E1.2 FlexTech: Final Presentation

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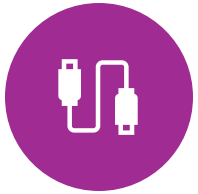
Introducing our Client

- Our client (Jan) is paraplegic she suffered a neck injury that left her body with limited mobility for the past 4 years.
- Due to her limited mobility, she requires a device to exercise her foot with dorsi and plantar flexion exercises.
- However, she requires a simple low-cost solution that can be remotely controlled, comfortable, and safe to use.

List of Client's Needs



Optional Heating

Avoid Blister Inducing Materials

Affordable

Loose Fitting

Can be used Lying Down

Simple User Interface

Fits a Women's Foot Size of 8 ½ - 9.

Can be Handled by Others to put on the User

Remote Controlled

Problem Statement

"A need exists for Jan to exercise her right foot with dorsi and plantar flexion exercises 30 minutes a day with a remote control. The foot flex assist device needs to be safe to wear, comfortable to use, and is low cost compared to the market."

Benchmarking

Product Name	Pictures	Final Specs	Comments
Ankle Rehabilitation Training Device [Brand: WESTN]		- Electric remote control - Large wide-angle training (30° plantarflexion, 40° dorsiflexion) - 360° rotating footrest - Hollow design - Adjustable foot support - No cost displayed	The rectangular box prism where the leg rests is a good addition for counterbalance for the motor. A heating pad could be integrated in the rectangular component and the angular component. The straps also make the device much hollower and simpler to clean. Uses minimal materials where it can, and I like the use of foam as the choice of comfort material.
Ankle Rehabilitation Training Device [Brand: WESTN]		- Electric remote control - "Full angle" training (45° plantarflexion, 50° dorsiflexion) - High-quality material that is bend-resistant and wear resistant. Metal reinforcement provides reliable force absorption and sponge pad is optimal	Like the design of metal framing, as it's sure to provide support and absorb as much force from the flexion motion. Seems a tad bulky and heavy, especially since the client will be laying on her bed using the device. Like the versatility of lying down
Electric Ankle Trainer, Foot Rehabilitation [Brand: DAZULI]		- Smart electric wired controller - "Bidirectional" training (40° plantarflexion, 30° dorsiflexion) - Interval exercise (30° -40° interval exercises) with 3-speed choice regulation. - Hollow ergonomic design - Adaptable trainer that can be used for many purposes - Costs $475.99 CAD	I like the idea of a three-speed regulation where you click the button to go slow, medium or fast, rather than using numerous buttons for too many precise speeds. Slightly cheaper than the others and uses less material all together. Can be used laying down or standing up, though not much cushion is observed in the pictures.
Total Ankle Trainer Ankle Exerciser [Brand: Total Ankle Trainer]		- No controller, fully manual - Manual training (60° plantarflexion, 60° dorsiflexion) - Utilizes elastic bands, straps, and polymers that you rock with your feet. - Hollow ergonomic	Despite not being specific to the problem we are solving, there are many elements we can take from this product to incorporate into ours. It's an extremely simple design utilizing simple rocking mechanics. Our patient will not have the ability to move her feet on her own, but we can

Target Specifications

Metrics ID Number	Metrics Descriptor	Unit	Marginal Values	Ideal Values
1	Device Weight	Kg	3	2
2	Adjustability (Foot Size)	Shoe Size (US)	6-10	4-12
3	Assembly time	Minutes	5	1.5
4	Range of Motion	Degrees (°)	80	90
5	Maintenance frequency	Uses	500	1000+

BOM

Part	Quantity	Unit Cost	Shortcut
Microcontroller & Processing Unit			
Arduino UNO	1	$15.99	Link
Motor & Motion Control			
DC Motor	1	$21.23	Link
Motor Driver L298N	1	$16.99	Link
Power Supply			
12V DC Power Adapter (Outlet-Based)	1	$13.99	Link
Voltage Regulator LM7805	1	$0.80	Link
Wireless Communication			
Bluetooth Module (HC-05 or HM-10)	1	$9.00	Link
Structural & Mechanical Components			
¼" MDF (18"x 24")	4	$4.00	Link
Screws	20	$0.10	Link
Gears (2:1 ratio)	1 Set	$21.99	Link
Mattress Foam Padding	1	-	-
	Total Cost =	$117.99	

