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SAE-Baja 4WD Redesign

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BAJA SAE - 4WD Design

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Faculty Mentor: Dr. Joseph Schroeder

The Design Team Members

Sam – Roll Cage Design and Instrumentation

Wyatt – Suspension and Shocks

Tyler – Drivetrain and Transmission

James – Suspension implementation and communications

Alex – Braking and Steering

Javier – Drivetrain and Transmission

Project Description

- Work with Olivet's Baja Club and manage the club
- Design and fabricate a vehicle capable to compete in the 2021-22 Baja SAE competition
- Design and fabrication includes but is not limited to:
  - Roll cage
  - Suspension
  - Steering
  - Braking
  - Drivetrain

Project Description

- Future AWD/4WD requirement
- Coordinating the work assignments for club members not on the senior design team
- Preparing all required documentation/presentations to SAE
- Ensuring the team's vehicle adheres to all rules outlined in the official Baja SAE Ruleset
- Safety held in utmost importance

Competition Description

- Tennessee Tech at Hyder-Burks Agricultural Pavilion
- Testing and Validation
- Judging and 2022 Baja SAE Ruleset
- Points awarded to best teams in dynamic events
  - Acceleration
  - Maneuverability
  - Sled Pull
  - Suspension
- 4 Hour Endurance Race

Design Objectives

- Low part and material cost
- Lightweight
- Strong enough to handle obstacles like jumps, rock gardens, and drops without breaking
- Achieve high speeds and high acceleration
- Maintain safety when achieving the above objectives

Functional Requirements

- 4WD
- Off-Road capability
  - Withstand large jumps and drops
  - Sufficient cornering capability
  - Traverse uneven terrain
- Driver Safety
  - 5-Point Harness
  - Finger Protection
  - HROE (Hazardous Release of Energy)

