Biomechatronic Hip Exoskeleton Team (BHET)

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Project Description

Client Information

- The NAU Biomechatronics Lab develops and tests robotic exoskeletons that provide powered assistance to the wearer during the walking gait cycle
- Research is focused on improving mobility for individuals with diminished motor function
- Created an exoskeleton for ankle assist

Project Description

Project Goal

- Design an exoskeleton device that applies torque assistance at the hips and measure the torque being delivered. The device will be used to test joint torque assistance needed to reduce the metabolic cost of walking.

Client

- Leah Liebelt
- NAU Biomechatronics Lab

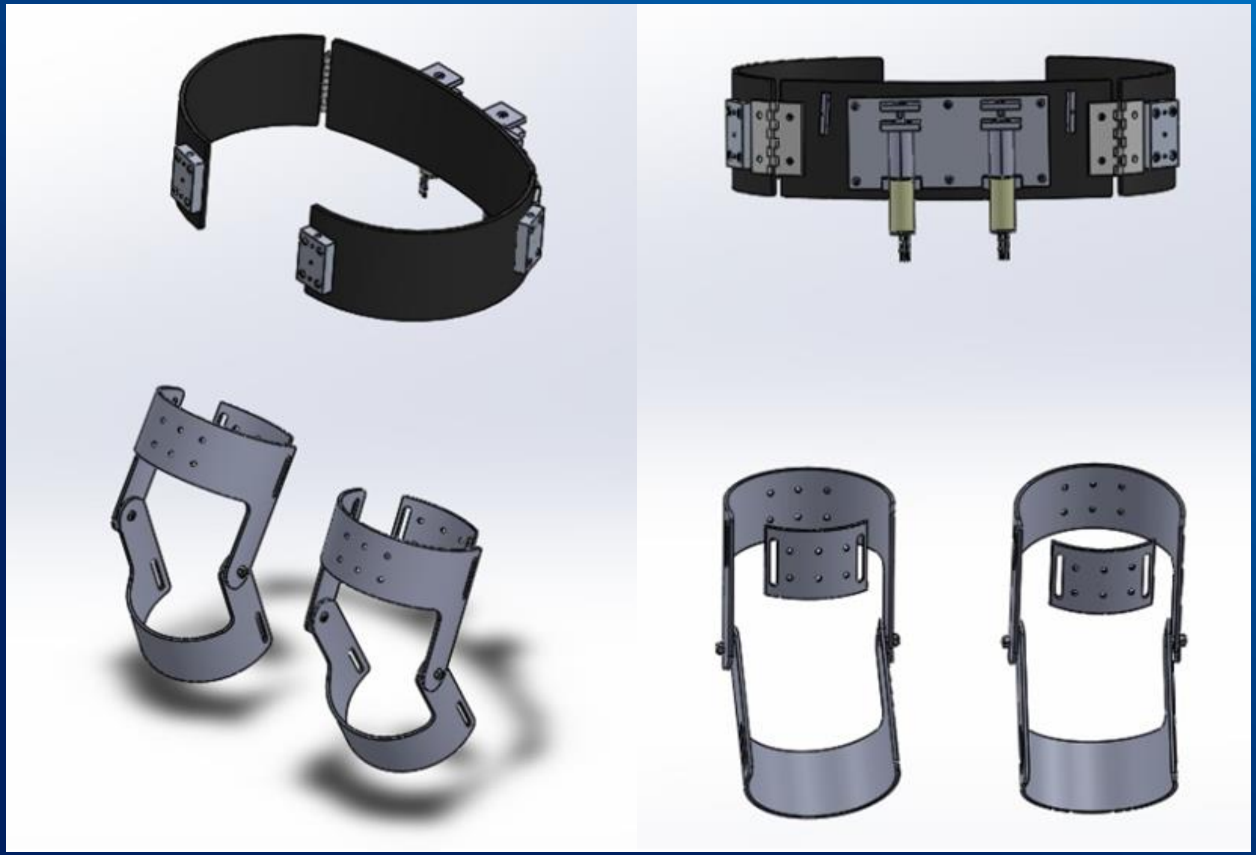
Sponsor

- W.L. Gore & Associates

Design Description – Hip Exo V3

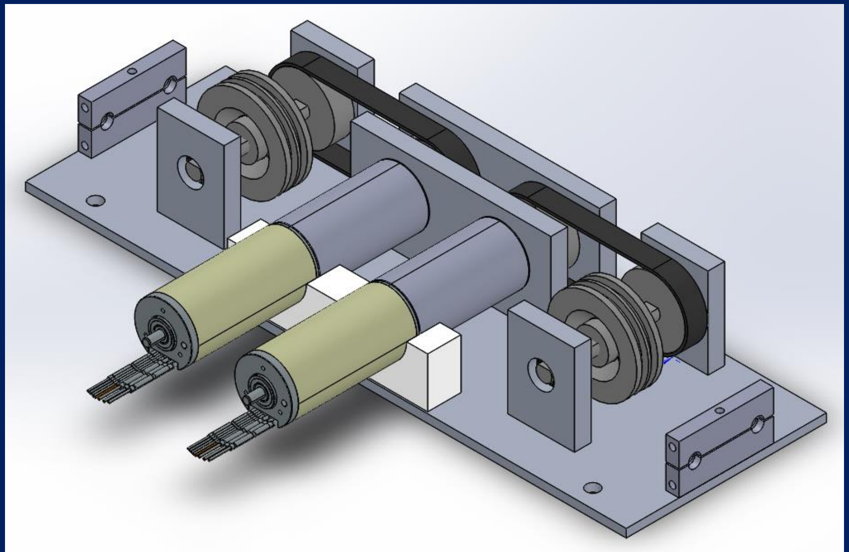
Changes made for current revision

- Integration of soft harness and rigid frame
- Motor mount
- Rigid articulating knee braces

