

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

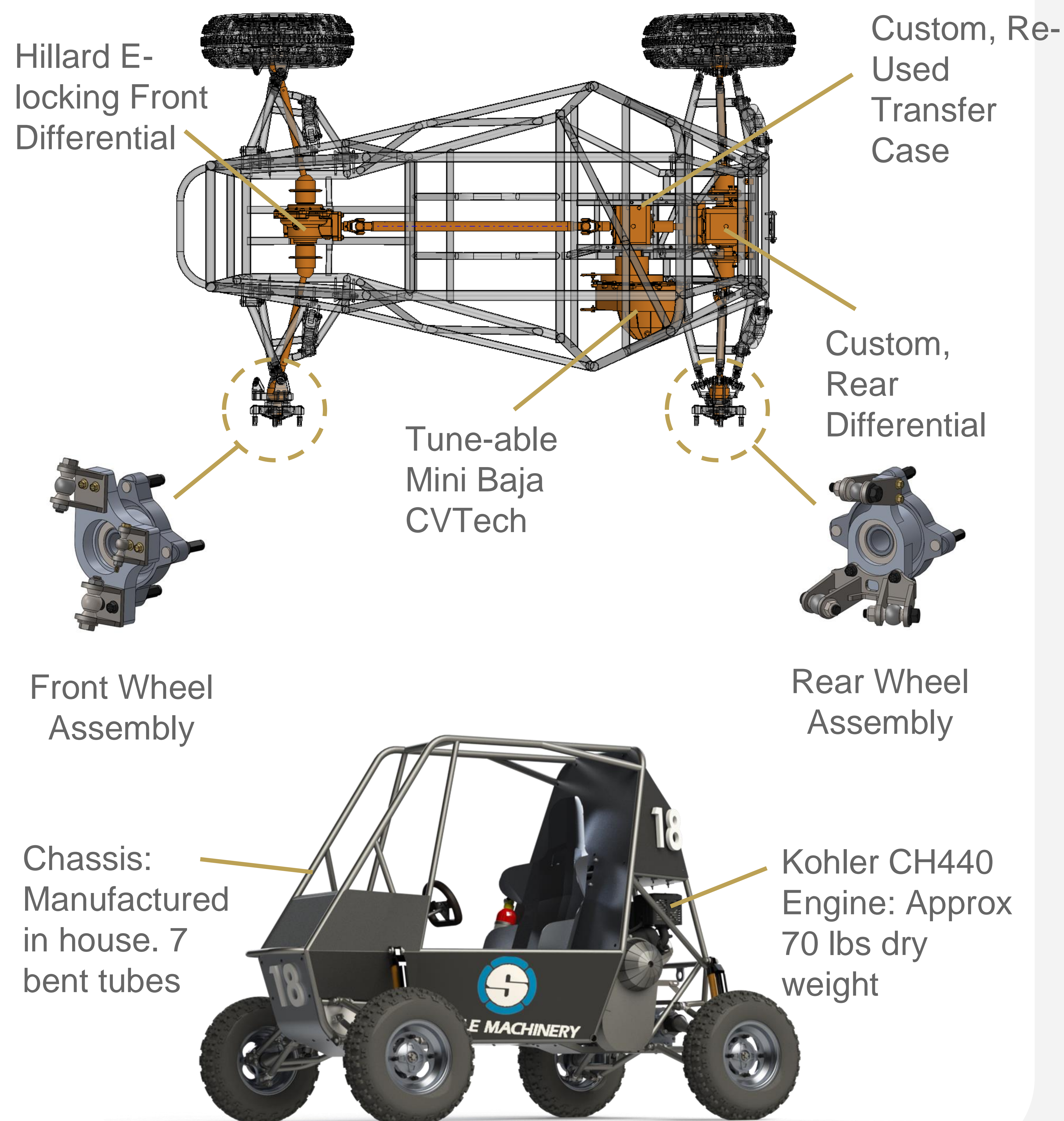
Top 15 at Competition

- Endurance race: worth 400 pts
 - Reduce Vehicle Size:
 - Track Width: 51 in center to center
 - Length: 68.5 in
 - Height: 63 in
- Agility race: worth 70 pts
 - Tighter Turning Radius: 13 → 9 ft
- Hill Climb: worth 70 pts
 - Reduce Weight: 548 lbs → 520 lbs
- Serviceability

Lessons Learned

- Investing time into checking the design of reused & off the shelf components will save integration headaches into the future.
- Design in extra clearance for things. Manufacturing tolerances can stack up in unexpected ways.