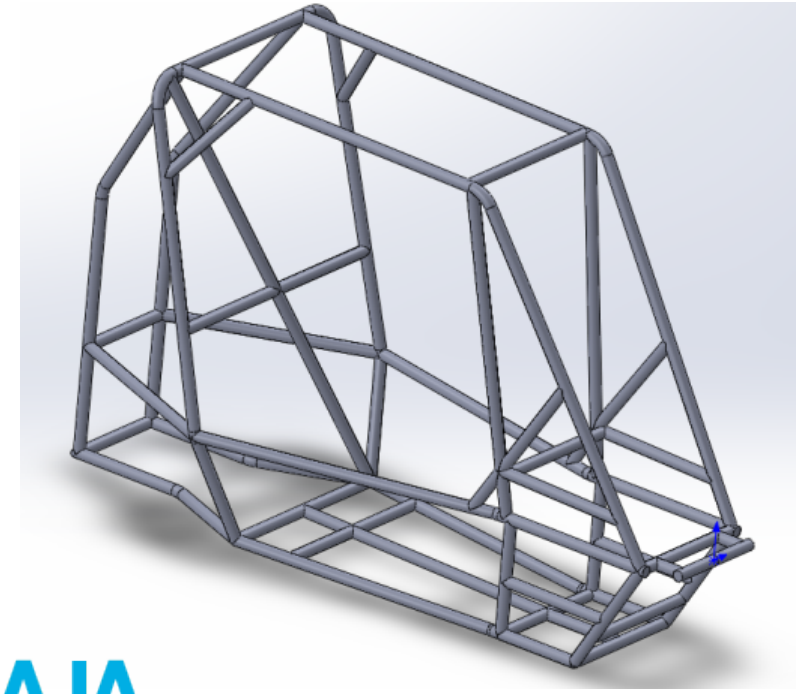
Design Constraints

- Budget set by ONU
- 2022 Baja SAE Rulebook
  - Engine
  - Safety
  - Chassis

Frame Redesign

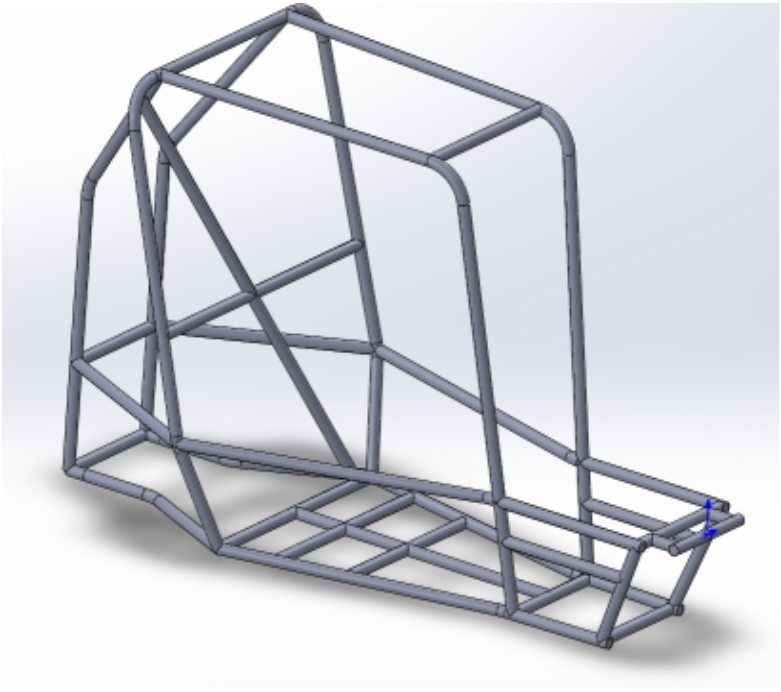
Previous and Initial Design

- Standard Model



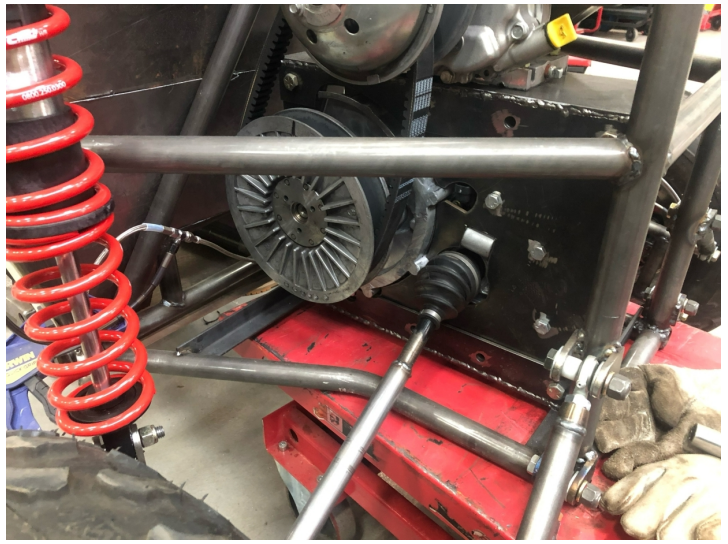
Final Design

- "Nose" Model



Drivetrain

- Main Criteria:
  - Selectable 4WD
  - Compatibility with Engine Size
- 2006 Polaris Hawkeye 300
  - Transmission
  - Front Differential
  - CV Axles
  - Driveshaft
  - Knuckles & Hubs



Suspension: Gas Charged

- Pros
  - Used by previous ONU Baja teams
  - Cheaper
  - Smaller diameter
- Cons
  - Progressive spring rate
  - Shock temperature increases
  - Low adjustability

Suspension: Coil-overs

- Pros
  - Popular choice for other Baja teams
  - Polaris, Honda and Can-am utilize a coil-over shock
  - Linear spring rate
  - Adjustable pre-load
  - Aesthetic gains
- Cons
  - More expensive
  - Larger outer-diameter
  - Spring selection
- Final decision
  - FOX 2.0 emulsion 5/8” shaft coil-overs
  - Eibach springs

Suspension: Design and Setup

- Front suspension
  - Double wishbone setup
  - TS: 225 lbf/in BS: 300 lbf/in
  - Combined free spring rate: 128.57 lbf/in
  - Pre-load: Springs compressed by 1.25" for 160.71 lbf of pre-load
- Rear suspension
  - Trailing arm setup
  - TS & BS: 300 lbf/in
  - Combined free spring rate: 150 lbf/in
  - Pre-load: Springs compressed by 1.5" for 225 lbf of pre-load
- Dual rate coil-overs

$$Combined\ spring\ rate = \frac{TS * BS}{TS + BS}$$

TS: Top spring
BS: Bottom spring

$$pL = k * T$$

pL: Pre-load
k: Spring rate
T: Length compressed

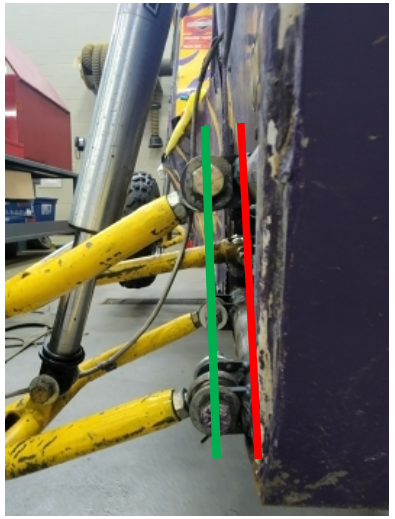
Suspension: Challenges

- Shock mount placement
  - 2019 Car: Shock mount on Lower-A-Arm
  - New Car: Shock mount on Upper-A-Arm
  - Rear Shocks
- Coil-over spring rate
  - Discussion with shock vendor
  - Vehicle weight range (400-500 lbs)

