MECHANICAL REPORT

SIMPLE

TO THE POINT

FREE BODY DIAGRAMS

PICTURES

MODELS

ETC

Background/qualifications:

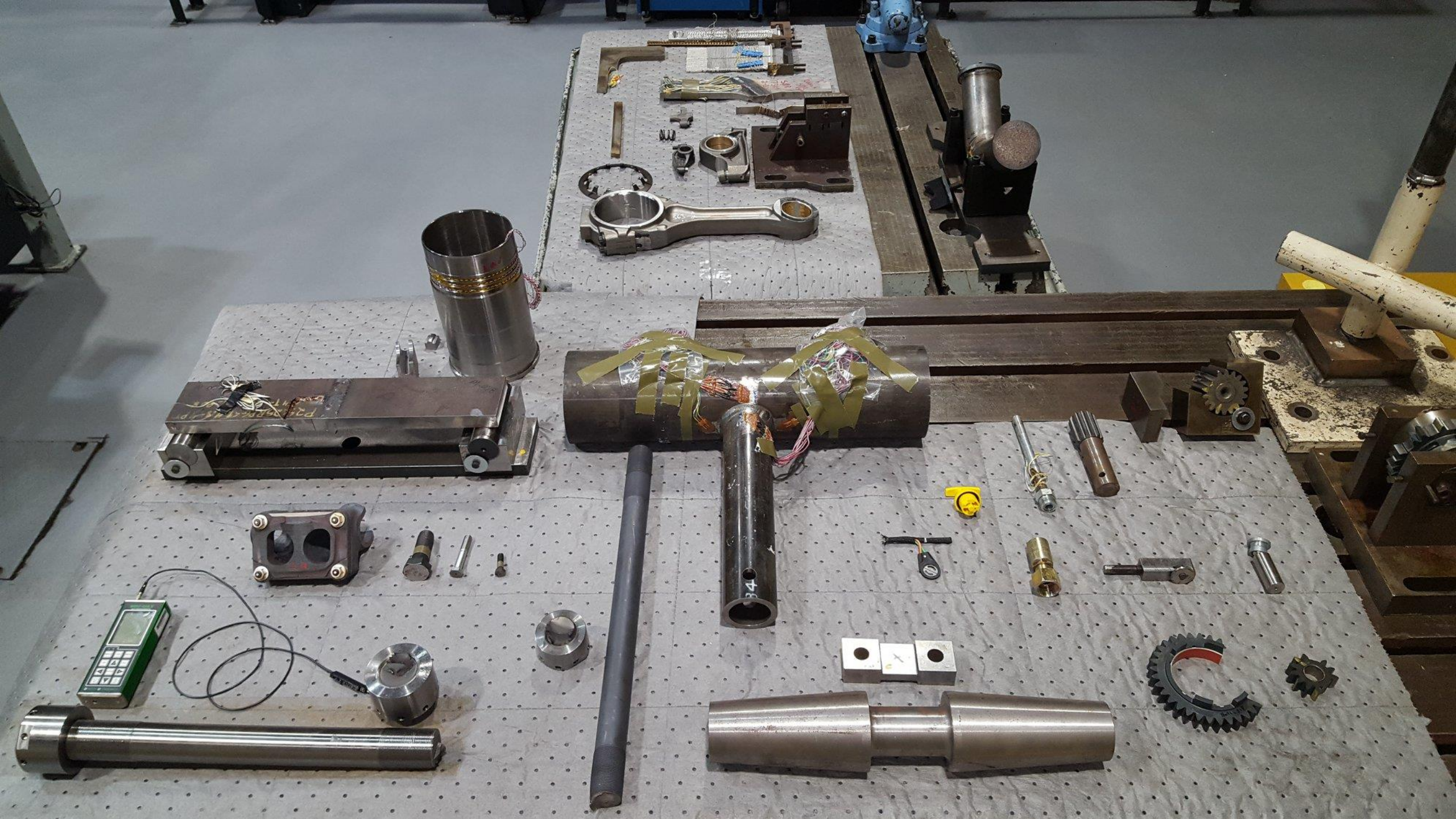
Mechanical Engineer: BS & MS- focused on fatigue & fracture

Solar Car Alumni: 1996 thru 1999 as a student before coming staff in Sunrayce 99
- Driver's station, Corner Worker, Check Point Crew, Dynamics Inspector, Roaming Inspector
- WSC Body & Sizing station 2007

Caterpillar:
- Undercarriage Design 4 years
- Component Fatigue & Bolt joints 18 years. Engineering Project Team Lead
  - 20 load frames ranging from 6 - 2,500 Kn tension compression (~350 TONS)
  - 87,000 Nm torsion
  - Clamp load studies (torque turn & ultrasonic bolts to measure clamp load)
  - Fixture design, test planning, results & recommendations
    - Almost all tests are one-off never done before
  - Data acquisition (MTS Flex Test & Somat Edaq)

Basically, I break nearly everything I touch!

