Department of
Biomedical Engineering
UNIVERSITY OF WISCONSIN-MADISON

# Low-Interference Wheelchair Footrest

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10/4/2024

# Outline

# Project Overview

- Final Deliverable
  - Functioning prototype of a wheelchair footrest that can be moved.
- Long Term Project Goals
  - Test and develop new iterations to fit client's feedback

- Client: Mr. Dan Dorszynski
- Advisor: Prof. Melissa Skala

*Figure 1: Quickie Q700m Wheelchair [1]*

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# Background Material

- In the U.S. alone, there are approximately 5.5 million people who use wheelchairs [2], electric and manual
  - 6.6% of them are ambulatory [3] with little accommodations of footrests
- An increase of 2 million people will be in wheelchairs every year [4]
- High demand for modifiable footrests.
- Customized wheelchair accessories are hard to find, and are often custom to that company's model.

# Current Designs

## FOLD & GO Hideaway Footrest

- Simple design and operation
- Compatible with companies models only
- Must be folded at the bottom of wheelchair

## Previous Semester's Design

- Electronically controlled
- Footrest was bulky
- Controlled directly through the wheelchair circuit


*Figure 2: FOLD & Go Design [5]*

*Figure 3: Last semester's project [6]*

# Problem Statement

- Current footrests on wheelchairs do not allow for users who have function in their legs to move them freely.
  - Positions are static and do not move aside for motion in the legs
- Models on the market are also not easily removed for storage
- While footrests are essential for support of the user's legs, it should also allow for a range of motion should the user desire it.
- A revised wheelchair footrest should:
  - Adapt to the user's lifestyle and abilities
  - Be easily removable and attachable
  - Function as a traditional footrest while in the original position

# Summary of PDS

- The footrest should be able to safely retract and extend, in addition to supporting the weight of the client's feet
- The footrest must be able to be stowed securely on the wheelchair
- Any powered parts need to have battery for the whole day
- The footrest should be able to withstand various weather conditions without degrading
- Must weigh less than 5 pounds
- Should not cost more than 200$ to produce

# Ball Jointed Lattice Footrest

- A thick lattice would act as the footrest
  - The lattice would collapse as the two actuators that supported it retracted
- The entire mechanism of lattice and its actuators would then be able to fold down via ball joints without contacting the ground

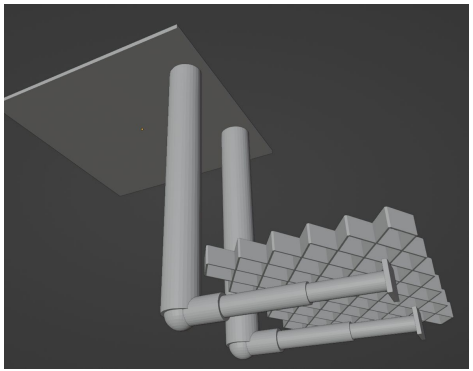

*Figure 4: Underside image of Lattice Footrest*

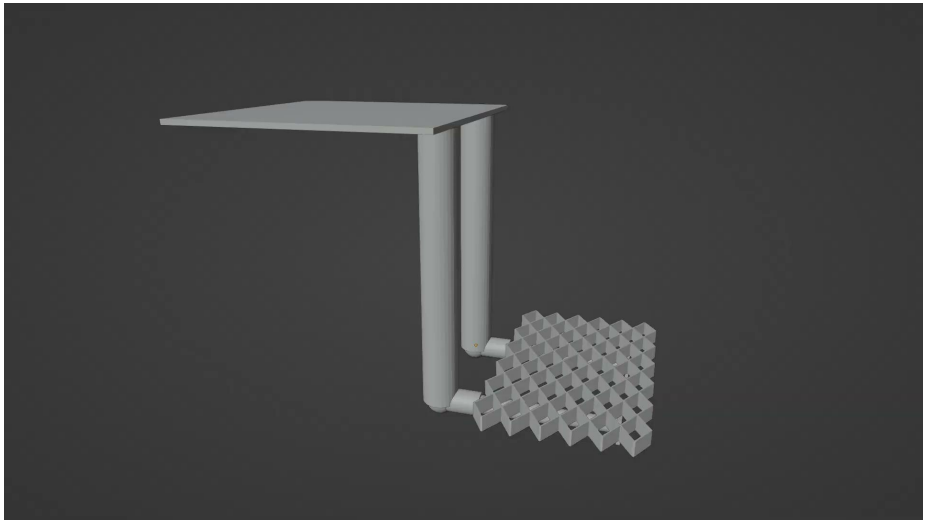

*Figure 5: Video of Lattice Footrest Retracting*

# Telescoping Footrest

- Rail mounting allows user to move the footrest to an optimal position
- Telescoping design combined with rail system allows for the footrest to be completely unobstructive when retracted
- Wheels situated underneath the footrest allow for less force to be exerted on the supports

