



P11: Robotic Shoulder Exoskeleton

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Gantt Chart

Project Start:

Display Week:

Mar 27, 2023 Apr 3, 2023 Apr 10, 2023

27 28 29 30 31 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16

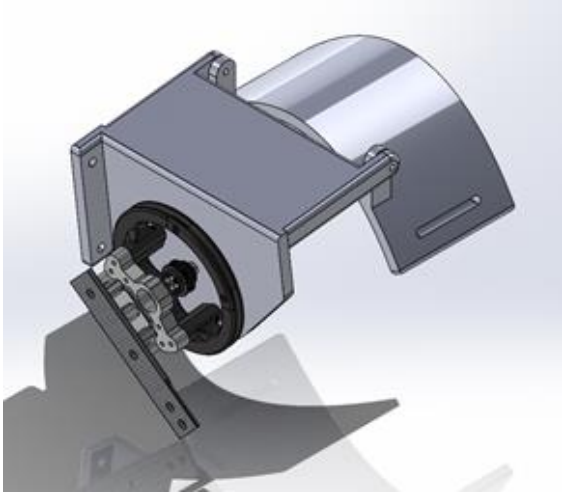
M T W T F S S M T W T F S S M T W T F S S

TASK	ASSIGNED TO	PROGRESS	START	END	M	T	W	T	F	S	S	M	T	W	T	F	S	S	M	T	W	T	F	S	S
67% to 100% Build																									
UGRADS Registration	Team	100%	3/6/23	3/10/23																					
Client Meeting #5: Present New Pivot Design	Team	100%	3/20/23	3/24/23																					
Redesign	Team	100%	3/24/23	3/30/23																					
Client Meeting #6: Present 100% Build, Get Client Approval	Team	100%	3/31/23	3/31/23																					
Complete Final Build: Harness System, Onyx/CF Printing, CF Arm Bar	Team	100%	3/31/23	4/5/23																					
Present 100% Build	Team	Late	3/31/23	4/4/23																					
Design Testing																									
Finalize Testing Plan	Team	100%	3/8/23	3/31/23																					
Meet with Client to Discuss Power System	Team	50%	4/4/23	4/8/23																					
Initial Testing Results	Team	0%	4/9/23	4/11/23																					
Final Testing Results: Pull-up Test	Team	0%	4/10/23	4/14/23																					
Final Poster Due: Display Testing Results	Team	0%	4/14/23	4/14/23																					

4/7/2023

- Currently behind schedule.
- 3D prints began after the 100% build was due.
- Our client is designing the powerhouse for the system. Testing is delayed until that is finished.