Project Plan Moving Forward

Develop a test plan to validate assumptions and DFXs of our idea

Developing our first prototype to visually test these assumptions

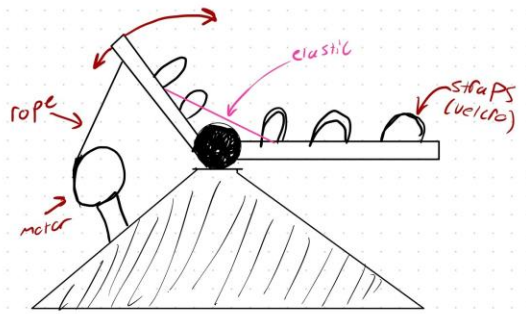
Record the data and compare expected vs actual results

Repeat the process

Prototype #1

Design Iterations

1.



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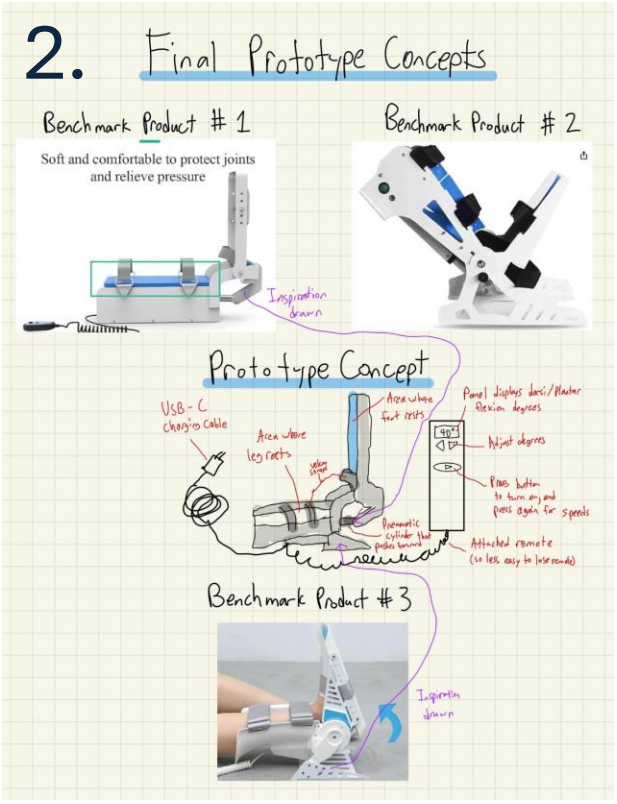

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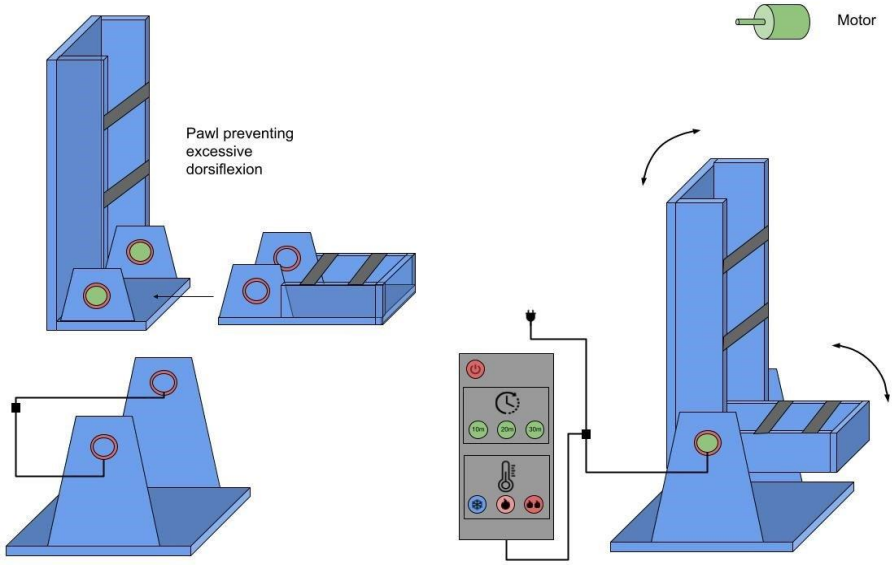