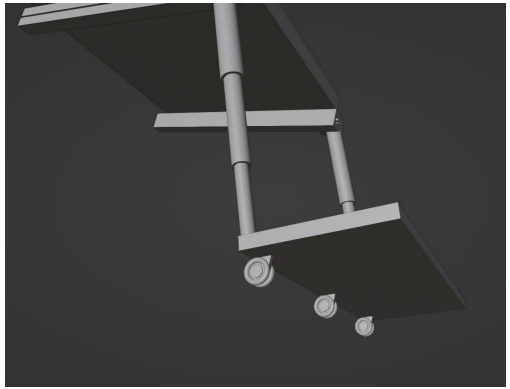

*Figure 6: Underside image of Telescoping Footrest*

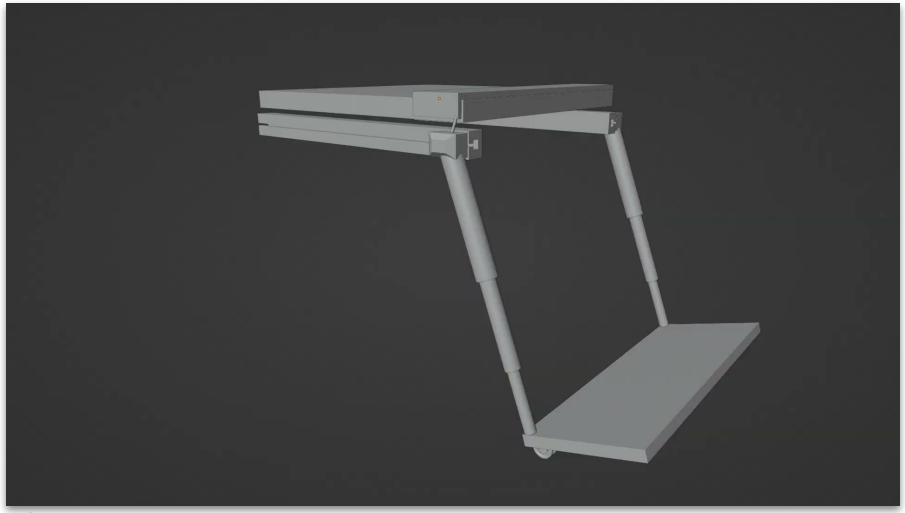

*Figure 7: Video of Telescoping Footrest Retracting*

# Hand Crank Panel Footrest

- Hand crank allows for a simple mechanical mechanism that doesn't put strain on the users legs or feet to activate
- Each footrest folds up separately allowing the user to utilize only one or the other
- Under foot supports fold to the side to allow the footrest to lie flush to the back
- Additional hinges can be added to allow back to fold under main set

