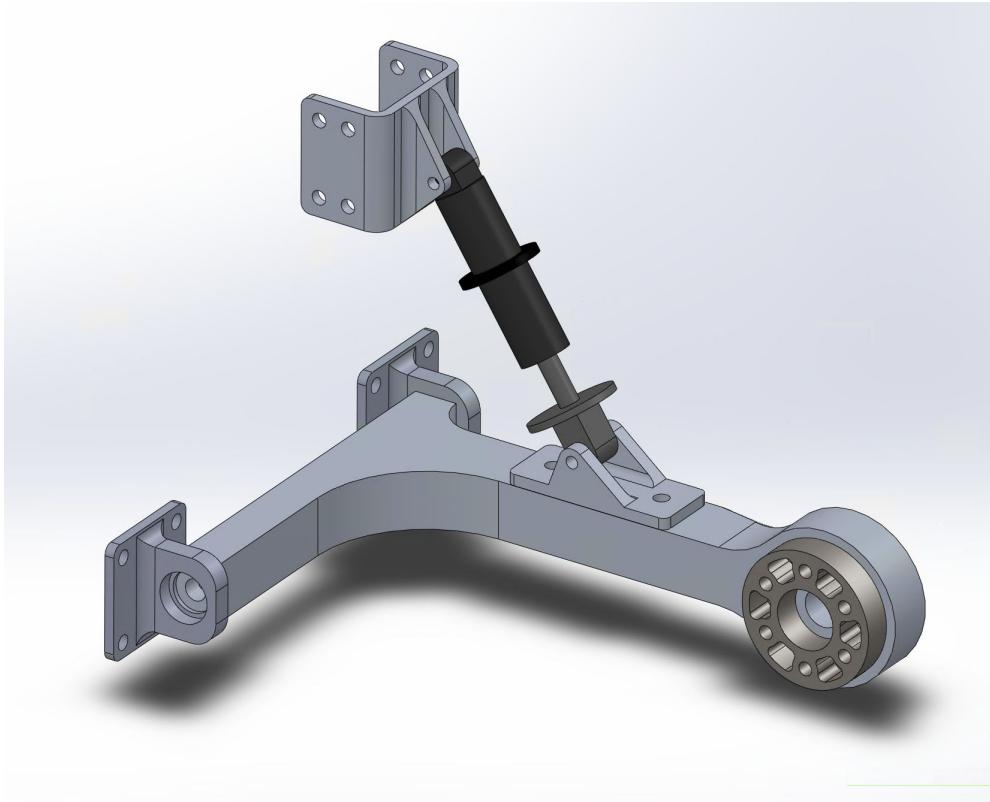
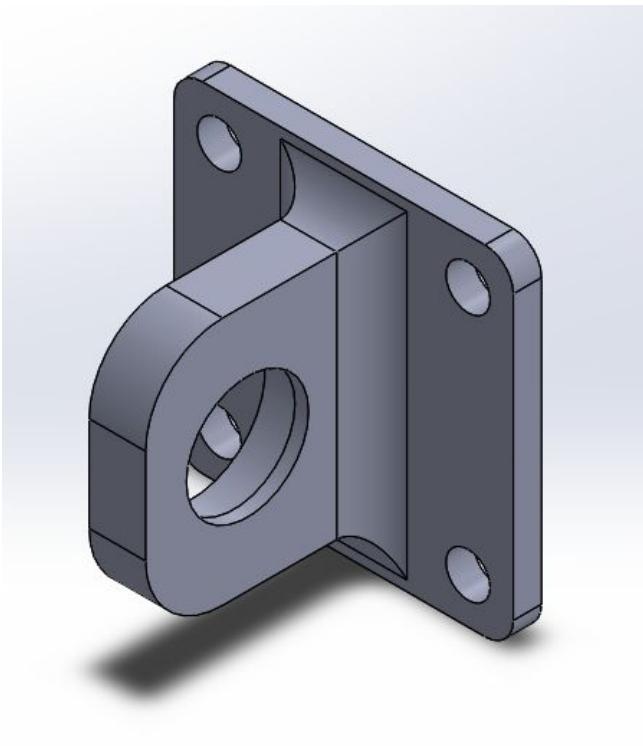