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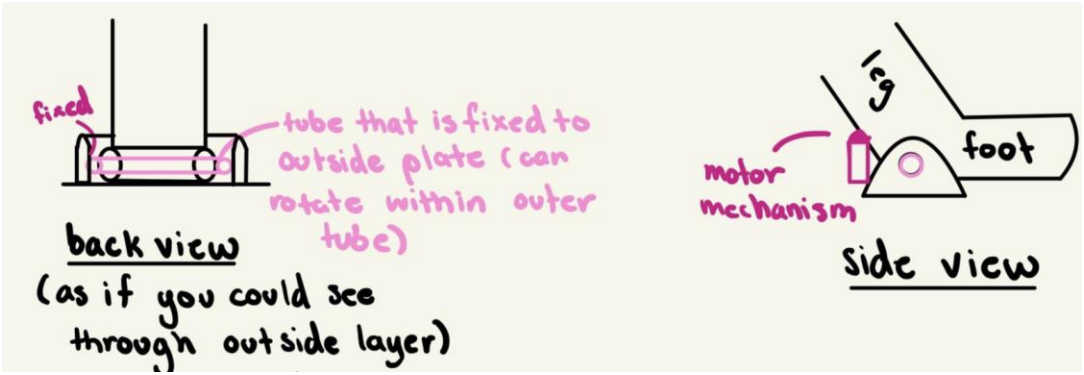
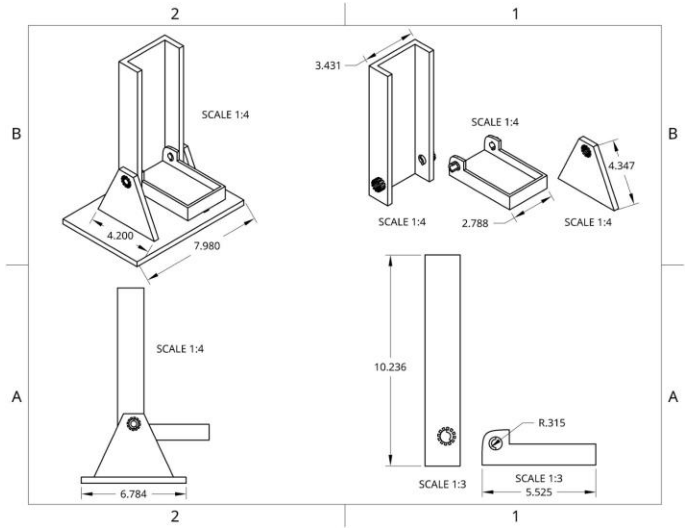
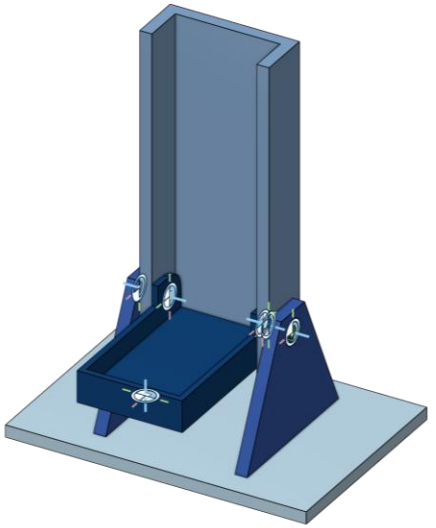


Final Design for Prototype #1





Our Prototype #1 Test Plan

- Things we want to test in Prototype #1:
  - **Supports the weight of a human foot** (Design for Safety, Reliability)
  - **Useability lying down or sitting** (Design for Safety, User Experience)
  - **Ergonomics of the range of motion** (Design for Safety, User Experience, Reliability)
  - **Force of motors** (Design for User Experience, Reliability)

