FSAE Racecar: AR-12 “Mantis”

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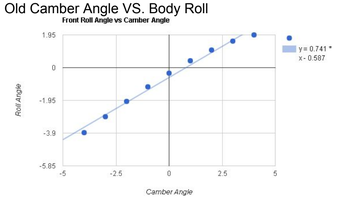
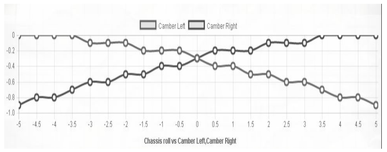
Suspension: Suspension design for AR-12 Mantis began with identifying the problems with last year’s car, AR-11 Savage. A high vertical center of gravity was the vehicle’s biggest enemy, which resulted in disqualification from competition after the car nearly rolled over under high cornering loads. Many of the 2014-2015 catastrophic design faults had been addressed with Savage last year, which provided a great starting point for this years design. Design goals for Mantis include; lowering the vertical c.g., reducing the force required to turn steering wheel, Incorporation of anti-roll bars (reducing body roll and adjustable handling characteristics), optimizing suspension geometry to utilize as much contact patch as possible.

Old Camber Angle VS. Body Roll

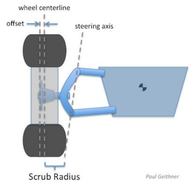


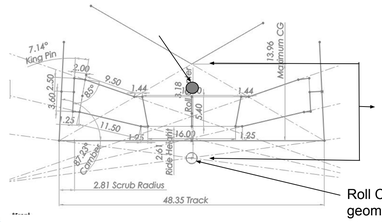
New Camber Angle VS. Body Roll



Optimization of Dynamic Camber-
Wheel camber of 0 degrees at all times is desirable

Savage’s Scrub Radius- 2.8 inches, and car was heavy. Mantis’ Scrub radius - 1.25 in. Wheel effort force is a function of scrub radius





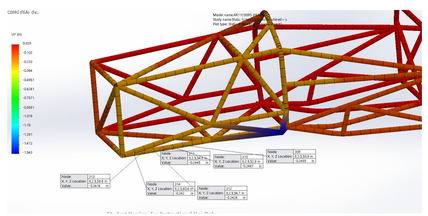
Roll Moment-
This is the lever arm between C.G. and roll center

Roll Center - geometric point that the car rolls about

Savage had a vertical c.g. of 16 inches. Mantis’ vertical C.G. is calculated to be 12.5 inches.

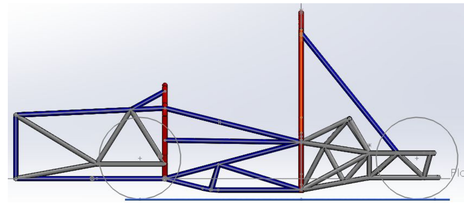
Chassis:

- Rules Compliant
  - Comply to the rules set by FSAE
- Lower Center of gravity
  - Lower center of car but keep nose and rear at original height for optimized suspension.
- Improved driver ergonomics
  - Reclined seat
  - Triangular shaped front roll hoop to give greater visibility
  - longer nose to accommodate reclined driver position
- Reduce weight
  - Smaller main roll hoop
- Strength
  - Torsional Rigidity minimum of 2000 lb/deg



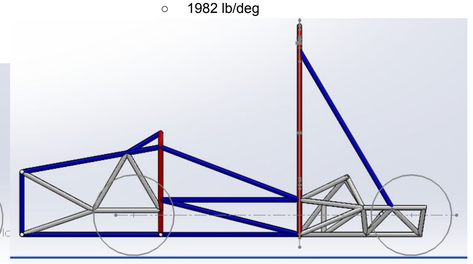
This Year’s Chassis:

- Theoretical weight
  - 76 lbs (no welds)
- Torsional Rigidity
  - Δy= -0.2443
  - Θ =0.875˚
  - 2286 lb/deg

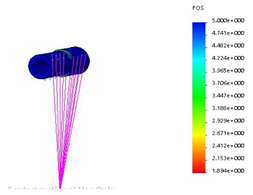


Last Year’s Chassis:

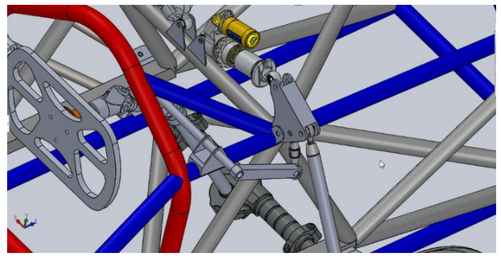
- Theoretical weight
  - 75 lbs (no welds)
- Torsional Rigidity
  - Δy= -0.282
  - Θ =1.009˚
  - 1982 lb/deg