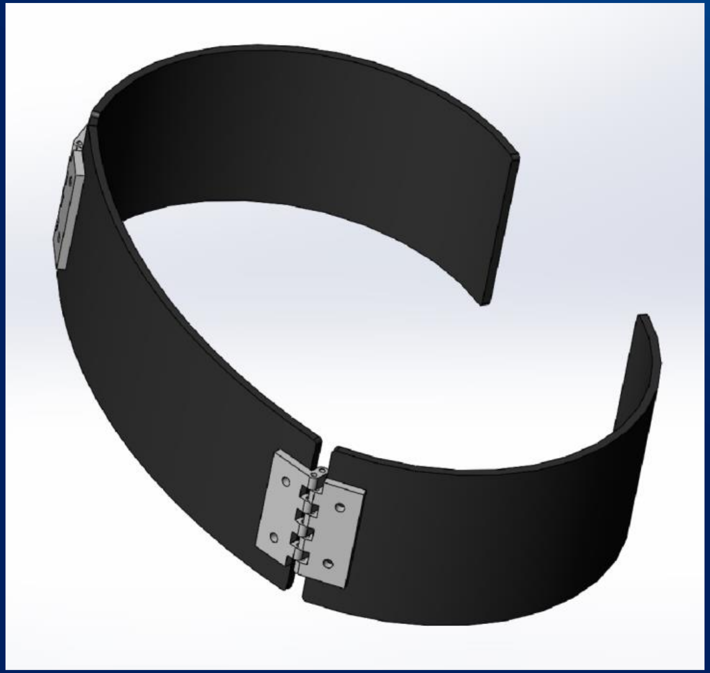


Design Description – Hip Exo V3

Motor Mount



Hip Belt



Knee Brace

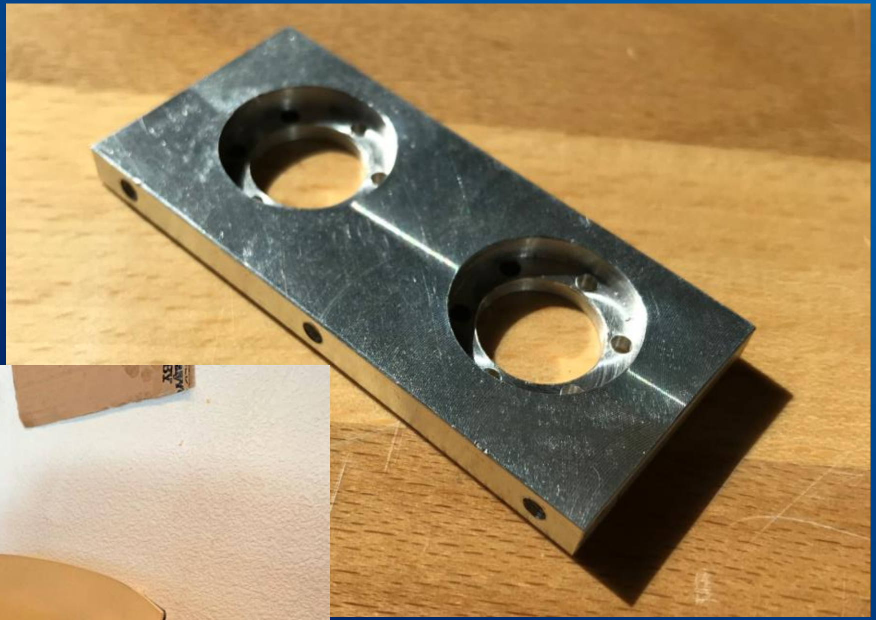
Current State of System

Belt	Motor Mount	Knee Brace
• Formed and fitted to subject • Thermoplastic and a foam lining • Light	• Base plate completed • ½ motor mounts completed • Other aspects of the motor mount are 3D printed	• Used template to cut shape out of thermoplastic • Still needs to be formed, but process is quick.

Primary Focus:

- Keep parts light
- Shave off as much material as we can, without compromising structure.

Current State of the System - Pictures



Engineering Requirements

Note: Bolded and underlined are requirements met

- Torque Applied
- Time to don/doff
- User Comfort Rating
- **<u>Weight</u>**
- Power required
- Cycles to Failure
- **<u>Cost to Manufacture</u>**
- Extension/Flexion
- Abduction/Adduction/Rotation
- Conformability/Compliance

Budget

PART (SOLIDWORKS PART NAME)	MATERIAL	DIMENSIONS (in.)	SUPPLIER	QTY.	COST/UNIT	COST