I am NOT featured in a Hot Wheels action pack!



Mechanical Report Basics

Number your pages & diagrams/figures/pictures (easy reference for review) Maximum 30 pages

Units: Pick ONE!

ROUND- significant digits

Vehicle layout- Steering, driver, batteries, ballast, motors, brakes, CG etc

Free body diagrams- labels, assumed loading direction, forces & moments

Dimensions/ Cross sectional area: moment of inertia in bending direction of interest

Rod eye: cross sectional area of threads calculation/table

Material properties: Source? Weld allowable for fatigue areas under FS 2.0

Roll Cage: No composites (carbon fiber, Kevlar, fiberglass)

Wheel Assembly cross section: How do all the parts fit together

Roll Cage

Material Property as WELD with YOUR methods

Example: 4130 tubing can achieve 120 Ksi yield strength, though welding can remove these enhancements if too much heat is applied

Mounting method (bolt, weld, bonded- will require supporting data)

Loading analysis matrix- Appendix F3.3

3D elements for FEA to capture the complex geometry
Simulated impact bumper impact along the entire occupant cell
MUST include the whole roll cage

Panel deflection- front hoop angled back – decapitation protection

Clearances to the helmet

Helmet to stay INSIDE the cage during a roll over event

Netting NOT permitted

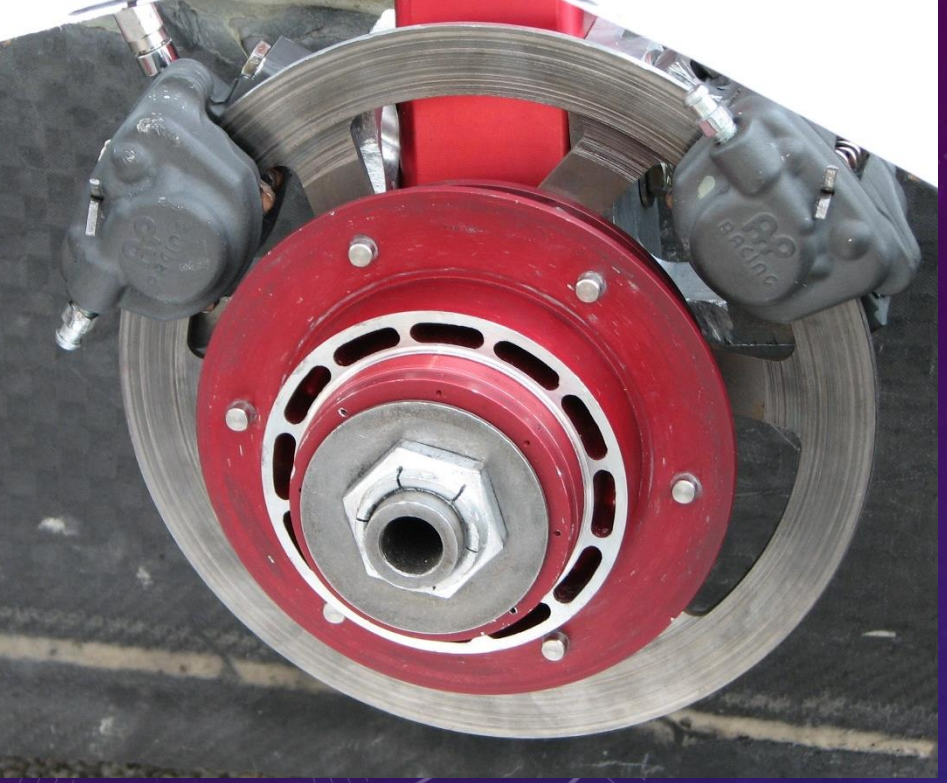
BOLTS!

- Mechanical securing:
  - A) Flex loc or Fuiji nuts (or similar)
    - must not damage threads
  - B) Mil spec twisted wire tie
  - C) Cotter key & castle nut
  - D) Bent tap against FLAT of a hex bolt head

- Hub Nuts must be secured

- No set screws to pre-load threads permitted

No loc-tite permitted or pinch set screws



Brakes!

Contact patch calculation
- meet the minimum area required for each pad

Slave cylinders:
- retractable?
- mounting method- bending moment accounted for in load analysis?

Brake Pedal
- Right foot only
- Balance method when using 2 master cylinders
  - consider load path when 1 system loses pressure
- Load path back into chassis
- Pivot points must be smooth (no rotation against threads)
- Force on pedal to stop in time vs lock up?
  - Method to ensure front wheels will lock before rear?

