Off network content for approval ☺

REV	DATE	DESCRIPTION
A	30_May_23	

LAST EDITED
1-Oct-21

PP Summary

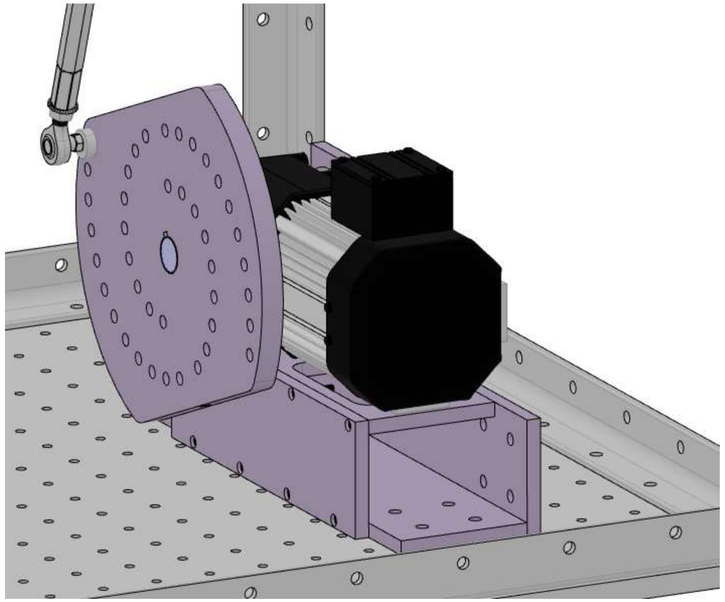
Ran out of time to make proper school presentation.

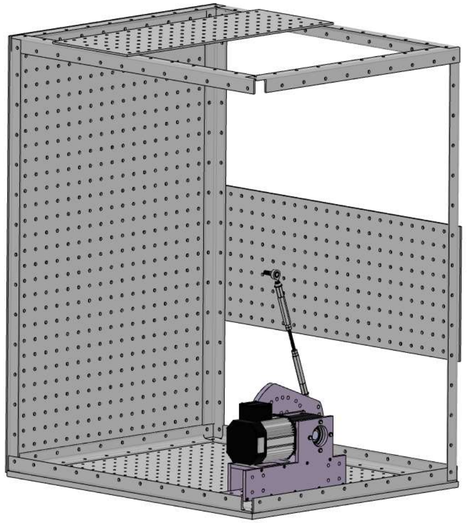
PP includes slides form internal presentations & pictures of the rig

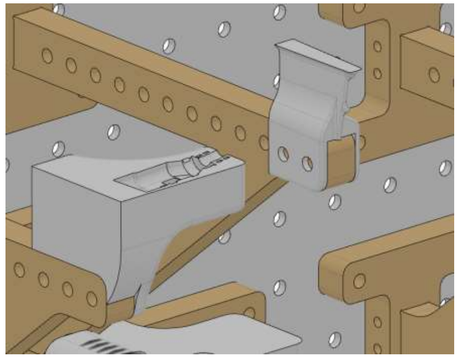
For approval to send off network

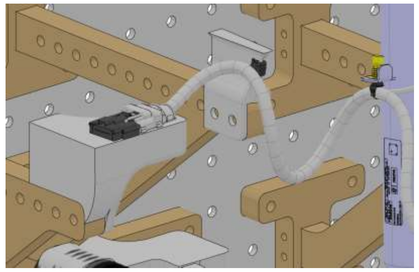
Includes

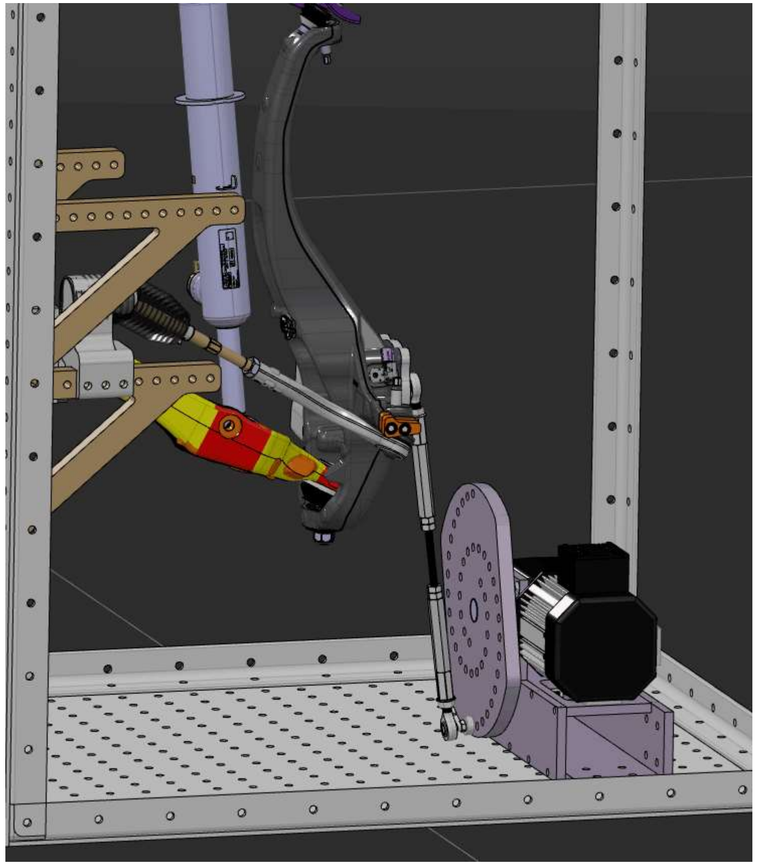
- Stroke testing rig
- Potential M3 mass down rr upper fore link
- CT aeroshield
- CT harness bracket (old)

