

SAE[®]Baja - Powertrain



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Overview

- Introduction
- Objectives
- Design
 - Continuous Variable Transmission (CVT)
 - Forward-Neutral-Reverse (FNR) & Gear Reduction
 - Rear End
- Testing



Introduction

- 2015 SAE Mini Baja collegiate competition
 - Portland, Oregon
 - May 27-30
- Events
 - Hill Climb
 - Rock Crawl
 - Acceleration
 - Endurance
 - Maneuverability

Photos courtesy of 2014 UWYO SAE Baja Team



Objectives

- Performance
 - Minimize overall weight
 - Forward, neutral and reverse capabilities
 - Speed range: 0-25 mph
 - Adequate low end torque
 - High power output operation
- Rule Compliance



Design - CVT

- CVTech AAB Continuously Variable Transmission
 - Driver Pulley: Model No. 0600-0021
 - Driven Pulley: Model No. 5600-0171
 - Low end ratio- 3:1
 - High end ratio- 0.45:1
- Infinite range of ratios between high and low end
- Adjustable engagement RPM
- Adjustable transition RPM

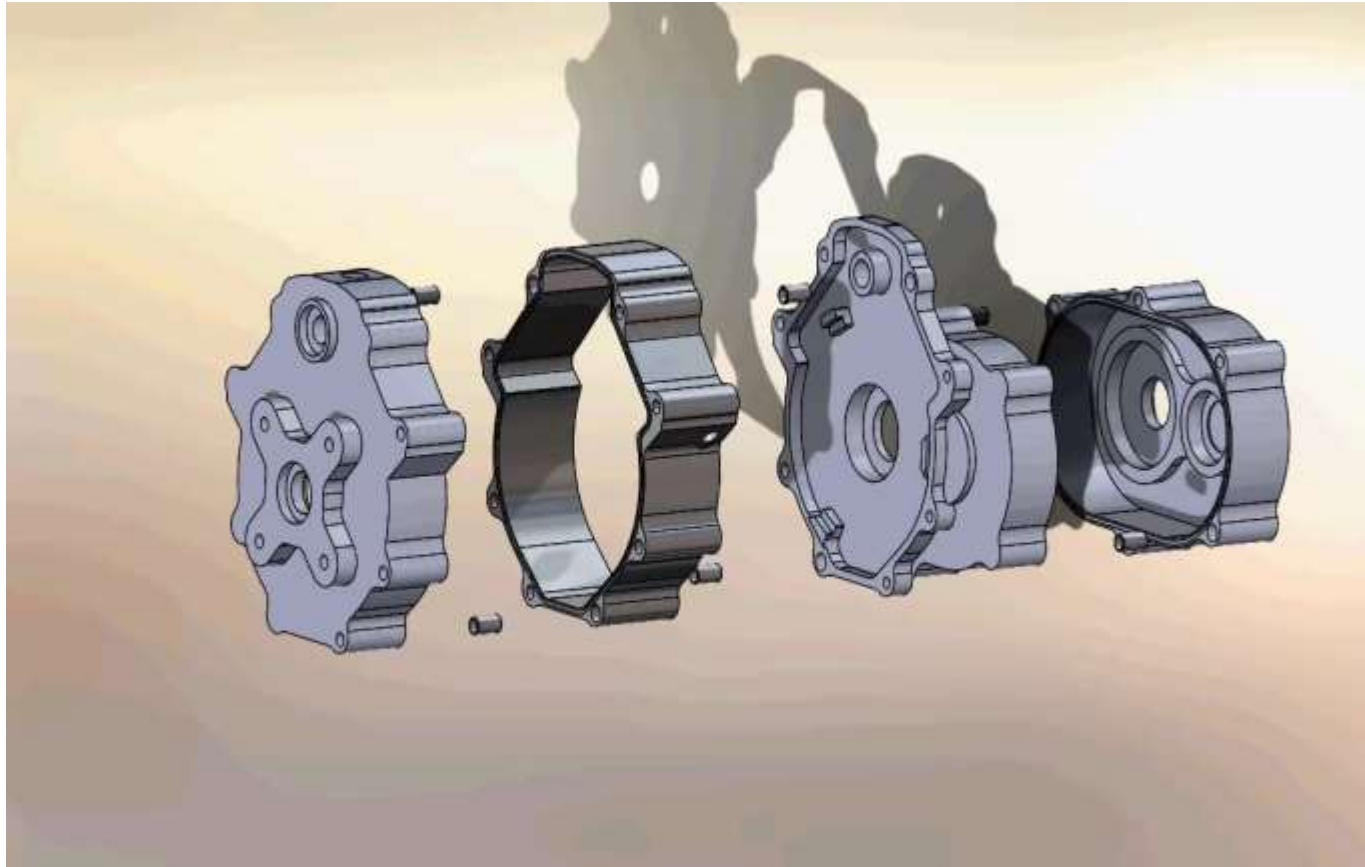


Design – FNR & Gear Reduction

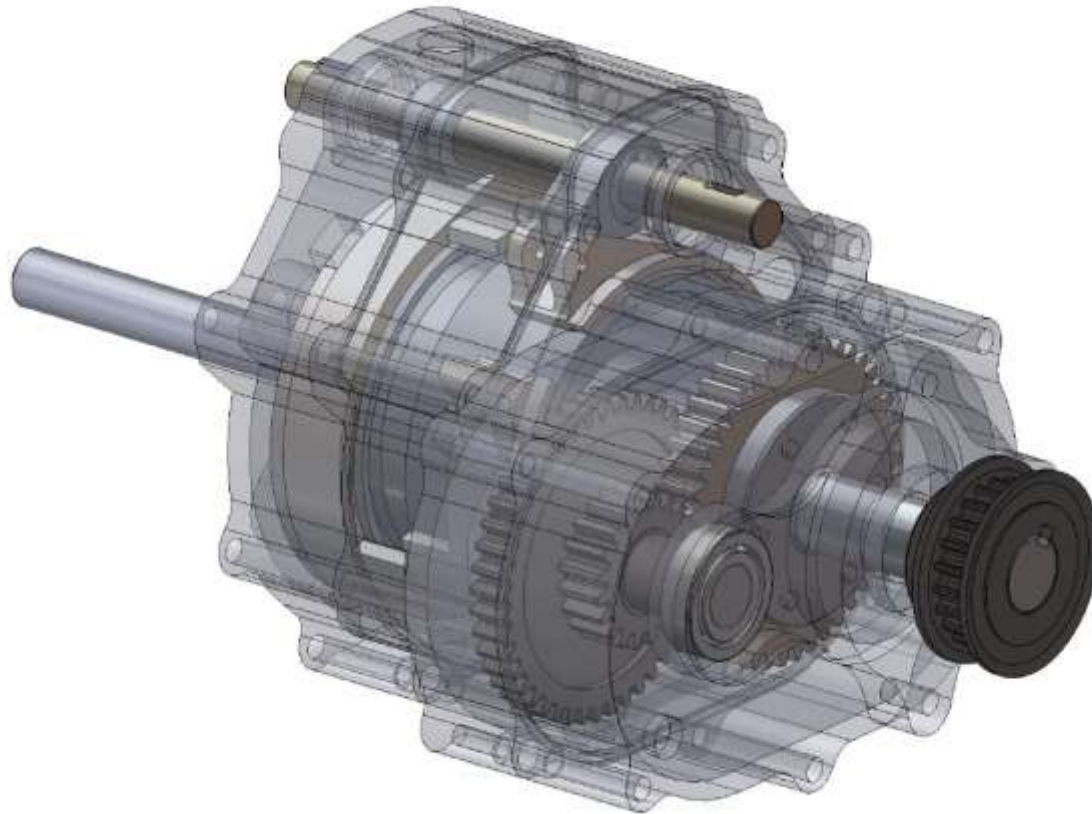
- Snow Nabstedt 5101 B Forward-Neutral-Reverse Gearbox
 - Gear Ratios- 2.47:1
 - Maximum Output Torque- 500 in-lbs
- Additional Gear Reduction
 - From Honda Odyssey FL250R
 - Gear Ratio- 5.6:1