Base_Plate_V1	6061 T6 AL	0.25 x 3 x 12	OnlineMetals	1	$6.30	$6.30
Bearing_Block_V1	6061 T6 AL	0.25 x 1.5 x 48	OnlineMetals	1	$10.05	$10.05
Housing Clamps (At motor assembly)						
Housing Clamps (At cable termination)						
Face_Plate_V2						
Mounting_Bracket_V5	6061 T6 AL	0.5 x 1.5 x 24	OnlineMetals	1	$12.06	$12.06
KneeBraceTop_V2	Kydex	0.125 x 12 x 12	McMaster-Carr	2	$10.16	$20.32
KneeBraceTop-Back_V2						
KneeBraceBottom_V2						
Motors	N/A	N/A	Maxxon	2	$815.73	$1,631.46
					Total	$1,680.19

HARDWARE	MATERIAL	DIMENSIONS (in.)	SUPPLIER	QTY.	COST/UNIT	COST
M4 x 20mm (100 pack)	SS A2-70	N/A	Copper State	1	$8.76	$8.76
M4 x 10mm (100 pack)	SS A2-70	N/A	Copper State	1	$6.20	$6.20
M3 x 10mm (100 pack)	SS A2-70	N/A	Copper State	1	$4.09	$4.09
M3 x 20mm (100 pack)	SS A2-70	N/A	Copper State	1	$5.77	$5.77
Shoulder screw	316 SS	0.25 Shoulder, 10-32	McMaster-Carr	2	$5.32	$10.64
Nylon Insert Locknut (50 Pack)	316 SS	10-32 Thread Size	McMaster-Carr	1	$4.71	$4.71
Bearings for Bearing_Block_V1	Steel	3mm W, ID 6mm, OD 10mm	McMaster-Carr	2	$12.06	$24.12
					Total	$64.29