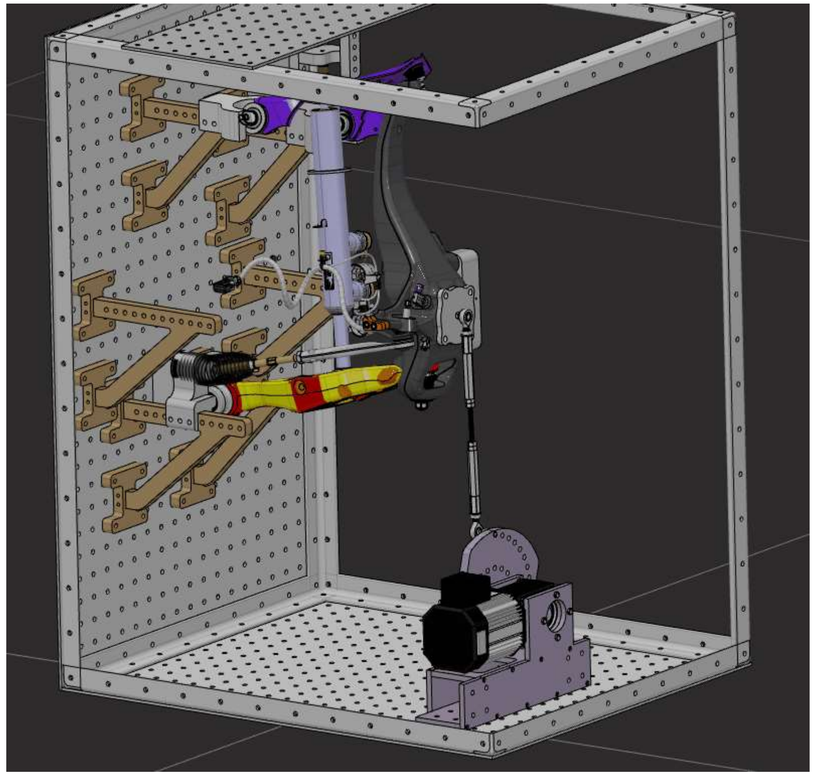


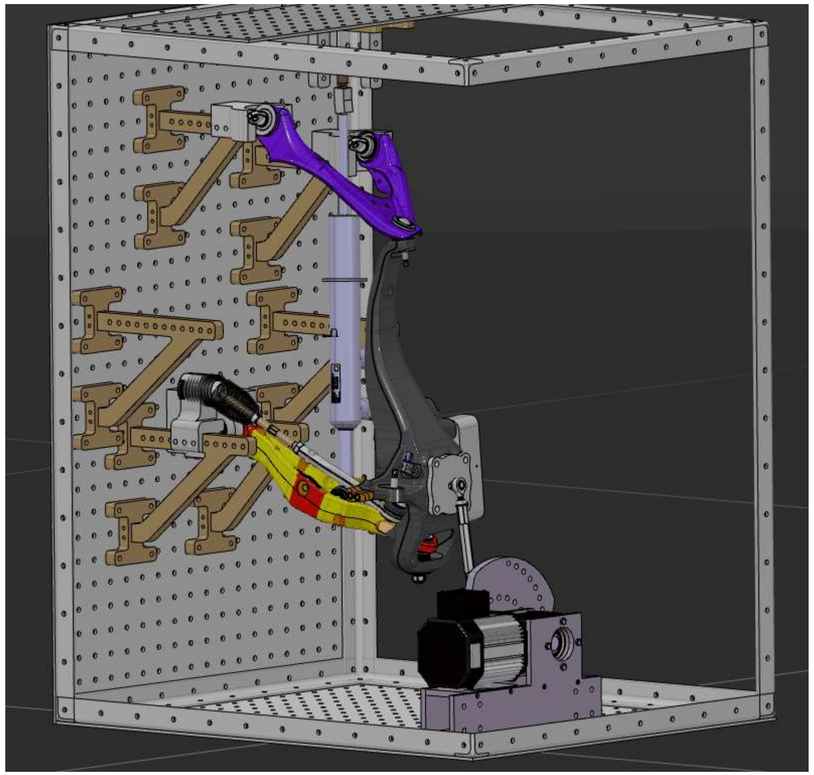












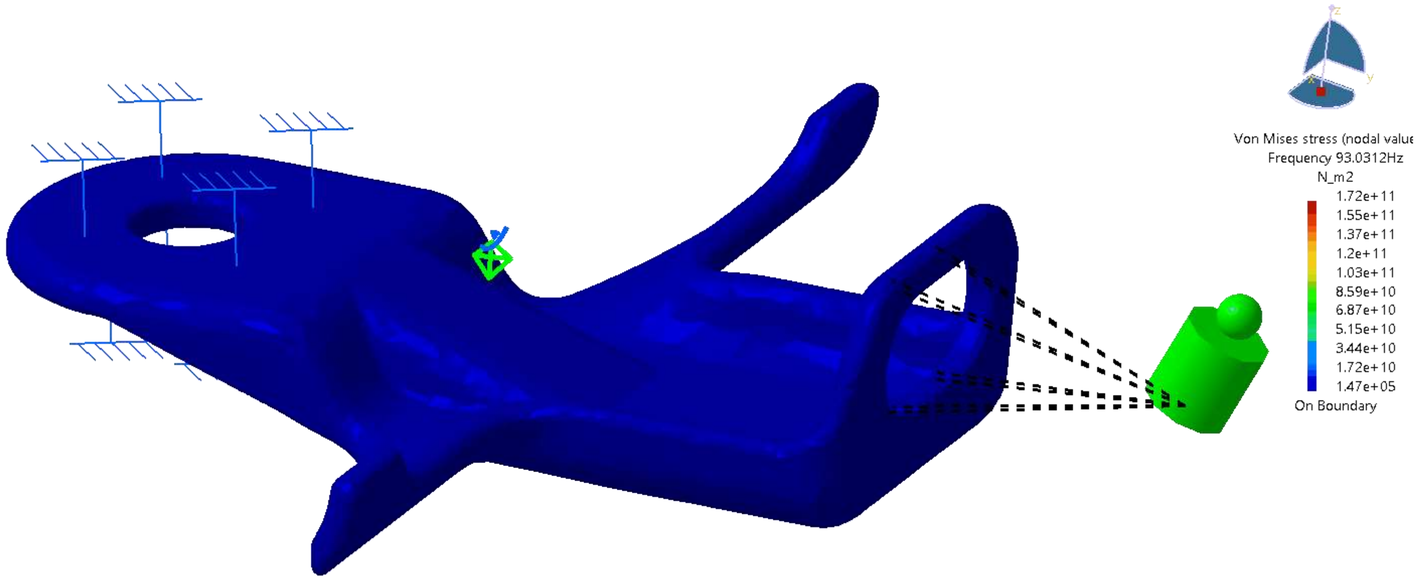
Input (mm)			Output (mm)	
x1	33.617		r	147
y1	72.4		L1	437
z1	577.093		L2	437
d1	582.5875			
x2	42.38			
y2	144.175			
z2	263.58			
d2	303.4088			

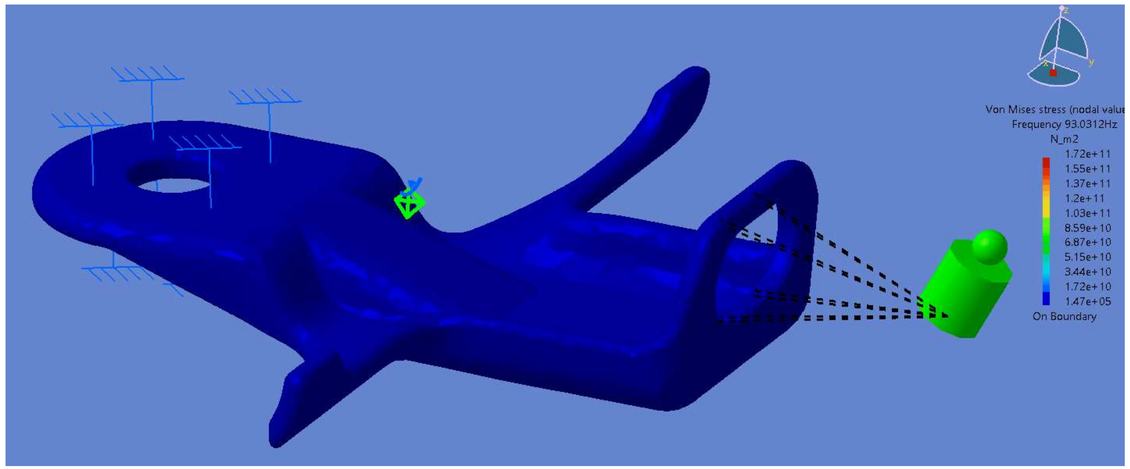
Input (mm)			Output (mm)	
x1	0		r	142
y1	0		L1	595
z1	-453		L2	595
d1	453			
x2	0			
y2	0			
z2	-737			
d2	737			

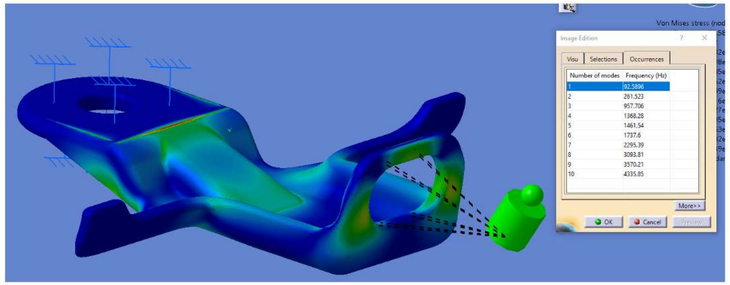
CT FR 10/25/2023

Input (mm)			Output (mm)	
x1	0.598		r	159
y1	13.002		L1	478
z1	636.607		L2	478
x2	-10.49			
y2	60.043		d1	637
z2	315.593		d2	321

Task	4-Sep	11-Sep	18-Sep	25-Sep	2-Oct	9-Oct	16-Oct	23-Oct	*30-Oct*	6-Nov	13-Nov	20-Nov	27-Nov	4-Dec	11-Dec
Design															
Bounding Dims		✓													
First Iteration				✓											
Kin & Vibe Analysis					✓										
Finalize; Drawings								✓							
Prototyping															
RFQ								✓							
Order Parts									✓						
3D Print Parts															
Find Space									✓						
Assembly															
Testing															
Electronics					✓										
Empty System															
With Harness, Short															
With Harness, Long															