Design – FNR & Gear Reduction

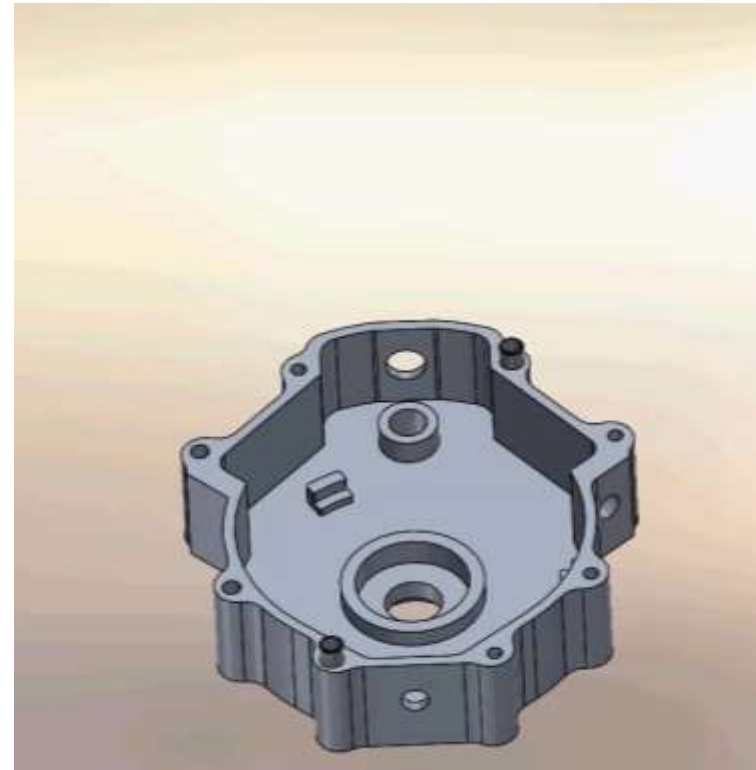


Design – FNR & Gear Reduction



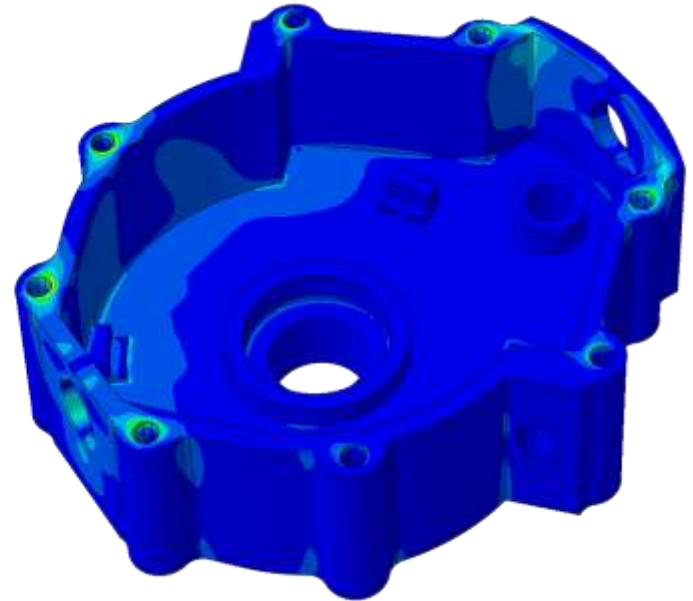
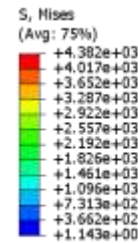
Case Stress and Bearing Displacement Analysis

- Modeling Approach
 - Solved for bearing reaction forces
 - Applied forces to rigid body disk bearing simulations
 - Simulated bolts with long rigid body cylinders
 - ~1.2 million tetrahedral elements
 - Required use of research license



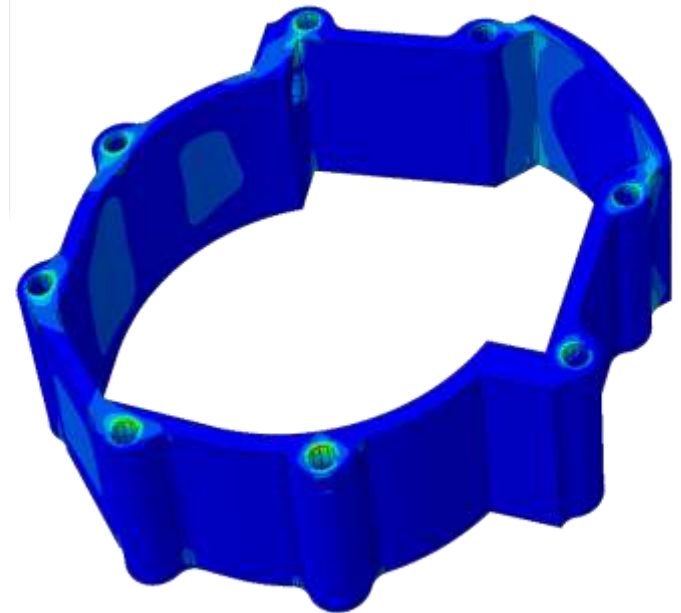
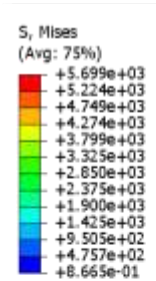
FEA Results – FNR Input Case Section

- Peak Mises Stress = 4.38 ksi
 - F.S. = 9.13
- Max Transverse Bearing Housing Deflection = 4.43E-5 in.



