

SAE Baja - Front Suspension Team



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SAE Mini Baja

Common Denominator

- Engine Size
- Max Track Width

Dynamics Events

- Maneuverability
 - Tight turn course
- Acceleration
- Breaking
- Rock Climb
 - Wheel travel
- Endurance
 - 4 hour
 - Variable terrain



Front Suspension and Steering

Objectives:

Front Suspension

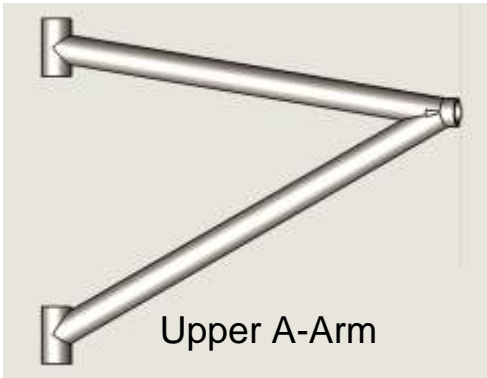
1. Design robust suspension components
2. Simplify suspension design
3. Maintain proper wheel geometry throughout travel
4. Reduce weight

Steering

1. Curb-To-Curb Turn Radius of 10 ft
2. Lock-to-Lock Steering Wheel Rotation of 360°
3. Improve geometry to reduce bump steer
4. Reduce understeer



A-Arm Geometry

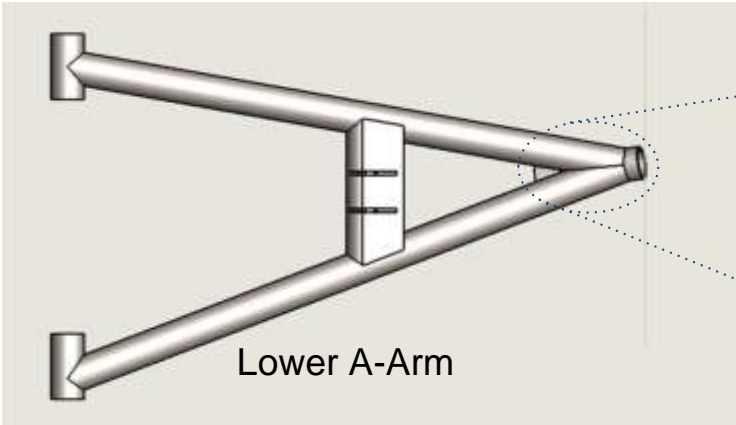


Upper A-Arm

Design Goals

- Simple geometry
- 10" ride height
- Threaded ball joints
- Jig and cope manufacturing process

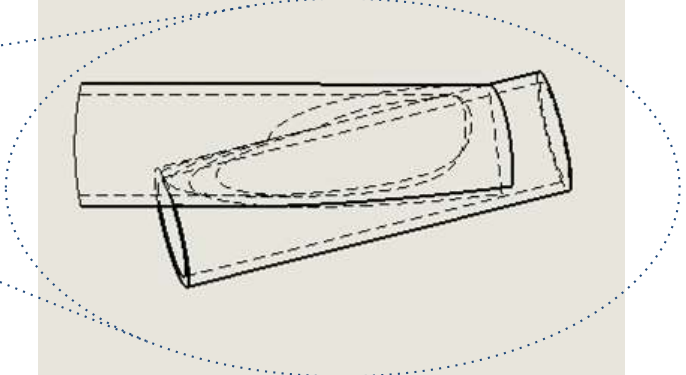
Design Challenges



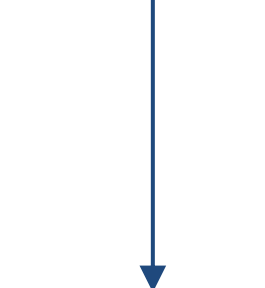
Lower A-Arm

Top View

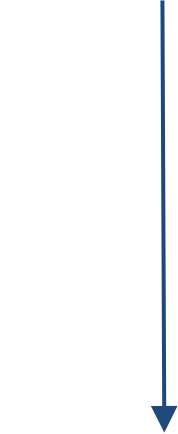
- Coping at ball joint attachment



Front View



Front of Vehicle



A-Arm Material Selection

Lower A-Arm

Material: **4130 Chromoly**

- good weldability

Dimensions: **1"OD x 0.065" Wall tubing**

- bushing selection
- tapped ends for ball joints

Weight: **1.86 lbs/A-Arm** (0.6576 lbs/ft)