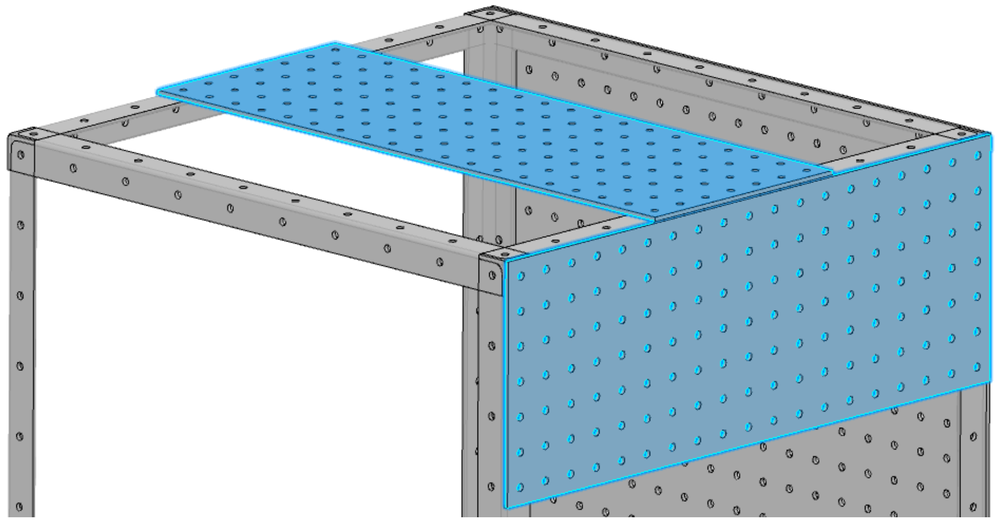
Gusset Impact

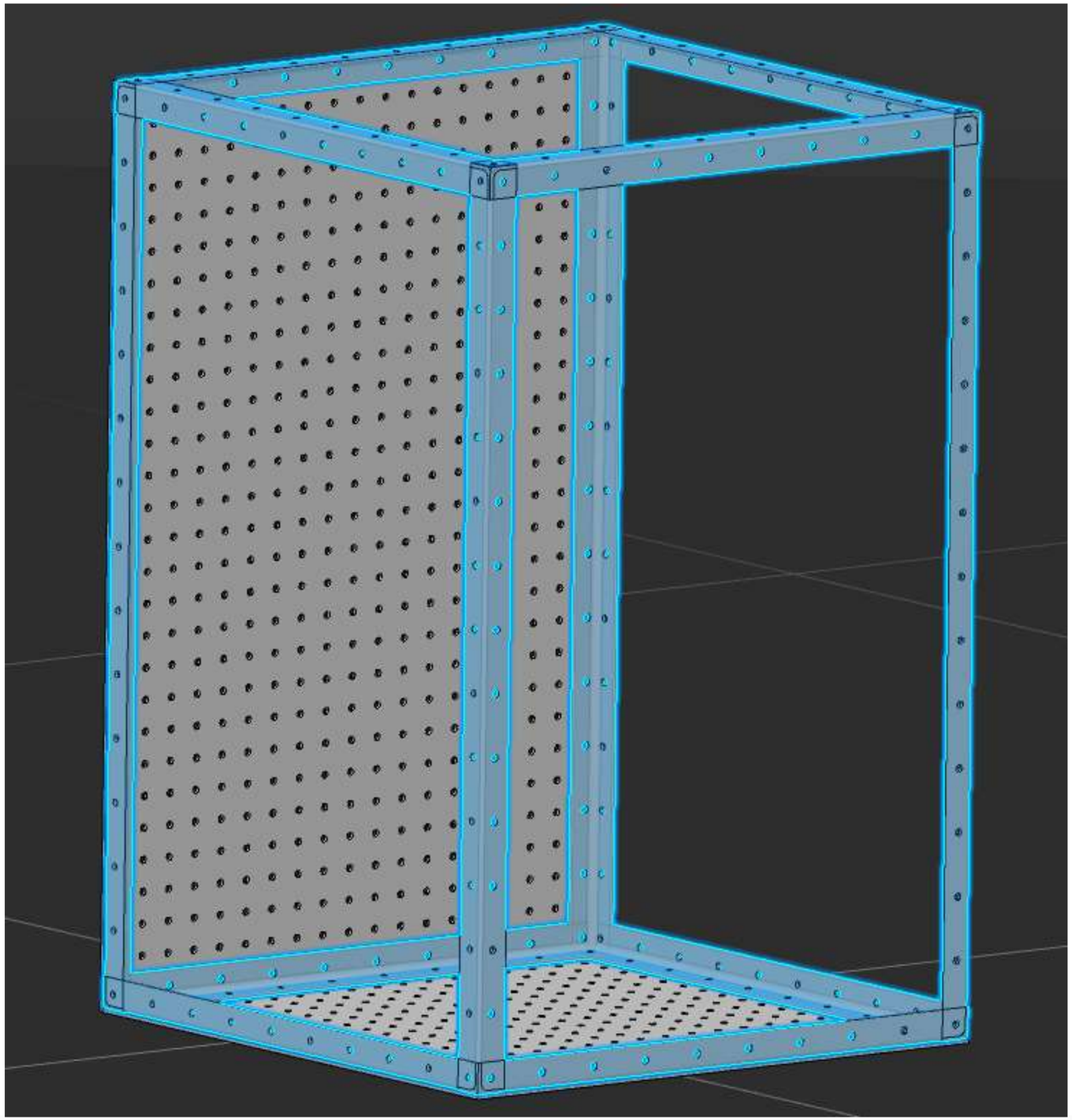
Far end
Without: 74 @ 3.97g
With: 87 @ 4.22g
+Thicken close end: 91 @ 4.33g

Final Solve
- Added gussets
- Increased thk 15%
  - Linear relationship w resonance

Frame

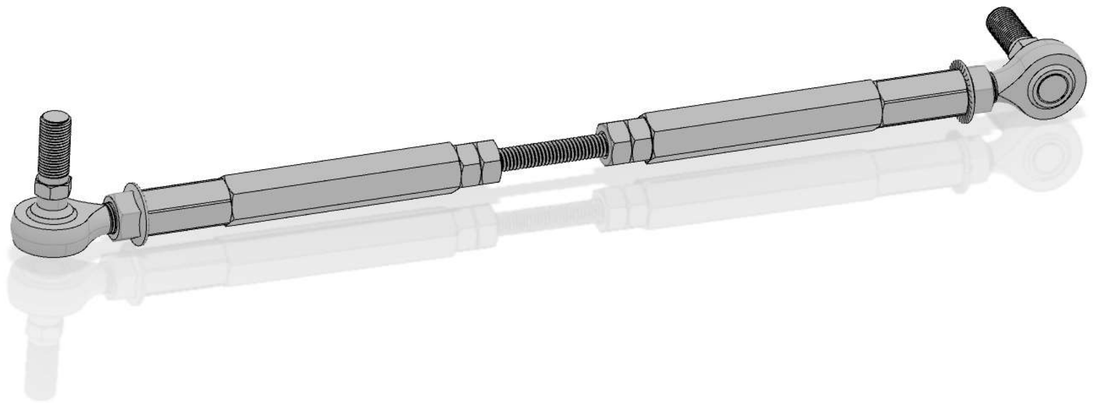
- 2” Angle iron – 1 x 1 x 1.5m
- ¼” Aluminum pegboard
  - Floor
  - Wall
  - Moveable sections
- Natural frequency ≈ 18Hz
- Weight ≈ 100kg

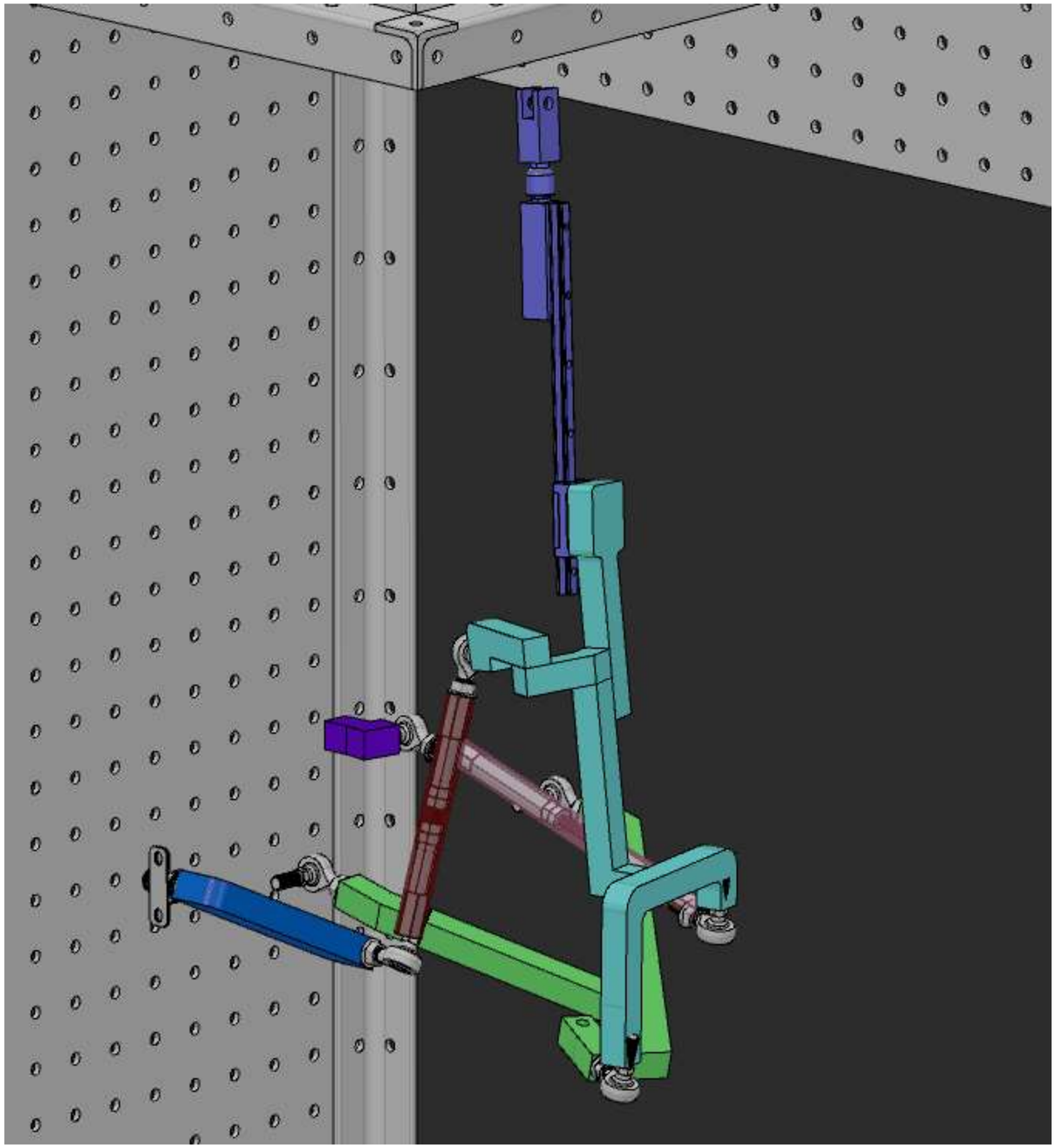




Suspension Quarter

- Adjustable 2-force members
- Water jet aluminum plate
- Linkage
  - ½” BJs & bearings
  - Strut: Ball bearing carriage
  - Ignore compliance
- Harness & hose connections
  - 3D printed mounts