2023 Vehicle



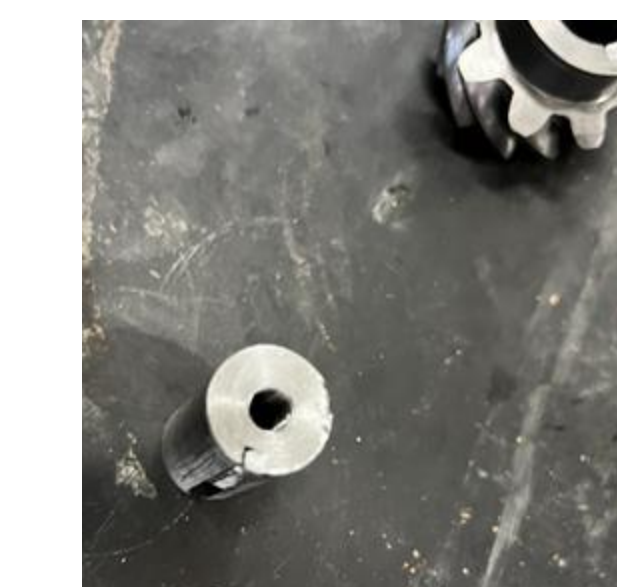
Special Thanks To: Peter Himpsel, Daria Kotys-Schwartz, Greg Potts, Chase Logsdon, Lauren McComb, Patrick Mcspadden

Testing

- Load Case Validation
 - Forces in suspension
 - Acceleration from impacts
- Top Speed
 - MoTec GPS speed measurement
 - CVTech transmission tuning