Target Specification Evaluation

Target Specification	Requirement Type	Unit	Expected Values	Actual Values	Verification Method
Load Capacity	Functional	Kg	6	~8	Test
Flexion Angle when Lying or Sitting	Functional	Degrees (°)	40	50	Test
Ergonomic Range of Motion	Functional	Degrees (°)	40	50	Test
Motor Force	Functional	Newtons Meter (Nm)	10	3	Analysis

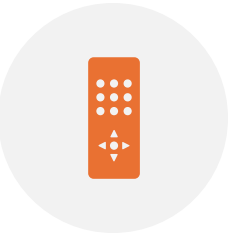
Prototype #2

Client Meeting 2: Feedback Learned

PORTABILITY

SPEED/TIME

CURRENT EXERCISES



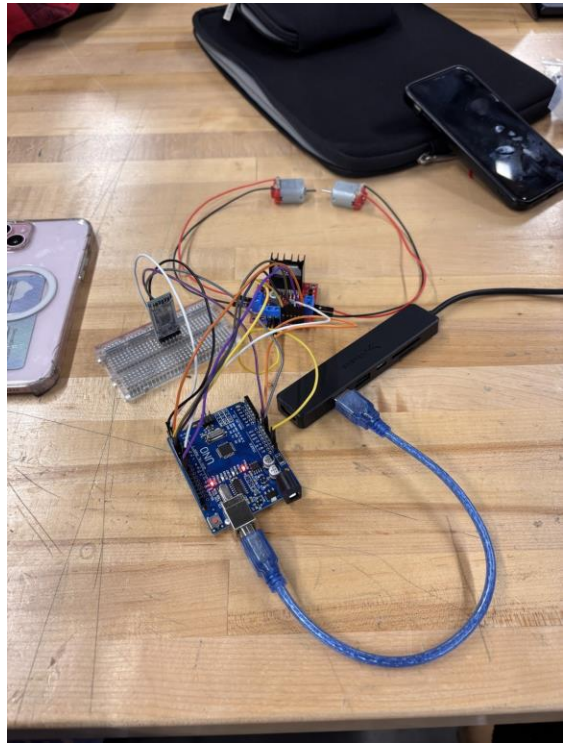
REMOTE (APP)