Motor

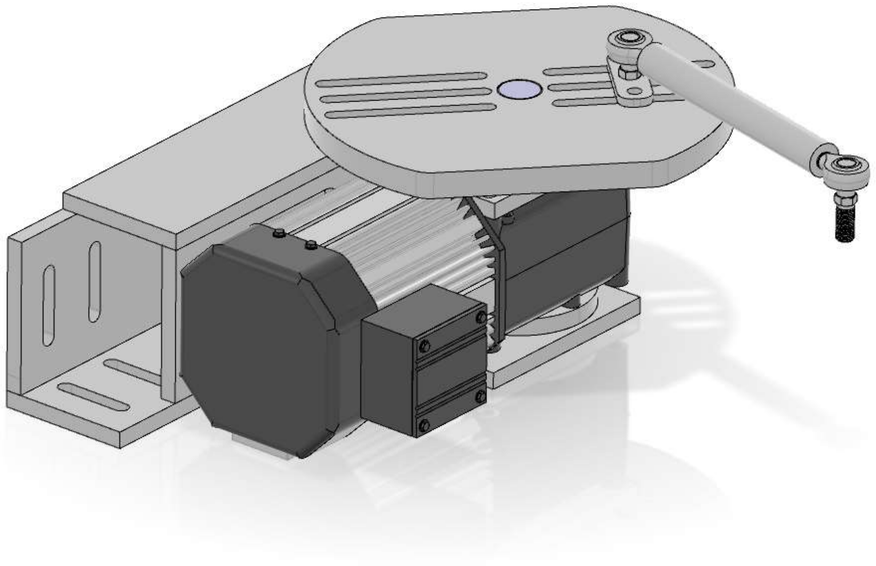
- 3-phase 230V Rotary
  - 160 rpm (2.7Hz)
  - 14 ft*lb
  - Plug type: L15-30P

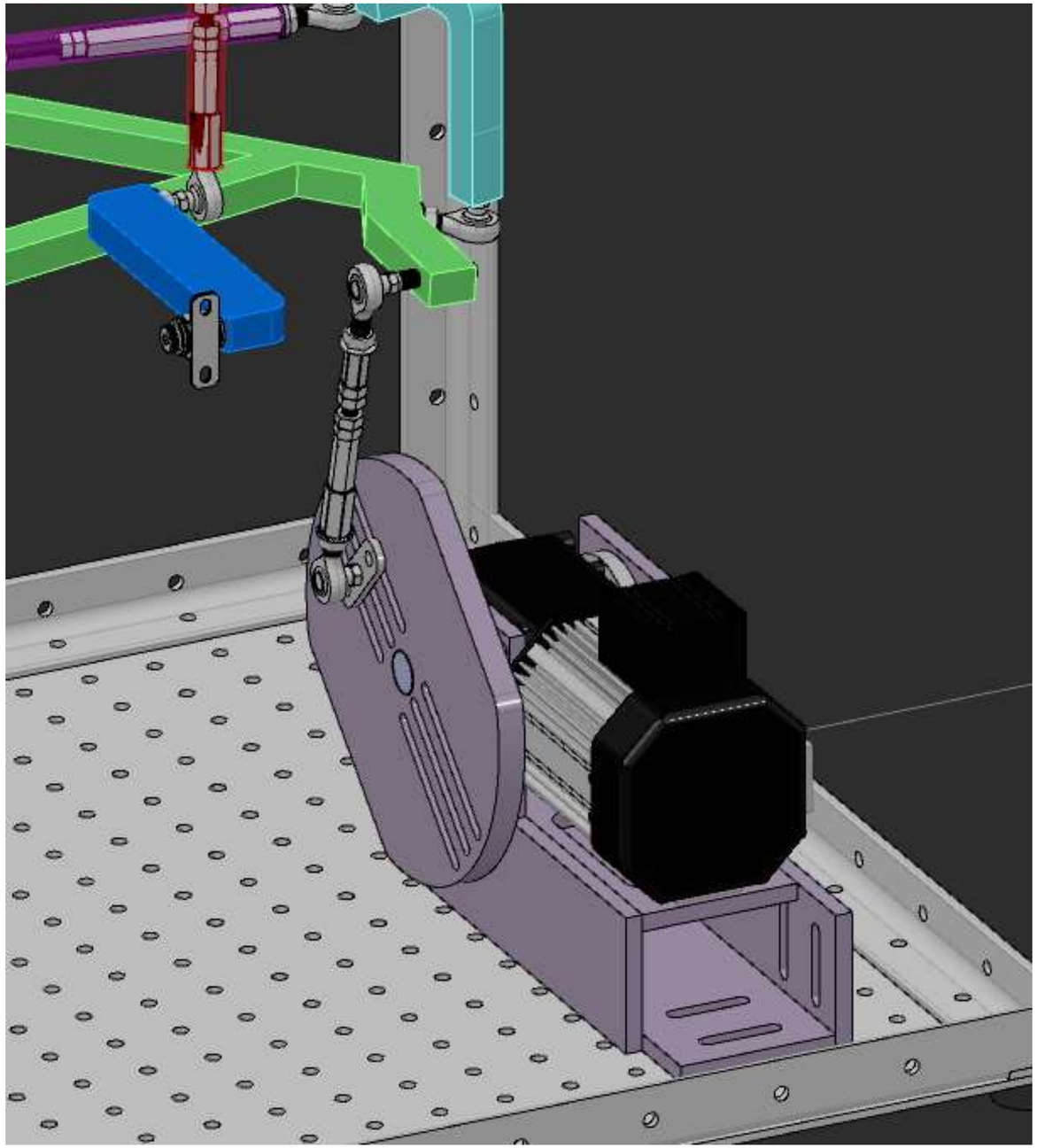
L15-30R

Product Series	730	Weight (Lbs)	24.6
Speed (RPM)	160	Output Shaft Diameter (In)	1.25
Torque (InLb)	168	Lubrication (Type)	Semi-Fluid Grease
Ratio :1	10	Motor Size Input	NA
Input Hp (HP)	1/2	Construction File	E89715
Input Hp (HP)	0.5	Insulation File	E199928
Volts (V)	230	Construction File	150393
Amps (A)	1.9	CE Certification	Yes
Overhung Load (Lbs)	465	IP Rating	IP54

Motor Linkages - Damper

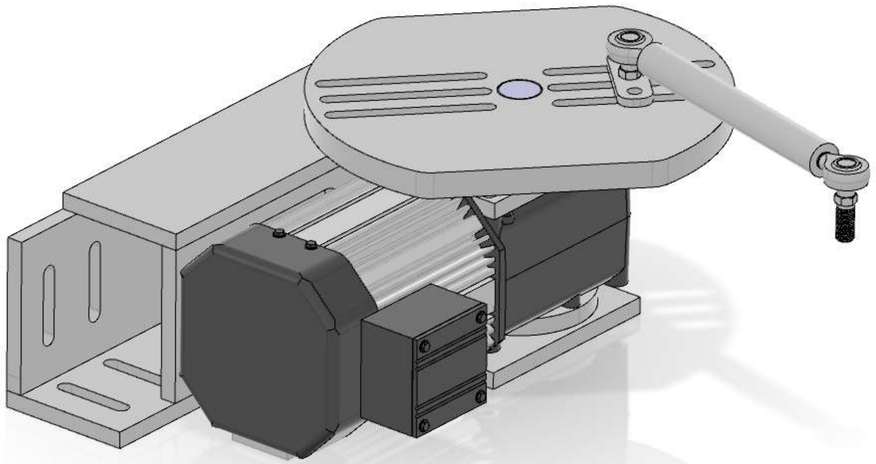
- Adjustable stroke length
  - Continuous vs discrete?
- Link length
  - Adjustable vs fixed?
- Y-compliance via BJ
- Mount on vibration dampeners?

