

Below the Knee Exoskeleton

Team:

Ryan Oppel (Budget Lead), Alexandra Schell (Team Lead),
Nicolas Watkins (Website and CAD Lead)

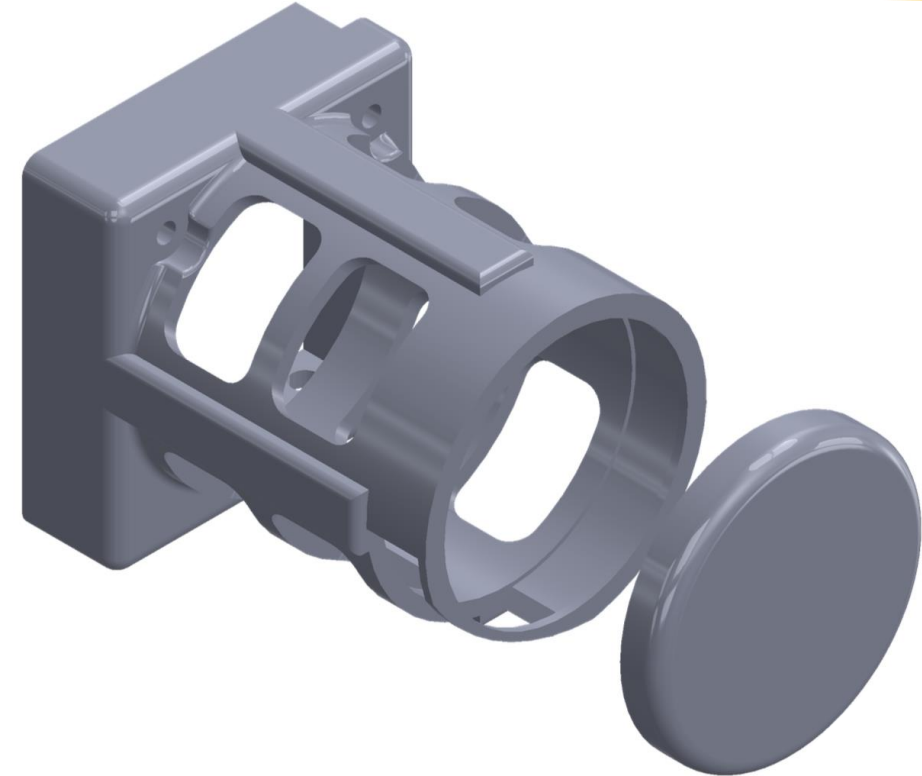
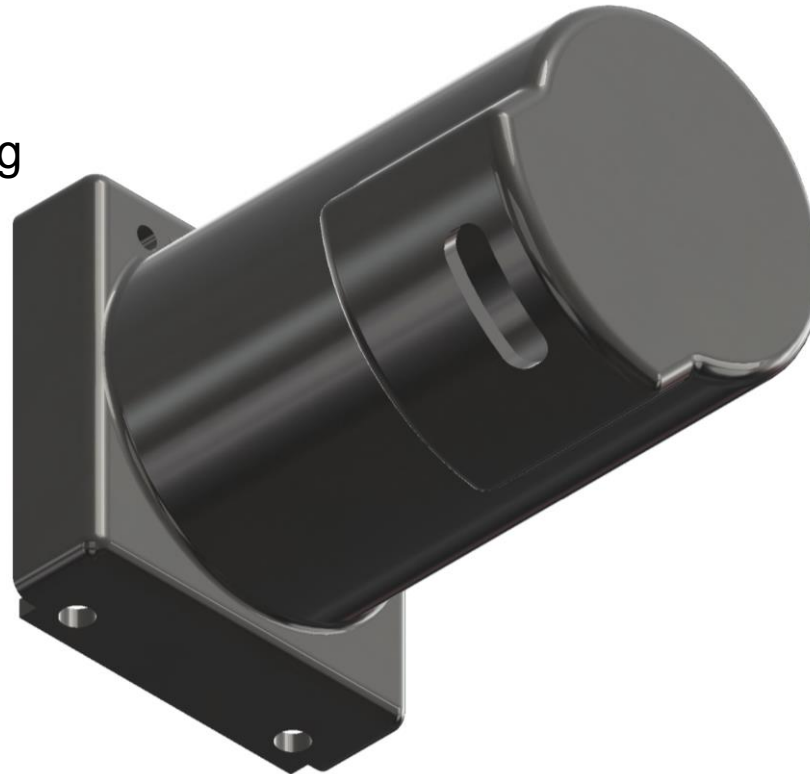
Design Efforts



