CU Boulder Baja SAE

James Zygmunt Omer Hart Ilian Varela Miri Garland Coby Fan Will Lederer Jarod Ocampo Erick Diaz

Mechanical Engineering
University of Colorado Boulder

Background

The CU Boulder Baja team is building a prototype single seater off-road vehicle. Our vehicle is designed with the intent to compete in the Baja SAE Collegiate Design series this coming May, which will include events such as a hill climb, agility test, and endurance race, where we'll be able to compete side-by-side with teams from all over the country.

Design Goals

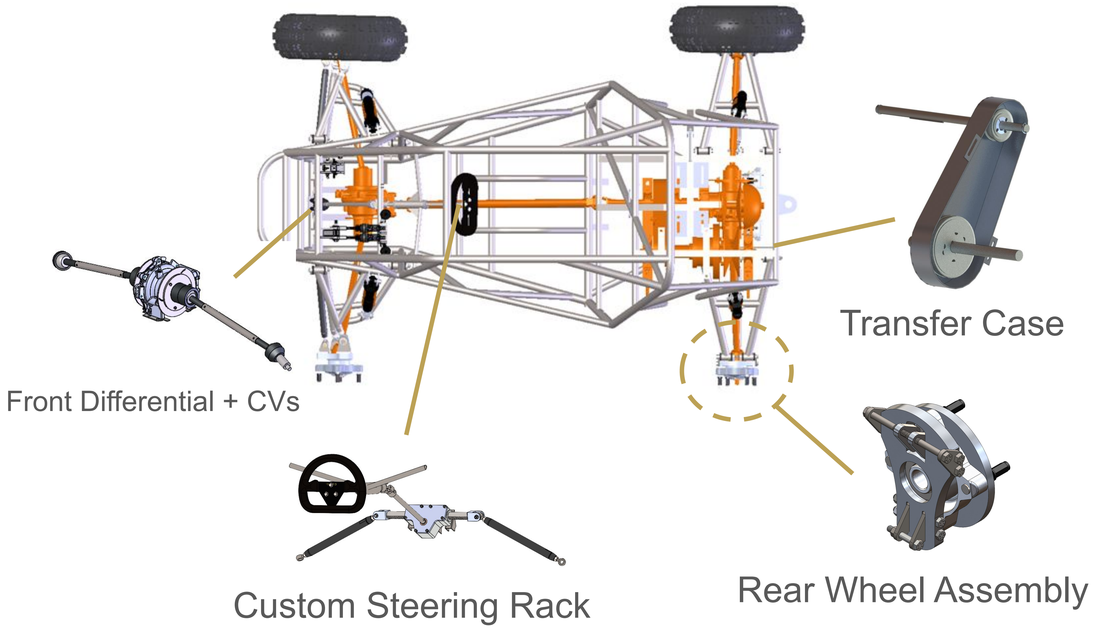
Top 25 at Competition

- Endurance race (400 Points)
  - Reduce Vehicle Size:
    - Track Width: 51" center to center
    - Wheel base: 61”
- Maneuverability race (70 Points)
  - Tighter Turning Radius: 18 ft → 12 ft
- Hill Climb (70 Points)
  - Reduce Weight: 580 lbs → 520 lbs
- Serviceability and durability
- Rule compliance

Lessons Learned

- Tolerance stack up when manufacturing, especially during welding and machining
- Integration between each subteam can pose a serious challenge
- Plan for mistakes

2024 Vehicle

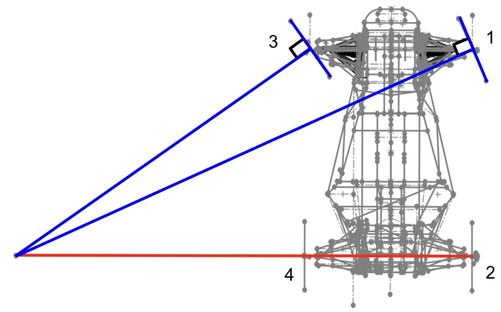


Special Thanks To: Peter Himpsel, Daria Kotys-Schwartz, Julie Steinbrenner, Greg Potts, Chase Logsdon, Lauren McComb, Patrick Mcspadden