- Understanding Torque Distribution via Keyway Shear



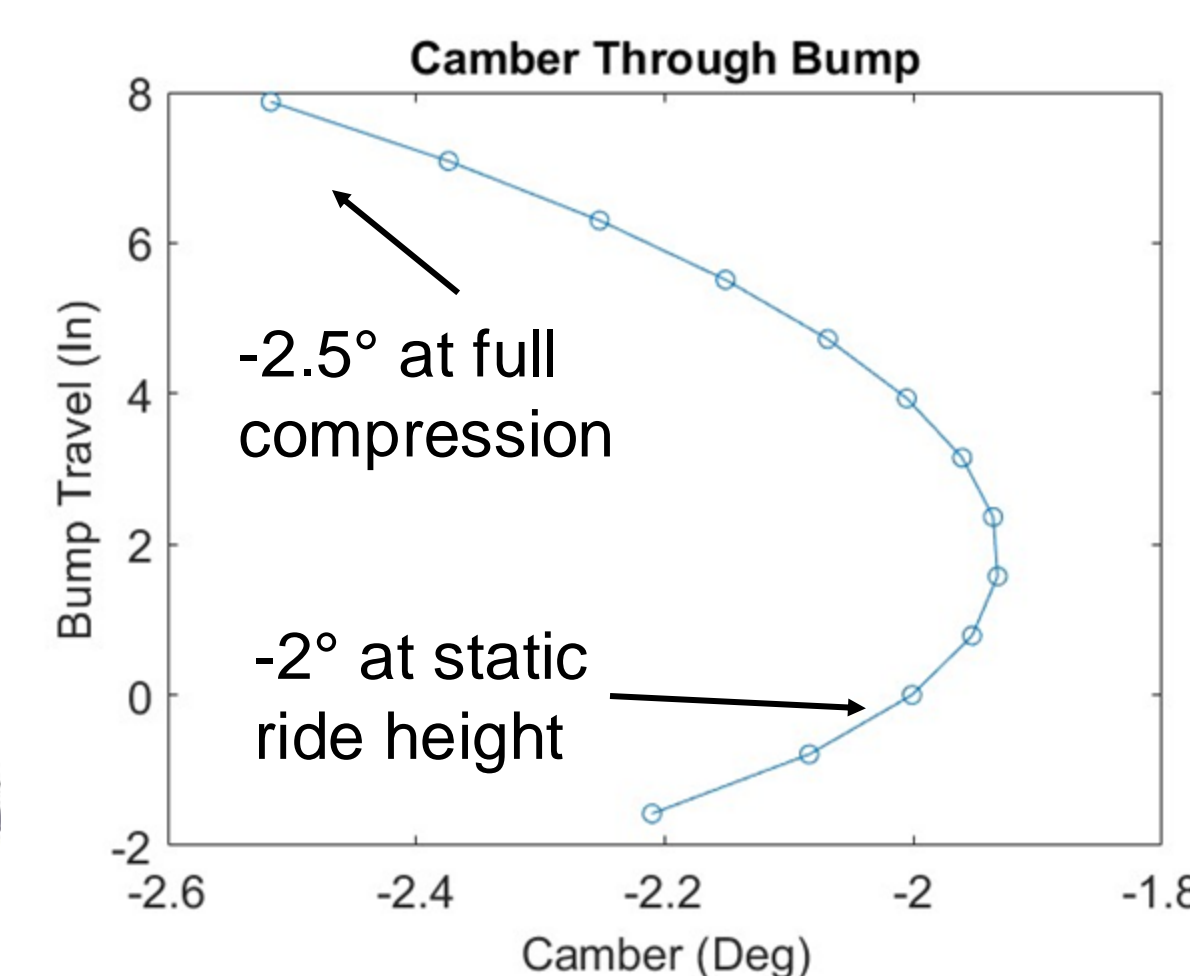