Design Efforts

Final Designs

- Test heat dissipation vs ingress protection for motor housing
- Design ratcheting gear system for ankle rotation
- Slim down PCB mount
- Work with client re-designing parts for manufacturing
- 100% designed
- 0% built



Purchasing Plan

- The original budget of \$4000 does not sit at \$2500 after the first semester of purchases.
- Total Assembly had 55 parts/pieces.
- 8 parts have been purchased
- 8 parts have been donated
- 5 are in the process of fabrication
- 38% purchased/on hand

Parts:	Column1
Bondable Flex Circuit	Donated
Cable Chain Linker	Donated
Carbon Fiber square tubing	Donated
Quick Connect torque sensor	Donated
Calibration Magnet	Donated
Sensor cable	Donated
Strain Gage	Donated
Torque Sensor Wires	Donated

Purchased Items:	Price
800cc Onyx Filament Spool	254.97
150cc Carbon Fiber CFF Spool	518.5
E-Flite 22.2v 910mAh li-po battery	53.29
ECXFL32L motor with a 1:35 Gear Ratio X2	599.51
Fluorine Rubber O-Rings, 42mm OD 38mm ID 2mm Width (pack of 10)	16.9
10 PCS O Rings Nitrile Rubber Round O-Rings Seal Grommets 185mm OD 181mm ID 2mm Width	16.91
SUNLU PLA 3D Printer Filament PLA Filament 1.75mm	27.27
Creality PLA Carbon Fiber Filament 1.75mm	39.28
Remaining Budget	\$2,527.25

Purchasing Plan

- Remaining Budget is \$2500
- \$850 is the estimate for machined aluminum parts
- \$218 is the estimate for all other parts.
- This leaves approximately \$1500 for future iterations/ 2nd ankle Exo

Remaining Budget:	2527.25
Estimated aluminium parts:	850
Estimated fasteners/other parts:	218
Remaining for 2nd Ankle Exo:	1459.25

Parts:	Part#:	Price:
Roller Chain sprocket	Manufactured	0
Big Gear modified Kog	Manufactured	50
Foot plate	Manufactured	0
Motor Bracket	Manufactured	175
Pully Quick connect	Manufactured	50
Bridge pulley	Manufactured	50
Sensor case	Manufactured	0
Calf Cuff	Manufactured	0
Calf Cuff adjuster	Manufactured	150
Cable Cover	Manufactured	0
Motor Bearing Case	Manufactured	175
Motor Mount	Manufactured	200
Total:		850

Parts:	Part #	Price
6mm ball bearing	49DD43	4
35 mm button head screw	38DA12	5
flanged ball bearing	49DD88	1
M8 Steel locknut	38DH71	1
M8 steel button head bolt	811X86	3
socket head screw	5GUD5	2
Hex Head drive screw	5KY28	5
M8 bracket bolt	808A65	4
Cable Crimp	16X825	2
6M Cuff Locknut	38DH70	3
FSR	FSR01CE	110
small linkage chain.	B1293497	12
M3 Nut	4EFZ9	2
M3 hex flat screw	811YK3	2
Clearance Cable	2TAA1	8
Pogo Pin Connector	3RWL9	7
M2 flat head screw	6HB56	2
M2 nut	6CA66	2
M3 sealing socket head screw	6CE47	2
M5 button head screw	811X87	4
M5 lock washer	826K20	5
6mm M5 shoulder screw	38CZ28	7
Thermal Pads	1MVP8	15
M3 25mm flathead screw	38DE72	3
M5 12mm torque screw	26LG26	3
M8 bolt	808A65	2
6mm Washer	38CV95	2
Total:		218

