BME Design-Spring 2024 - CHARLES MAYSACK-LANDRY
Complete Notebook

PDF Version generated by

Sam TAN

on

May 03, 2024 @11:30 PM CDT

Table of Contents

Team contact Information

CHARLES MAYSACK-LANDRY - Jan 26, 2024, 1:00 PM CST

Last Name	First Name	Role	E-mail	Phone	Office Room/Building
Puccinelli	John	Advisor	john.puccinelli@wisc.edu	(608)-890-3573	2132 ENGINEERING CENTERS BUILDING
Dorszynski	Dan	Client	wetsand@gmail.com		
Maysack-Landry	Charles	Leader	maysacklandr@wisc.edu	(608)381-3081	
O'Halloran	Jayson	Communicator	ohalloran2@wisc.edu	(715)-529-5317	
Tan	Sam	BWIG	stan68@wisc.edu	(417)-837-9889	
Fang	Haoming	BPAG	hfang45@wisc.edu	(608)-886-6163	

Project description

John Puccinelli - Aug 14, 2013, 12:01 PM CDT

Course Number:

Project Name:

Short Name:

Project description/problem statement:

About the client:

2024/02/06-Client Meeting

Sam TAN - Feb 07, 2024, 1:56 PM CST

Title: Client Meeting 1

Date: 2/6/24

Content by: Sam

Present: Bobby, Jayson, Sam

Goals: Get questions answer

Content:

Design Requirements:
What functions should the footrest have? Or preferred?
Would the device be an individual specific device or generalized to fit more population?
What is the weight range of the device? How light/heavy does it need to be?
Is the device a permanent alteration to the wheelchair or will it need to be removed at some point?
What is the working environment of the device? (Indoor/ outdoor)
Ergonomic Considerations?
How might the prototype footrest enhance the user's ability to perform tasks such as opening doors or reaching for objects?
What considerations are important in designing a footrest that balances safety and functionality for wheelchair users?
What are some potential challenges that the project team might encounter during the development of the prototype footrest, and how could they be addressed? (ask about last semester what he liked/didn't like, etc)
Client Specific:
How paralyzed is the intended user? What degrees of freedom are available?
What is the intended weight during use?

No footrest at all.
Footrest should be use outside (traveling), disassemble
Be light to pack and reassemble for transferring purposes
Limbs are movable, just not enough strength to pull
Better for the footrest to not to move with the reclining with the chair (but open to new designs)

Easy to move
Able to fit foot in
Portability

Specific customized to the client's chair instead of generalization but could potentially think of the border audience.

Conclusions/action items:

In-person client meeting to discuss more concept, and strategies for the client.

2024/02/10- Client Meeting 2

Loading [MathJax]/extensions/Safe.js

Sam TAN - Feb 10, 2024, 2:23 PM CST

Title: In person client meeting

Date: 2/10/24

Content by: Sam

Present: All

Goals: Client meeting

Content:


QUICKIE

Conclusions/action items:

To be update

2024/03/03 - Online Client Meeting

Sam TAN - Mar 03, 2024, 4:02 PM CST

Title: Zoom Meeting with client

Date: 3/3/24

Content by: Sam

Present: Sam, Charles, Jayson

Goals: Updates to our client, more info requested.

Content:

Presentation Rundown, recent design updates.

Client weight: 120kg

Client height: 187cm

Conclusions/action items:

Use anthropometric data to find some useful information that guide 3D modelings.

2024/02/02-Advisor Meeting 1

Sam TAN - Feb 07, 2024, 12:50 PM CST

Title: Advisor Meeting 1

Date: 02/02/2024

Content by: N/A

Present: All

Goals: Literature Review and future plans

Content:

Went over Literature.
Made plans for meeting clients.

Finished up progress report.

Designs from projects of other university can be use as a reference for future designs.

Conclusions/action items:

Review last semester's report.

2024/-2/09- Advisor Meeting 2

Sam TAN - Feb 09, 2024, 1:31 PM CST

Title: Advisor Meeting

Date: 2/9/24

Content by: All

Present: All

Goals: Advisor discussion

Content:

Identify the types of wheelchair that can be use for.

Design integrate and alter to fit more universal. Replicable.

Easily adjustable to fit on different wheelchair.

Be able to support way, non slip.

Put down sketches and document.

Spinal cord injury vs. muscular dystrophy.

The last team said client wanted a cast support.

Patient needs assistance anyway, so not the need to do electronically.

Put standards in notebook!!!