Upper A-Arm

Material: **4130 Chromoly**

- favorable strength:weight ratio
- good weldability

Dimensions: **1"OD x 0.065" Wall tubing**

- tapped ends for ball joints
- capable of 2.5G load

Weight: **2.81 lbs/A-Arm** (0.6576 lbs/ft)



Manufacturing

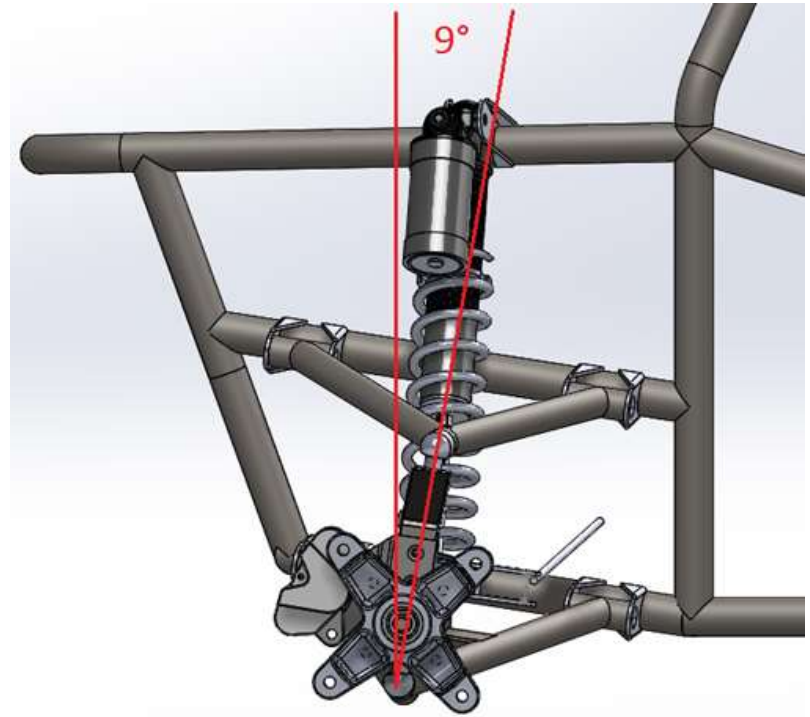
- A-Arms
 - Jigs
 - Upper and lower A-arm jigs to hold mounting points in correct locations
 - Hand coped tubing
 - 100% student welded
 - Ball joint sleeves
 - Turned, threaded, and back drilled by students
 - Mounting Tabs
 - Water Jet Part
 - Fitted for each arm
- Steering Mechanism
 - Rack Extensions
 - Machined equal lengthed extension pieces by students
 - Drilled and tapped by students
 - Clevis Head
 - Turned down to length and tapped by students
 - Tie Rods
 - Turned down to length, drilled and tapped by students



Suspension Geometry

Caster ($\sim 9^\circ$)

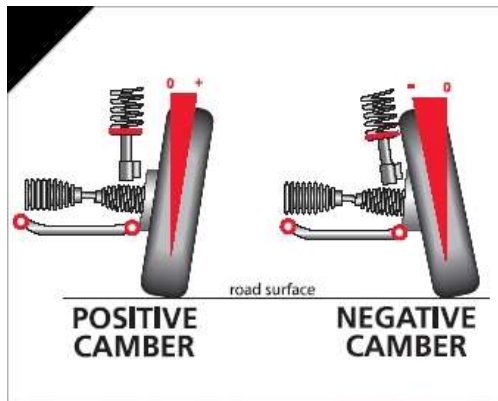
- A large positive caster angle will cause the steering to feel heavy at low speeds yet makes the vehicle stable at high speeds.
- A small positive caster angle makes the vehicle steer easily at low speeds at the forfeit of high speed stability.