Manufacturing Plan

Current Plan:

- Current tasks:
 - Redesigning motor cover and mount, PCB cover, battery cover
- The upright, motor mounts and front cover have been manufactured for the previous design
- Due to our new motor size though, the motor mount needs to be resized
- Using manufacturer determined by Prof. Lerner
- 100% planned

Part:	Cost:	Materials:	Manufacturing:	Manufacturer:	Part #:
Motor Cover	Undetermined	7075 Aluminum Alloy	Machined	NAU CNC	N/A
PCB Housing	518.5	PLA Carbon Fiber Filament	3D Printed	Biomechatronics 3D Printer	F-FG-0005
Motor - Mount Upright	Undetermined	7075 Aluminum Alloy	Machined	NAU CNC	N/A
Motor Mount - leaf	Undetermined	7075 Aluminum Alloy	Machined	NAU CNC	N/A
STTR Upright	55.2	Carbon Fiber	Milled	McMaster Carr - Tapped & milled cable clearances	2040N11
Front Cover	518.5	PLA Carbon Fiber Filament	3D Printed	Biomechatronics 3D Printer	F-FG-0005

Design Progress



Arduino thermocouple DAQ assembled for testing motor housing thermals



O-rings for motor mount and PCB & battery housing



Upgraded LiPo battery

Design Progress



Lerner's Ankle Exo-Skeleton: Here is a view of an Ankle Exo-skeleton we will be working with. Our team will be building off this exoskeleton and be modifying some parts and changing the design. As per Lerner's instruction this Exo-skeleton will stay with him in his lab.



Gantt Chart

Status:

- Currently behind schedule but with much space to catch up once manufacturing plans get sent out for purchasing
- We are waiting on CAD materials for manufacturing of the main base of exoskeleton
- Plan to have everything purchased in the next two weeks

3 Major Deadlines 2nd Semester							1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	
WBS Number	Task Title	Task Owner	Start Date	End Date	Duration	% Done																
3.1	Engineering Model	Team	1/13/25	1/23/25	10	100%	█	█														
3.2	Test 2nd Prototype	Alex S	12/13/24	1/20/25	37	100%	█	█	█	█	█	█	█	█	█	█	█	█	█	█	█	█
3.3	Analysis of 2nd Prototype	Alex S	1/13/25	2/1/25	18	50%	█	█	█													
3.4	Hardware Status Check 1	Team	1/13/25	2/13/25	30	60%	█	█	█	█	█											
3.5	Order all parts	Ryan O	1/13/25	2/13/25	30	0%	█	█	█	█	█											
3.6	Website check	Nick W	1/13/25	2/27/25	44	30%	█	█	█	█	█	█	█	█								
3.7	Testing Plan	Ryan O	3/1/25	3/27/25	26	0%						█	█	█	█	█	█	█	█	█	█	█
3.8	Hardware Status Check 2	Team	2/13/25	3/6/25	23	0%					█	█	█	█	█	█	█	█	█	█	█	█
3.9	Final CAD	Ryan O	3/6/25	4/3/25	27	0%																
4	Final Hardware Status and Prototype	Team	3/6/25	4/3/25	27	0%																
4.1	Website check	Nick W	2/28/25	4/17/25	47	0%																
4.2	Test and Analyze Prototype	Alex S	4/3/25	4/17/25	14	0%																
4.3	Final Report	Team	4/1/25	4/17/25	16	0%																

Thank You!