Low Interference Wheelchair Footrest

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Client: Dan Dorszynski

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Presentation Overview

- Client and Problem Statement
- Background Material
- Product Design Specifications
- Designs and Design Matrices
- Future Work
- Acknowledgements
- References

Client and Problem Statement

- Client Mr. Dan Dorszynski
- The project aims to innovate a wheelchair footrest design to overcome the limitations of current models which are often cumbersome, heavy, and restrict leg movement or access to the ground. The goal is to create a footrest that is lightweight, easily detachable, and foldable.
- This will enhance the wheelchair user's comfort, and allow interactions with surroundings through the footrest.

Figure 1: Quickie Q700 M Powered Wheelchair [1]

Background Material

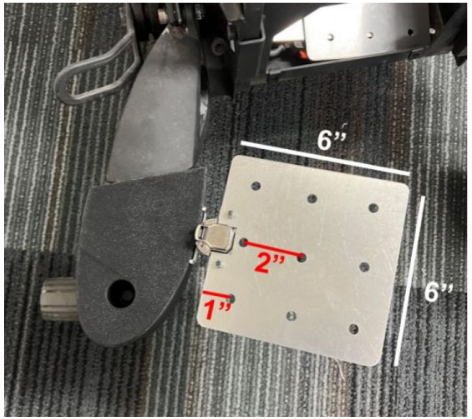
- Mobility issues solved with wheelchairs
- Electric wheelchair prices decreasing, while increasing in use
- Not all needs fully addressed by manufacturers
- Our client, Dan, has Becker's Muscular Dystrophy
- Some lower body mobility to open doors or get into bed
- Current market footrests have challenges

Current Designs

- **SEDEO PRO:**
  - Feet Manually folds up
  - Interferes with legs during transfers
  - Electrically controlled
- **Previous Project:**
  - Easily removable
  - Automatic hinges
  - Requires a good amount of force

Figure 2: Sedeo Pro Footrest [2]

Figure 3: Last semester's final prototype [3]



Product Design Specifications

- **Client Requirements:**
  - Movable to not interfere with standing out of the chair
  - Support lower body weight with a significant factor of safety
  - Lightweight design for easy usage
  - Easily removed and stored
  - Stable and remains in place when reclining

Electric Vs Manual Control

- Manual movement with counterbalance
  - Weights and pulleys move footrest with small forces
  - Lightweight and can be moved by user
- Electric circuit with linear actuators
  - Button or joystick controlled
  - Similar to rest of wheelchair controls

Design Matrix I

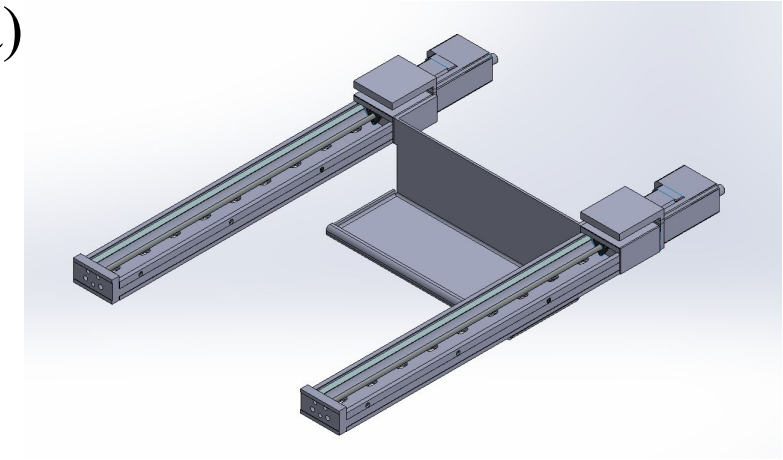
Criteria (Weight %)	Design 1: Electric Footrest		Design 2: Manual Footrest	
Ergonomics (35)	5/5	35	4/5	28
Weight (25)	4/5	20	2/5	10
Adjustability (20)	3/5	12	2/5	8
Cost (10)	3/5	6	4/5	8
Ease of Fabrication (10)	3/5	6	3/5	6
Total = 100	**79**		**58**	

Table 1: Control design matrix, ranking each design

Design 1: Autonomous Footrest

- Autonomous system
- Slides using linear actuator rail design
- DC Motor battery powered
- Controlled via button on wheelchair

a)



b)