Brake System Layout
- Top view of car showing primary brakes, e-brake & line path
- include balance valve location & securing method (NOT MOUNTING)

Material Strength: Composites

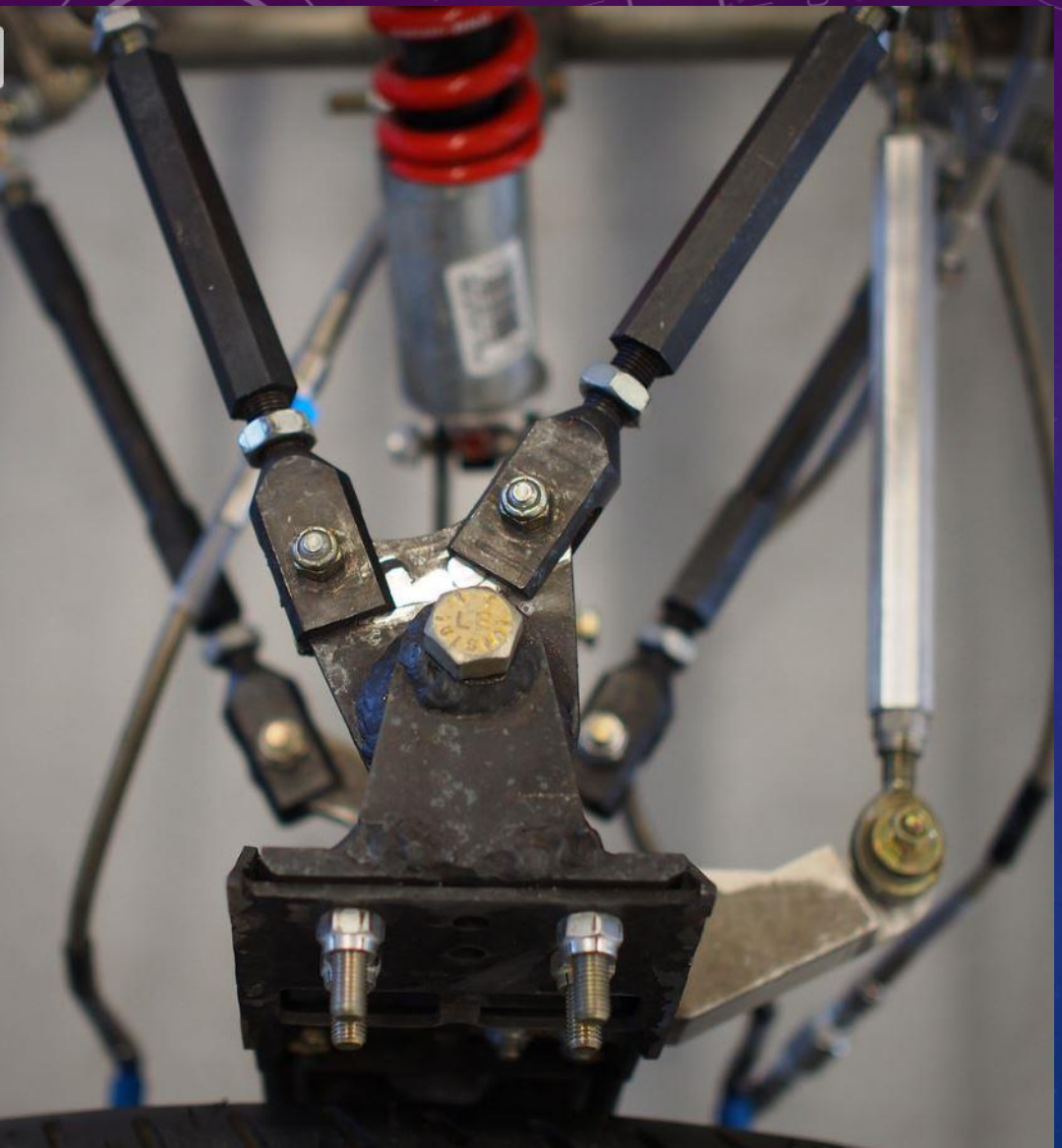
Composites: Kevlar, fiberglass, carbon fiber

Supporting material strengths for similar geometry & loading direction
weave type & direction cloth weight, core type epoxy cure methods

Suspension components: Threaded insert pull out strength!
Positive engagement allowed

Can be a SIMPLE test coupon, sand/rope/scale.

Mechanical Design Considerations



Rules are the MIMIMUM for design loads with no yielding
- 1-2-1 1G Brake, 2G Bump, 1G side loading
- 1x1 “board” causes at least a 10 G bump at 15 mph

Yield strength and deflection!

Bearing surfaces should be smooth- no all thread on pivot points!

Force inputs from drive: think panic situations aka Brake test!
- How much force from driver’s leg?

Pressure ratings for brake lines & fittings?
- nylon lines should have tube insert for ferrule to crush against

Alignment: Method? See also Evan & Bill!

Bearings: drag from grease- smaller diameter more efficient?