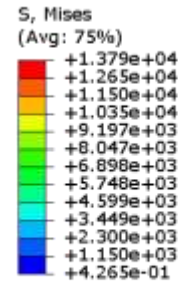
FEA Results – Case Spacer Section

- Peak Mises Stress = 5.7 ksi
 - F.S. = 7.02
- Max Transverse Bearing Housing Deflection = N/A



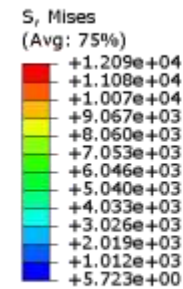
FEA Results – FNR Output Case Section

- Peak Mises Stress = 13.8 ksi
 - F.S. = 2.90
- Max Transverse Bearing Housing Deflection = 1.05E-3 in



FEA Results – Gearset Case Section

- Peak Mises Stress = 12.1 ksi
 - F.S. = 3.31
- Max Transverse Bearing Housing Deflection = 1.47E-4 in

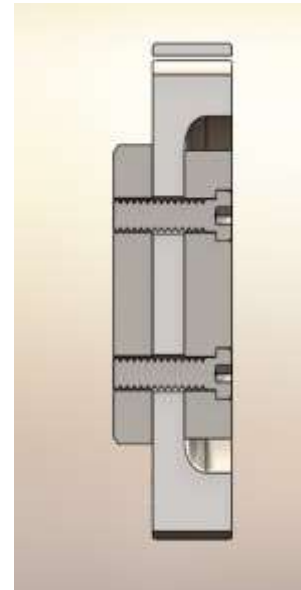


FEA Conclusions

- Much material could be safely removed
 - Weight was reduced by ~ 2 lbs. (20%)
- No complications with gear meshing are expected.



Output Shaft Gear Assembly

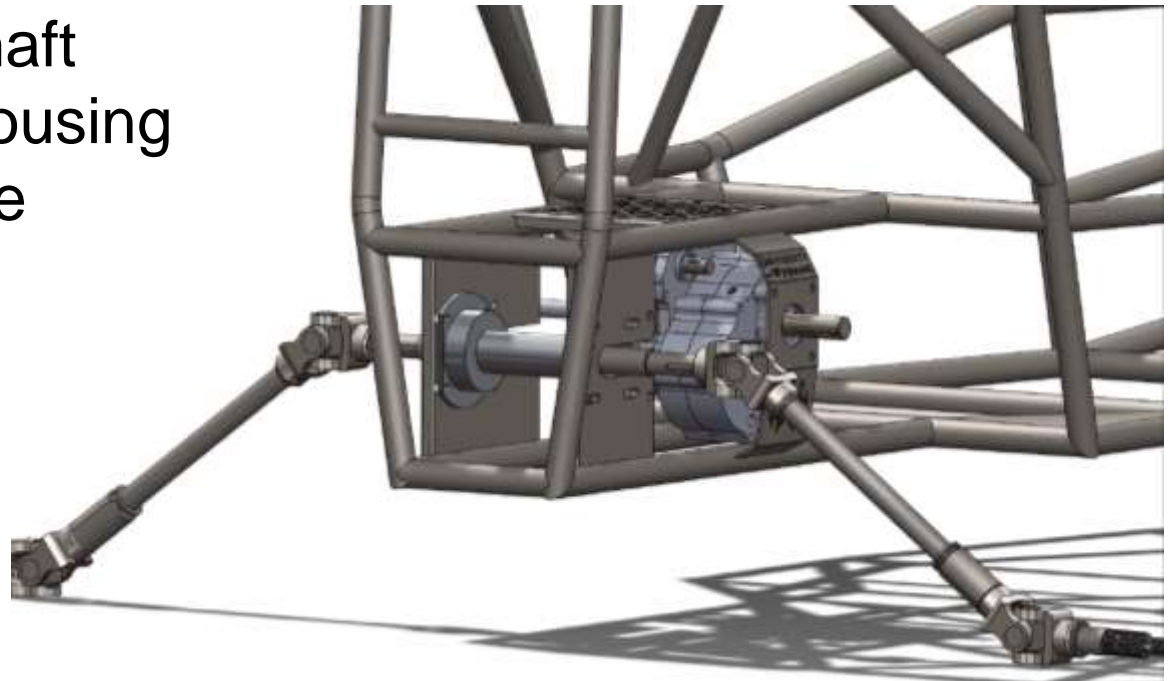


- Fastener Force:
 - $F_b = 2018$ lb/bolt
- Shear stress:
 - $\tau_b = 41.1$ ksi/bolt
- Factor of safety:
 - $n_o = 2.3$