# Back Suspension Design

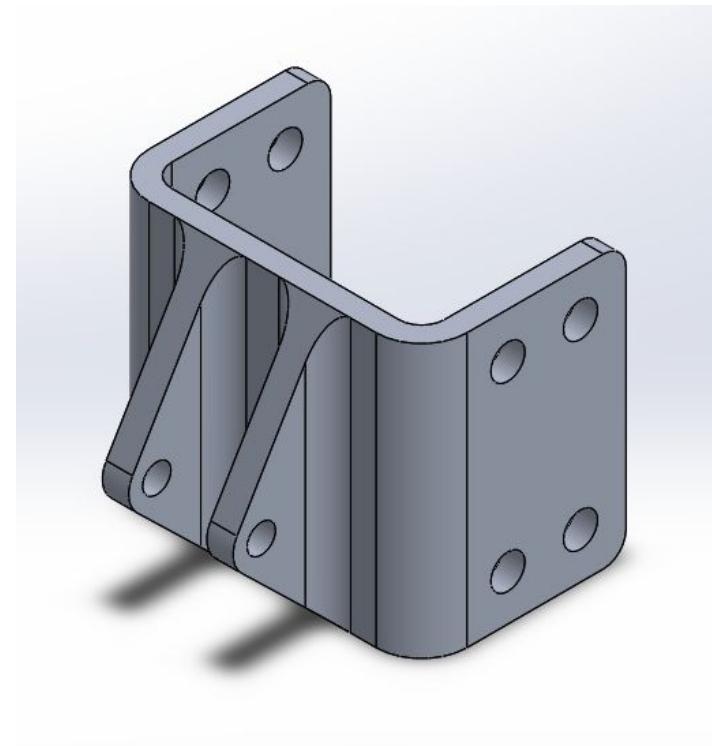
# Assembly Design



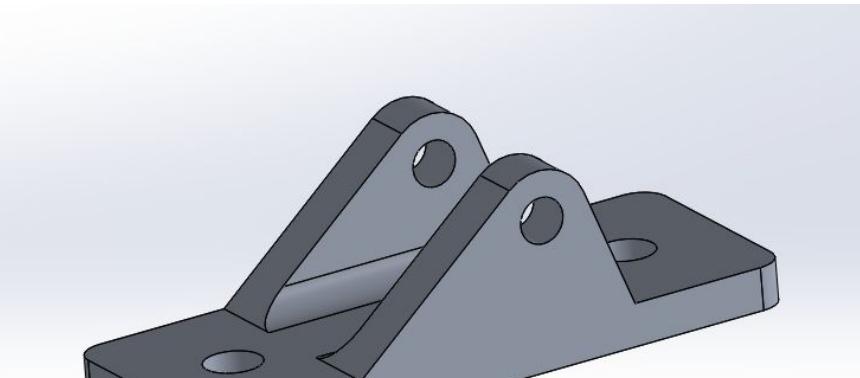
## Chassis-Arm Mount



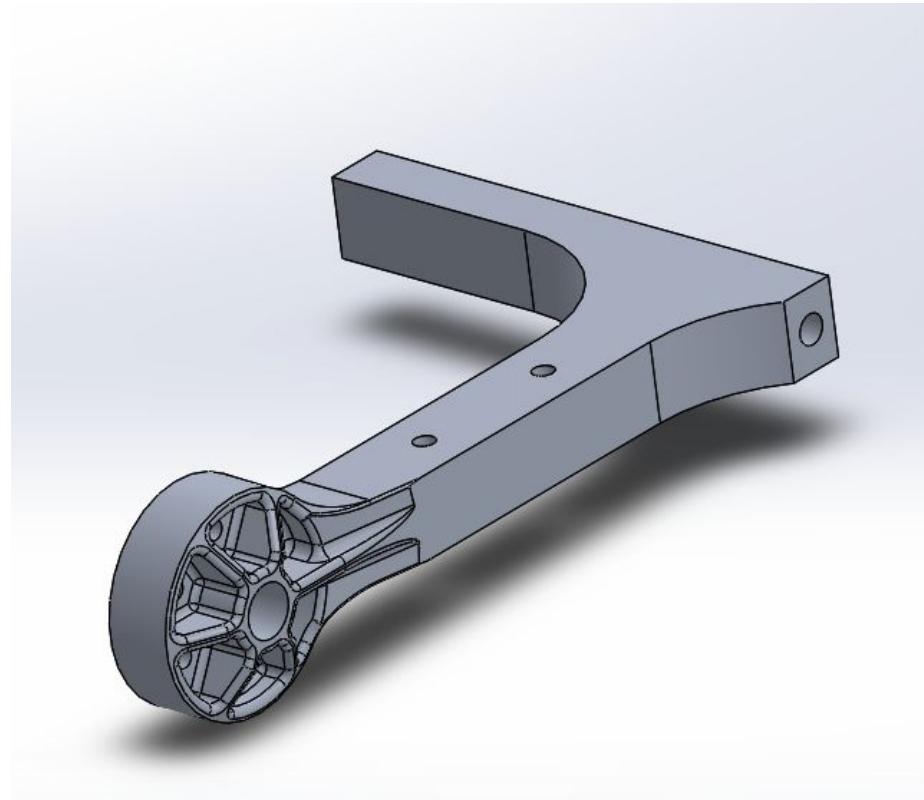
## Chassis-Shock Mount



# Arm-Shock Mount



# L Arm



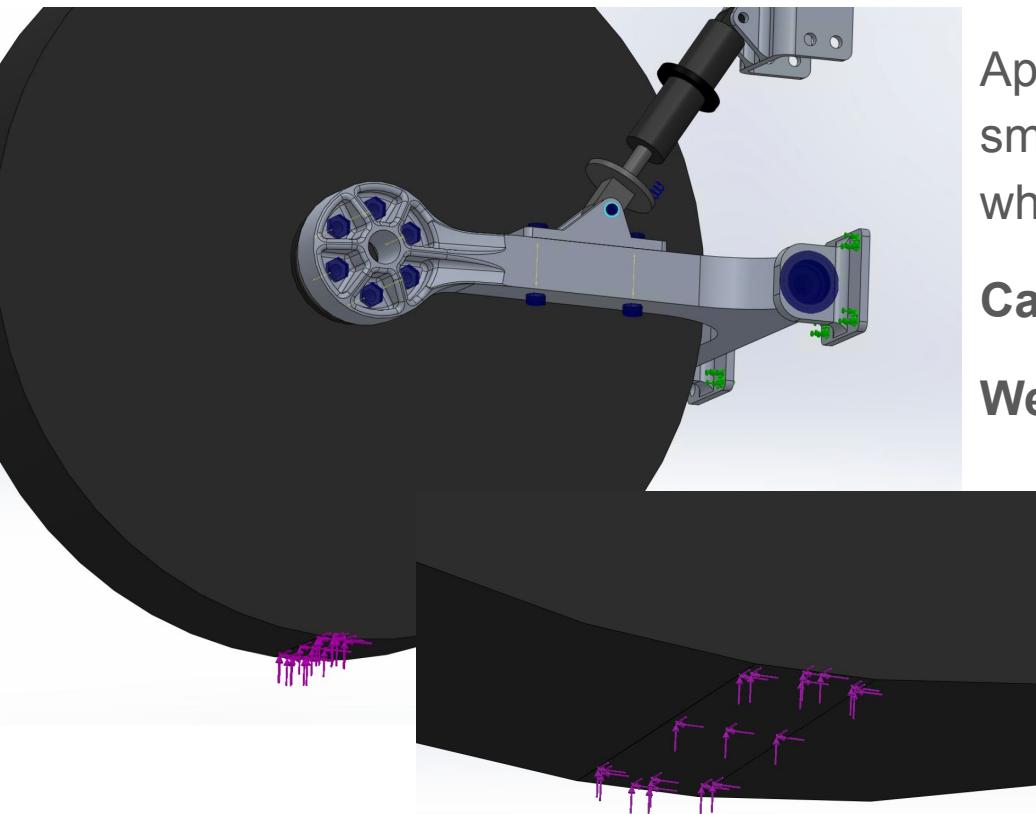
# Simulation Study

# Regs Appendix D. PVDR - Instructions

## Mechanical Loading Conditions

Teams shall consider road and traffic conditions when determining loading criteria and potential failure modes. For suspension and steering systems, analysis shall include a minimum of **1G turn, a 2G bump, and 1G braking case** loads with a **worst-case condition of the loads combined**. These loads shall to be applied at the wheel patch where the tire makes contact with the ground. Loads shall be provided in dimensional units, along with any relevant assumptions used in the analysis.

# FEA Loading Conditions



Applied as concentrated loads on a small contact patch at the bottom of the wheel.