Footrest don't need premarket approval.

Do more literature research and dive into footrest, electrical wheelchair, muscular dystrophy.
Divide and conquer different aspect of the design project and problem promoted by the client.

Look at different designs and options provided by each design.

Have different design matrices to evaluate independently and final design can combine multiple designs to make into one final one.

Battery research if electronically powered. (Mechanical switch)

Conclusions/action items:

Research/Sketches

2024/02/16- Advisor Meeting 3

Sam TAN - Feb 16, 2024, 1:39 PM CST

Title: Advisor Meeting

Date: 2/16/24

Content by: Sam

Present: All

Goals: Advisor Suggestion

Content:

Goal before presentation:

take cardboards, move cardboards for spacial arrangement. See how it work in reality.

Two design matrix:

Took the the advantages and dissavantages.

1. Mechanical movement vs. electrical movements

Don't forget about universally design, not just client.

Think about the movement of the footrest itself, not just the motor.

Focus on electrical or mechanical.

Change design matrix criteria.

Separate design matrix

Use mechanical designs to make electronic components less.

Think about using other parts of the wheelchair in design as well. Not just focusing on the wheelchair footrest part. Back of the wheelchair can also be use for design considerations.

Think about factory safety. Double the weight intended to have a factor of safety of 2.

Research:
find conditions that use wheelchair but have some mobility. Use specific numbers of this kinds of condition. Motivation and huge impact. Number of wheelchair that does this.

Conclusions/action items:

2024/02/27- Advisor Meeting 4

Sam TAN - Feb 27, 2024, 8:10 PM CST

Title: Advisor Meeting

Date: 2/27/24

Content by: Sam

Present: All

Goals: Meet and discuss some designs with had, ask questions regarding mechanism

Content:

It is important to have the structure be able to support more weight.

Specifically two times more weight of the client's entire body weight. This is to avoid accidentally standing on the footrest and avoid the footrest break due to misuse.

Consider making designs better and sketch out/ CAD designs.

Presentation Printout.

Conclusions/action items:

Print copies of slide using the six page method.

2/8/24 PDS

JAYSON O'HALLORAN - Feb 09, 2024, 12:37 PM CST

BME Design

LOW INTERFACE WHEELCHAIR FOOTREST

PRELIMINARY PRODUCT DESIGN SPECIFICATIONS

BME 301

Lab Section #: 302

Team Members:

Charles Maysack-Landry, Team Leader

Jayson O'Halloran, Communicator & BSAC

Haoming (Bobby) Fang, BPAG

Sam Tan , BWIG

Client

Dan Dorszynski

Advisor

Dr. John Puccinelli

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PDS_BME_301.pdf (204 kB)

3/01/24 Preliminary Presentation

JAYSON O'HALLORAN - May 03, 2024, 7:45 PM CDT

Download

Preliminary_Presentation_-_Low_interference_wheelchair_footrest_1_.pdf (2.08 MB)

3/02/24 Preliminary Report

JAYSON O'HALLORAN - May 03, 2024, 7:44 PM CDT

Department of
Biomedical Engineering
UNIVERSITY OF WISCONSIN–MADISON

Low Interference Wheelchair Footrest

Preliminary Report

BME 301
3/02/2024

Client:

Dan Dorszynski

Advisors:

Dr. John Puccinelli - Biomedical Engineering

Sarah Edwards - Biomedical Engineering Teaching Assistant

Team Members:

Charles Moysack-Landry - Team Leader

Sara Tan - BWIG

Haoming (Bobby) Fang - BPAG

Jayson O'Halloran - Communicator, BSAC

1

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Preliminary_Report_-_Low_Interference_Wheelchair_Footrest_1_.pdf (3.03 MB)

4/26/24 BME 301 Final Poster

JAYSON O'HALLORAN - May 03, 2024, 7:42 PM CDT

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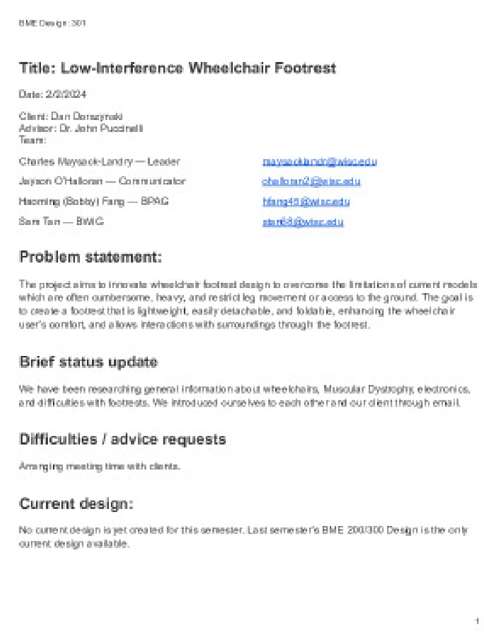
BME_301_Final_Poster_Presentation.pdf (1.17 MB)