Alternative Part Materials	MATERIAL	DIMENSIONS (in.)	SUPPLIER	QTY.	COST/UNIT	COST
Bearing_Block_V1	7075 T6	0.25 x 1.5 x 48	OnlineMetals	1	$40.24	$40.24
Housing Clamps (At motor assembly)						
Housing Clamps (At cable termination)						
Face_Plate_V2						
					Total	$40.24

Legend
Already Purchased
Aquired w/out Purchase
No longer needed

Shipping - Online Metals	$21.92
Amount Purchased	$1,681.79
Amount to Purchase	$64.29
Budget	$2,250.00
Funds Available	$568.21

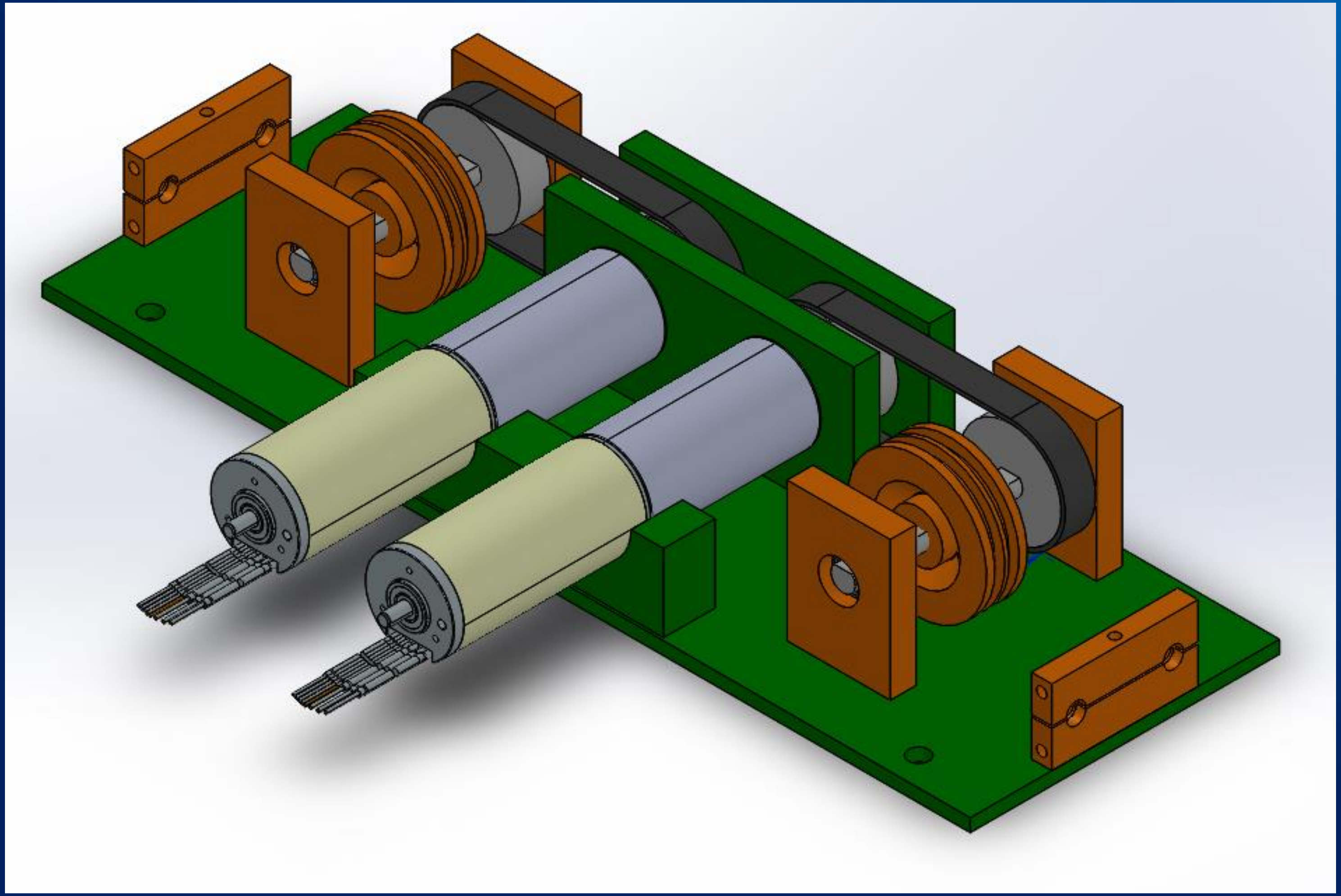
Breakdown of Tasks:

- Keegan and Inna: primarily working on milling the pieces of the motor mounts
- Sean and Mohanad: Assisted on any design changes
- All: Worked on forming the belt and knee brace

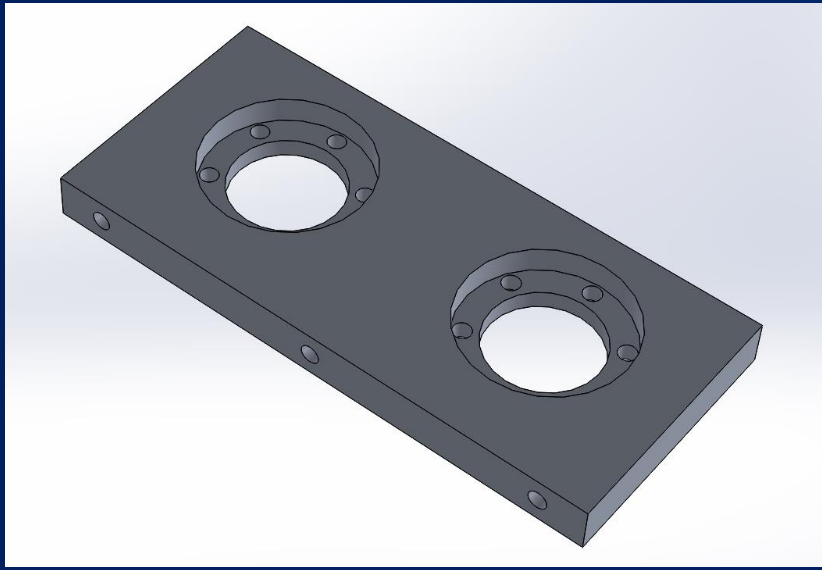
Implementation plan – Upcoming Tasks

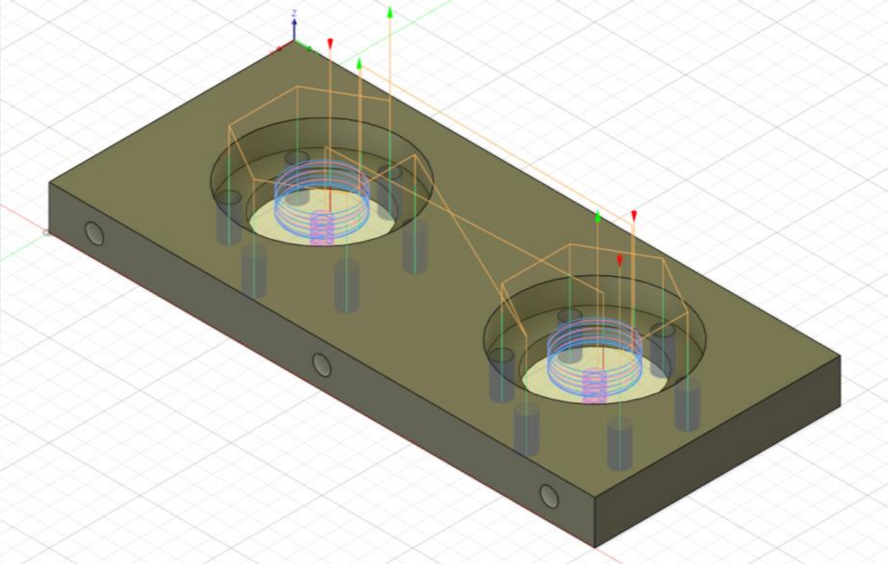
Manufacturing and Assembly	• Inna • Keegan
Design Updates in Tandem with Manufacturing	• Mohanad • Sean
Testing	• All group members