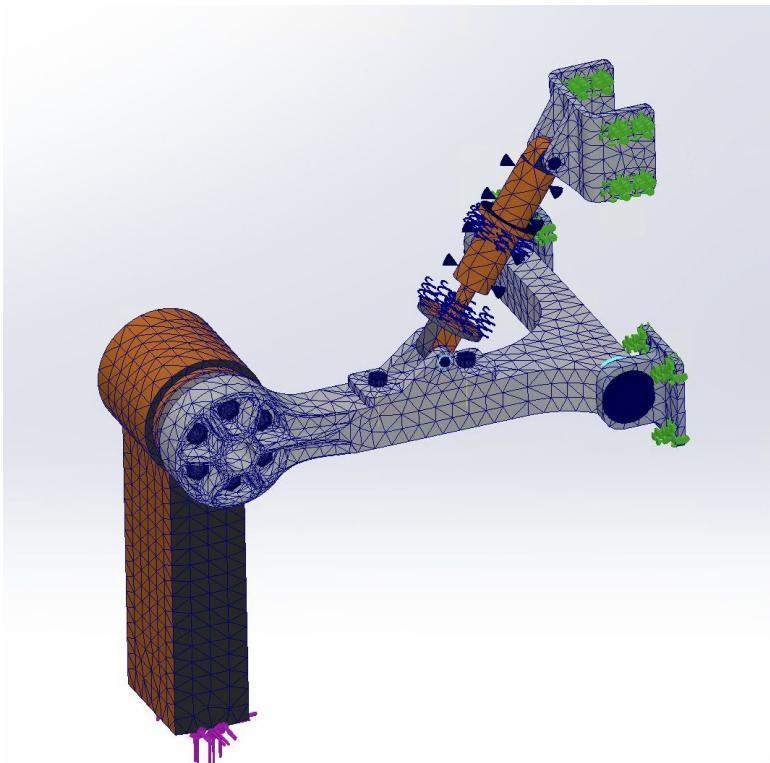
**Car Mass Estimate:** 600kg

**Weight Distribution Estimate:** 50%

- Assuming that in worst-case, the combination of cornering and imbalance, half the weight of the car is held by a back wheel.