Figure 4: a) Sliding Linear Footrest
b) Button on wheelchair

Design 1 Previous Circuit Schematics

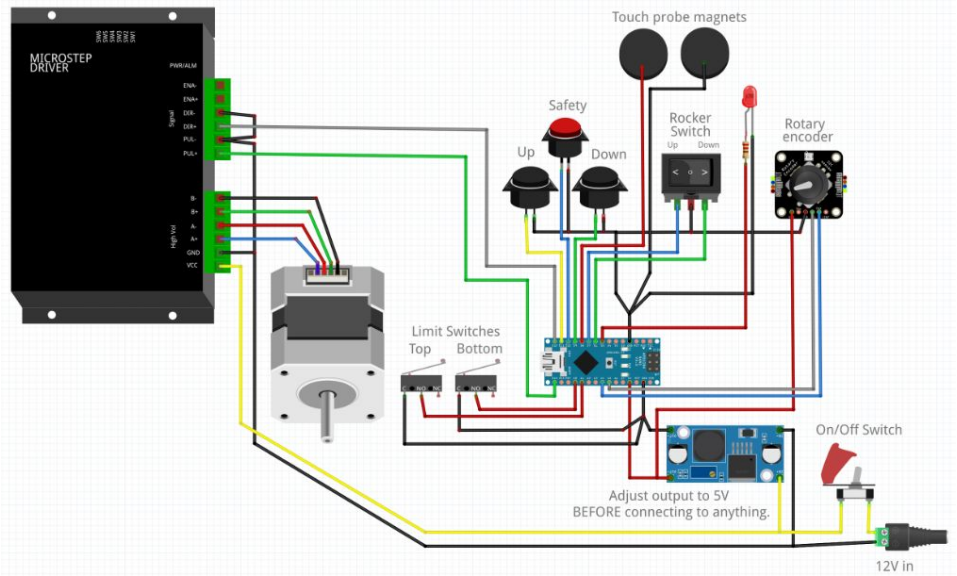


Figure 5: Up and Down Schematic [4]

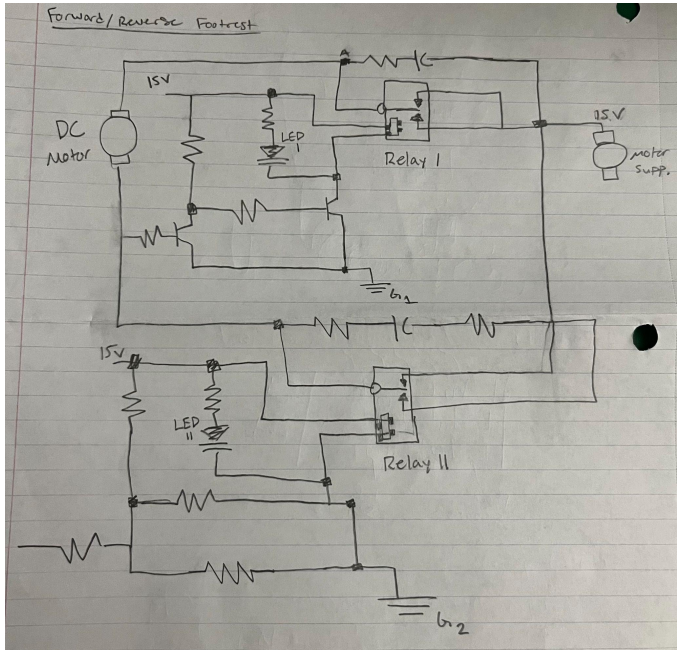


Figure 6: Forward and Reverse Schematic [5]

Design 2: Lock and Pulley

- Internal Sliding Mechanism
- DC Motor
- Pulley

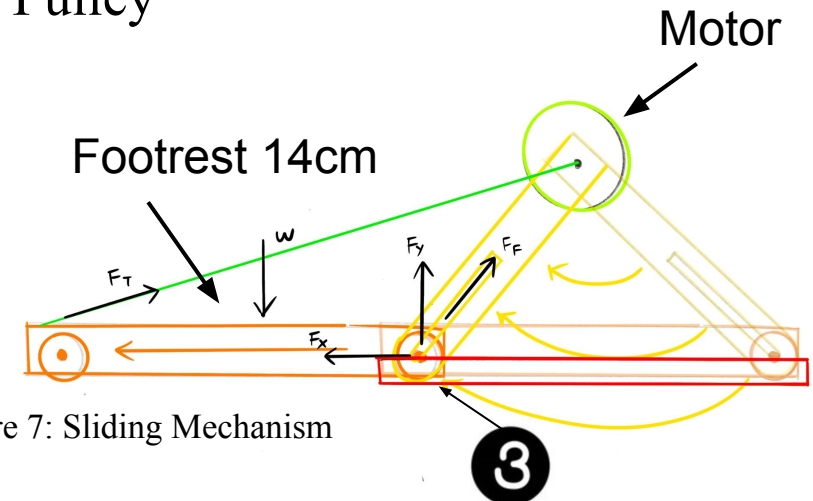
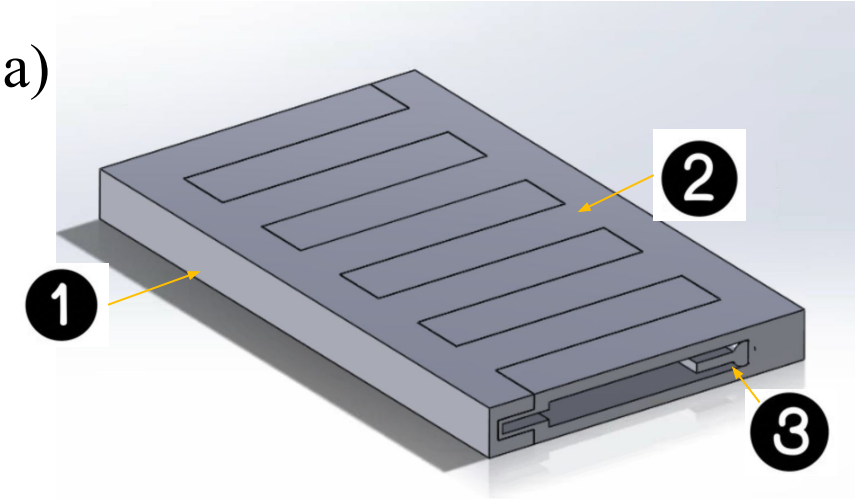