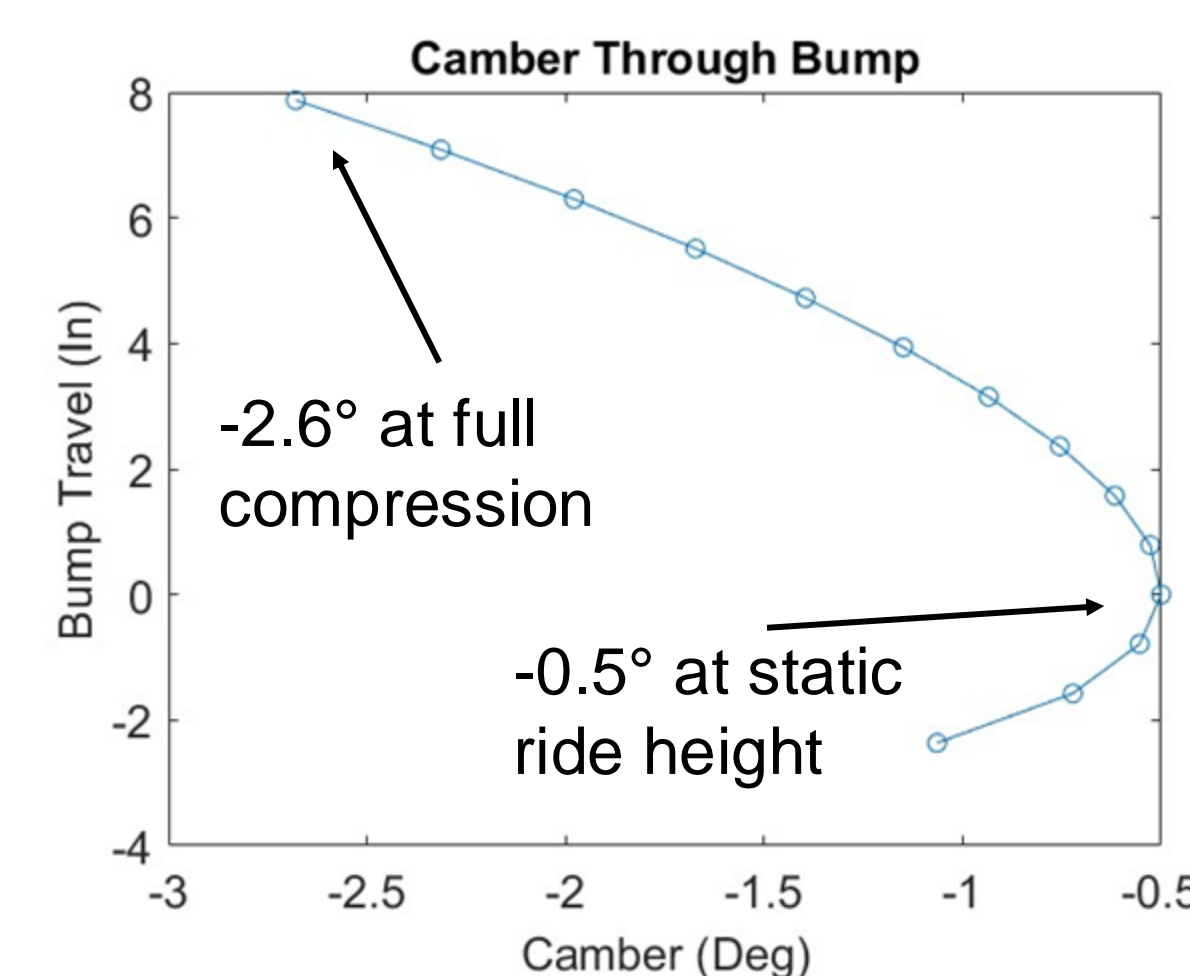
- Tie Rod Durability via Bushing Wear in Steering