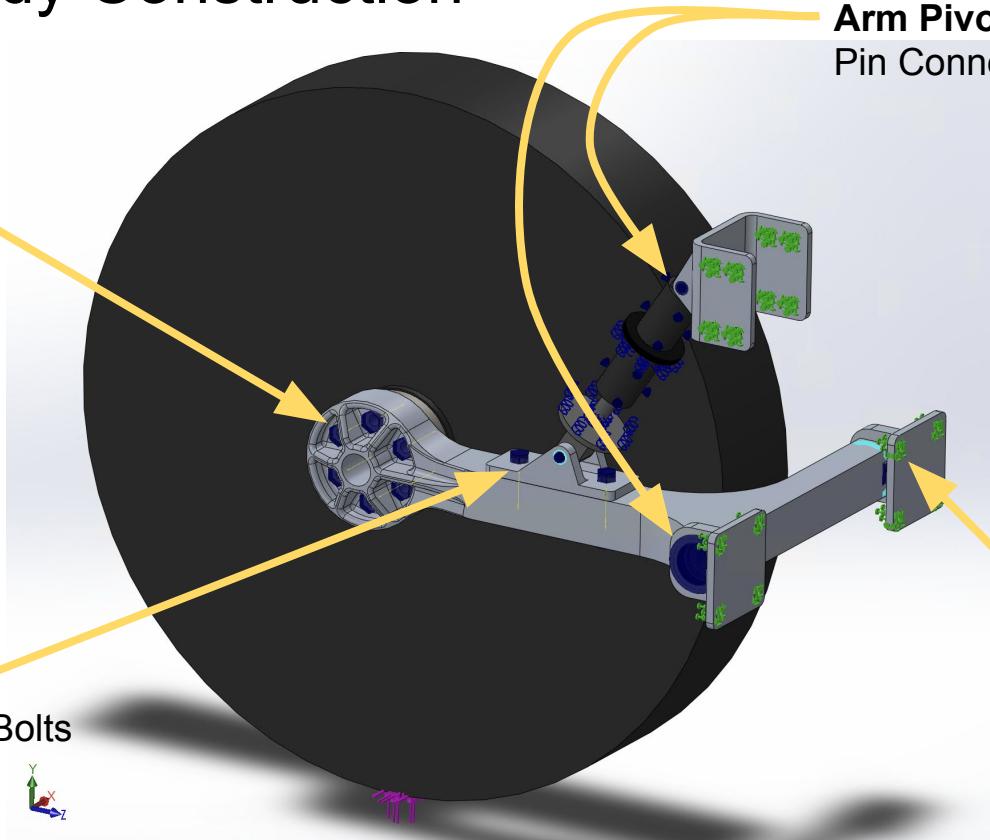
$$\rightarrow 1G \approx 3000N$$

# FEA Mesh



# FEA Study Construction

**Motor Bolts**  
M8 Counterbore  
Screws

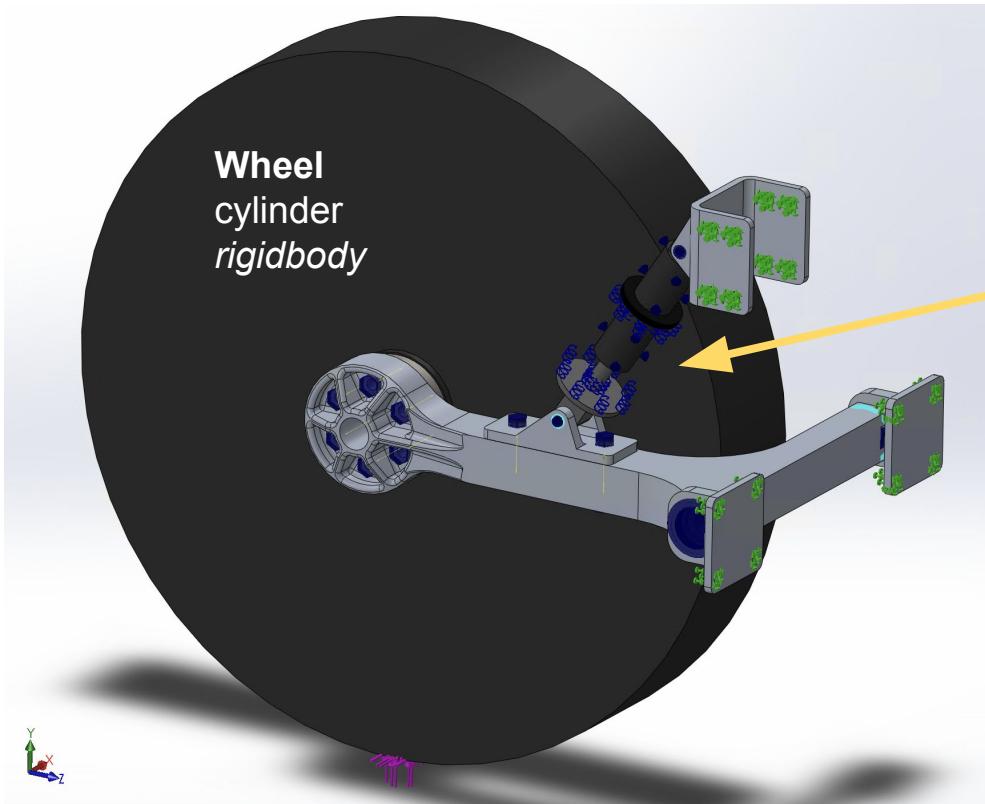


**Shock Pivots,  
Arm Pivots  
Pin Connections**

**Arm-Shock  
Mount Bolts**  
3/8" Counterbore Bolts

**Chassis Mounts**  
Virtual Wall +  
Fixed Bolt Faces

# FEA Study Construction



## Shock

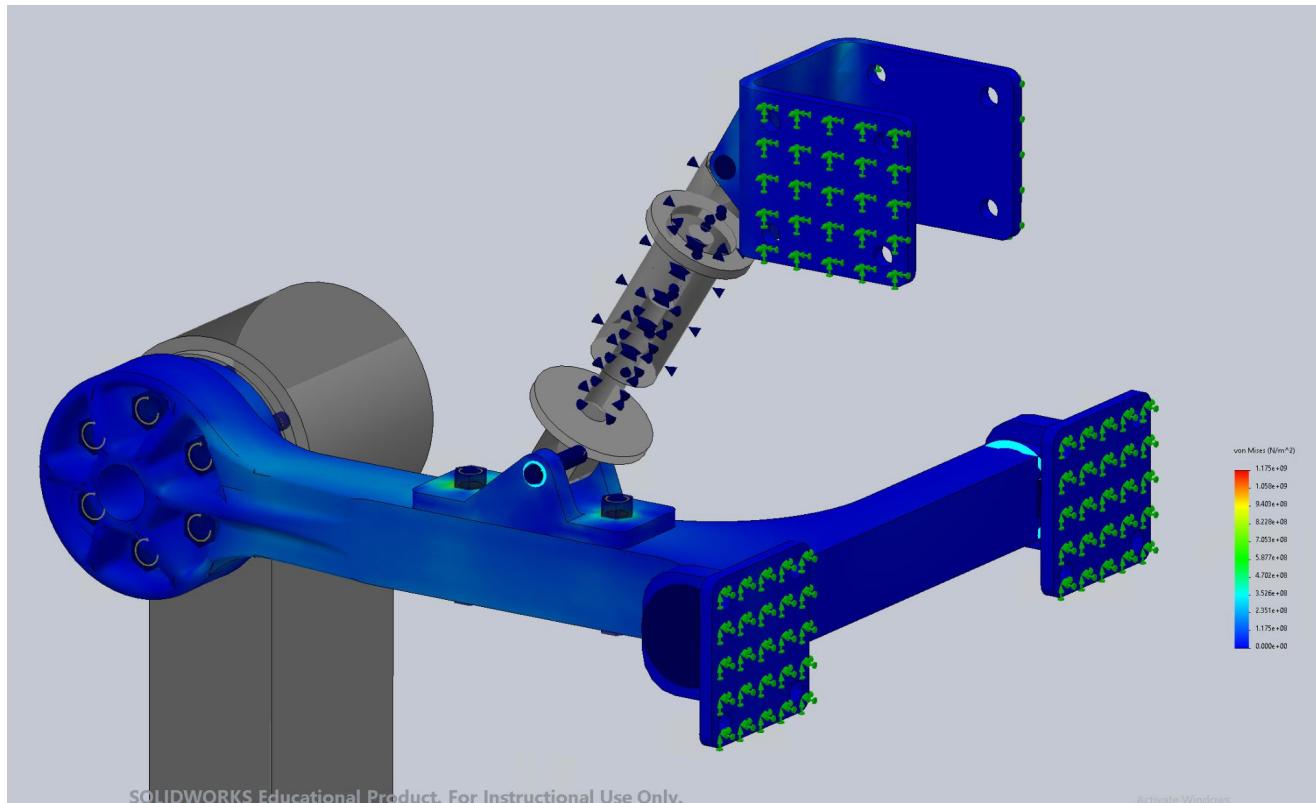
Simplified geometry:

- cylinder
- plunger
- adjustment nut

Spring connection between plunger and adjustment nut

*rigidbody*

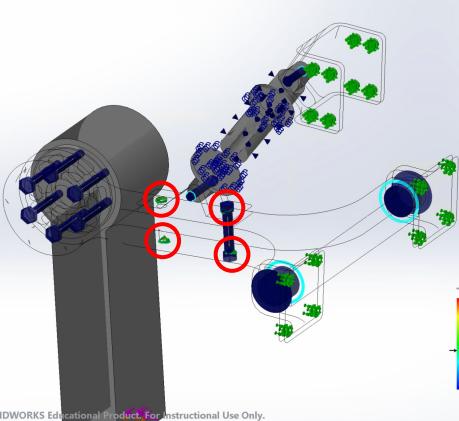
# FEA Results



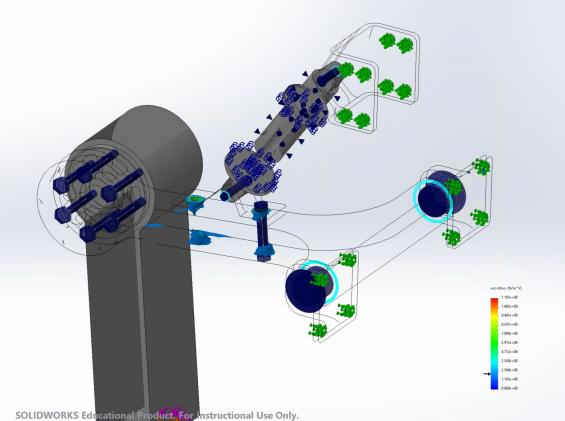
# FEA Results

## Isometric View

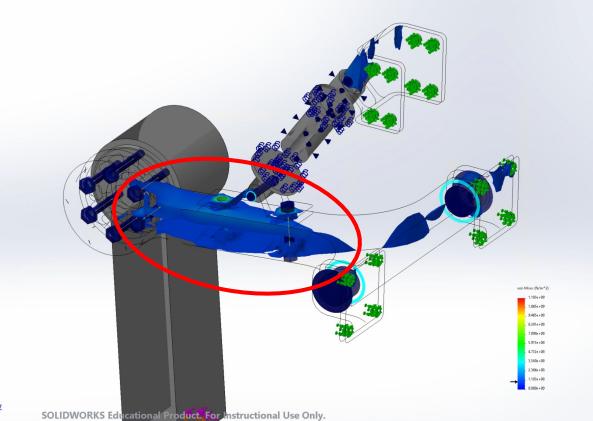
Shows regions of material with stress greater-than-or-equal-to certain value



yield (505 GPa)