Design Efforts - CAD Iterations



Design 1 – Fall Prototype



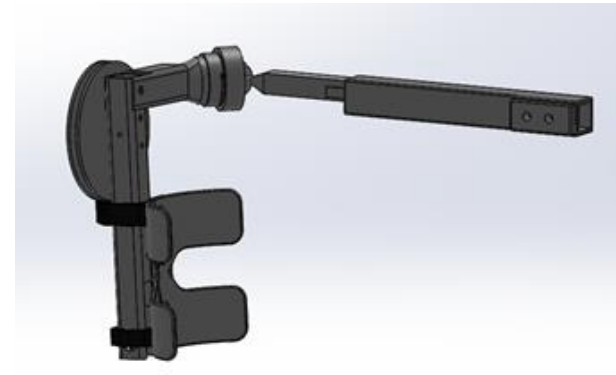
Design 2 – Ball & Socket



Design 3 – Revised Ball & Socket

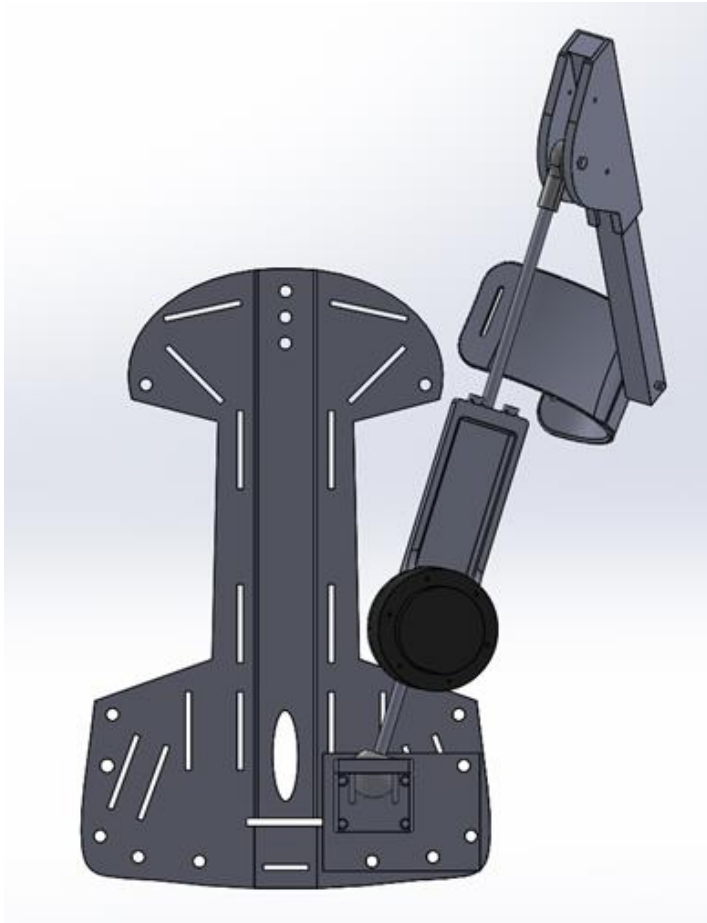


Design 4 – Revolute Joint

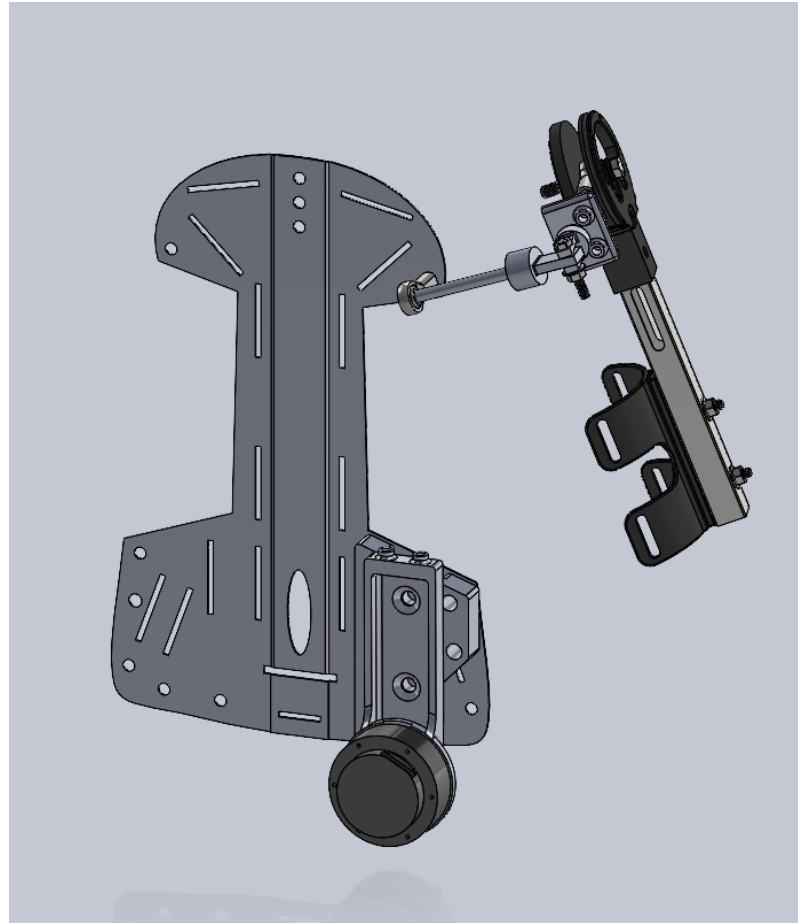


Design 5 – Revised Revolute Joint

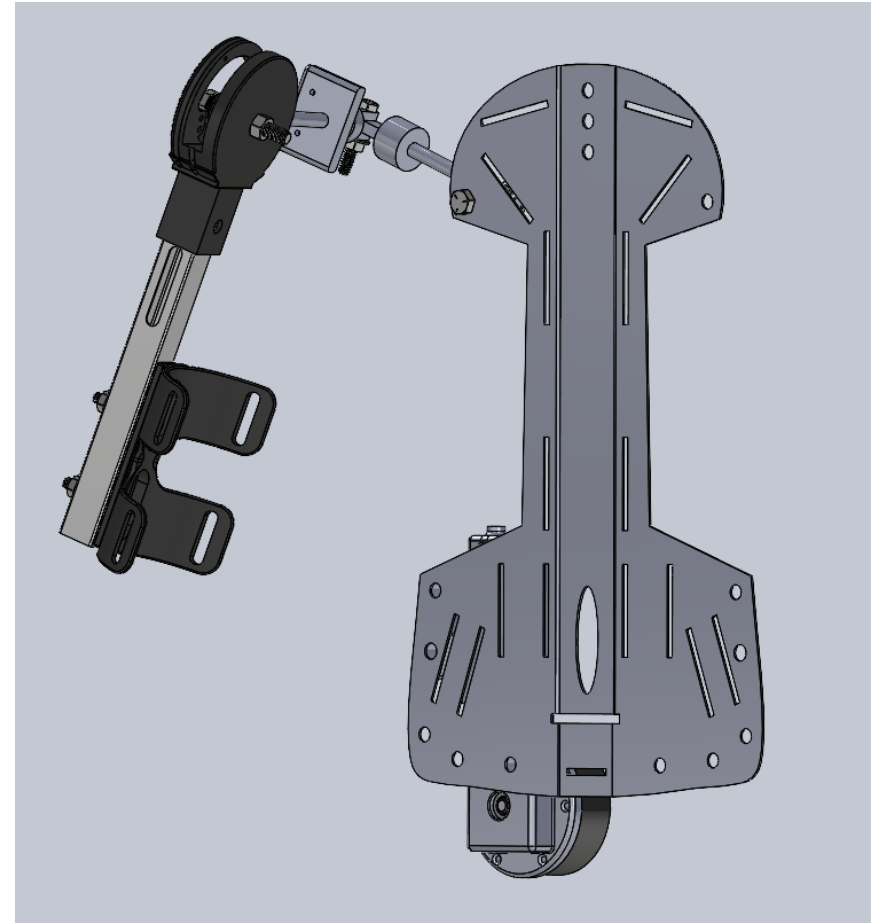