Testing

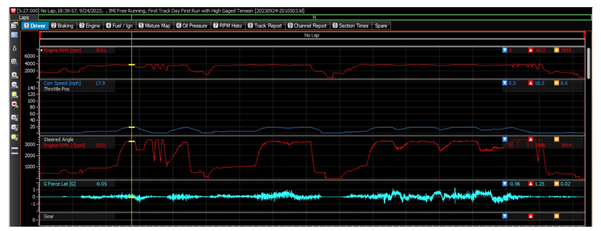
Track Day

- Wheel-lock test - Do all 4 wheels lock up?
- What is our top speed?
- Fuel efficiency - What is our MPG?
- Durability/endurance testing - Does our car still operate well after hours of continuous use?
- Pedal Testing - Does our throttle go from 0-100%?
- Overall comfort
  - Are the pedals easy to operate?
  - How does our suspension feel?
  - Does our ride height match what we designed for?
- Steering Tests - What is our turning radius?
  - Is our Ackerman steering in line with what we designed?



Ackerman steering example diagram (inner vs outer tire turning radius)

- CVT Testing
  - What temperature does our CVT get to?
  - What ratios is it achieving?



Motec i2 Dash Manger (for testing CVT ratios)

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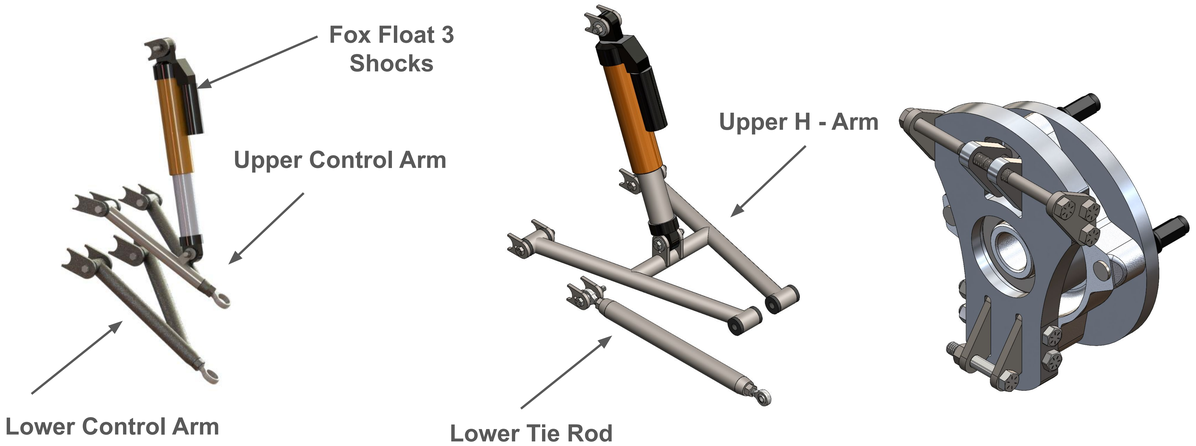
Suspension



Double A-Arm Front Suspension

- Weight Reduction ~ 20%
- Reduction of Manufacturing Complexity
- Increase of Ground Clearance ~ 12”
- Camber/Toe integrated adjustability
- Material 4130 Steel

H-Arm Rear Suspension

- Weight Reduction ~ 15%
- Reduction of Manufacturing Complexity
- Increase of Ground Clearance ~ 0.75”
- Decreased Cost ~ 30%
- Material 4130 Steel

