

# Let 'R Buck Racing Steering Team

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# Objectives

- Eliminate bump steer
- Reduce turning radius
- Eliminate Ackerman angle
- Relocate rack and pinion

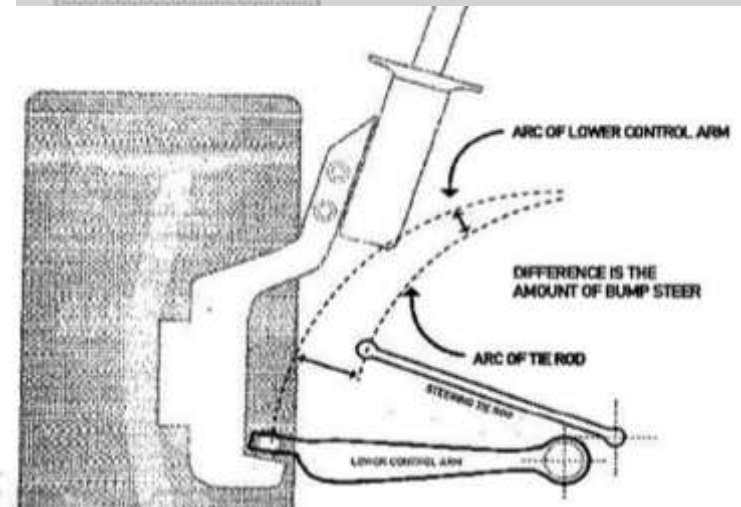
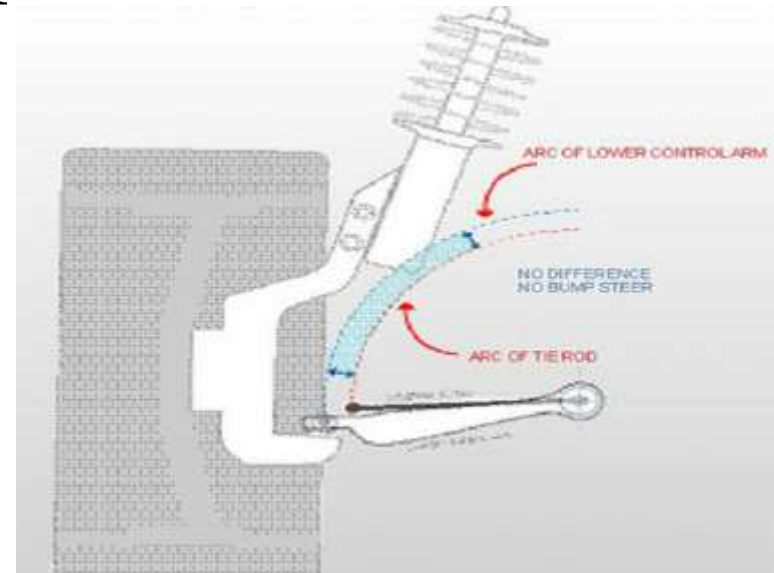
# Design Considerations

- Placement of rack and pinion
- Actuator rod/spindle assembly
- Geometry of tie rods
- Strength of materials (failure)