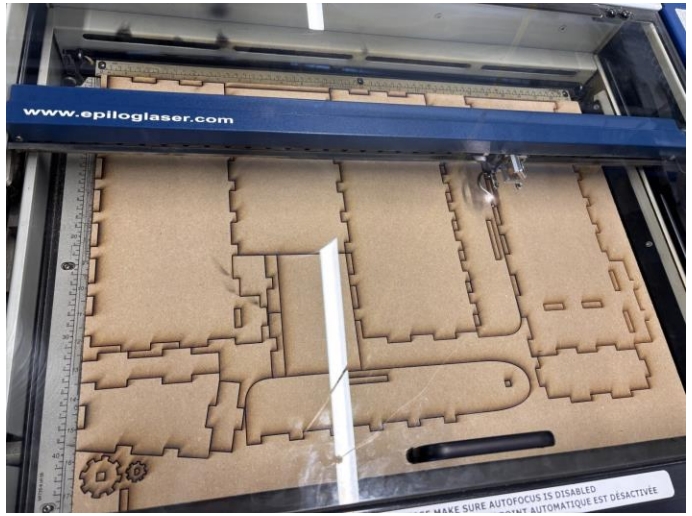
CHARGING

Our Prototype #2 Test Plan

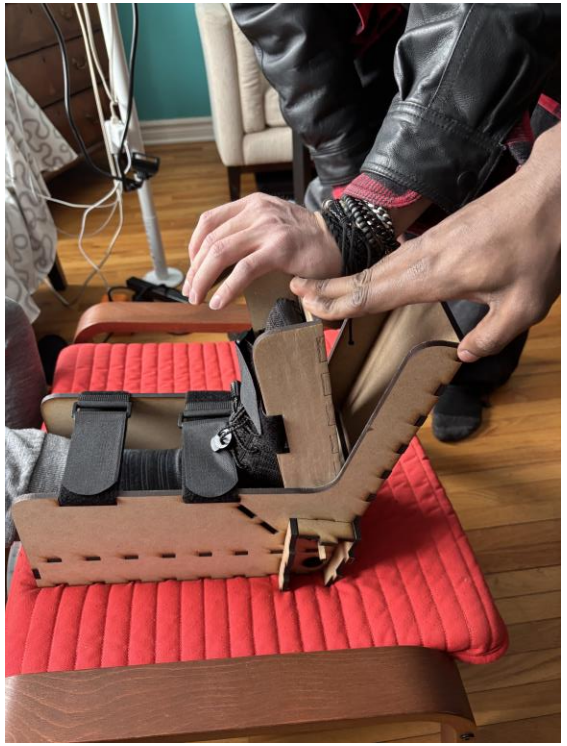
- Things we want to test in Prototype #2:
  - **Ergonomics of the range of motion** (Design for Safety, User Experience, Reliability)
  - **Comfortability** (Design for Safety, User Experience)
  - **Force of motors** (Design for User Experience, Reliability)