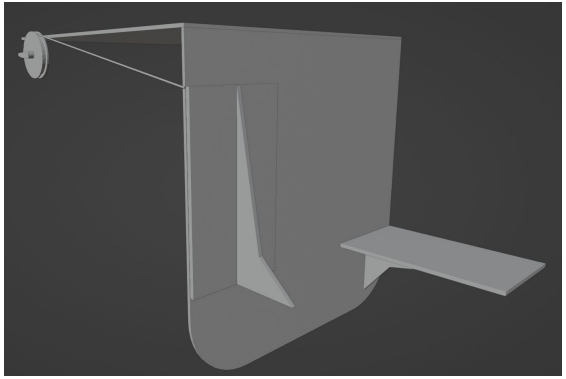

*Figure 8: image of Single Footrest Retracted*

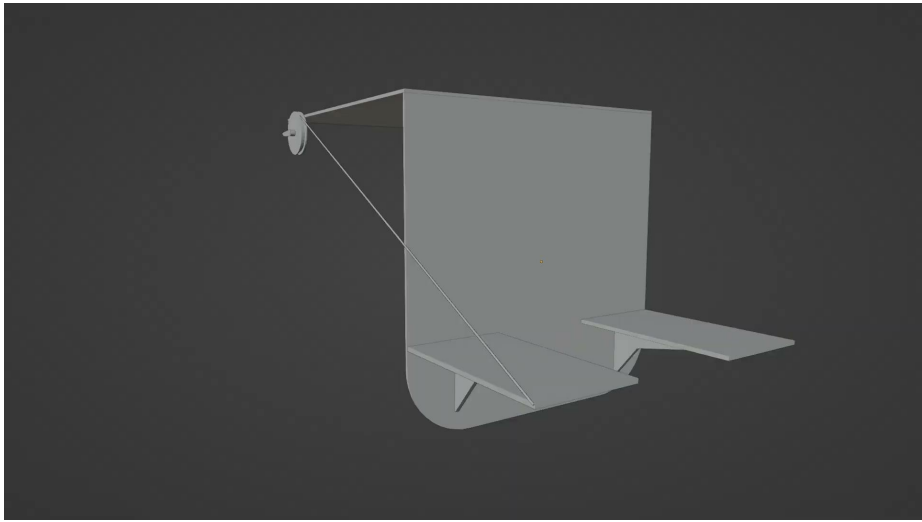

*Figure 9: Video of Hand Crank Panel Footrest Retracting*

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# Design Matrix

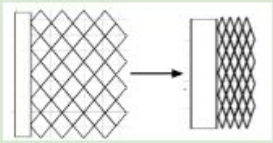
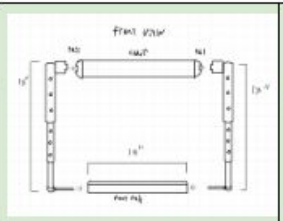
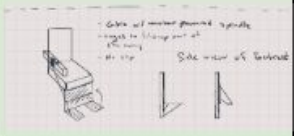
| |  | |  | |  | |
|---|---|---|---|---|---|---|
| **Design Criteria** | **Design 1: Lattice Ball Joint Footrest** | | **Design 2: Telescoping Sunglasses** | | **Design 3: Hand Crank Panel** | |
| Ease of Use (25) | 3/5 | 15 | 4/5 | 20 | 4/5 | 20 |
| Client Comfort (20) | 4/5 | 16 | 5/5 | 20 | 3/5 | 12 |
| Safety (20) | 4/5 | 16 | 4/5 | 16 | 5/5 | 20 |
| Compactability (15) | 3/5 | 9 | 4/5 | 12 | 3/5 | 9 |
| Cost (10) | 3/5 | 6 | 3/5 | 6 | 4/5 | 8 |
| Ease of Fabrication (10) | 1/5 | 2 | 3/5 | 6 | 2/5 | 4 |
| **Total (100)** | 64 | | 80 | | 73 | |