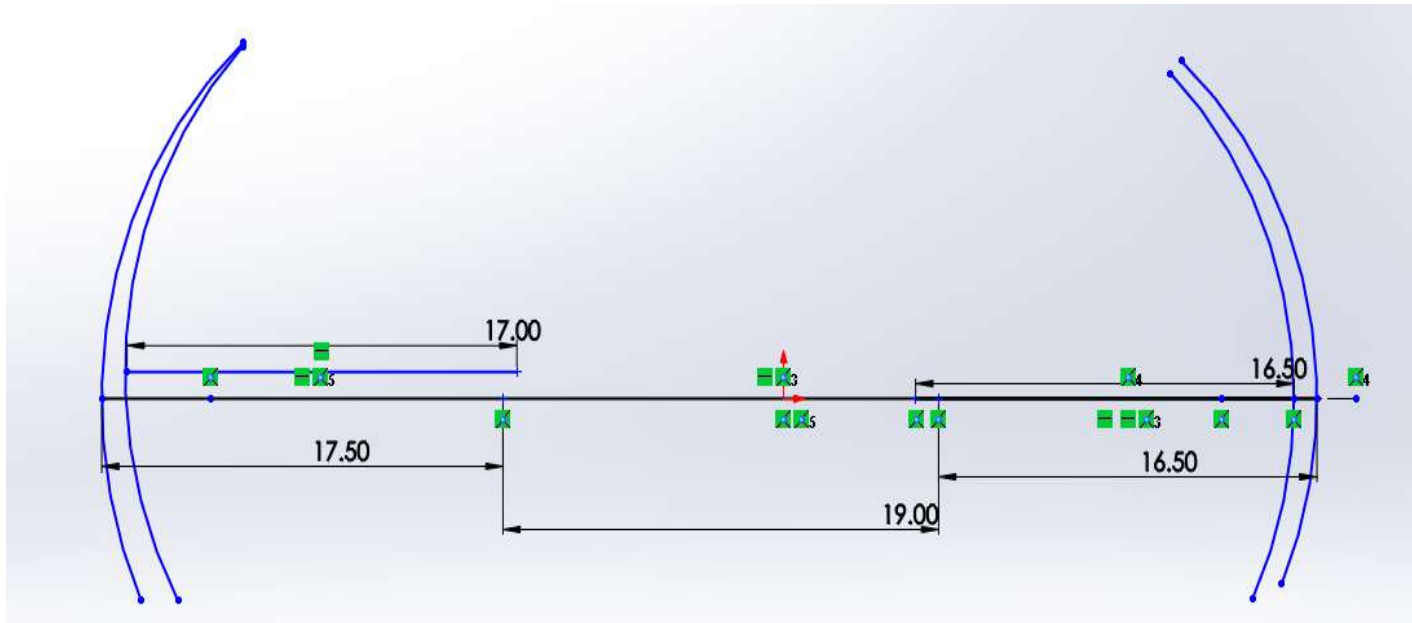
# Avoiding bump steer

- Design the tie rod and the A-arm to rotate about the same axis on the same plane of action.
- Concentric arcs demonstrate the path of the two pivot points of equal distance.



# Bump steer improvement from last year

- The change in distance between the two arcs indicates bump steer. Left:2015 baja. Right:2016 baja



# Turning Radius

- Objectives:

Reduce turning radius to the smallest sweep a vehicle can pivot.

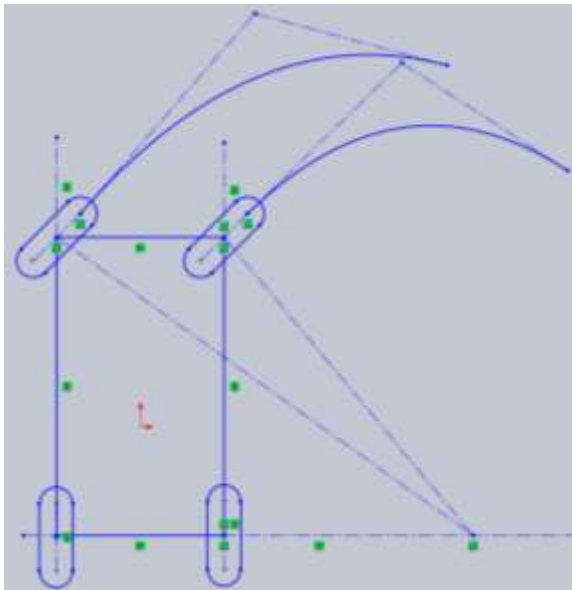
- Achievements:

- Reduced turning radius from 15 feet to 7.5 feet.
- Can use a cutting break to achieve a turning radius of 7.2 feet.