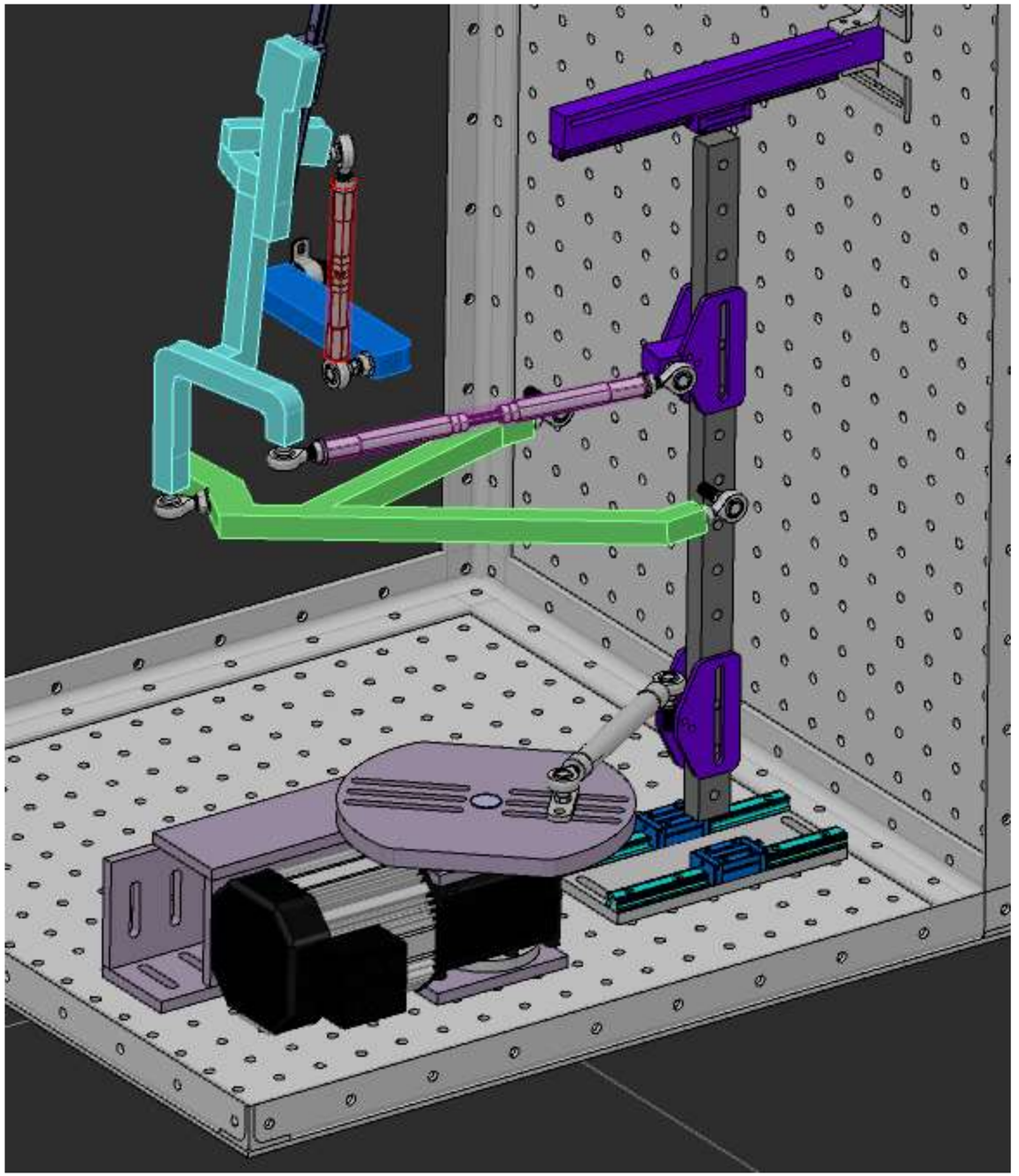


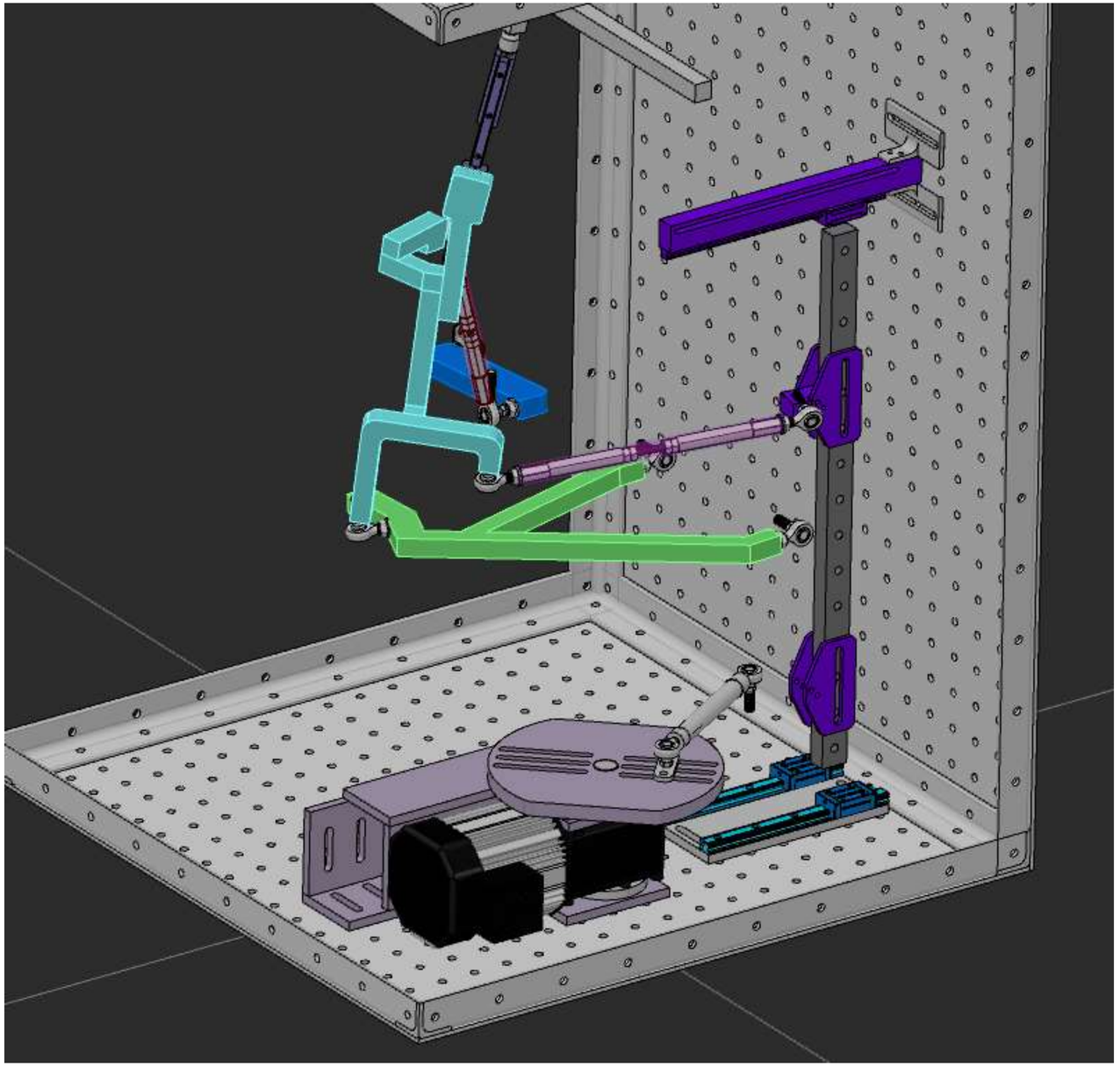


Motor Linkages - Steer

- Adjustable stroke length
  - Continuous vs discrete?
- Link length
  - Adjustable vs fixed?