*Figure 10: Design Matrix: Judges three designs against six criteria*

# Final Design – Telescoping Footrest

Highest Scoring in 4 Categories

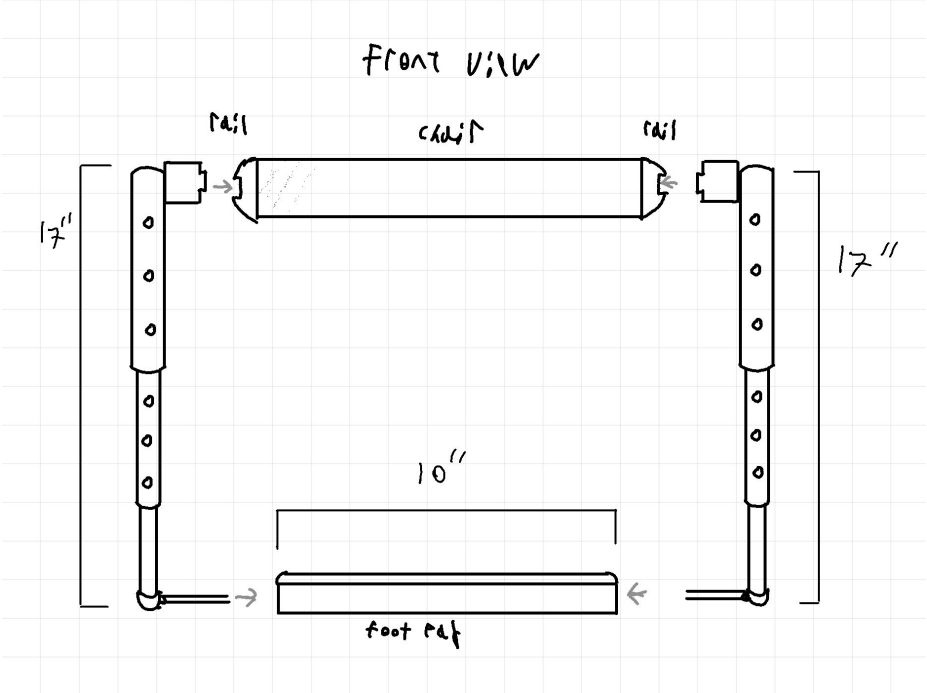



Figure 11: top view of final design

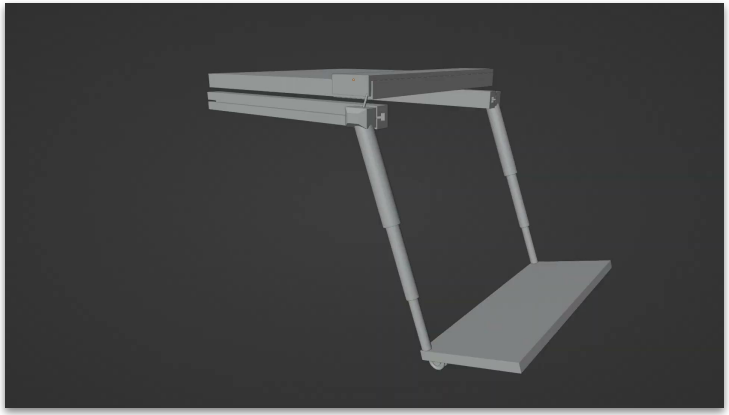


Figure 12: rendered drawing of movement

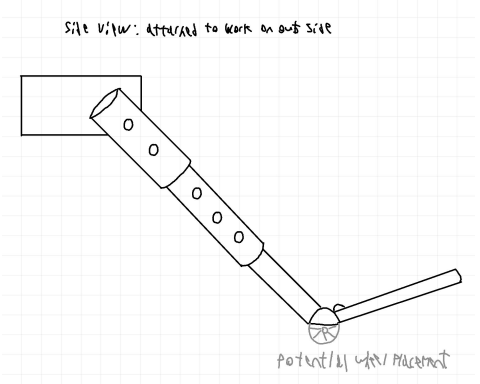



Figure 13: side view of final design

# Future Work

Remainder of the Fall 2024 Semester

- Order materials
- Manufacture
  - Start constructing the design part by part and research attachments once movement is clear.
- Testing
  - Does the product hold up against our expectations of the structure and materials used. As well as competing designs.

Future Work

- Guarantee ADA requirements are met
- FDA approval
- Apply for a patent

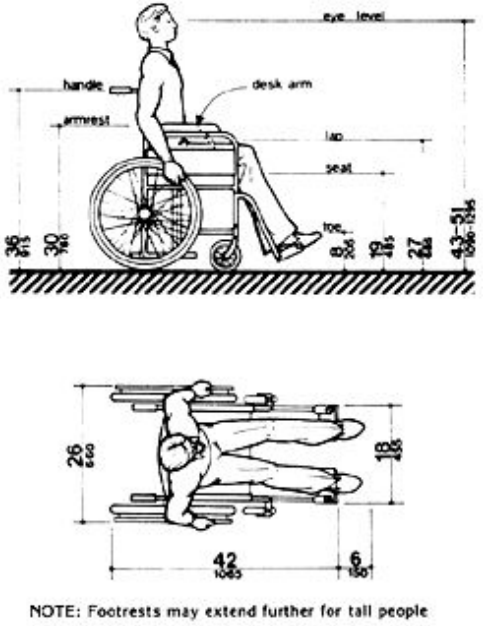



*Figure 14: ADA Requirements for wheelchair dimensions in adult-size wheelchairs.[7]*

# References and Acknowledgments

## Acknowledgements:


- Mr. Dan Dorszynski
- Professor Melissa Skala
- The BME Department



[1]"QUICKIE Q700 M Power Wheelchair," *Sunrise Medical*. https://www.sunrisemedical.com/power-wheelchairs/quickie/mid-wheel-drive/q700-m

[2]"Secretary Buttigieg Announces Proposed Rule to Ensure Passengers Who Use Wheelchairs Can Fly with Dignity | US Department of Transportation," *Transportation.gov*, 2024. https://www.transportation.gov/briefing-room/secretary-buttigieg-announces-proposed-rule-ensure-passengers-who-use-wheelchairs-can

[3]R. Gilani, "Ambulatory Wheelchair Users & Their Unique Experience," *Gilani Mobility*, Mar. 14, 2024. https://www.gilanimobility.ae/ambulatory-wheelchair-user/ (accessed Oct. 03, 2024).

[4]"Wheelchair Users," *Physiopedia*. https://www.physio-pedia.com/Wheelchair_Users

[5]"FOLD + GO Hideaway Footrest," *FOLD + GO Wheelchairs*®, Sep. 17, 2024. https://www.foldandgowheelchairs.com/travel-friendly/fold-go-hideway-footrest/

[6]"Low-interference wheelchair footrest," *Wisc.edu*, 2024. https://bmedesign.engr.wisc.edu/projects/s24/super_footrest (accessed Oct. 03, 2024).

[7] "Department of Justice ADA Title III Regulation 28 CFR Part 36 (1991)," archive.ada.gov. https://archive.ada.gov/reg3a.html#anchor03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# Questions?