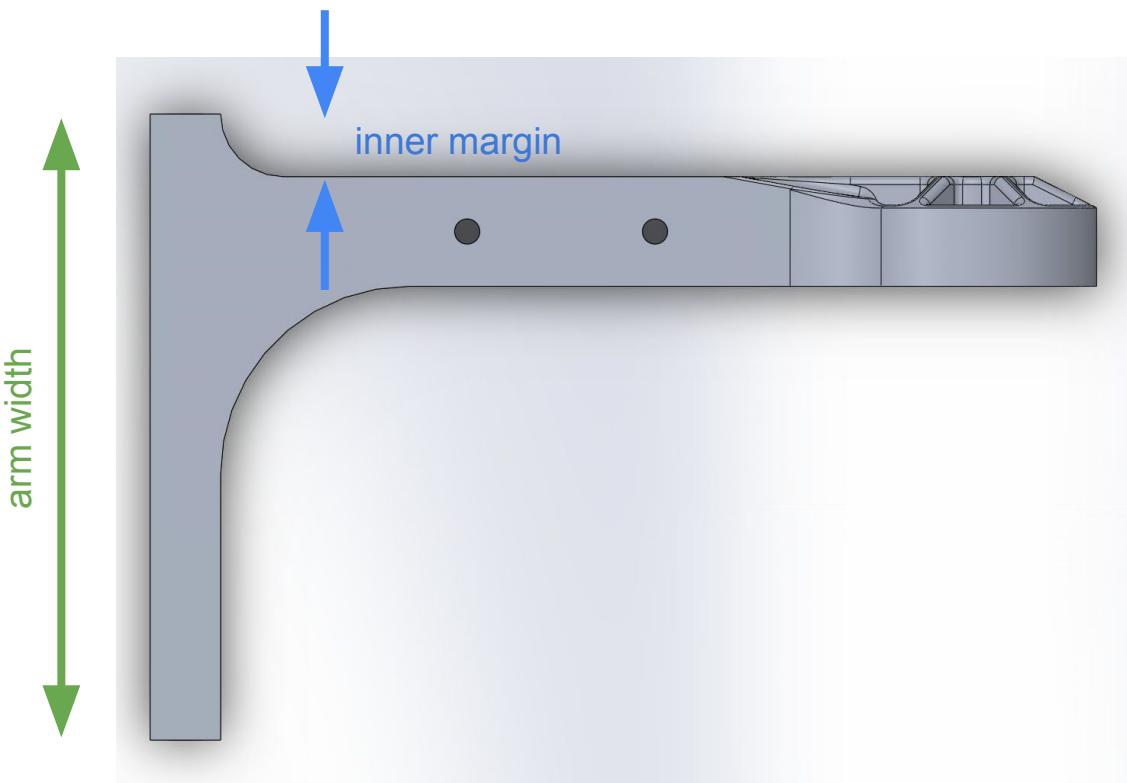


20% of yield



10% of yield

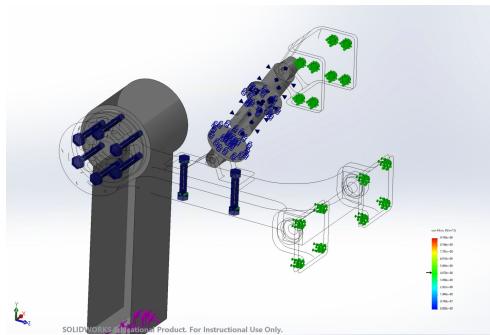
# Varying Dimensions (for science)



Arm Width	Inner Margin
10"	1"
8"	2"
6"	3"

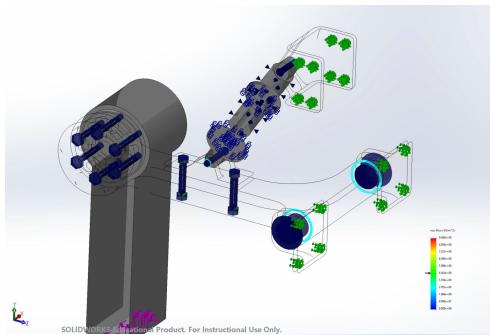
# Varying Dimensions – Stress

6"

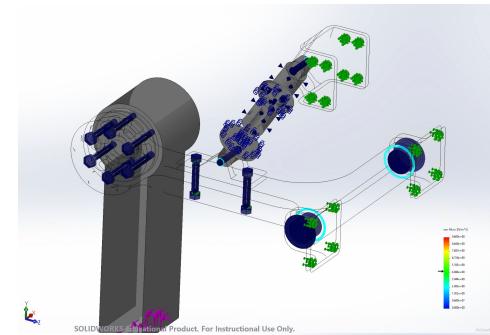


1"

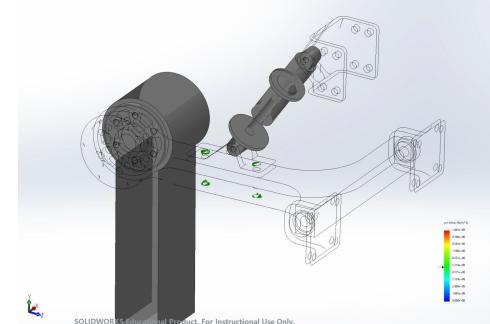
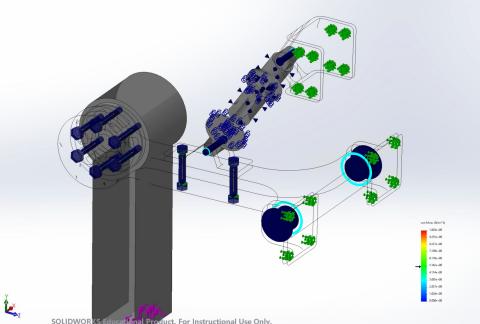
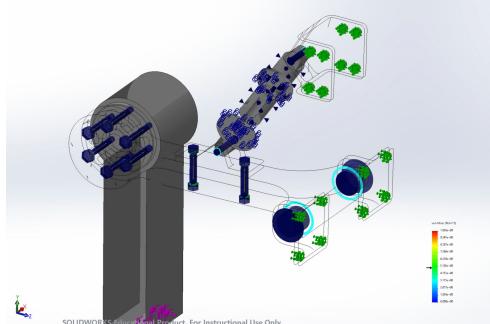
8"



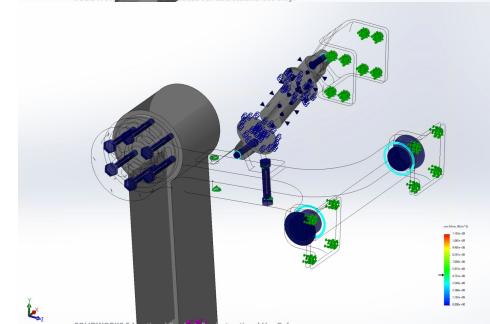
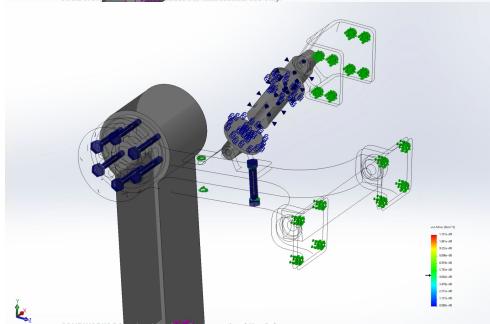
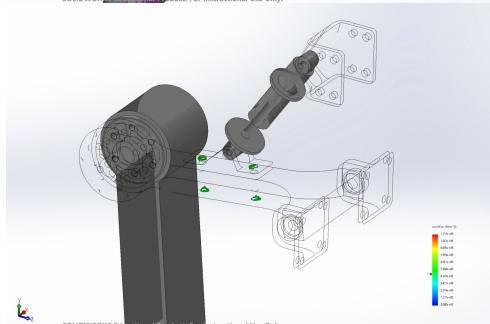
10"



2"



3"



SOLIDWORKS Educational Product. For Instructional Use Only.