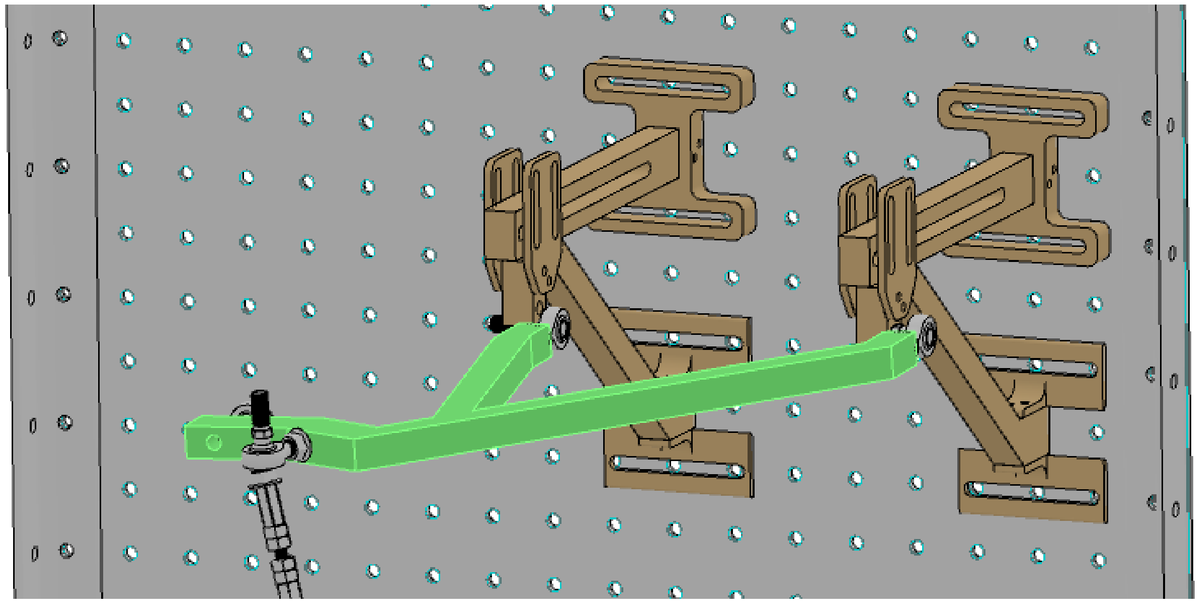


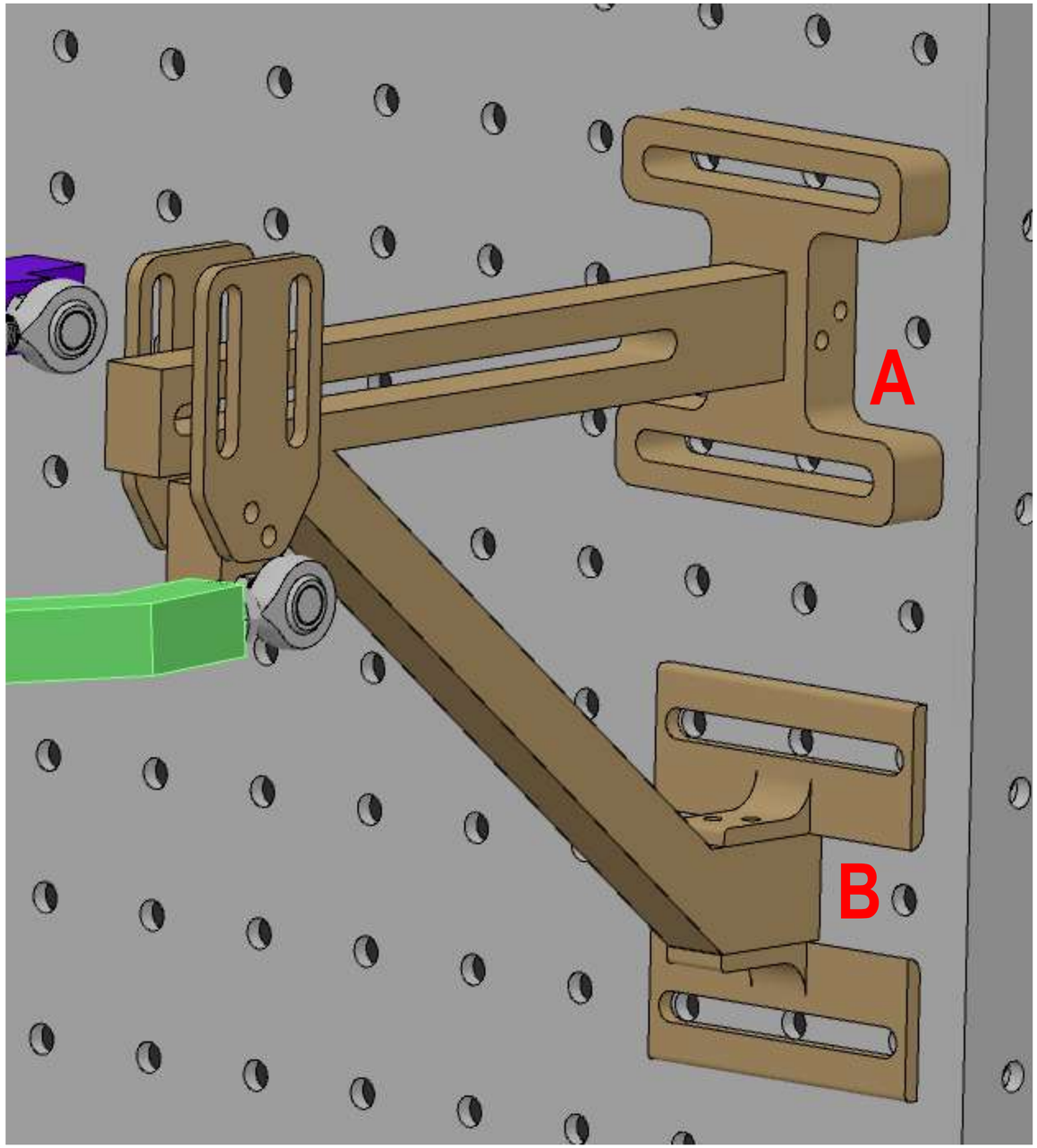




Mounts - Arm

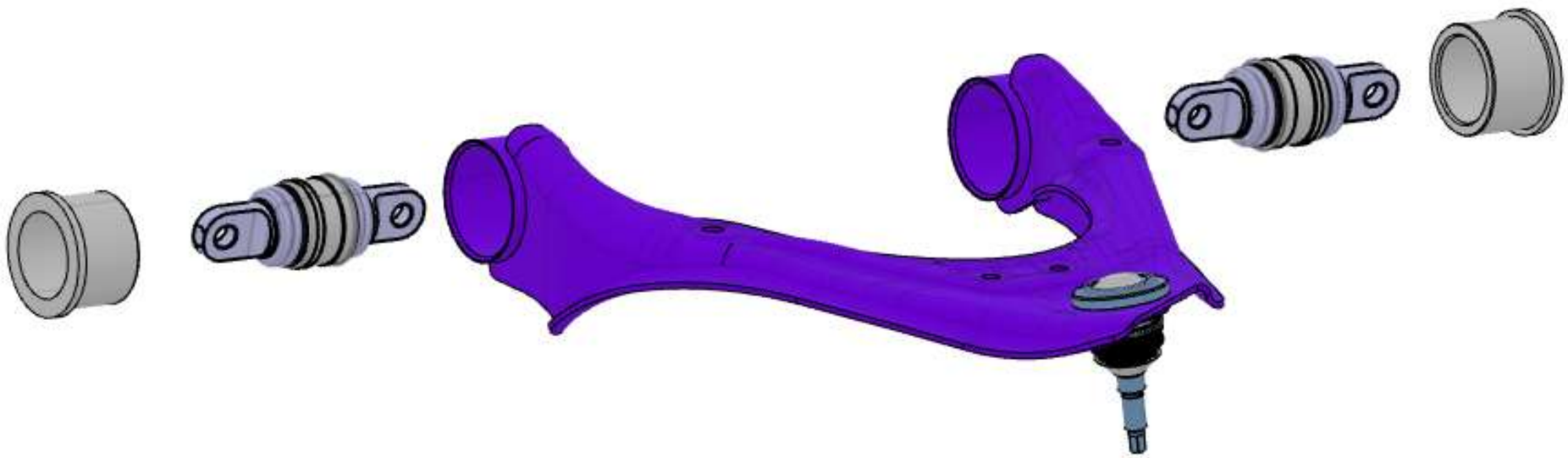
- Adjustable in x, y, z
- Breadboard mounts
  - A – Water jet 1” aluminum plate (or steel)
  - B – Machined ¼” angle iron





Front Upper Control Arm

- Press bushings out of FUCA
- Press new ball joints into plugs
- Press plugs into FUCA

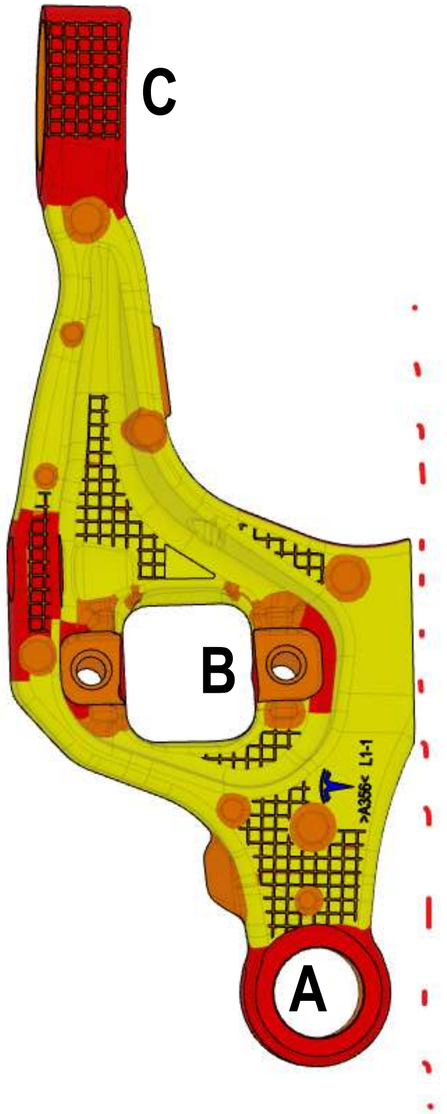


Front Lower Control Arm

- Press bushing out of FLCA
- Press plug into FLCA
- NOTE: FLCA is not currently cut. If KFS can support the cut as well please see following slide, otherwise this can be done by a separate team after this task

Front Lower Control Arm Cut

- FLCA aft arm to be removed
- Features that must remain undamaged:
  - A
  - B
  - C



Project Constraints

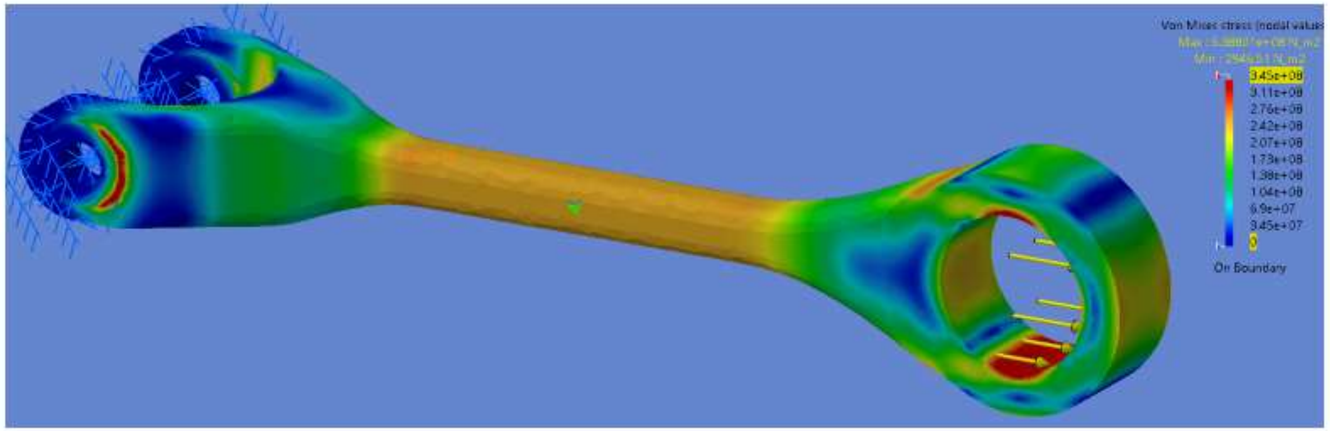
	Target	Previous	Achieved	Comments
Mass (kg)	<562	687	464	-0.446kg per vehicle
Compression/ Tension (KN)	>60KN	90KN	90KN	Will fail in buckling
Clevis Stiffness (KN/mm)		14.2	8.7	Previous in this case is MY forged Must be <= previous

