SAE Baja: Concept Generation & Selection

Suspension and Steering

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Wednesday, October 30, 2013

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Introduction

Client: Dr. John Tester

- Problem Statement:

  Design and build a safe, maneuverable, and versatile vehicle for competition use.

- Goal:

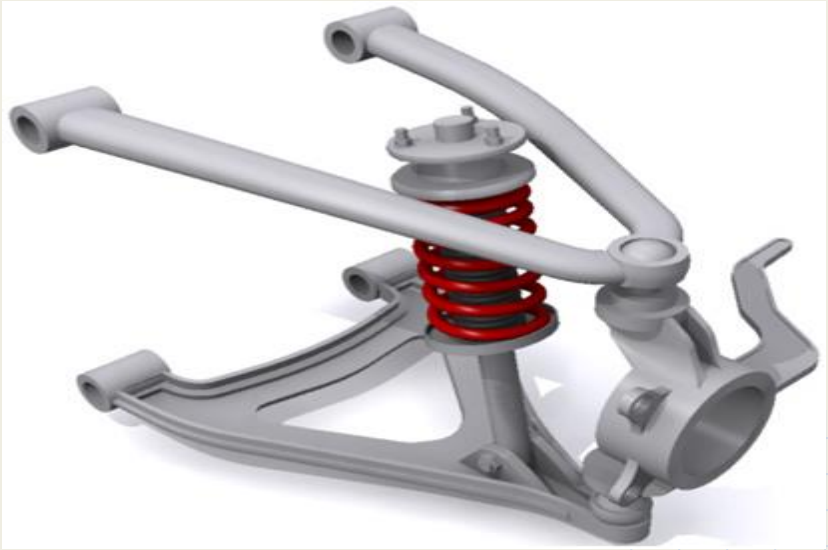
  Design a suspension and steering system that will meet the demands of off road racing.

Suspension Concepts

- 4 Designs truly considered
  - Dual A-arms (front and rear)
  - Twin I-beam (front)
  - Semi-trailing arms (rear)
  - Solid Axle (rear)
- Design that did not make it past preliminary choosing process
  - Twin Trailing Arm (front)

Suspension Design 1 (Front & Rear)

- Independent Suspension
- Advantages
  - Lightest weight
  - Alignment control throughout travel
- Disadvantages
  - Easier to break (mostly due to CV axles)



Source: CarBibles

Suspension Design 2 (Front)

- Equal I Beams
- Advantages
  - Allows for maximum travel
  - Best articulation
- Disadvantage
  - Susceptible to bumpsteer
  - Radical camber change
  - Uneven tire wear due to camber wear

Source: HM Racing Design

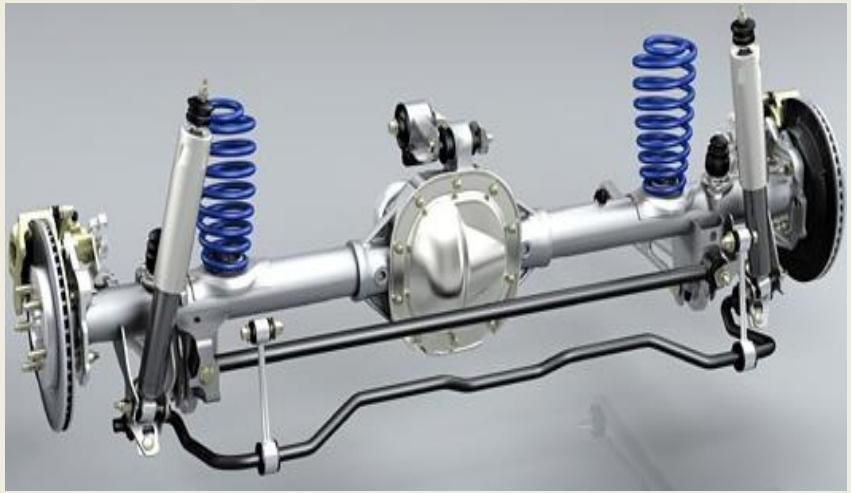
Suspension Design 3 (Rear)

- Trailing Arm
- Advantages
  - Lots of travel
  - Truly independent
  - Strong
  - Simple
- Disadvantages
  - Camber is static
  - Handling suffers at limit

Source: SAEBaja.net

Suspension Design 4 (Rear)

- Live Axle/Solid Rear Axle
- Advantages
  - Tough
  - Simple design
  - Good articulation
  - Reliable
- Disadvantage
  - Large unsprung weight
  - Wheels are not independent



Source: Motor Trend

Decision Matrix (Suspension Front)

Table 1: Suspension Decision Matrix (Front)