- Vehicle Kinematics:
 - Bump Steer
 - Turning Radius



Suspension



A-Arm Front Suspension

- Weight Optimization and Reduction ~5.7 lbs
- Shifted Front Tire Locations Forward
- Increased Ride Height - 2 inch
- Improved Kinematics
 - Maintain < 5° of negative camber change in bump
 - 2.1° of camber change through bump
 - Maintain < 3° of toe change in bump
 - 1.5° of toe change through bump
- Maintain < 1 inch of plunge at all times
 - Maximum of 0.62 inches of plunge

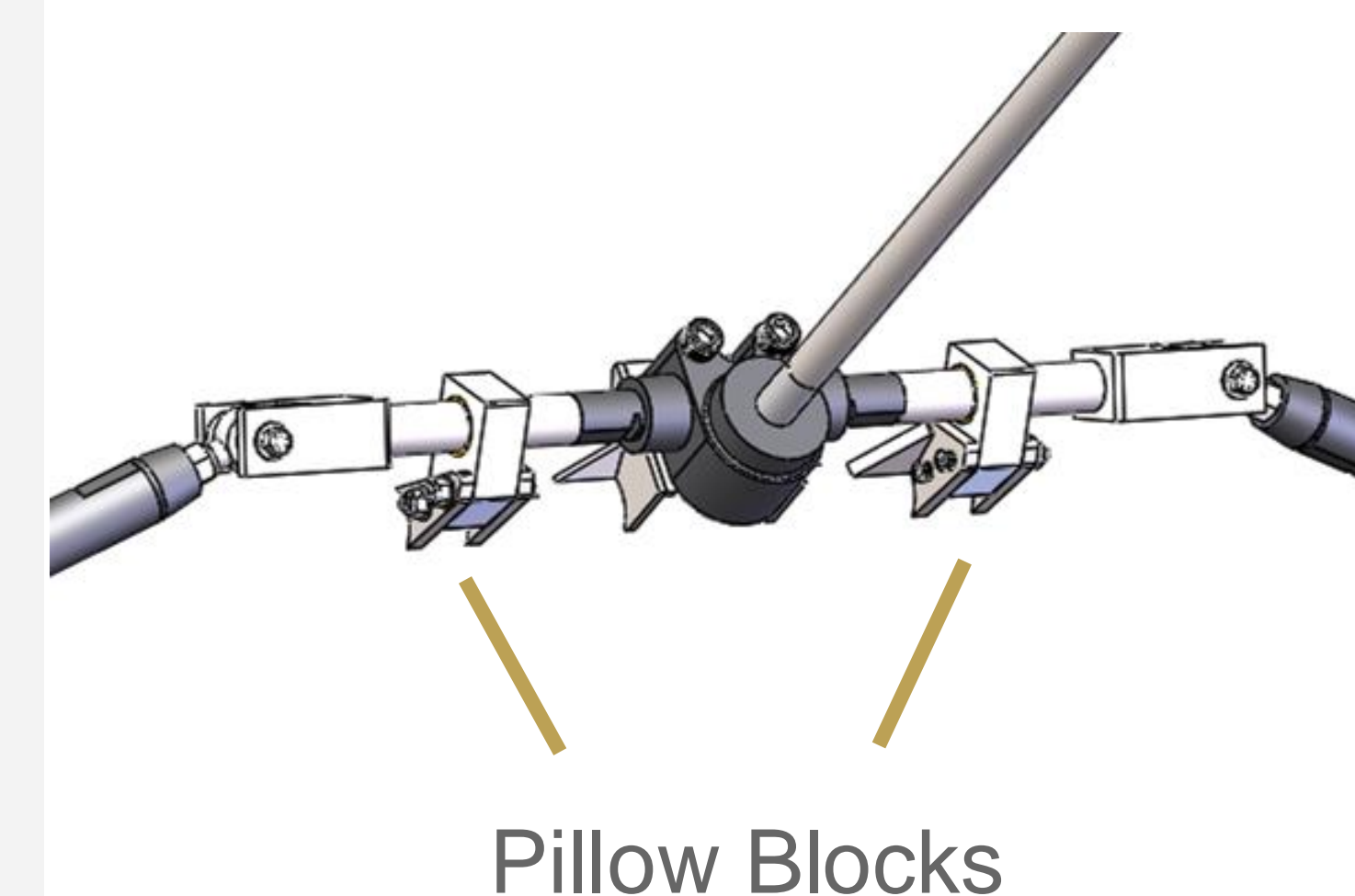
H-Arm Rear Suspension

- Reduced Weight - ~33.9 lbs
- Reduced Manufacturing Complexity
- Increased Ride Height - 2.25 inch
- Improved Kinematics
 - Maintain < 5° of negative camber change in bump
 - 0.6° of camber change through bump
 - Maintain < 2° of toe change in bump
 - 0° of toe change through bump
- Maintain < 1 inch of plunge at all times
 - Maximum of 0.5 inches of plunge

Controls

Pedals, Brakes, Driver Integration

- Eliminate hand-over-hand turning: 1 turn
- Single Rear Brake Rotor
- Modified Pedal Assembly
- Increase serviceability, increase driver comfort
 - Strict driver fit rules required cockpit
 - Unable to accommodate drivers outside 95th percentile



Steering Rack Extension

- Previous year had extreme bushing wear in steering
- Extended tie-rods to achieve good steering characteristics in suspension - increases anticipated wear on bushings
- Bending moment calculated - 453 ft*lb
- External additional bushings added to increase FOS on steering rack
- Modified to achieve 27° steer angle in 1 turn lock to lock

Drivetrain

4WD System

- New requirement this year
- Year 2 of running 4WD at CU
- CVTech, Custom transfer case, E-locker front differential
- Standardized Kohler CH440: 70lbs dry weight

What is Underdrive?