Task: Design forged Al link to replace stamped steel link

Objective: Mass down

Strength Validation

Catia Yield Check



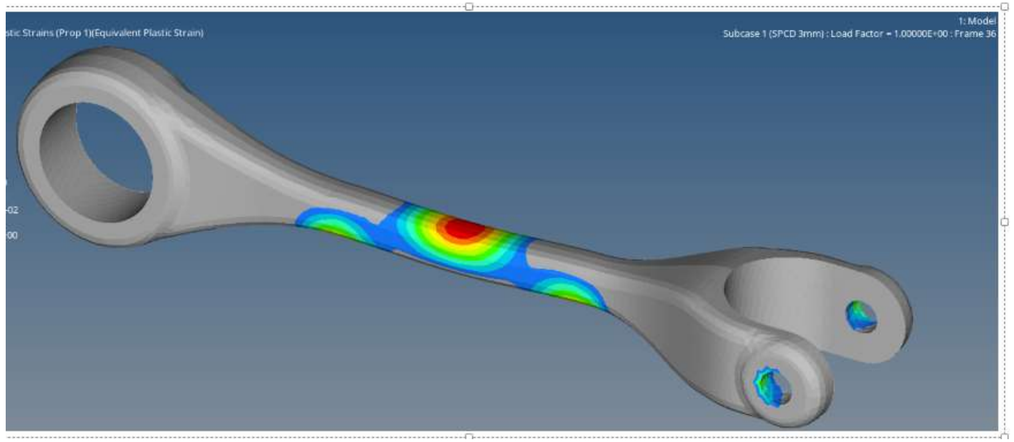
Forged Al NV35, 60KN - *Al NV35 Upper Fore Link Development V2.CATAnalysis*
Colors: 0 - 100% yield
79% at corners
76% in bar

6110-T6 Aluminum
Yield: 345Mpa

Mass: 475g 16x16
Mass down: 212g
Total Mass Down: 424g

Buckling Analysis Sim (Hypermesh)

Results: 80KN, 3mm displacement



Strength Validation

Buckling Hand Calculations

$$F_{cr} = \frac{\pi^2 EI}{l^2}$$

E = 69GPa
I = 4.43 e-9 m^2, for length = width = 0.016m

Knowing that F = 80KN from hypermesh sim, we can solve for effective length
l = .194m

Now to design for 90KN, using l = .194m, we can solve for required moment of inertia
I = 5 e-9m^2

This corresponds to a side length of 0.0165m, or 16.5mm

NOTE: Moment of inertia I is calculated for a square cross section with 5mm fillets
- This website is great & reliable

Other Design Considerations

Split line

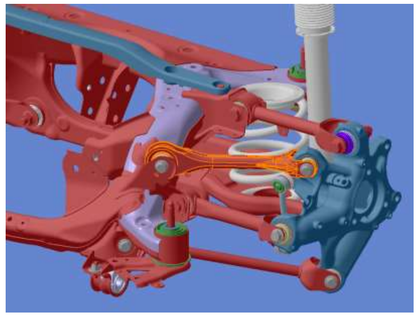
- Plane chosen for least possible machining

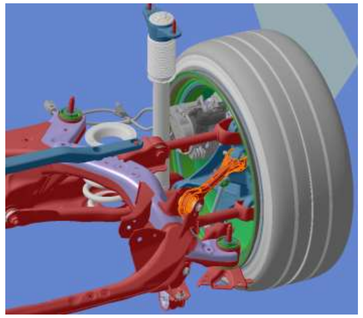
Clevis geometry

- Matched to current MY forged Al design
- Lower clevis stiffness

Next Steps

- LO Check
  - Current design lies within the bounding boxes of existing stamped & forged parts, but a check should still be performed
- Drawing Feedback
  - Module & part level drawing submitted to Steve for review
- DFM Feedback
- RFQ





Final Design Thickness

$$F_{cr} = \frac{\pi^2 EI}{l^2} = \cdots = 80KN$$

Where

E = 69GPa, I = 4.43 e-9 m^2

Solving

l = .194m *, -->* ***16.5x16.5*** ***for 90KN***

17x17 for 104KN

l - effective length found from buckling analysis sim results.

- ***Have force, solve for l***

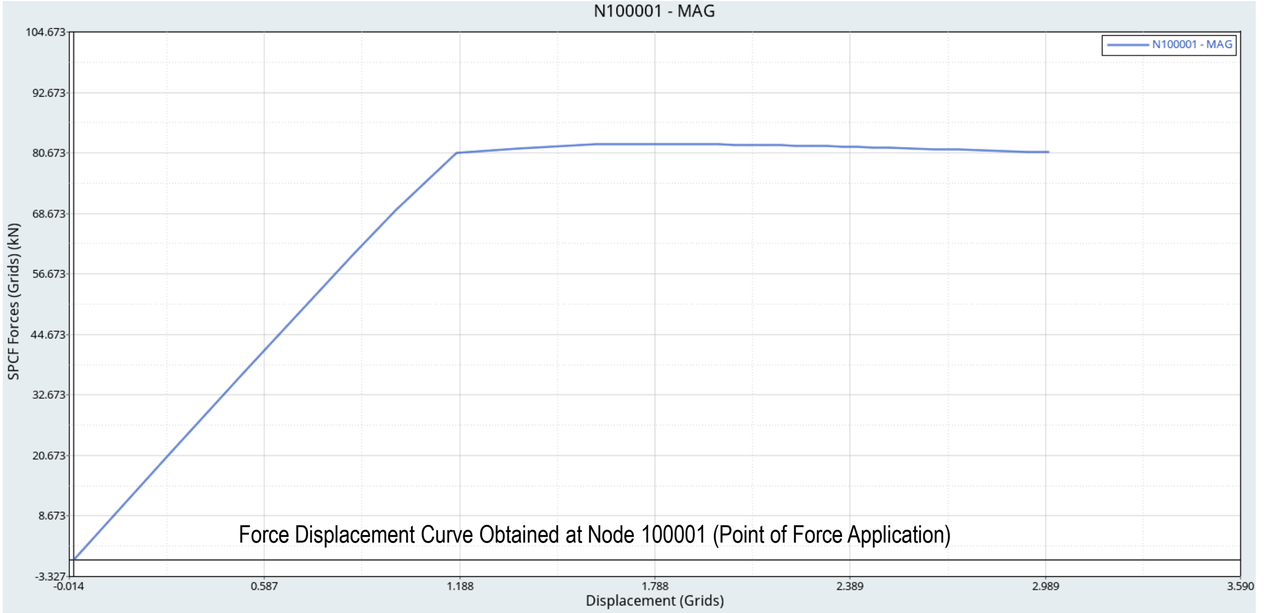
Summary

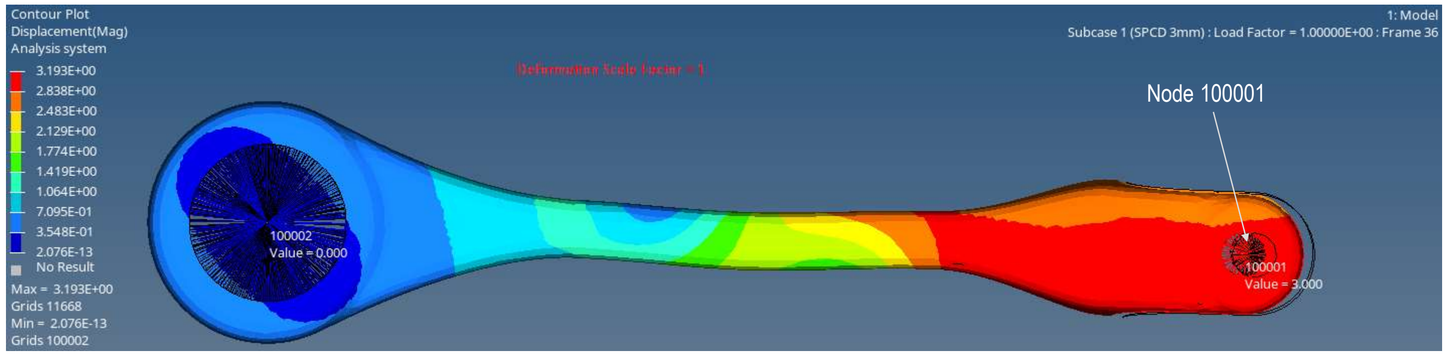
Objective: Determine compression load at which the link fails in buckling.