Academy Works

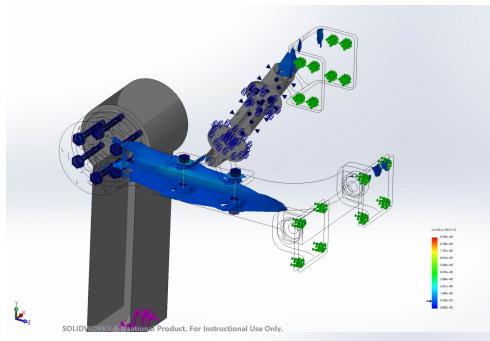
SOLIDWORKS Educational Product. For Instructional Use Only.

Academy Works

SOLIDWORKS Educational Product. For Instructional Use Only.

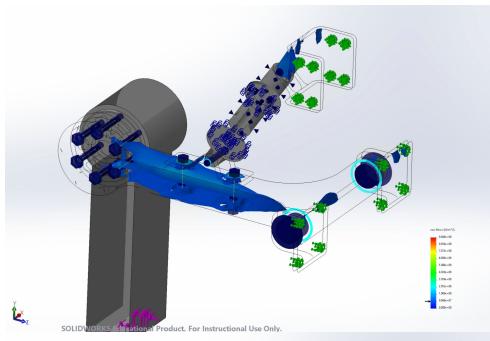
Academy Works

6"

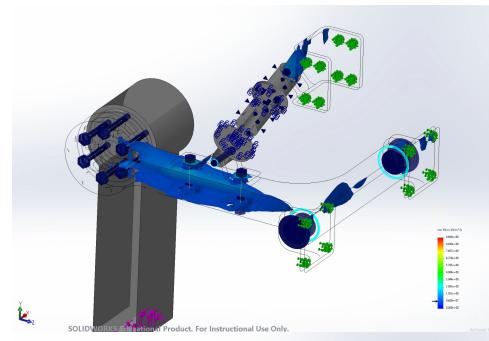


1"

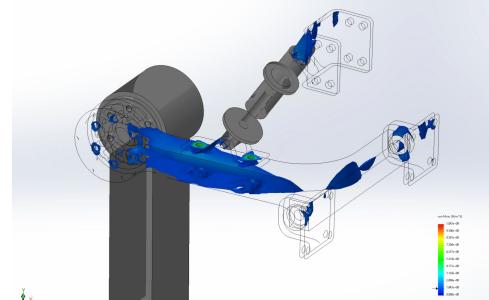
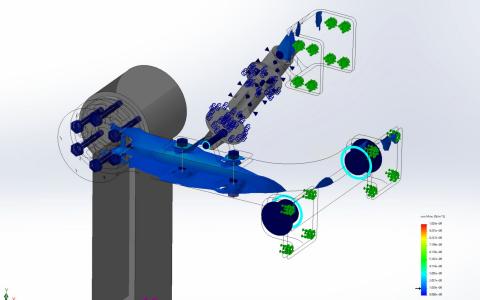
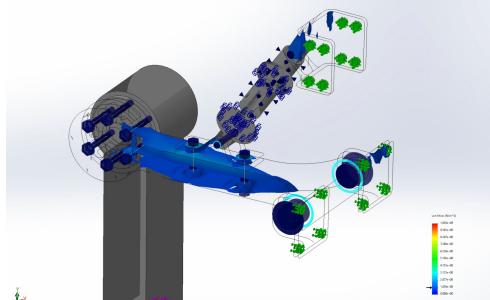
8"



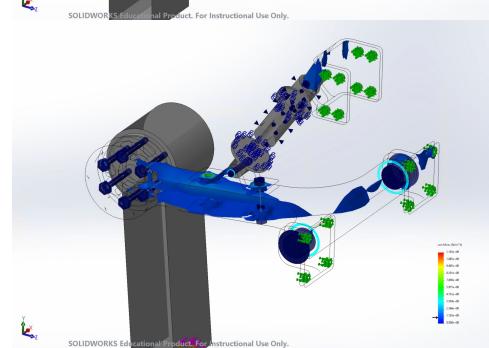
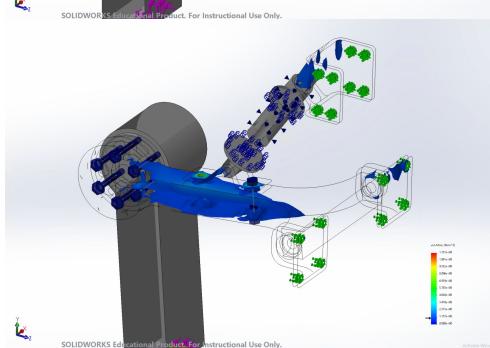
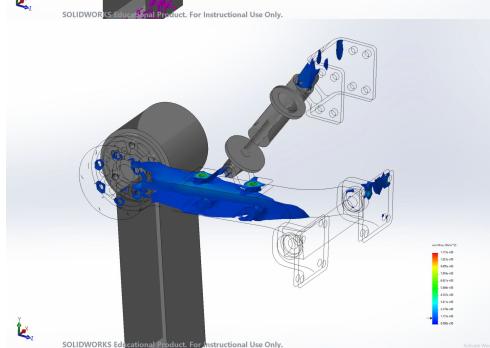
10"



2"



3"