67% to 100% Design Iteration



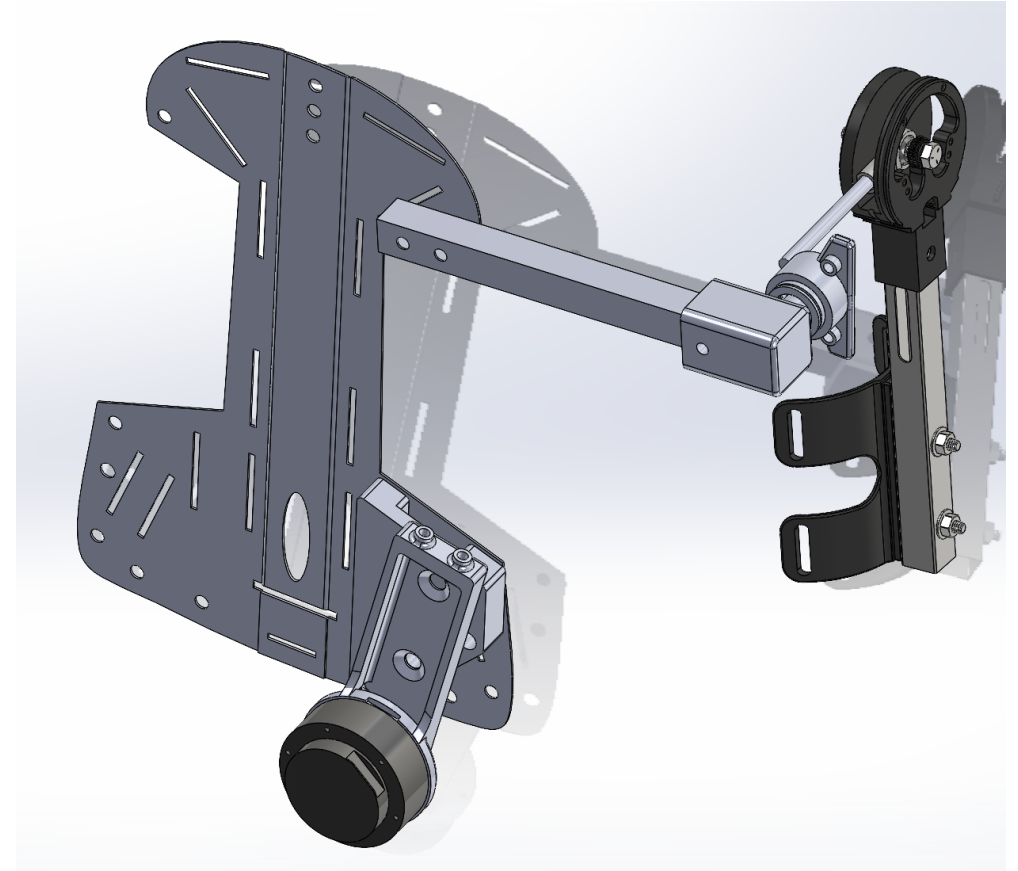
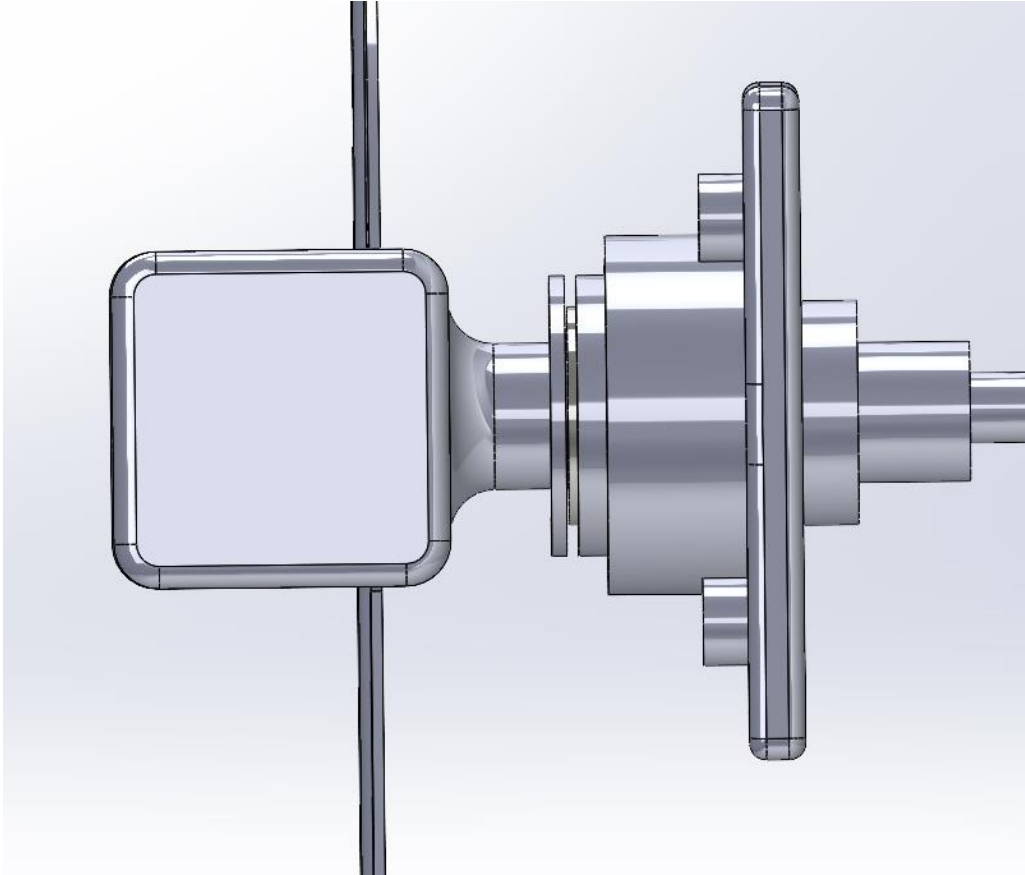
Design 6 – Spring 67% Prototype
4/7/2023