Final Design for Prototype #2





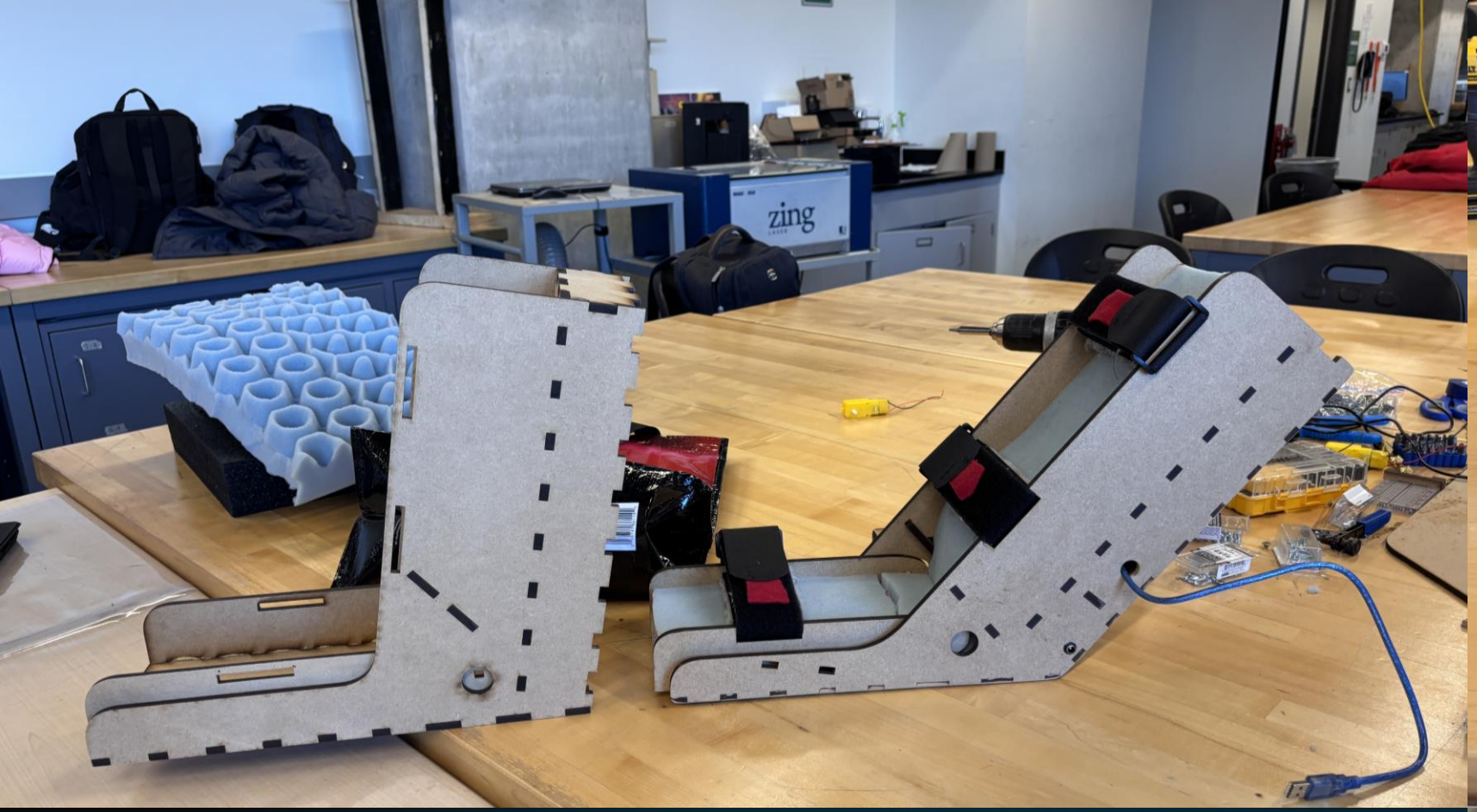
Client Meeting 3: Testing



Target Specification Evaluation

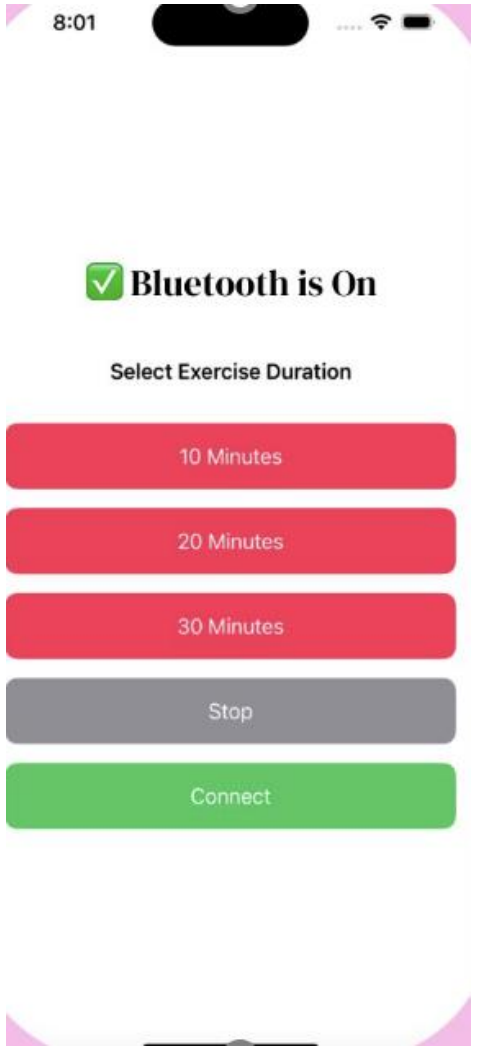
Target Specification	Requirement Type	Unit	Expected Values	Actual Values	Verification Method
Ergonomic Range of Motion	Functional	Degrees (°)	50	35	Test
Comfortability	Non-Functional	# of Blisters	0	0	Test
Motor Force	Functional	Newtons Meter (Nm)	0.1	0.4	Analysis