Suspension Geometry

Camber (adjustable)

- Adjustable via threaded 90° ball joints.
- Negative camber will cause the vehicle to be more stable at speed as well as increase cornering ability compared to 0°.



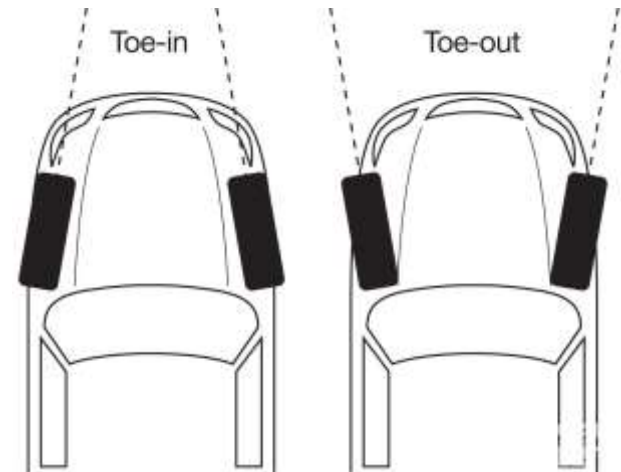
Source: www.bestcoiloverguide.com



Suspension Geometry

Toe (adjustable)

- Adjustable via steering links
- Toe-in causes high speed stability and initial understeer in a corner.
- Toe-out causes high speed instability and initial oversteer in a corner.



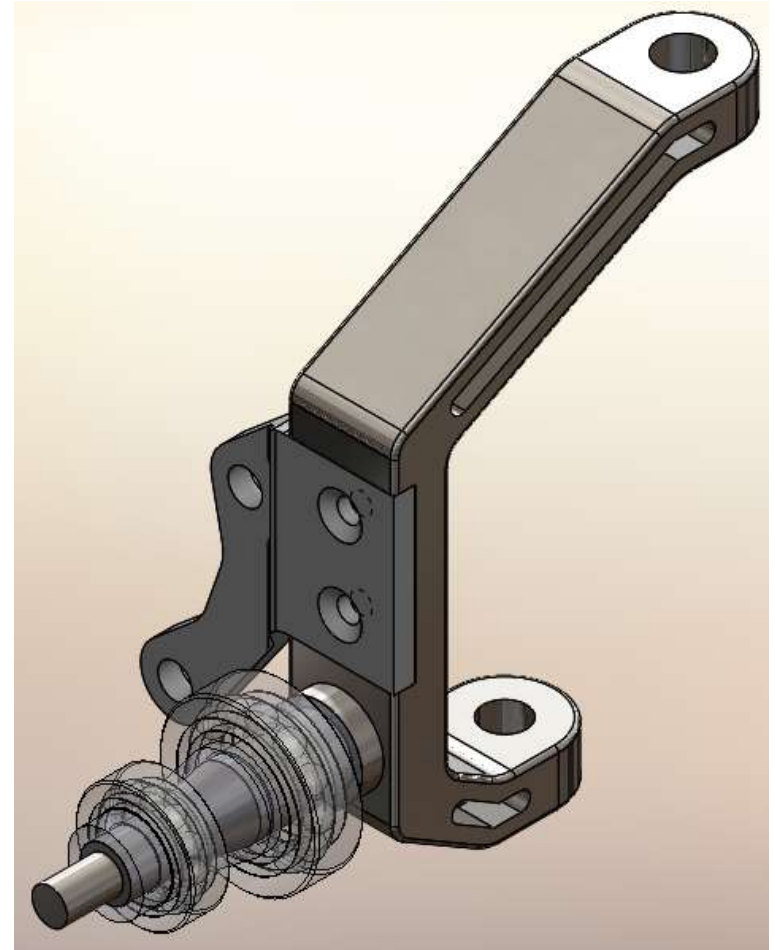
Source: www.superstreetonline.com

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Spindle Fork

- 1018 Steel Spindle Fork
 - CNC Machined
- 1018 Steel Spindle Shaft
 - Designed to fit Polaris 525 front wheel bearings
- Tapered Ball-Joint Mounts