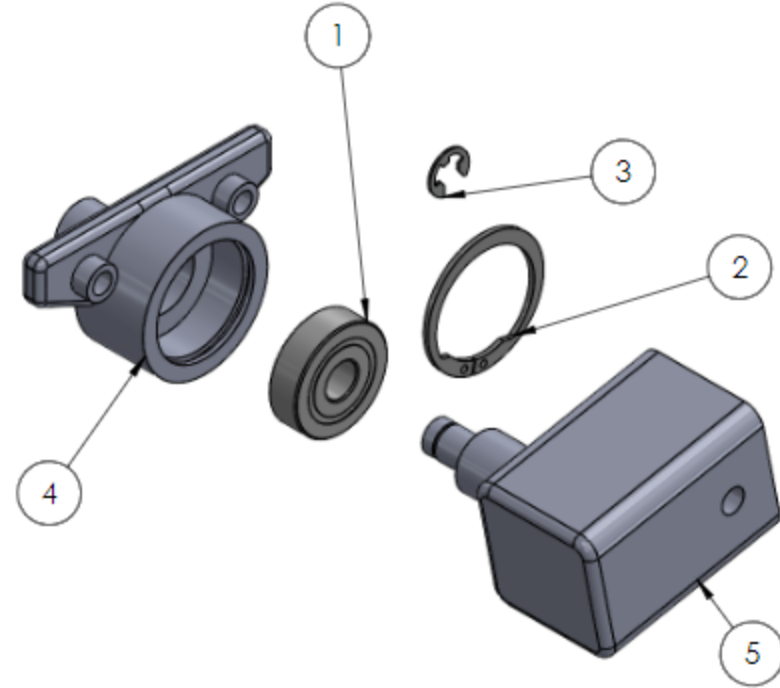
Design 7 – 95% Build



Current and Final CAD

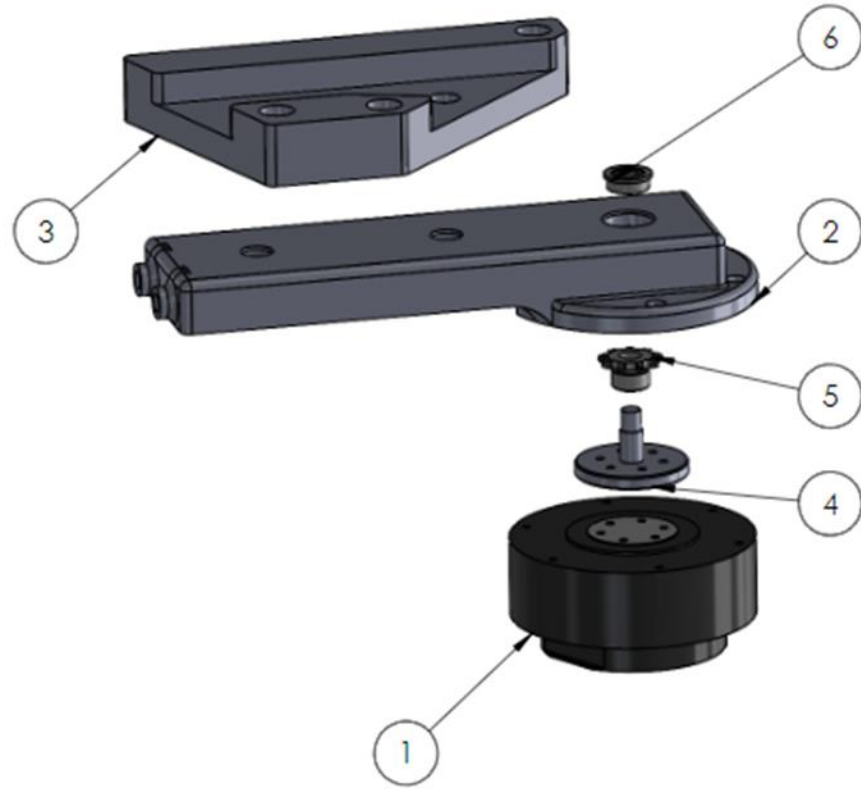


Sub-Assembly A: Bowden Termination Block



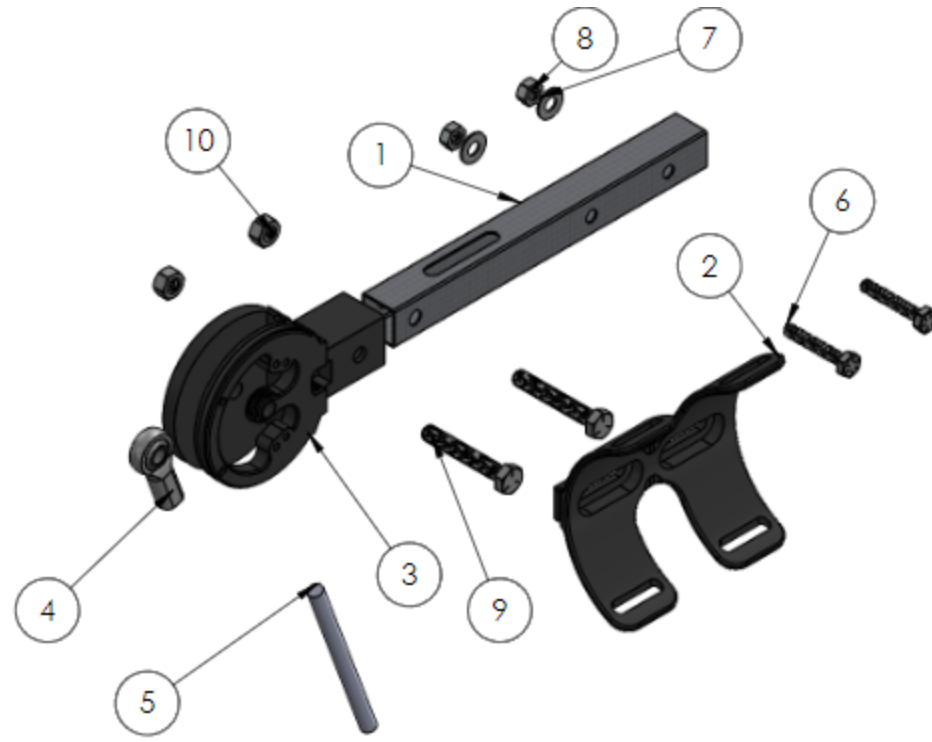
ITEM NO.	PART NUMBER	DESCRIPTION	QTY.
1	A-01	Ball Bearing	1
2	A-02	Inverted External Retaining Rings	1
3	A-03	Side-Mount External Retaining Rings	1
4	A-04	TERMINATION BLOCK	1
5	A-05	TUBE CAP	1