Figure 7: Sliding Mechanism

a)



b)

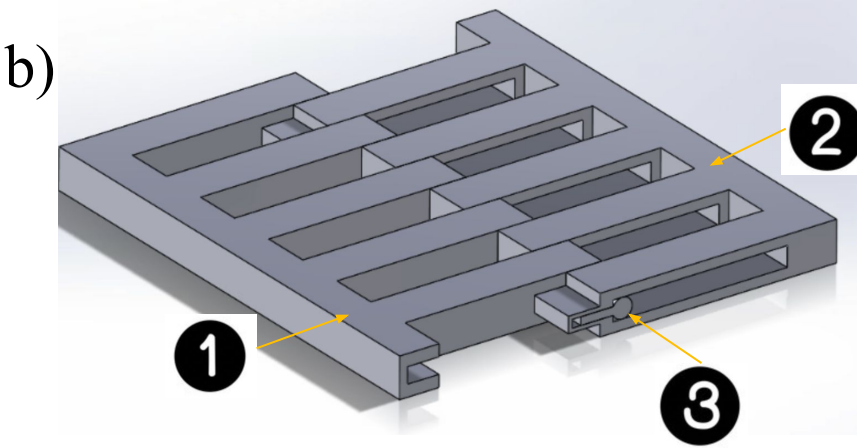


Figure 8: a) Retracted Footrest, b) Extended Footrest

Design 3: Sliding Footrest

- Overlapped Sliding Mechanism
- Linear actuator
- Acrylic
- Under wheelchair seat