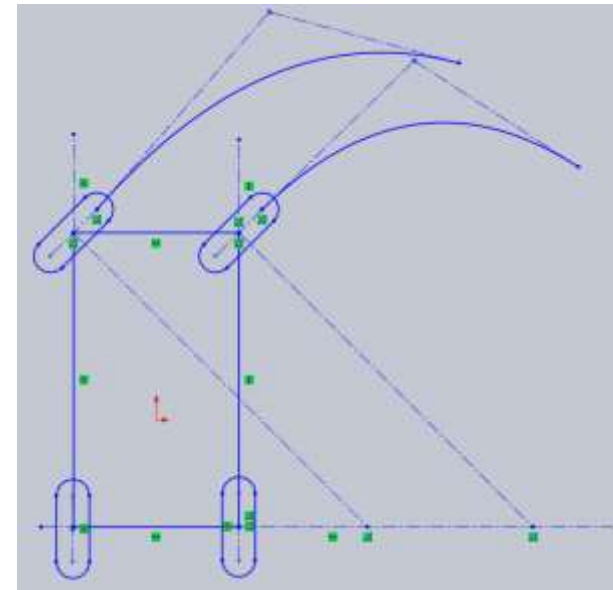


# Turning Radius

Goal R = 7.5 ft			
	$\delta_i$ (Inner)	$\delta_o$ Outer	R
Ackerman angle	49.9°	29.9°	10.8ft
Without Ackerman angle	50°	50°	7.5ft
Cutting break	N/A	N/A	~7.2ft



With Ackerman



Parallel steering



# Increase Cockpit Space



- Keep the cockpit free for driver
  - Comfort, safety, and performance
- Relocation of Rack and pinion
- Ideas
  - Move rack and pinion above the driver's feet
  - Move rack and pinion in front of driver's feet
  - Lower rack and pinion
- Final Decision
  - Lowered and relocated rack and pinion



# Actuator rod/spindle assembly

- Avoid buckling
- Not cause Ackerman angle
- Produce a smooth parallel turning system

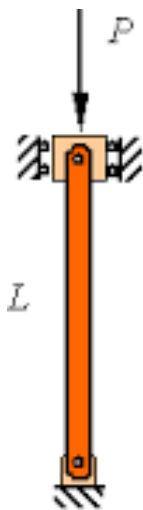




# Tie Rods Robustness

## Yield of aluminum connector rods

- Axial load,  $P_{cr}$ , of 280 Lbs.

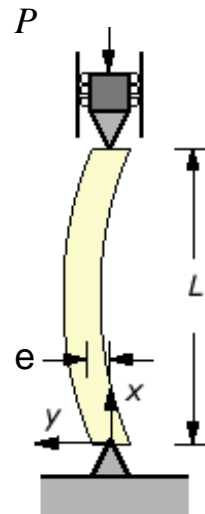


$$P_{cr} = \frac{\pi^2 EI}{L^2}$$

$$I = \frac{\pi r^4}{4}$$

## Yield of steel tubing connector rods

- Axial load,  $P_{cr}$ , of 490 Lbs.
- Robust design while not compromising weight.



$$P = F_y \left( \frac{S}{e} + A \right)$$

$$S = \frac{I}{C}$$

$$A = \pi(r_o^2 - r_i^2)$$



# Budget and Cost

- We planned on a \$500 budget
- Actual costs for modifications were much less

Actual Cost	
Component:	Price:
U-Joints	\$151.78
Tie-rod Tubing	\$72
Total	\$223.78



# Conclusion

## Objectives

- Eliminate bump steer
- Reduce turning radius
- Eliminate Ackerman angle
- Relocate rack and pinion



## Final Results

- Minimal bump steer
- Reduced from 15' to 7.5'
- Minimal Ackerman angle, less than 2 degrees of Ackerman
- Lowered the rack and pinion by 1.5" and relocated it 4" forward for optimal space



# Questions??