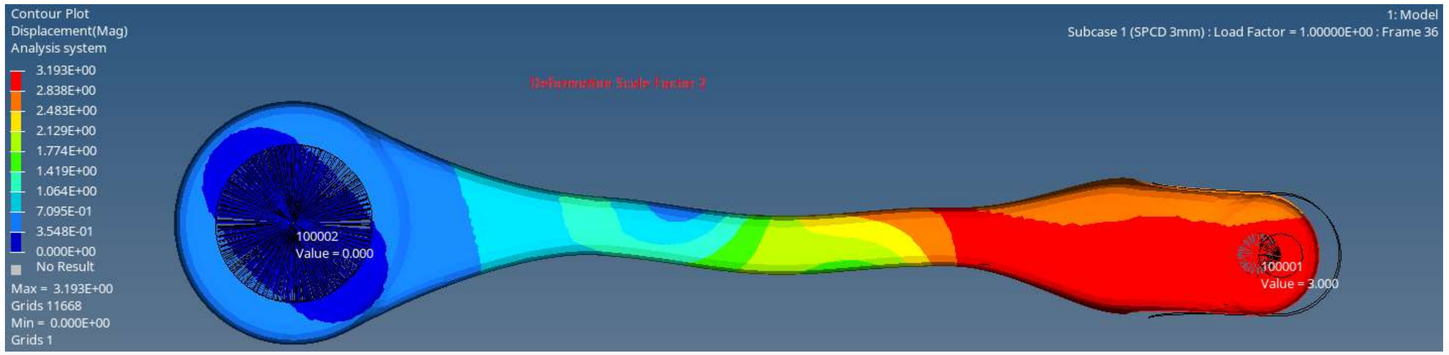
Conclusion: Buckling Load = **80 kN**

(Refer Force-displacement curve)

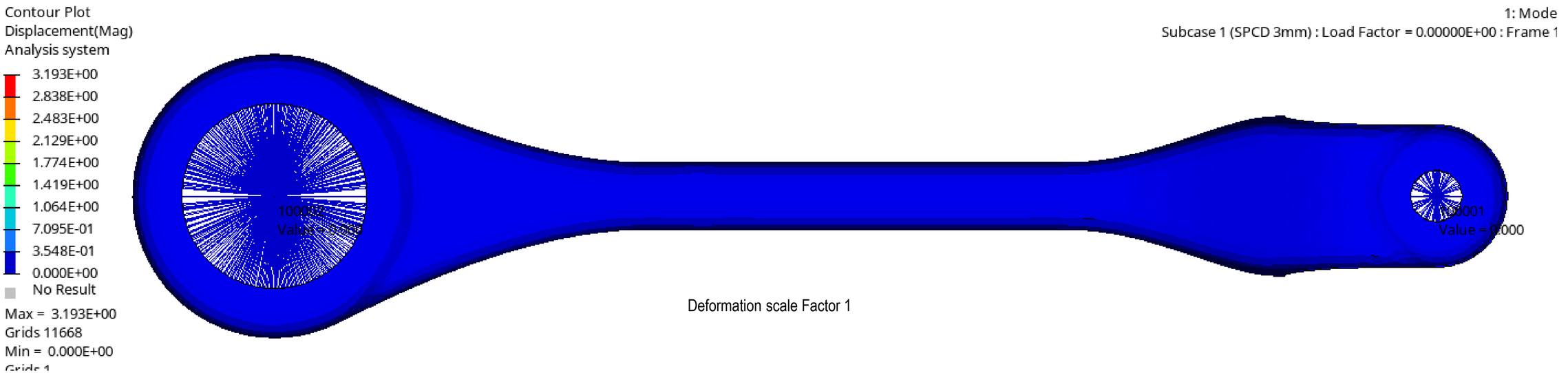
Enforced Displacement = 3mm at Node 100001







Animation

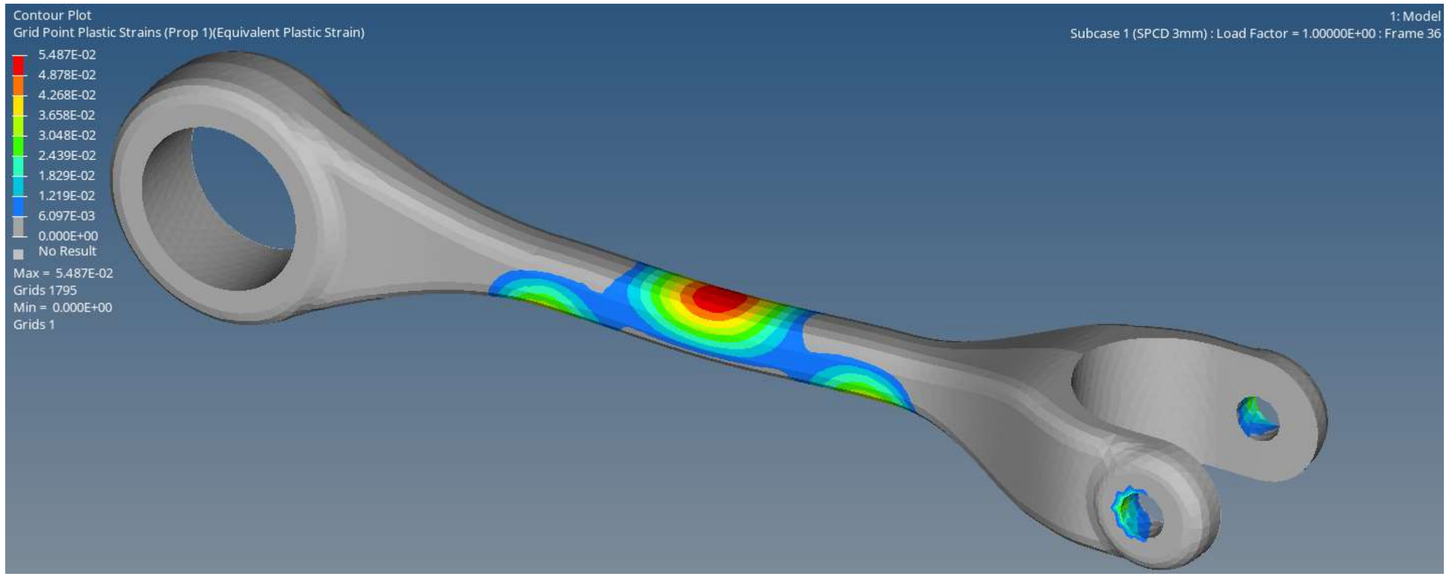


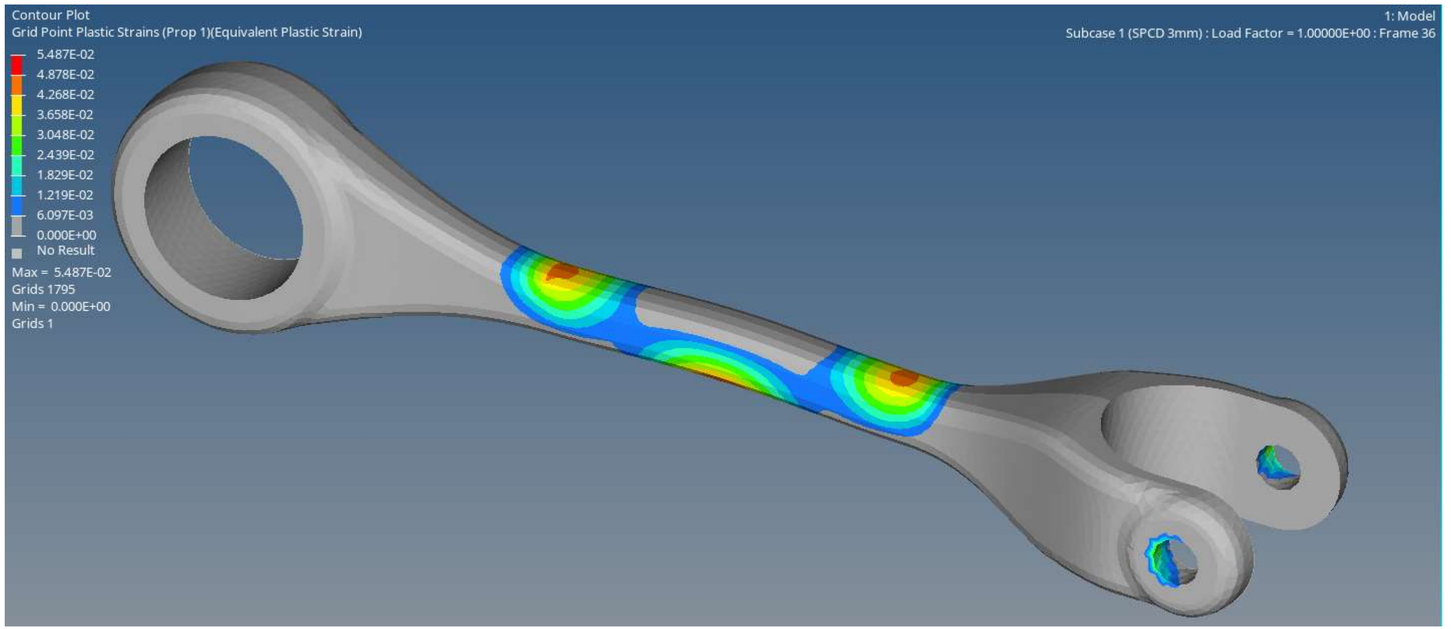
Plastic Strain

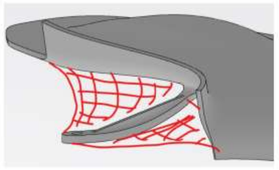
Tensile Elongation Uniform = 0.091

Tensile Elongation Total = 0.12

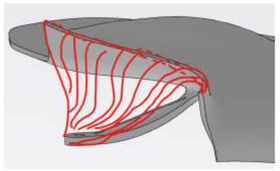
Max Plastic Strain in part = 0.055



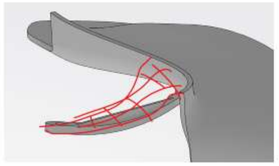




Not moldable



Too much



Yeah BUDDY