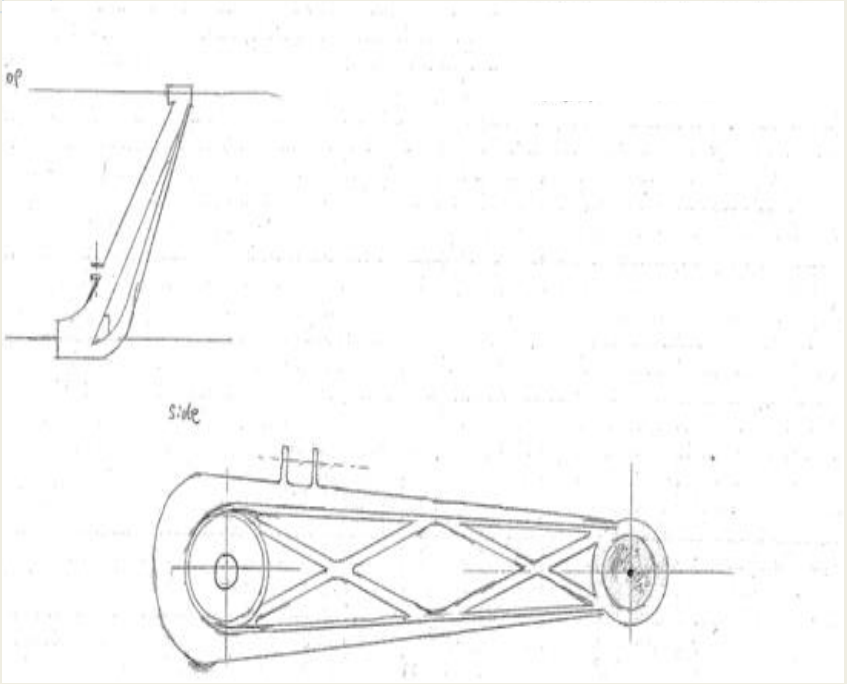
Requirements	A Arm	Equal I Beam	Solid Axle
Simplicity (0.20)	4	4	5
Reliability (0.30)	4	4	5
Weight (0.30)	3	2	1
Cost (0.20)	4	3	2
Totals	3.7	3.2	3.2

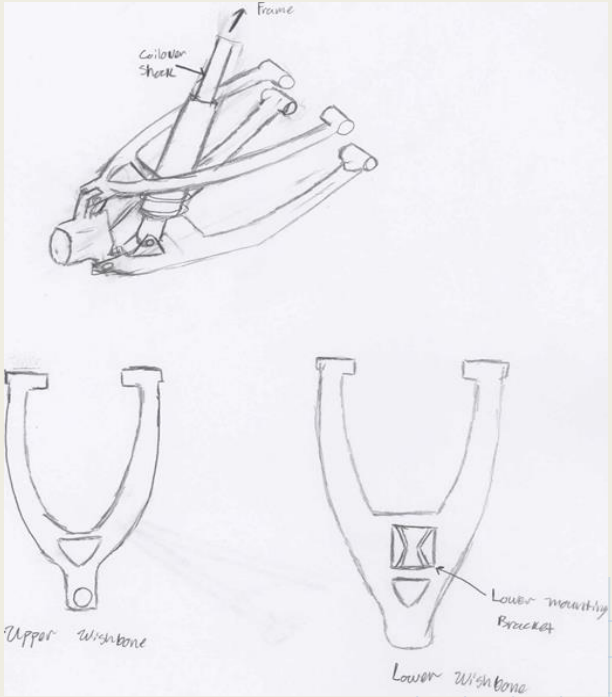
Decision Matrix (Suspension Rear)

Table 2: Suspension Decision Matrix (Rear)

Requirements	A Arm	Solid Axle	Trailing Arms
Simplicity (0.20)	3	4	4
Reliability (0.30)	3	5	3
Weight (0.30)	4	1	4
Cost (0.20)	4	2	4
Totals	3.5	3.3	3.7

Final Design (Suspension)