Old Car

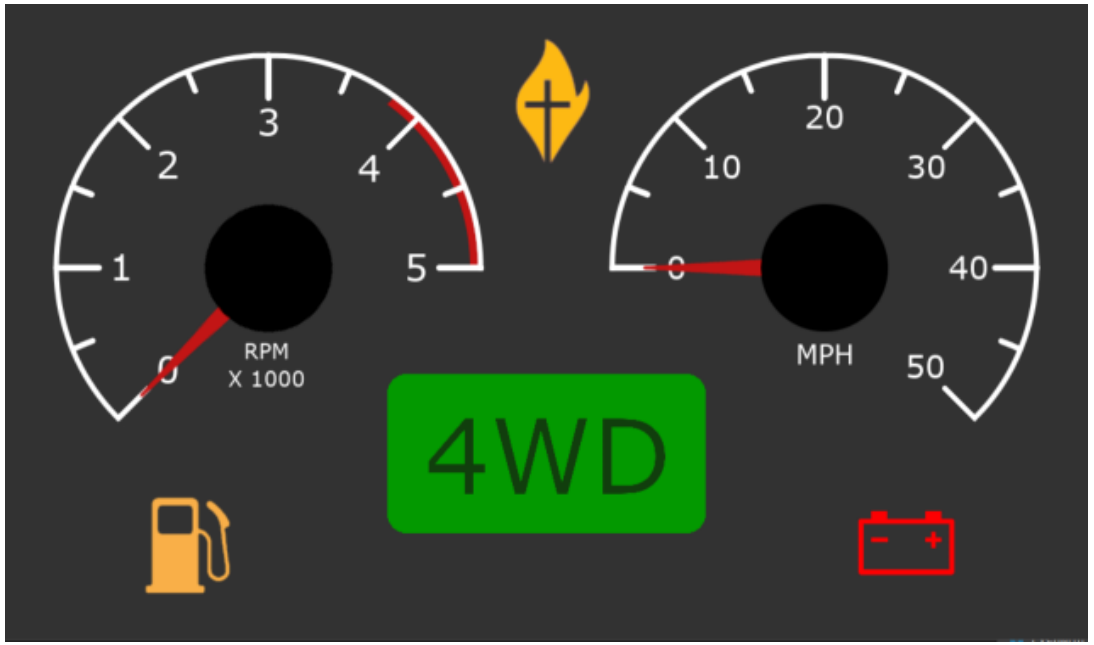
New Car

Bump-Steer Issue

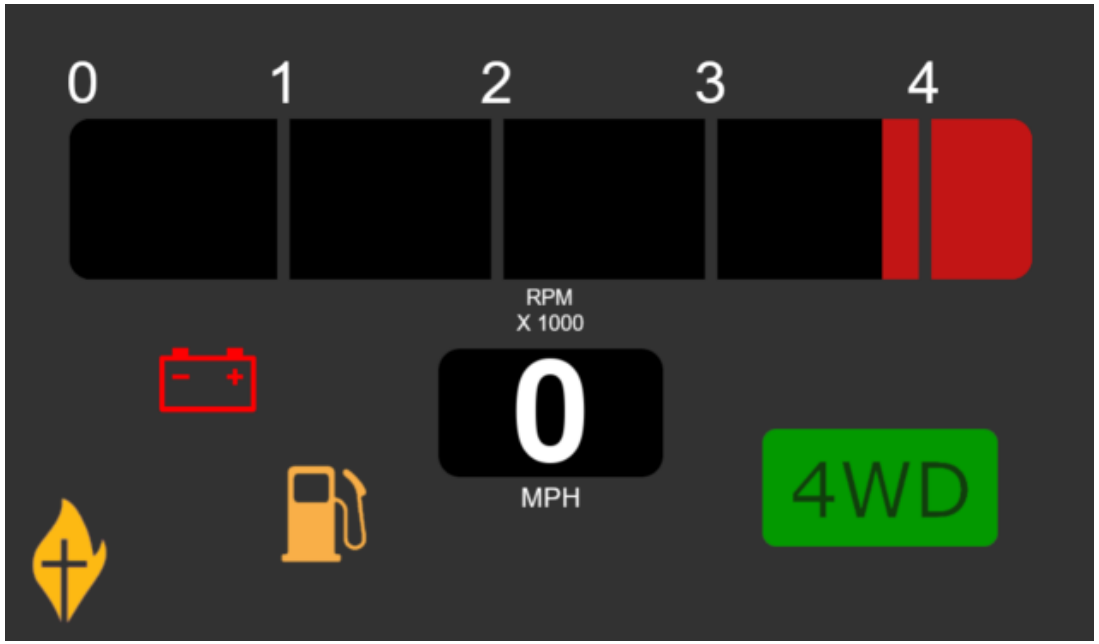


Instrumentation Package

Standard Gauges

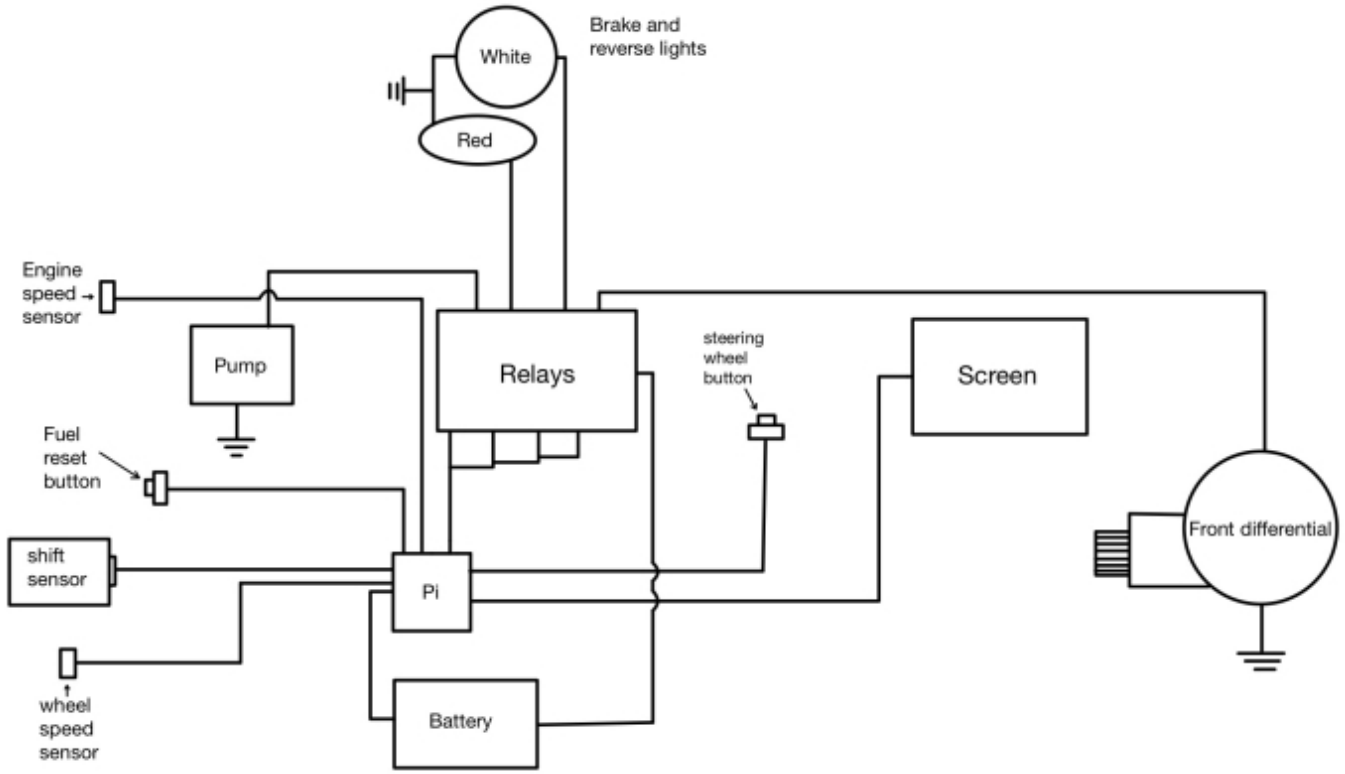


Modern Bar



Instrumentation Package

Wiring Diagram



Design Testing

- Not Yet Complete
  - Need to be considered safe
- Will be testing:
  - Speed
  - Acceleration
  - Climbing Ability
  - Durability
- Competition

Challenges faced

- Long lead times for part availability
- Implementing a functional 4WD system
- Solve problems that the old car had
  - Bump steer
  - Suspension sag
  - Shifter design
- Time management
- Cost management
- SAE Documentation

Goals Accomplished

- Fully functioning 4WD system
- Under budget
- Instrumentation Package
- Bump Steer
- Updated Shifter

Goals to Come

- Testing machined CVT hubs
- Drive and test the car to prepare for competition
- Paint car
- Pass technical inspections at competition
- Perform well at competition

Special Thanks

- Olivet Nazarene University Engineering
- Dr. Schroeder
- Kristie Schultz
- Walker Manufacturing
- Ability Engineering Technology
- Olivet Baja Club

Questions?

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