5/03/24 Final Report

Progress Report 1

JAYSON O'HALLORAN - May 03, 2024, 7:30 PM CDT



BME Design 301

Title: Low-Interference Wheelchair Footrest

Date: 2/2/2024

Client: Dan Dorszynski
Advisor: Dr. John Puccinelli
Team:

Charles Maysack-Landry — Leader	maysacklandr@wisc.edu
Jayson O'Halloran — Communicator	ohalloran2@wisc.edu
Haoming (Bobby) Fang — BPAG	hfang45@wisc.edu
Sam Tan — BWIG	stan63@wisc.edu

Problem statement:

The project aims to innovate 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, enhancing the wheelchair user's comfort, and allows interactions with surroundings through the footrest.

Brief status update

We have been researching general information about wheelchairs, Muscular Dystrophy, electronics, and difficulties with footrests. We introduced ourselves to each other and our client through email.

Difficulties / advice requests

Arranging meeting time with clients.

Current design:

No current design is yet created for this semester. Last semester's BME 200/300 Design is the only current design available.

1

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Progress_report_1_-_Low-Interference_Wheelchair_Footrest.pdf (102 kB)

Progress Report 2

JAYSON O'HALLORAN - May 03, 2024, 7:31 PM CDT

BME Design: 301

Title: Low-Interference Wheelchair Footrest

Date: 2/2/2024

Client: Dan Dorszynski
Advisor: Dr. John Puccinelli
Team:

Charles Maysack-Landry — Leader	maysacklandr@wisc.edu
Jayson O'Halloran — Communicator	ohalloran2@wisc.edu
Haoming (Bobby) Fang — BPAG	hfang45@wisc.edu
Sam Tan — BWIG	stan68@wisc.edu

Problem statement:

The project aims to innovate 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, enhancing the wheelchair user's comfort, and allows interactions with surroundings through the footrest.

Brief status update

We have been researching general information about wheelchairs, muscular dystrophy, electronics, and difficulties with footrests. We had our first client meeting, and finished our PDS.

Difficulties / advice requests

N/A

Current design:

No current design is yet created for this semester. Last semester's BME 200/300 Design is the only current design available.

1

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Progress_report_2_-_Low-Interference_Wheelchair_Footrest.pdf (103 kB)

Progress Report 3

JAYSON O'HALLORAN - May 03, 2024, 7:31 PM CDT

BME Design 301

Title: Low-Interference Wheelchair Footrest

Date: 2/16/2024

Client: Dan Dorszynski
Advisor: Dr. John Puccinelli
Team:

Charles Maysack-Landry — Leader maysacklandr@wisc.edu

Jayson O'Halloran — Communicator ohalloran2@wisc.edu

Haoming (Bobby) Fang — BPAG hfang45@wisc.edu

Sam Tan — BWIG stan63@wisc.edu

Problem statement:

The project aims to innovate 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, enhancing the wheelchair user's comfort, and allows interactions with surroundings through the footrest.

Brief status update

- More research was conducted
- Met with client for more specifications
- Design sketches

Difficulties / advice requests

- Reach out to professors with experience in electronics

Current design:

No current design is yet created for this semester. Last semester's BME 200/300 Design is the only current design available.

1

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Progress_report_3_-_Low-Interference_Wheelchair_Footrest.pdf (102 kB)

Progress Report 4

JAYSON O'HALLORAN - May 03, 2024, 7:31 PM CDT

BME Design 301

Title: Low-Interference Wheelchair Footrest

Date: 2/22/2024

Client: Dan Dorszynski
Advisor: Dr. John Puccinelli
Team:

Charles Maysack-Landry — Leader maysacklandr@wisc.edu

Jayson O'Halloran — Communicator ohalloran2@wisc.edu

Haoming (Bobby) Fang — BPAG hfang45@wisc.edu

Sam Tan — BWIG stan63@wisc.edu

Problem statement:

The project aims to innovate 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, enhancing the wheelchair user's comfort, and allows interactions with surroundings through the footrest.