Sub-Assembly B: Motor



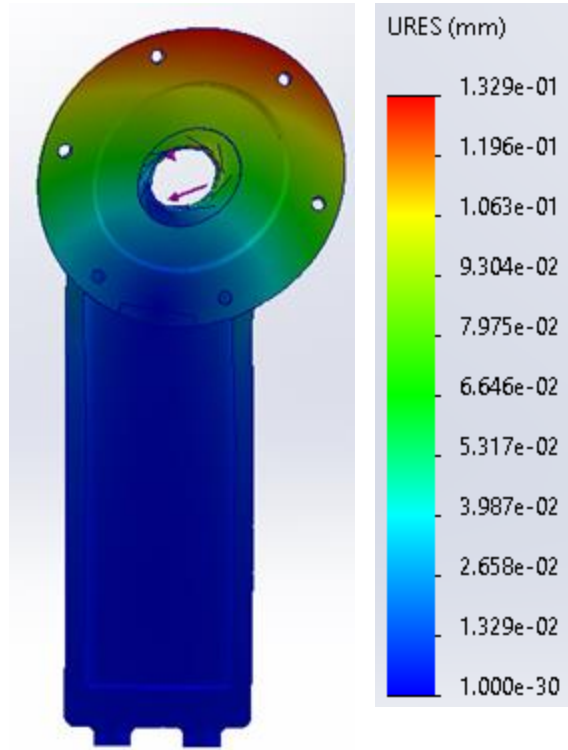
ITEM NO.	PART NUMBER	DESCRIPTION	QTY.
1	B-01	MOTOR AK60-6	1
2	B-02	MOTOR MOUNT	1
3	B-03	MOTOR ADAPTER PLATE	1
4	B-04	SPROCKET PLATE	1
5	B-05	CHAIN SPROCKET 2302K68	1
6	B-06	MOTOR BEARING 780K143	1

Sub-Assembly C: Pulley



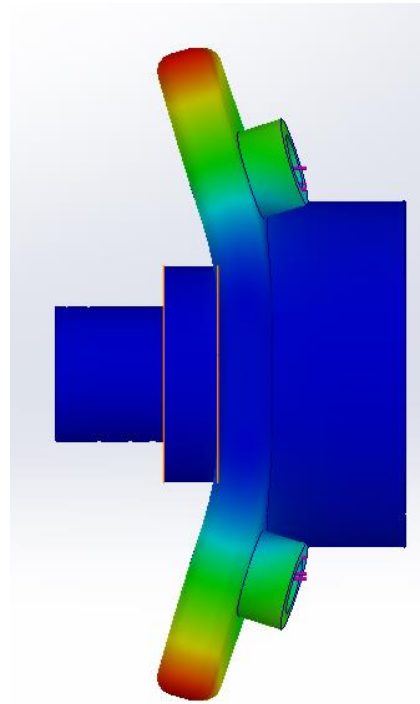
ITEM NO.	PART NUMBER	DESCRIPTION	QTY.
1	C-01	Ultra-Strength Lightweight Carbon Fiber Tube	1
2	C-02	ARM CUFF	1
3	C-03	PULLEY	1
4	C-04	ROD END	1
5	C-05	ALLTHREAD	1
6	C-06	HEX BOLT 1/4-20	2
7	C-07	1/4in Steel Washer	2
8	C-08	1/4-20 NUT	2
9	C-09	5/16-20 HEX BOLT	2
10	C-10	5/16-20 HEX BOLT	2