Spindle Assembly

- Bolt on caliper mount
- Polaris Outlaw 525 Hub
- Adjustable tie rod mounting



Steering Angle

- Steep enough steering angle to achieve 10 foot curb-to-curb turn radius.
- Using the equation below to solve for average steering angle.

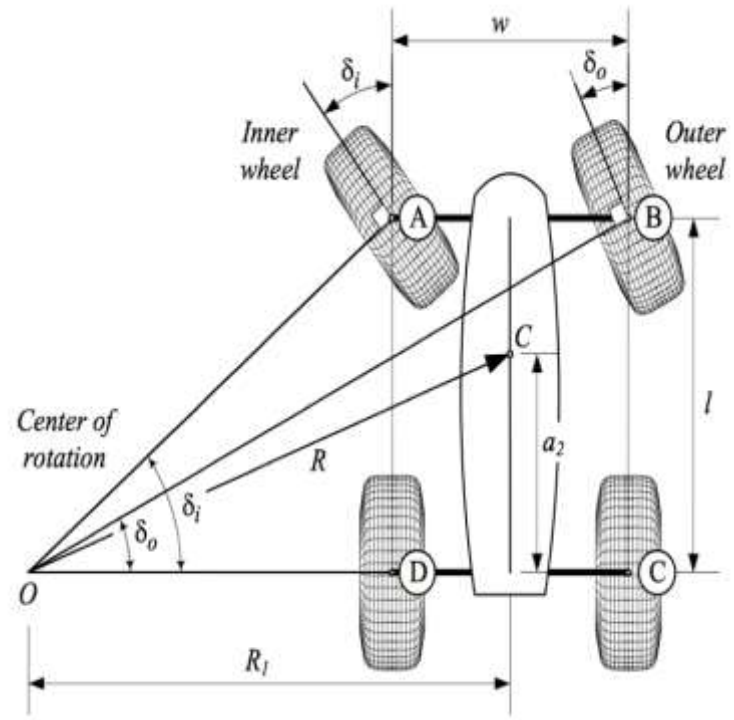
$$\cot(\delta) = R_1 * L$$

$$\delta = 37^\circ$$

- Ackerman Angles (From Model)

$$\delta_i = 41.1^\circ$$

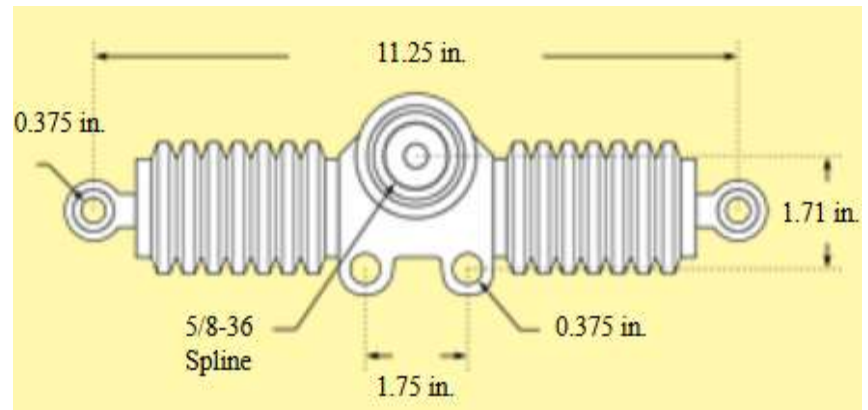
$$\delta_o = 33.2^\circ$$



Rack and Pinion Set-Up

Positives:

- Cost effective
- Lightweight
- Manufactured for Mini-baja
- 315° lock-to-lock
- Achieves Curb-To-Curb Turn Radius Objective
- Throw Length: 4.50"

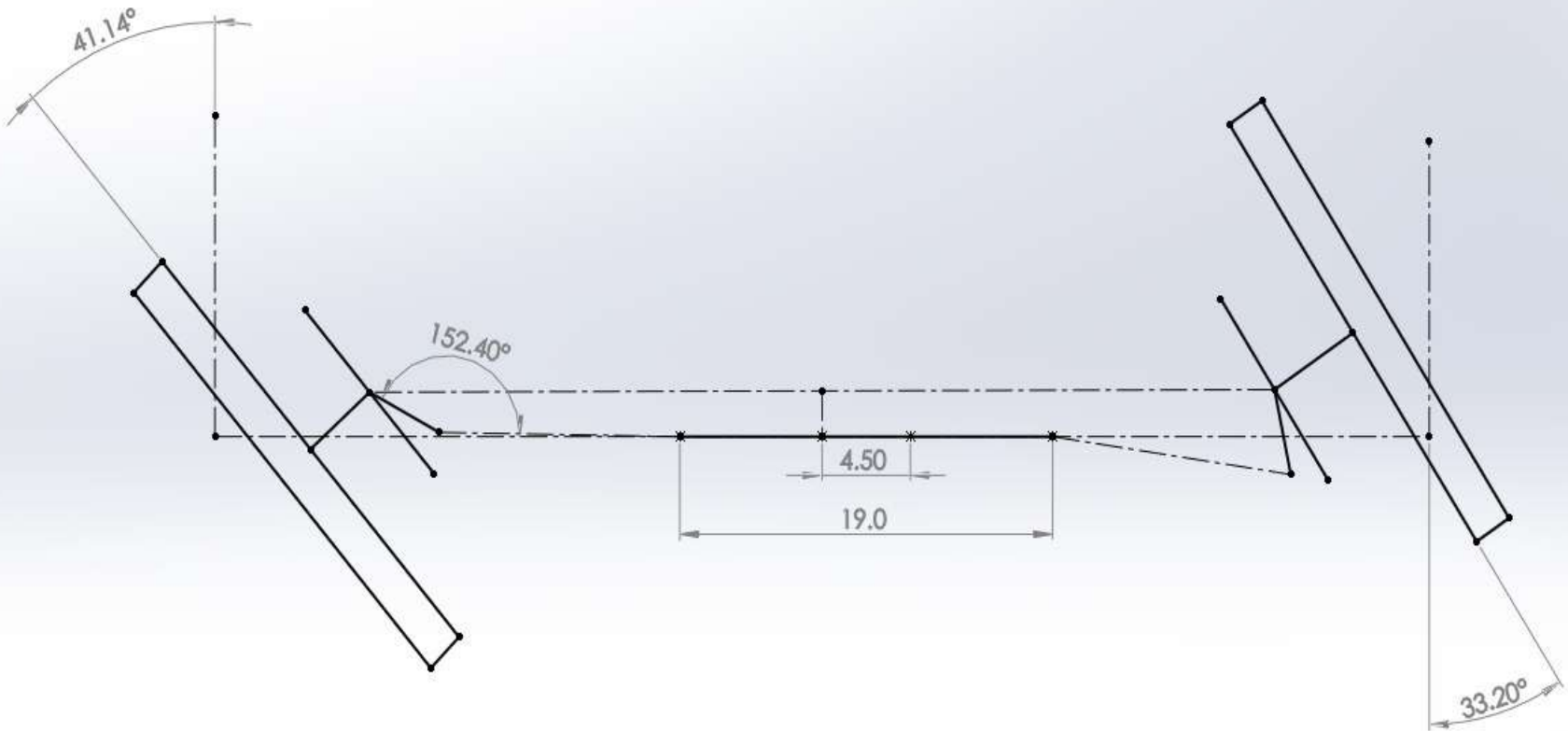


Negatives:

- Overall rack length



Steering Model



Steering Design



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