Steering Concepts

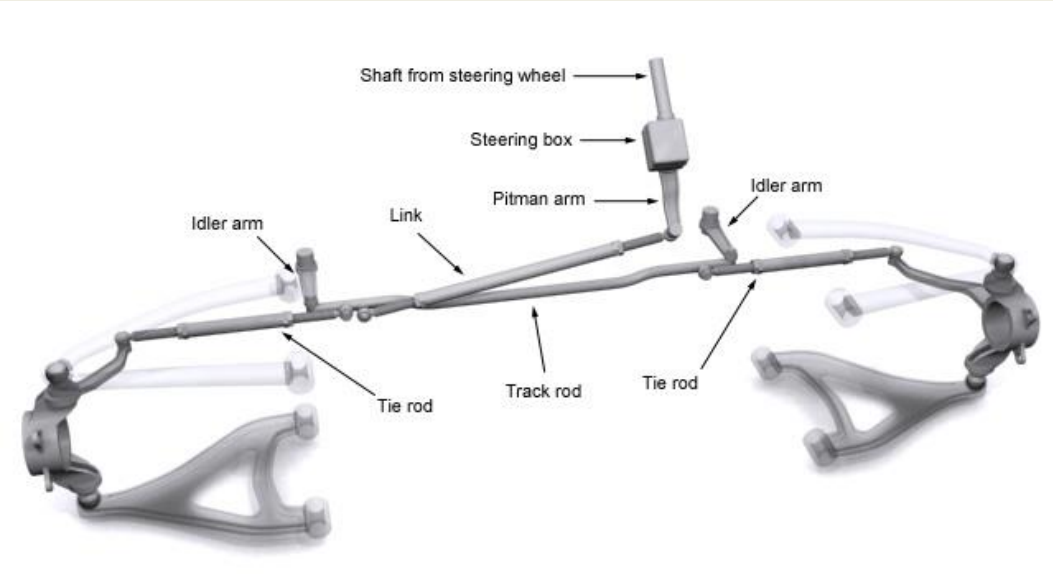
- 3 Designs considered
  - Pitman arms
  - Rack & pinion
  - Steer-by-Wire

Steering Design 1

- Pitman Arm Steering Assembly
- Advantages
  - Easily repaired
  - Robust
  - Strictly Mechanical Components
- Disadvantage
  - “Dead Spot”
    - Response time

Steering Design 1

- Pitman Arm Steering

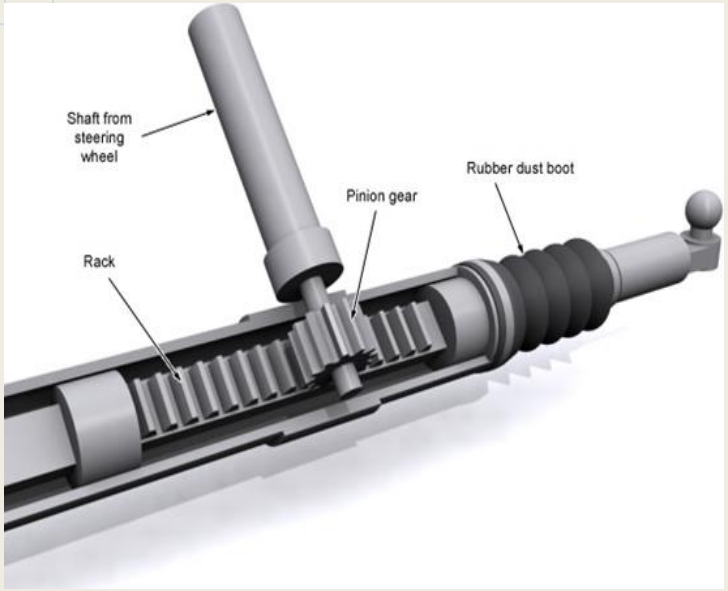


Source: CarBibles

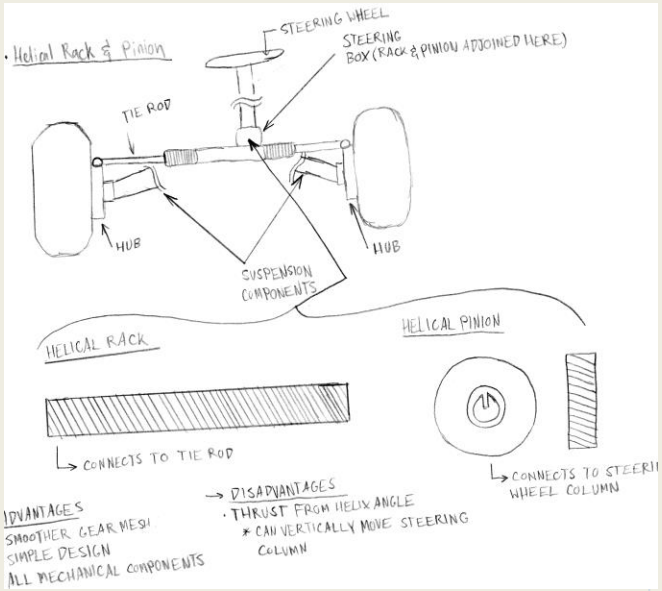
Steering Design 2

- Rack and Pinion
- Types
  - Helical
  - Spur
- Advantages
  - Smooth gear Meshing(Helical)
  - Simple mechanical design
- Disadvantage
  - Steering Column Thrust Load(Helical)