Final Prototype

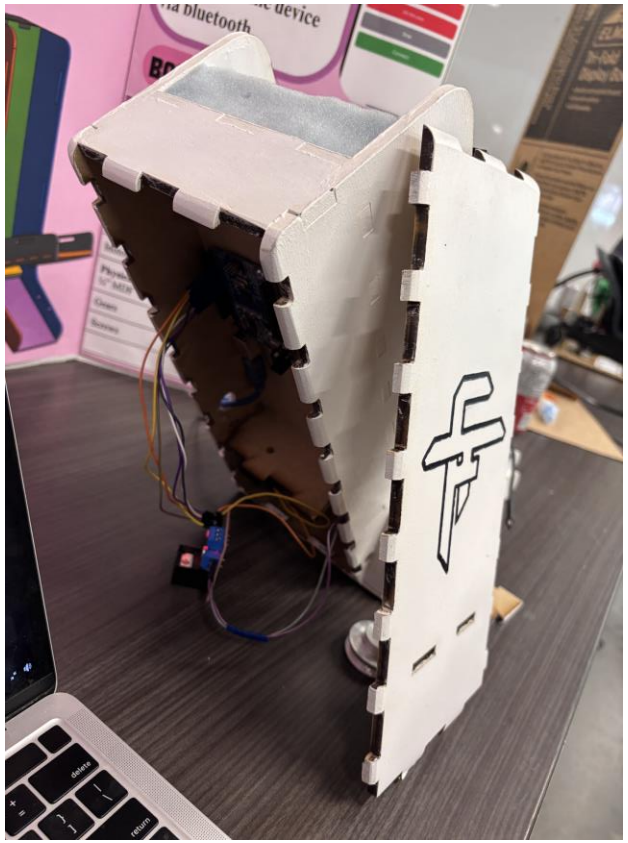


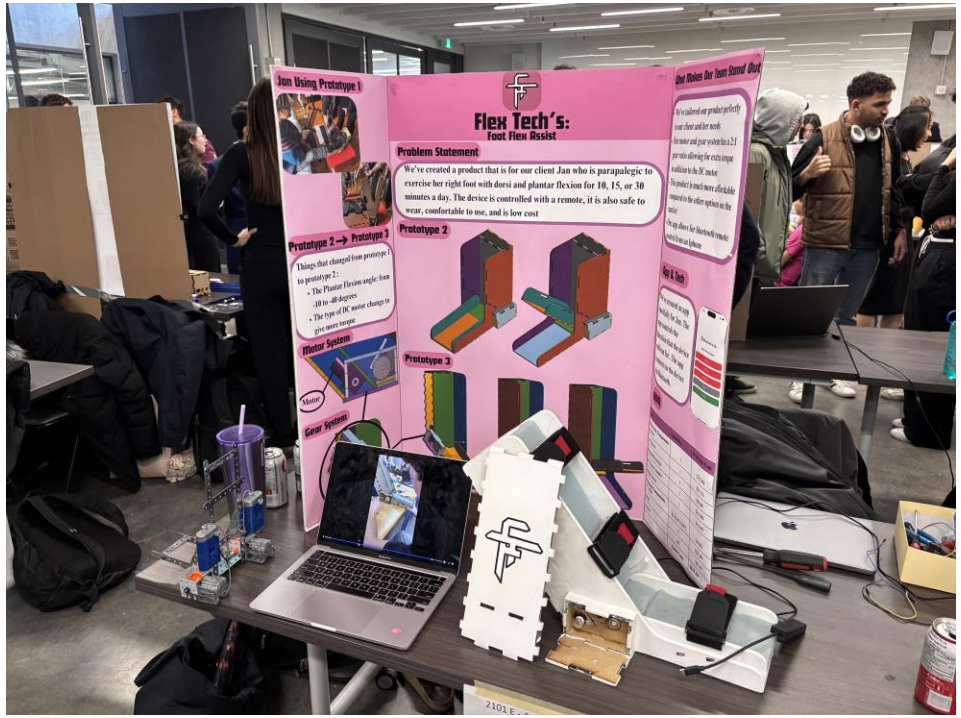
Final Design for the Final Prototype

Components of our Final Design

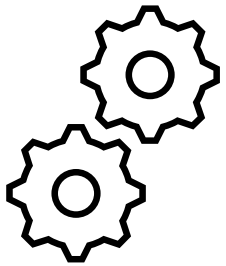


Design Day Booth



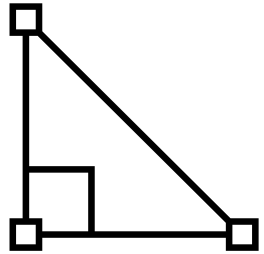


Future Steps



Upgraded Motors

Exercise Modes



Custom Flexion Angles

Thank You!