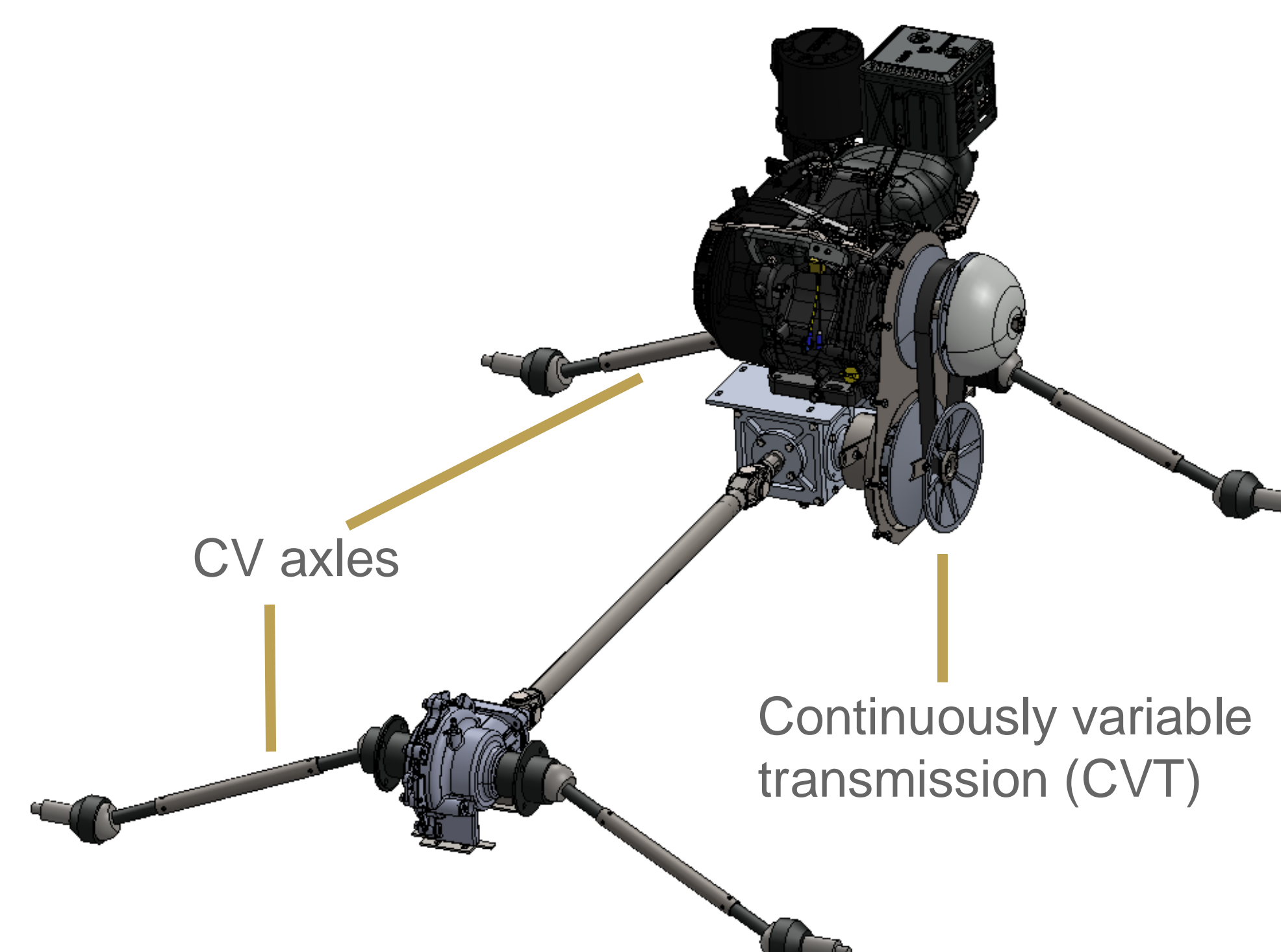
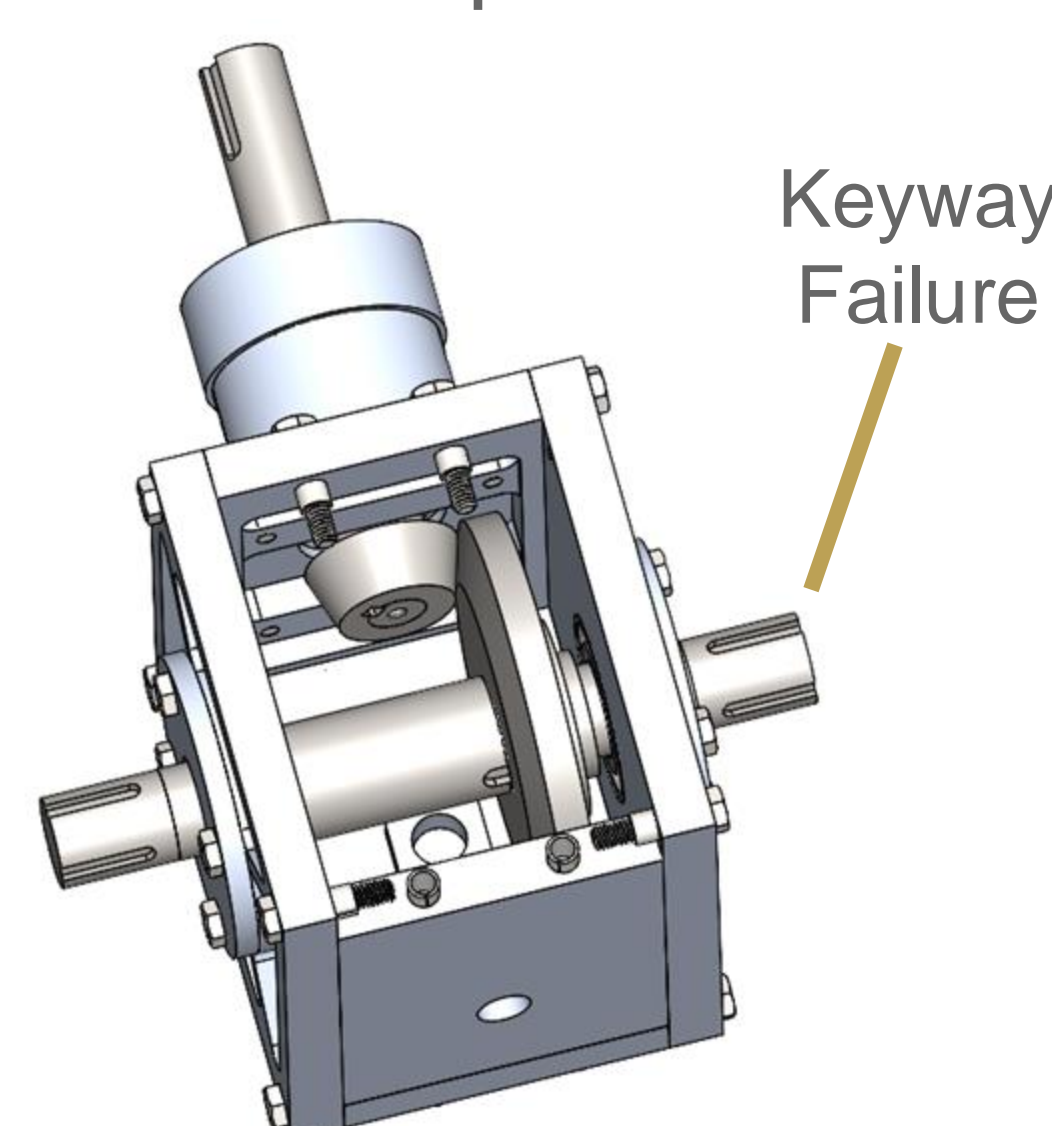
- Underdrive allows the front wheels to automatically disconnect from the drivetrain when there is ample traction, reducing frictional losses and increasing efficiency.

