	**1000**

Braking

- Master cylinders packaged underneath floor to lower center of gravity and save space
- Even 95th percentile male driver will fit due to clever packaging
- FEA used to ensure safety and strategically save weight
- Brake force ~80% F / ~20% R



Ergonomics and Steering

- Miter gears in place of U-joints for lower steering effort
- Adjustable Ackermann with steering ratio of 4.6:1
- Upholstered foam seat insert molded to fit drivers
- Electronics mounted on firewall beneath seat