FEA

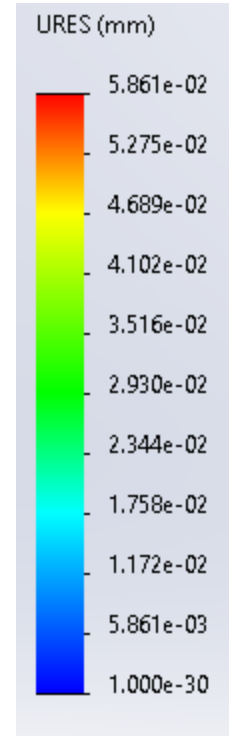


The total deflection was less than one millimeter assuming all torque is going into deflecting the motor mount

4/7/2023



Bowden Cable Termination block experiences less than a millimeter of deformation which passes the theoretical loading it will experience



Carbon Fiber Square stock has almost no deformation due to the forces from the motor

Colin 9

Purchasing Plan

Total Budget: \$3750

Total Spent: \$2726.26

Remaining Budget: \$1023.74

- Highly iterative design process with 3D printing
- Additional hardware is either owned or purchased outside of the project funding

Item	Quantity	Vendor/Manufacturer	Total Cost
AK 60-6 Motor	2	T-Motor	\$ 650.00
Onyx Filament 800cc	2	MarkedForge	\$ 380.00
CF Filament 150cc	2	MarkedForge	\$ 900.00
Roller Chain Sprocket	2	McMaster Carr	\$ 26.00
Roller Chain	2	McMaster Carr	\$ 36.00
Connecting Link	4	McMaster Carr	\$ 7.32
CF Square Stock 32"	1	McMaster Carr	\$ 139.99
Adding and Connecting	2	McMaster Carr	\$ 6.78
Steel Rod Machinable	1	McMaster Carr	\$ 54.17
Onyx Filament 800cc	1	MarkedForge	\$ 210.00
CF Filament 50cc	1	MarkedForge	\$ 170.00
PLA	1	MarkedForge	\$ 56.00
Pirahna Dive Harness	1	Pirahna Dive	\$ 90.00
Total Spent			\$ 2,726.26
Total Budget			\$ 3,750.00
Total Utilization			73%

Manufacturing Plan

- All manufactured parts were 3D printed in house
- The sprocket weld was done in the machine shop by one of the team members
- All components have been purchased, printed, and assembled onto the device.

Item	Quantity	Vendor/Manufacturer	Total Cost
Shoulder Plate	1	Team 3D Print	\$0.00
Hinge Plate	1	Team 3D Print	\$0.00
Large Pulley	1	Team 3D Print	\$0.00
Large Pulley Bridge	1	Team 3D Print	\$0.00
Pulley Flat Anchor	1	Team 3D Print	\$0.00
Tube Spacer	1	Team 3D Print	\$0.00
Bicep Cuff	2	Team 3D Print	\$0.00
Bicep Mount Upper	1	Team 3D Print	\$0.00
Bicep Mount Lower	1	Team 3D Print	\$0.00
Ball Joint Bar	2	Team 3D Print	\$0.00
Ball Joint	1	Team 3D Print	\$0.00
Pivot Point	1	Team 3D Print	\$0.00
Socket Mounting Plate	1	Team 3D Print	\$0.00
Corner Hinge	1	Team 3D Print	\$0.00
Motor Mount Plate	1	Team 3D Print	\$0.00
Motor Mount	3	Team 3D Print	\$0.00
Onyx Pulley	1	Team 3D Print	\$0.00
Onyx Corner Hinge	1	Team 3D Print	\$0.00
Sprocket Shaft Weld	1	Team Machine Shop	\$0.00

Testing Plan

CUSTOMER REQUIREMENTS	INITIAL TESTS	FINAL TESTS
Cable Actuated	Is it cable actuated?	N/A
Utilize a Pulley	Is a pulley used to create torque?	N/A
User Operable	N/A	Can the user operate the device independently of stationary machines?
Lightweight	Does the device weigh less than or more than 6 lbs.?	N/A
Low-Profile	Does the device protrude less than 10cm (3.94in) from the user's body?	N/A
Assist Pull-up Motion	N/A	15% Increase in pull-ups assisted as measured from the unassisted number



Demonstration