Implementation plan - Parts to Complete



Implementation plan – Machining


CAD from SolidWorks

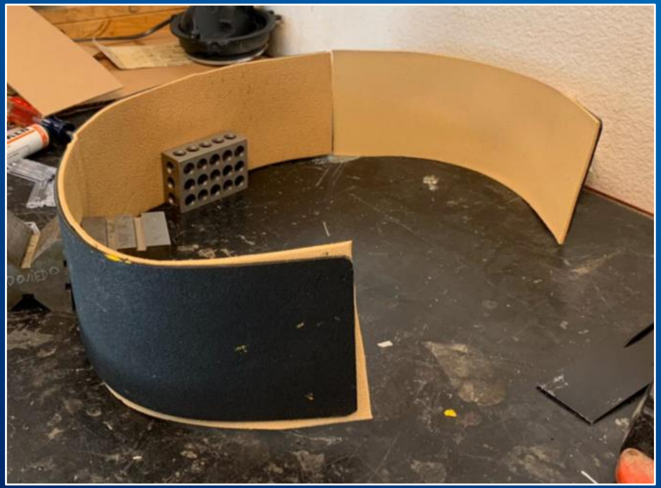

CAM from Fusion 360


Machined Product

Implementation plan – Summary

Current Week

- Knee Brace – Molding



Next week/Spring Break

- Motor assembly – Machining
- Complete Assembly

Testing Plan

Testing Procedure 1: Torque/Power Output

- **Testing Procedure: Objective**

This test will evaluate the output torque that is produced by the hip exoskeleton. Performing the test allows the team to verify the torque applied and power delivery of the design.

- **Testing Procedure: Resources Required**

This test will be conducted at the NAU Biomechatronics Lab. The test will also require the construction of the test fixture shown in Figure 1 and the completed hip exoskeleton.