Finite Element Analysis is performed to validate part’s strength, here on our front spindle

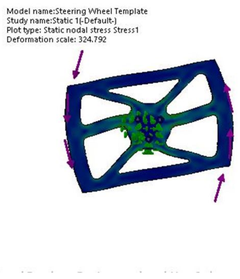


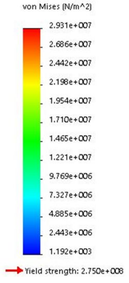
AR-12 Front Dampers and Sway Bar

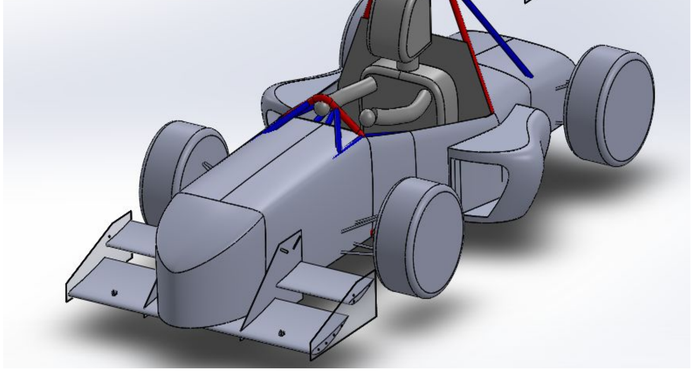


Human Interface:

- Our main objective for the design of Human Interface components was to push the seat further back and to have a larger angle with reference taken from the vertical
  - The back support of the seat is angled at 42 degrees
  - Better visibility that is still FSAE rules compliant by having a span of 200 degrees (100 left and right)
- Using a 3/16” steering wheel thickness, it was tailored to have tailored 3” of clearance from the front roll-hoop
  - Steering wheel increased diameter size to 10.5”, with flat cut outs on top and bottom to decrease steering effort







Powertrain

Main Goal

Increase power to weight ratio, without sacrificing reliability

Objectives

- Optimize the packaging of all components
- Stronger and lighter parts

Packaging

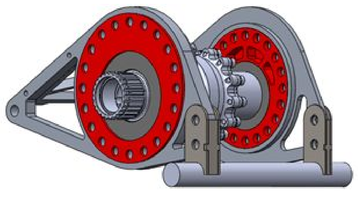
- Achieved lower center of gravity through lower engine placement

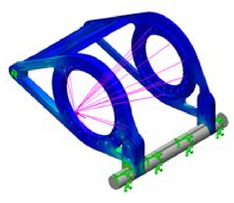
Drivetrain

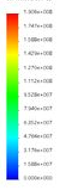
- Features a ~ 3 lb lighter differential made by Drexler Motorsports
- Differential Carrier shown to withstand an expected 3200 lb chain force with FOS = 1.84

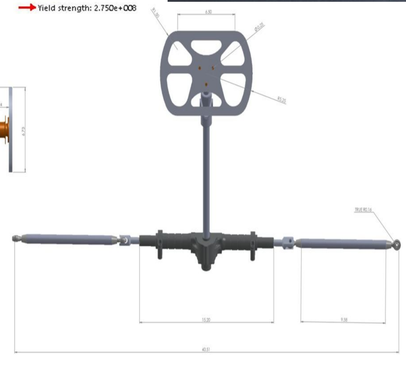
Air Induction System

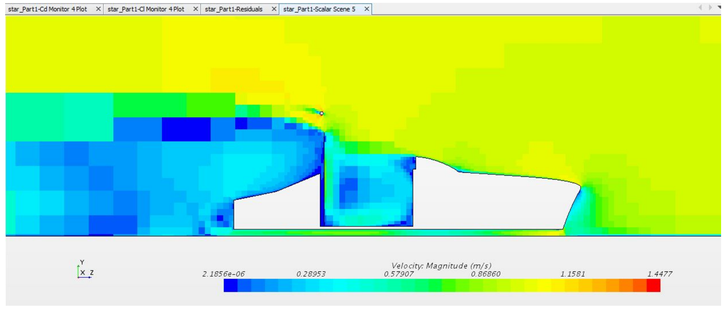
- Intake manifold weight reduction of ~ 4 lbs, utilizing pre-preg carbon fiber
- Induced lower power band through enhanced runner dimensions











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