Steering Design 2



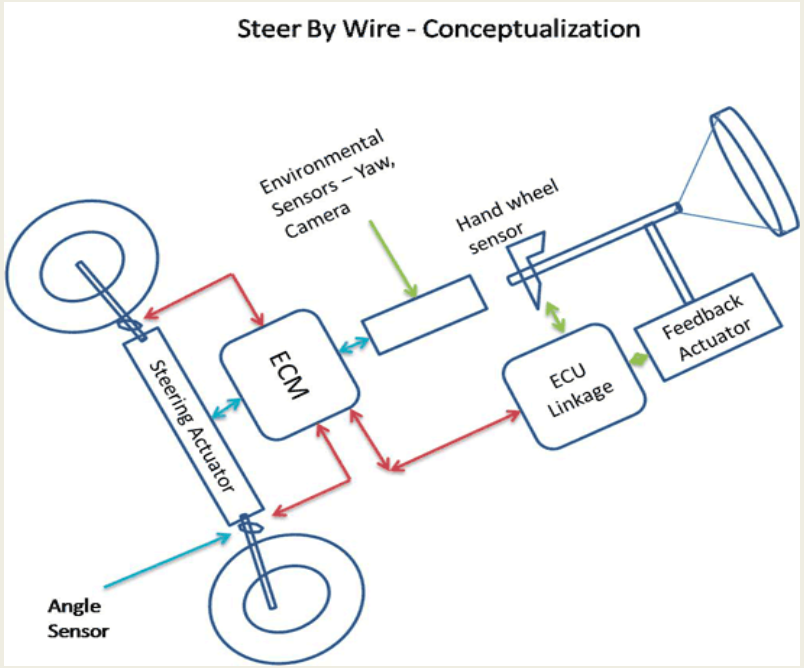
Source: CarBibles



Steering Design 3

- Steer by wire
- Advantages
  - Lightweight
  - Advanced Electronic Traction and Stability control
- Disadvantage
  - Precise programing
  - Needs watertight connections
  - Needs to be well grounded

Steering Design 3

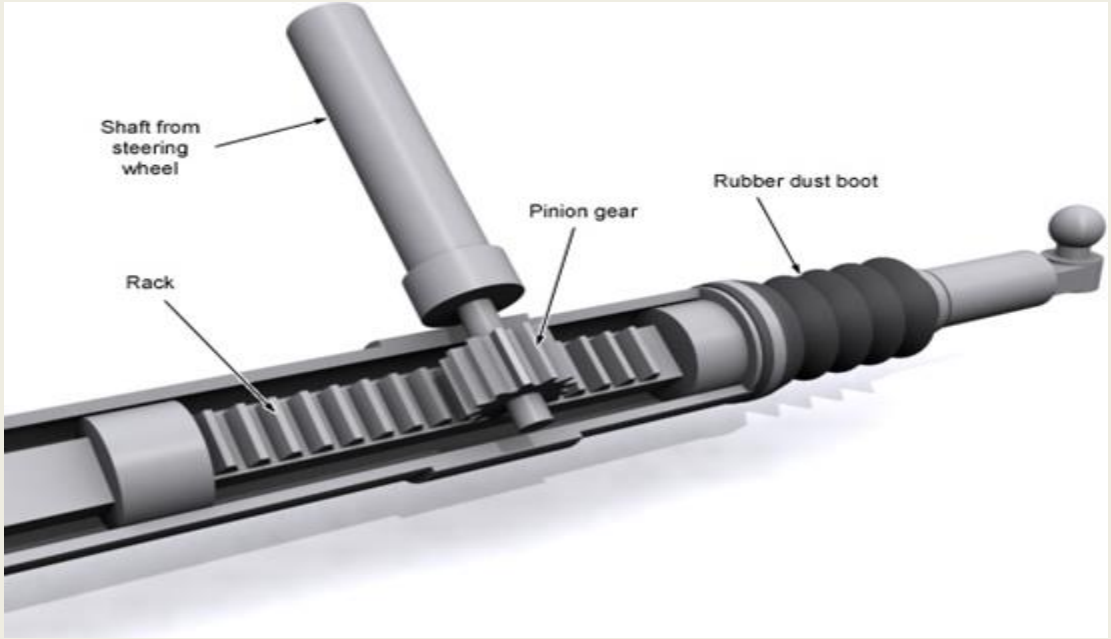


Source: Cvel Clemson

Decision Matrix (Steering)

Requirements	Rack & Pinion	Pitman Arm	Steer by Wire
Simplicity (0.20)	5	4	2
Reliability (0.30)	4	5	2
Weight (0.30)	4	3	3
Cost (0.20)	4	3	1
Totals	4.2	3.8	2.1

Final Design (Steering)



Source: Car Bibles

Conclusion

- Front and Rear Suspension Concepts
  - Double A-arm (independent)
  - Solid Axle
  - I-Beam
  - Trailing Arm
- Steering Design Concepts
  - Rack & Pinion
  - Pitman Arm
  - Steer-by-wire
- Final Suspension and Steering Concepts
  - Trailing Arm/A-arm
  - Rack & Pinion

References

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