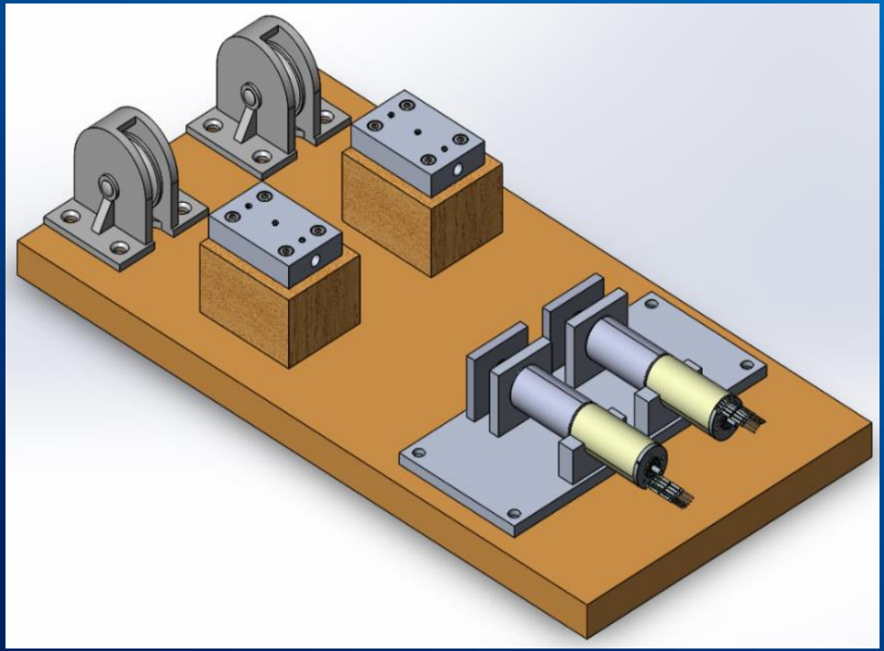


Figure 1: Test fixture

Testing Plan

Testing Procedure 2: Fatigue Failure Modes

- **Testing Procedure: Objective**

The objective of this test is to identify the most likely points of failure in the completed design.

- **Testing Procedure: Resources Required**

This test will be conducted at the NAU Biomechatronics Lab. The test will also require the construction of the test fixture shown in Figure 1 and the completed hip exoskeleton.

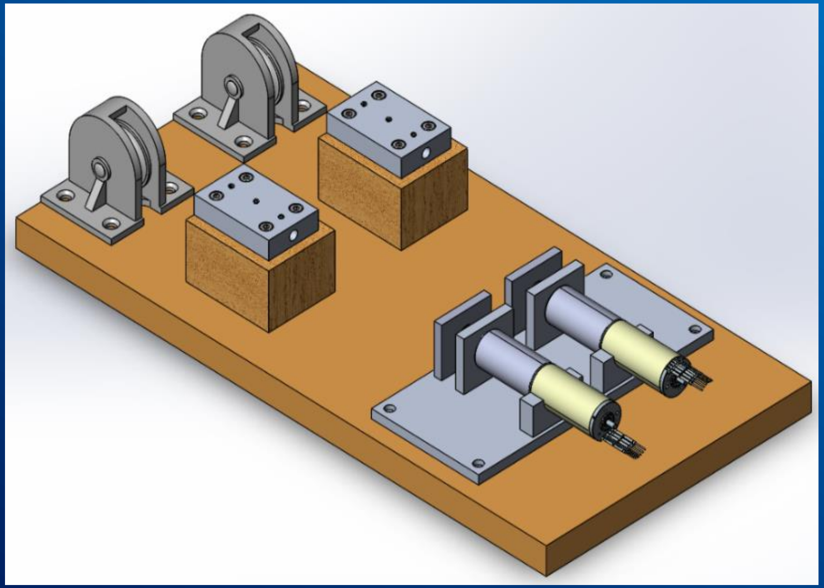


Figure 1: Test fixture

Testing Plan

Testing Procedure 3: User Comfort

- **Testing Procedure : Objective**

The primary objective of this test is to get feedback about the new hip exoskeleton design from variety of people and check if there are any minor changes that need to be done to help get a more universal fit.

- **Testing Procedure : Resources Required**
- This test will be conducted at the NAU Biomechatronics Lab. The goal is to get 10 random people to try the new hip exoskeleton design and answer survey questions and comment on their experience.

Survey Qusetion	User 1	User 2	User 3	User 4	User 5	User 6	User 7	User 8	User 9	User 10	Total
User comfort(Hip Belt)											
User comfort(Knee Brace)											
Time to don/doff											

Table 1: User Comfort Rating/Survey

Testing Plan

<u>**Testing Procedure 4: Fitment Tests**</u>

- **Testing Procedure: Objective**

This test will be run by the BHET team and it will be conducted on each team member. These tests will test the ‘fit’ of the device. Specifically, it is testing weight, conformability, and the range of motion.

- **Testing Procedure: Resources Required**

This test will be conducted at the NAU Biomechatronics Lab, a scale, measuring tape, and a goniometer.

Testing Plan Schedule

Testing Procedure Name	Date
Torque/Power Output Test	week of March 30th
Fatigue Failure Modes Test	week of March 30th
User Comfort Test	week of March 23rd
Fitment Tests	week of March 23rd

Thank you

Questions?