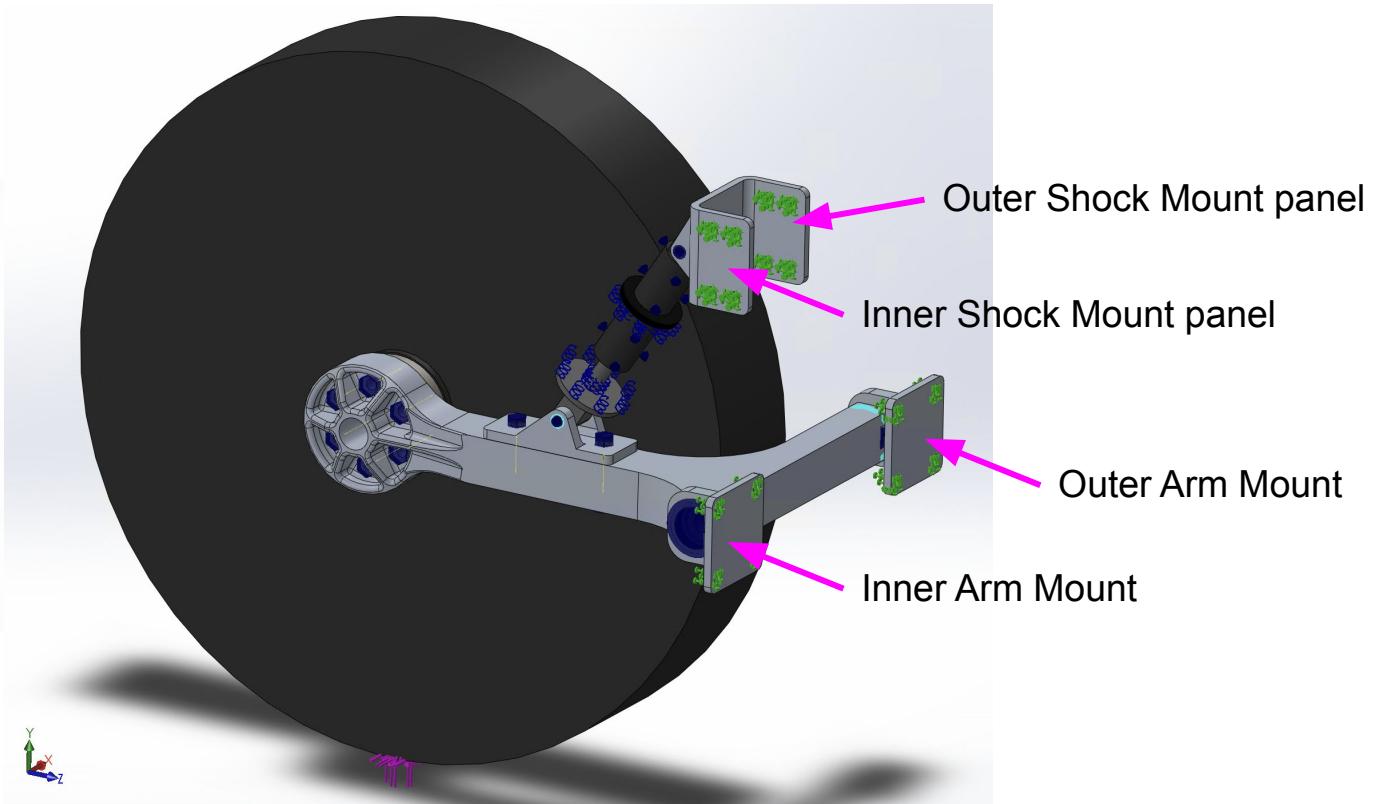
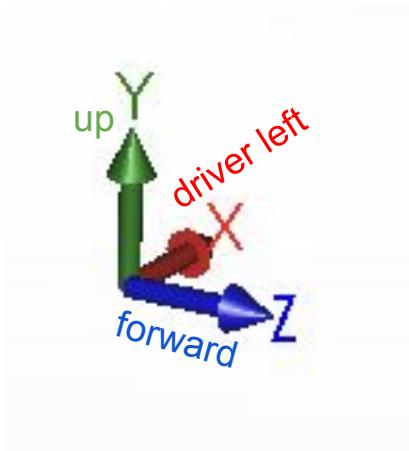


# Main Takeaways

- Changing arm width and inner margin does not seem to appreciably change the stress in back part of the L-arm—stays well below 20% of yield strength
- Having a smaller arm width decreases the stresses in the back part of the arm
- Inner margin does not seem to make a difference in the stresses throughout the part
- The mounts pass with sub-20%-of-yield stresses in all of the scenarios.

# Varying Dimensions – Chassis Forces

# Chassis Mount Faces



# Shock Mount Outer Panel

Shock ALeft FX	6 in	8 in	10 in		Shock ALeft FY	6 in	8 in	10 in		Shock ALeft FZ	6 in	8 in	10 in
1 in	6710	6720	6740		1 in	11200	11300	11400		1 in	2600	2670	2770
2 in	6840	6840	6820		2 in	11200	11100	11100		2 in	2530	2500	2440
3 in	7070	7070	7030		3 in	12300	12100	11900		3 in	1870	1830	1670
1 in reverse	7590	7450	7280		1 in reverse	5800	5110	4260		1 in reverse	3950	3270	2430
2 in reverse	7800	7710	7520		2 in reverse	4360	5490	4590		2 in reverse	4360	3960	3120
3 in reverse	8230	8220	8080		3 in reverse	6250	6240	5430		3 in reverse	4750	4720	3970

1 in	100.00%	100.15%	100.45%		1 in	100.90%	101.80%	102.70%		1 in	155.69%	159.88%	165.87%
2 in	101.94%	101.94%	101.64%		2 in	100.90%	100.00%	100.00%		2 in	151.50%	149.70%	146.11%
3 in	105.37%	105.37%	104.77%		3 in	110.81%	109.01%	107.21%		3 in	111.98%	109.58%	100.00%
1 in reverse	104.26%	102.34%	100.00%		1 in reverse	136.15%	119.95%	100.00%		1 in reverse	162.55%	134.57%	100.00%
2 in reverse	107.14%	105.91%	103.30%		2 in reverse	102.35%	128.87%	107.75%		2 in reverse	179.42%	162.96%	128.40%
3 in reverse	113.05%	112.91%	110.99%		3 in reverse	146.71%	146.48%	127.46%		3 in reverse	195.47%	194.24%	163.37%

# Shock Mount Inner Panel

Shock ARight FX	6 in	8 in	10 in		Shock ARight FY	6 in	8 in	10 in		Shock ARight FZ	6 in	8 in	10 in
1 in	8530	8520	8500		1 in	4740	4640	4500		1 in	7870	7790	7690
2 in	8610	8610	8620		2 in	4860	4930	4970		2 in	8190	8230	8280
3 in	9130	9130	9160		3 in	4060	4280	4470		3 in	9380	9420	9590
1 in reverse	7670	7800	7970		1 in reverse	10100	10800	11700		1 in reverse	6520	7190	8040
2 in reverse	7780	7850	8000		2 in reverse	10100	10600	11500		2 in reverse	6360	6760	7600
3 in reverse	8110	8120	8260		3 in reverse	10100	10200	11000		3 in reverse	6500	6530	7280
1 in	100.35%	100.24%	100.00%		1 in	116.75%	114.29%	110.84%		1 in	102.34%	101.30%	100.00%
2 in	101.29%	101.29%	101.41%		2 in	119.70%	121.43%	122.41%		2 in	106.50%	107.02%	107.67%
3 in	107.41%	107.41%	107.76%		3 in	100.00%	105.42%	110.10%		3 in	121.98%	122.50%	124.71%
1 in reverse	100.00%	101.69%	103.91%		1 in reverse	100.00%	106.93%	115.84%		1 in reverse	102.52%	113.05%	126.42%
2 in reverse	101.43%	102.35%	104.30%		2 in reverse	100.00%	104.95%	113.86%		2 in reverse	100.00%	106.29%	119.50%
3 in reverse	105.74%	105.87%	107.69%		3 in reverse	100.00%	100.99%	108.91%		3 in reverse	102.20%	102.67%	114.47%