Design – Rear End

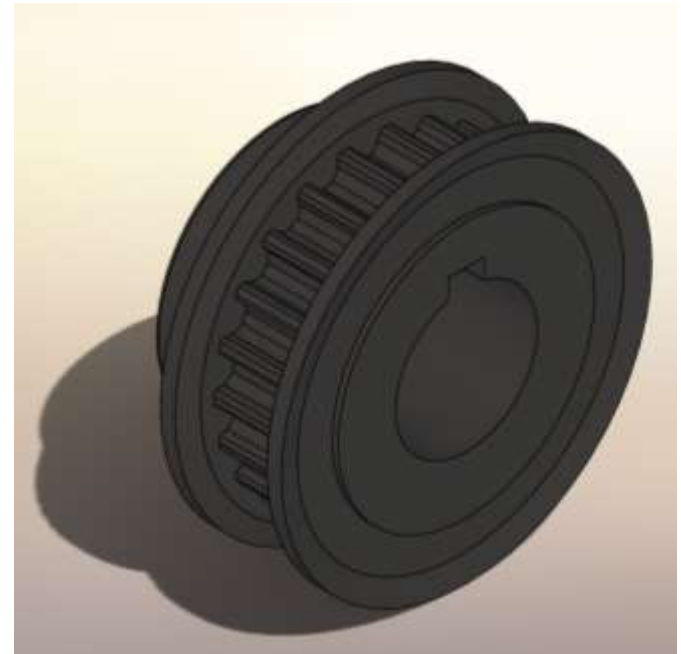
- Major Components
 - Sprockets and Belt
 - Final Drive Shaft
 - Drive Shaft Housing
 - Split Rear Axle



Design – Final Drive Sprockets and Belt

- Driver Sprocket – 25 teeth
- Driven Sprocket – 36 teeth
- Belt – 100 teeth

- Center-to-Center distance – 10.9 in
- Reduction ratio - 1.44:1



Design – Split Rear Axle

- Neapco Model No. 10-0493 Universal-Joints
- AISI 4130 steel tube
- Square slip shaft
- Splined spindle



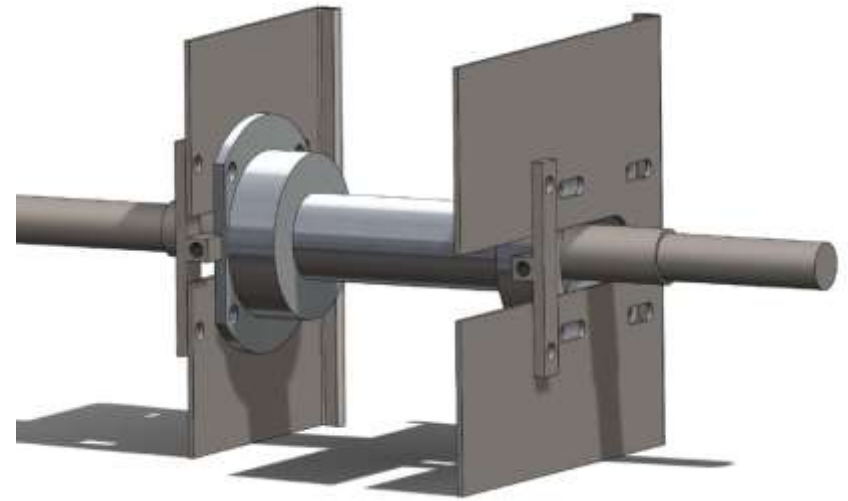
Design – Final Drive Shaft

- Length – 19.1 in
- Max diameter – 1.2 in
- Min diameter - 0.998 in
- Shear Pin diameter – 3/8 in
- Key way size – 1/4 in
- Max Shear Stress – 15 ksi
- Factor of Safety – 4



Design – Drive Shaft Housing

- Tensioners
- Slots for adjustment
- Drive Tunnel
 - Bearings do not rely on positioning from frame



Testing

- Calibrate CVT flyweights and springs to optimize engagement and operational RPM.
 - Engagement RPM should be slightly higher than engine idle RPM.
 - Maximum operational RPM gives greatest power output.



Questions?