Controls

Pedals

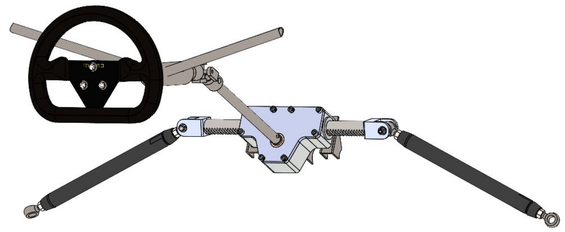
- Design goals:
  - Switching to hanging pedals
  - Must be able to withstand force of 450 lbf
  - Throttle cable must fully actuate engine

Brakes

- Design Goals
  - Two Separate circuits (front and rear)
  - Must be able to lock all four wheels
  - Calipers must align with brake rotors

Steering Rack

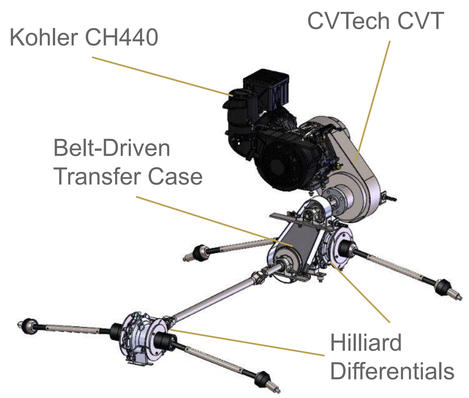
- Implemented a new steering geometry
- Reduced the need for hand over hand steering by ~ 30%
- Increased wheel turning angle from 25° to 50°, a percent difference of ~ 100%
- Saved in overall costs by ~ 40%
- Reduced overall turning radius to ~ 20%



Drivetrain

Simplify Drivetrain Components

- Return to factory-built rear Hilliard differential
- Implement belt-driven transfer case linking the driveshaft to the CVT
- 3 Shafts, 2 Belts
- Retain last years, forward drivetrain components
- Remanufactured CV Axles to fit new suspension

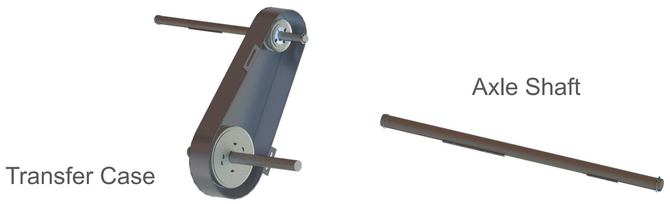


Design Barriers

- Belt tensioning, both CVT and transfer case
- Clearance and packaging of all components
- Hazardous Release Covering Rules compliance

Drivetrain Results

- Torque: 530 ft-lbs
- Top Speed: 31 mph

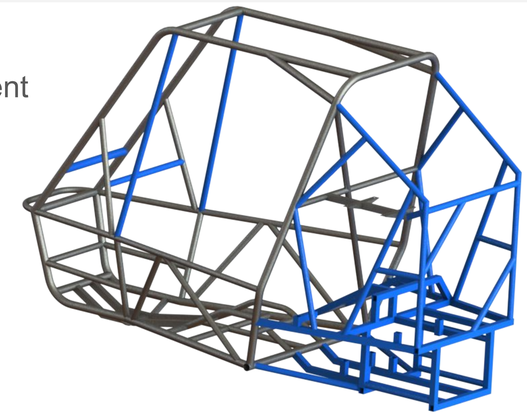


Chassis

Modify 2023 Chassis

Not practical to manufacture full chassis with current team size. New drivetrain design is unable to fit in the rear of the 2023 chassis

- Rear of chassis redesigned to fit new drivetrain
- Square structure and tube when possible
- Fixed old rules violations
- Repaired chassis damage
- Prioritization of chassis weight dropped
- Chassis weight (SolidWorks estimate): 106 lb



Engine Access and Adjustability

- Engine removable through rear of chassis
- Engine position controls CVT belt tension
- Engine mounts built to minimize flexing under load