# Arm Mount Outer

Arm ALeft FX	6 in	8 in	10 in		Arm ALeft FY	6 in	8 in	10 in		Arm ALeft FZ	6 in	8 in	10 in
1 in	541	543	1270		1 in	2350	1800	1410		1 in	1740	1290	990
2 in	2780	2600	2470		2 in	1170	1000	821		2 in	714	502	369
3 in	3630	4310	5060		3 in	977	524	342		3 in	3610	2700	2090
1 in reverse	8330	12600	15300		1 in reverse	3710	2740	2120		1 in reverse	11500	8370	6300
2 in reverse	5960	11100	15200		2 in reverse	5600	4150	3230		2 in reverse	14000	10400	8020
3 in reverse	4160	9040	14400		3 in reverse	8010	6030	4730		3 in reverse	16700	12700	9940

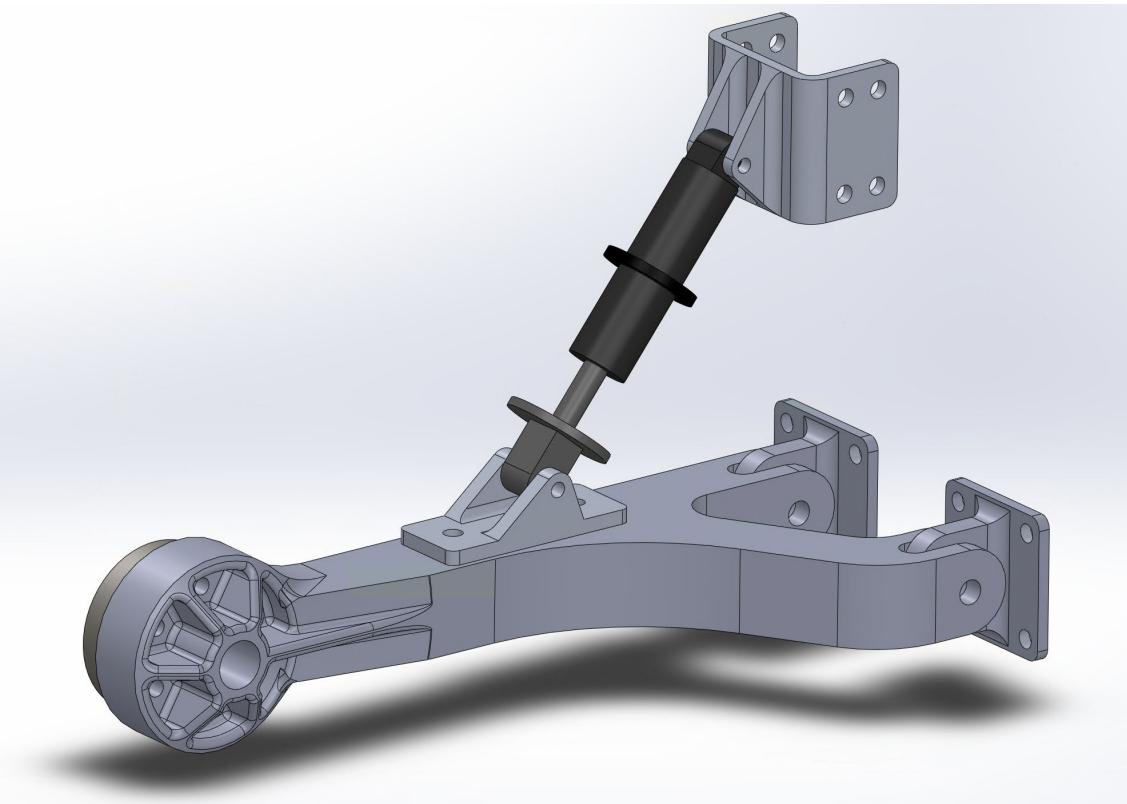
1 in	100.00%	100.37%	234.75%		1 in	687.13%	526.32%	412.28%		1 in	471.54%	349.59%	268.29%
2 in	513.86%	480.59%	456.56%		2 in	342.11%	292.40%	240.06%		2 in	193.50%	136.04%	100.00%
3 in	670.98%	796.67%	935.30%		3 in	285.67%	153.22%	100.00%		3 in	978.32%	731.71%	566.40%
1 in reverse	200.24%	302.88%	367.79%		1 in reverse	175.00%	129.25%	100.00%		1 in reverse	182.54%	132.86%	100.00%
2 in reverse	143.27%	266.83%	365.38%		2 in reverse	264.15%	195.75%	152.36%		2 in reverse	222.22%	165.08%	127.30%
3 in reverse	100.00%	217.31%	346.15%		3 in reverse	377.83%	284.43%	223.11%		3 in reverse	265.08%	201.59%	157.78%

# Arm Mount Inner

Arm ARight FX	6 in	8 in	10 in		Arm ARight FY	6 in	8 in	10 in		Arm ARight FZ	6 in	8 in	10 in
1 in	5360	4250	3490		1 in	12300	11700	11300		1 in	15200	14700	14400
2 in	7550	7380	7270		2 in	11300	11100	11000		2 in	13200	13400	13500
3 in	8700	9380	10200		3 in	9730	10200	12700		3 in	11200	12100	12700
1 in reverse	5410	9990	13000		1 in reverse	6210	7190	7800		1 in reverse	1910	5060	7120
2 in reverse	2940	8270	12700		2 in reverse	4540	5990	6910		2 in reverse	122	3440	5860
3 in reverse	1030	5930	11600		3 in reverse	2690	4680	5970		3 in reverse	1930	2120	4870

1 in	153.58%	121.78%	100.00%		1 in	126.41%	120.25%	116.14%		1 in	135.71%	131.25%	128.57%
2 in	216.33%	211.46%	208.31%		2 in	116.14%	114.08%	113.05%		2 in	117.86%	119.64%	120.54%
3 in	249.28%	268.77%	292.26%		3 in	100.00%	104.83%	130.52%		3 in	100.00%	108.04%	113.39%
1 in reverse	525.24%	969.90%	1262.14%		1 in reverse	230.86%	267.29%	289.96%		1 in reverse	1565.57%	4147.54%	5836.07%
2 in reverse	285.44%	802.91%	1233.01%		2 in reverse	168.77%	222.68%	256.88%		2 in reverse	100.00%	2819.67%	4803.28%
3 in reverse	100.00%	575.73%	1126.21%		3 in reverse	100.00%	173.98%	221.93%		3 in reverse	1581.97%	1737.70%	3991.80%

# Alternate Design: Lambda Arm



- Reduce distance between arm mount points to reduce mass
- Diagonal support portion to increase contribution to strength
- New “lambda”-shape