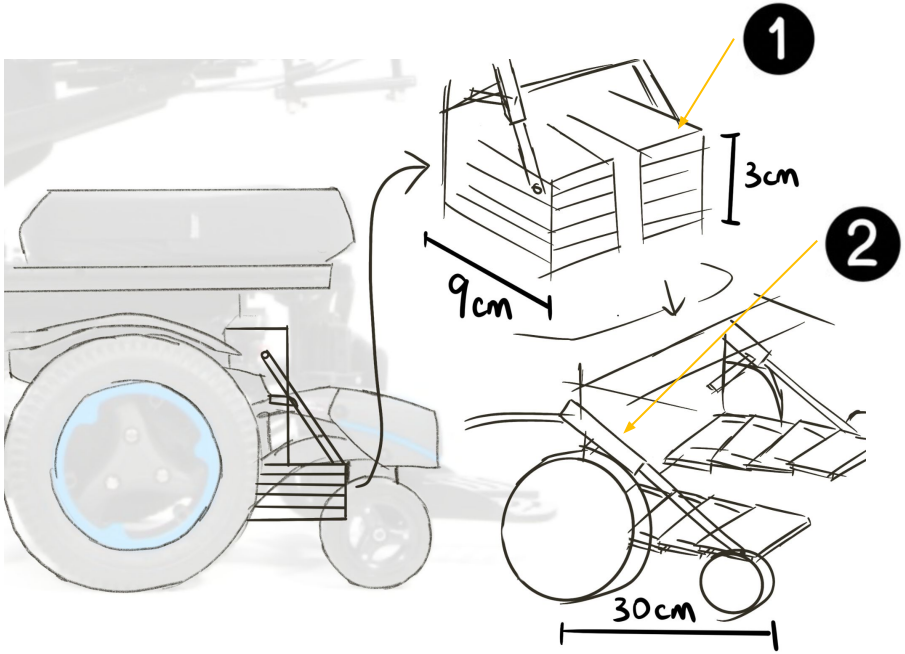


Figure 9: Sliding Footrest Sketch. 1) Footrest Plate, 2) Linear actuator

Design Matrix II

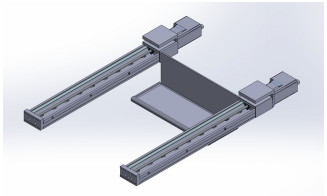
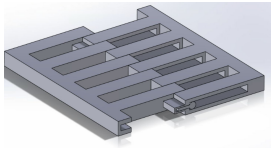
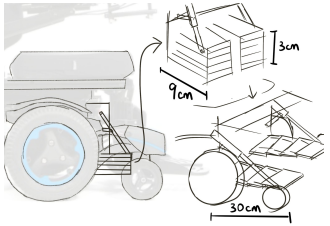
Criteria (Weight %)	Design 1: 	Design 2: 	Design 3: 
Size (35)	3/5	4/5	5/5
Durability (25)	5/5	3/5	4/5
Weight (20)	3/5	5/5	2/5
Cost (10)	5/5	4/5	3/5
Fabrication (10)	4/5	2/5	2/5
Total = 100	76	75	73

Table 2: Footrest design matrix, ranking each design

Future Work

- Electronic Design 1
- Incorporate aspects from multiple designs
- Sliding Mechanism
- Circuit integration as needed
- Mechanical Structure
- Consider 2x bodyweight

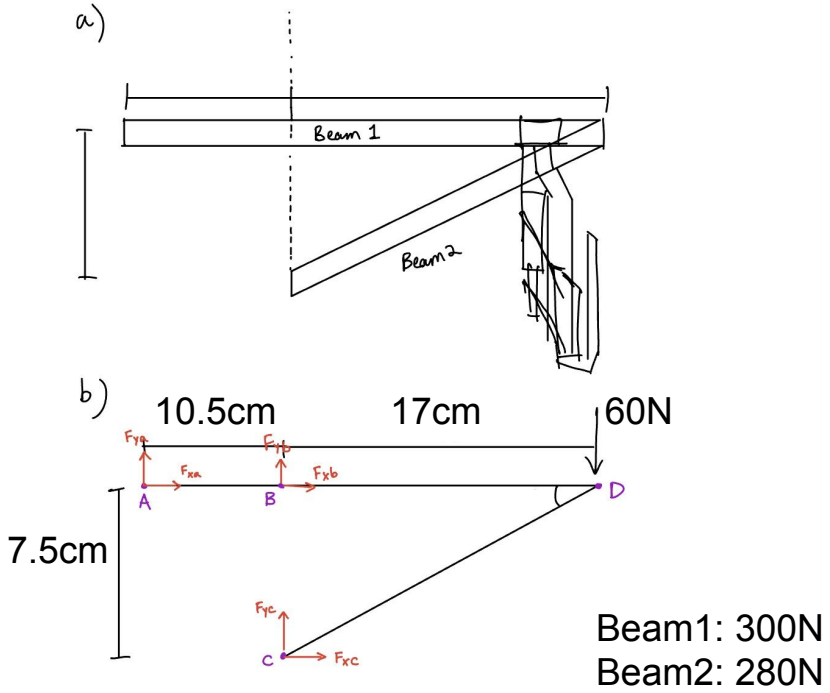


Figure 10: a) Realistic Diagram of support. b) FBD of support system

Acknowledgements

- Advisor: Dr. John Puccinelli
- TA: Sarah Edwards
- Client: Mr. Dan Dorszynski
- Fellow Peers in BME 301

References

[1] “Quickie Q700 M power wheelchair,” Sunrise Medical, https://www.sunrisemedical.com/power-wheelchairs/quickie/mid-wheel-drive/q700-m (accessed Feb. 24, 2024).

[2] “SEDEO power seating,” Sunrise Medical, https://www.sunrisemedical.com/power-wheelchairs/quickie/sedeo-power-seating (accessed Feb. 29, 2024).

[3] L. Baumann et al., *Low-Interface Wheelchair Footrest Poster Presentation*. 2023., https://bmedesign.engr.wisc.edu/projects/f23/super_footrest (accessed Feb. 24, 2024).

[4] T. Agarwal, “Up/Down Counter : Circuit, Working, IC74193 & Its Applications,” ElProCus - Electronic Projects for Engineering Students, Jul. 19, 2022. https://www.elprocus.com/up-down-counter/ (accessed Feb. 26, 2024).

[5] A. Lee and C. Flinn, “Forward/Reverse Control Circuits,” Opentextbc.ca, Aug. 20, 2020. https://opentextbc.ca/basicmotorcontrol/chapter/forward-reverse-control-circuits/ (accessed Feb. 28, 2024).

Questions?