Custom Axles

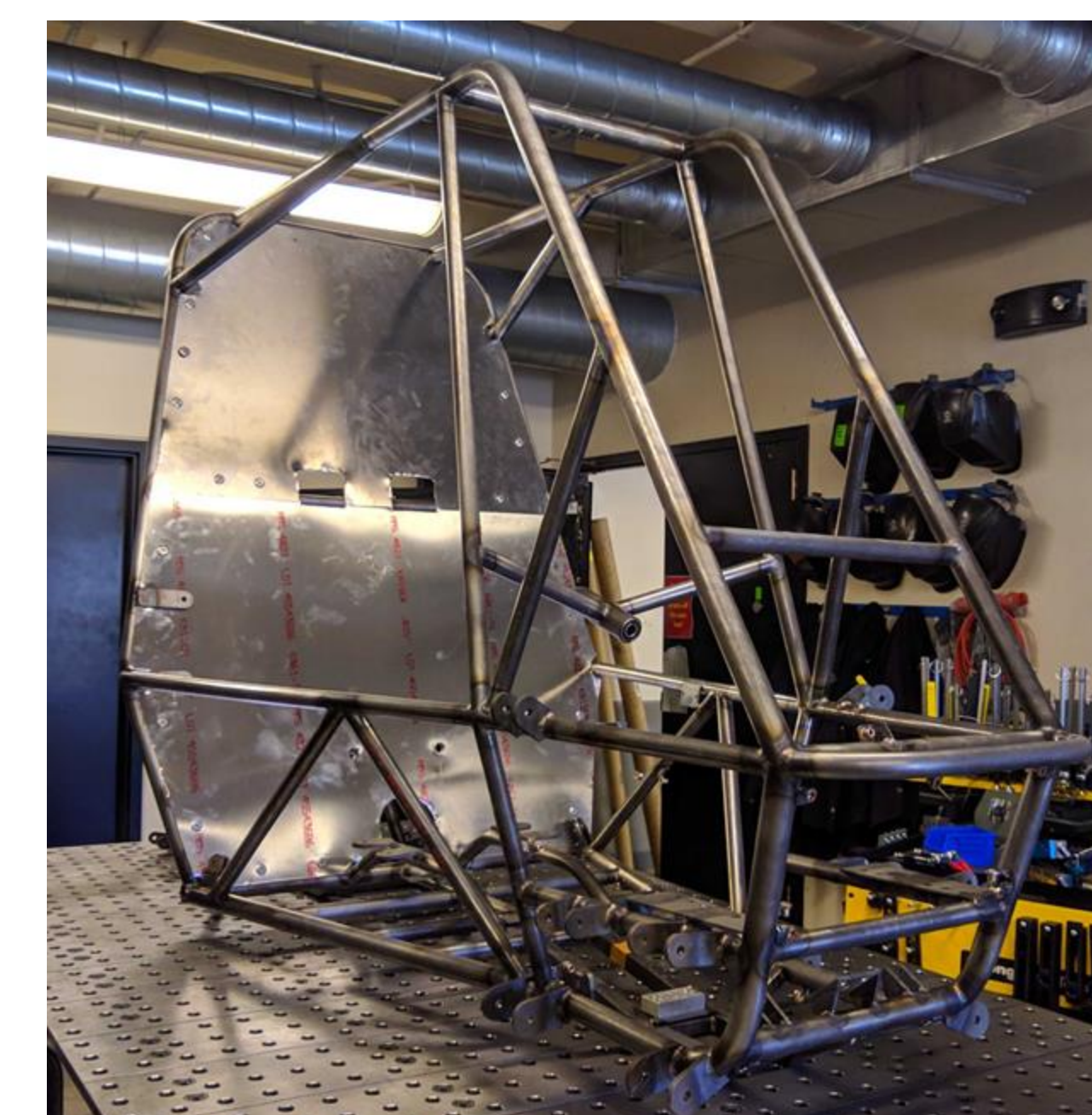
- Sleeved to custom length for our car
- Tested past calculated max torques

Custom Rear Differential

- Fully locked
- 3:1 ratio
- Single rear brake



Chassis



In-House Frame Manufacturing

Due to a rules clarification this year, all chassis tubes must be manufactured entirely in house.

- Reduced amount of complicated tubes
- Tubes still had to be remade or added, frame was not simplified enough
- Welds needed to cover gaps at some joints
- Frame weight - 116 lbs

Rear Packaging

- Front braced instead of rear braced
- Allow for *relatively* easy engine removal/installation by one person