Brief status update

- Extension Ideas/Sketches
- Inclusion Considerations

Difficulties / advice requests

- Reach out to professors with experience in electronics
- Motor Extension Unit

Current design:

No current design is yet created for this semester. Last semester's BME 200/300 Design is the only current design available.

1

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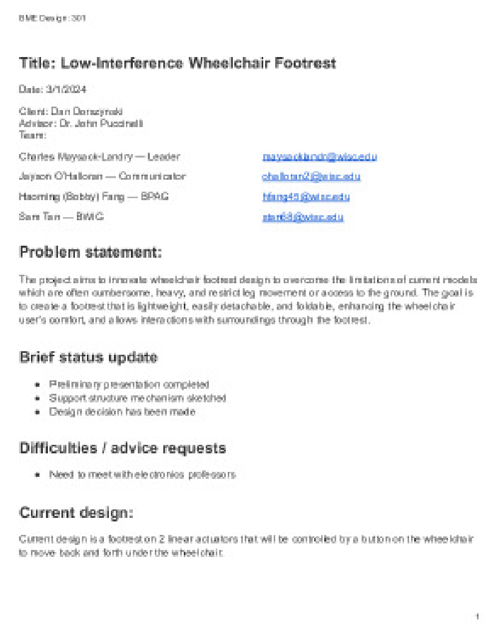
Progress_report_4_-_Low-Interference_Wheelchair_Footrest.pdf (103 kB)

Progress Report 5

JAYSON O'HALLORAN - May 03, 2024, 7:31 PM CDT



BME Design 301

Title: Low-Interference Wheelchair Footrest

Date: 3/1/2024

Client: Dan Dorszynski
Advisor: Dr. John Puccinelli
Team:

Charles Maysack-Landry — Leader	maysacklandr@wisc.edu
Jayson O'Halloran — Communicator	ohalloran2@wisc.edu
Haoming (Bobby) Fang — BPAG	hfang45@wisc.edu
Sam Tan — BWIG	stan68@wisc.edu

Problem statement:

The project aims to innovate 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, enhancing the wheelchair user's comfort, and allows interactions with surroundings through the footrest.

Brief status update

- Preliminary presentation completed
- Support structure mechanism sketched
- Design decision has been made

Difficulties / advice requests

- Need to meet with electronics professors

Current design:

Current design is a footrest on 2 linear actuators that will be controlled by a button on the wheelchair to move back and forth under the wheelchair.

1

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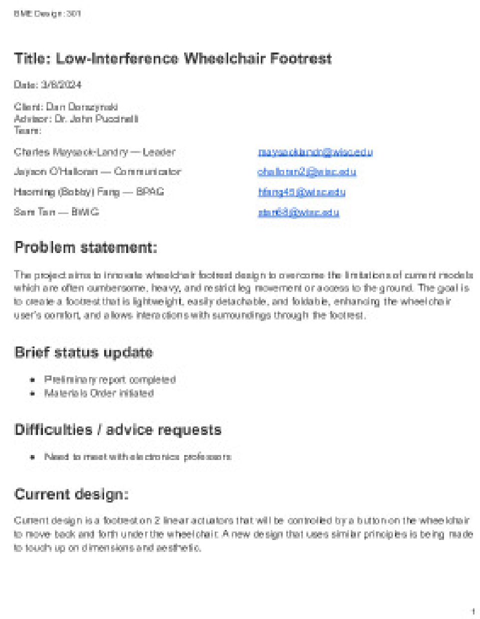
Progress Report 6

JAYSON O'HALLORAN - May 03, 2024, 7:32 PM CDT



BME Design 301

Title: Low-Interference Wheelchair Footrest

Date: 3/8/2024

Client: Dan Dorszynski
Advisor: Dr. John Puccinelli
Team:

Charles Maysack-Landry — Leader	maysacklandr@wisc.edu
Jayson O'Halloran — Communicator	ohalloran2@wisc.edu
Haoming (Bobby) Fang — BPAG	hfang45@wisc.edu
Sam Tan — BWIG	stan63@wisc.edu

Problem statement:

The project aims to innovate 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, enhancing the wheelchair user's comfort, and allows interactions with surroundings through the footrest.

Brief status update

- Preliminary report completed
- Materials Order initiated

Difficulties / advice requests

- Need to meet with electronics professors

Current design:

Current design is a footrest on 2 linear actuators that will be controlled by a button on the wheelchair to move back and forth under the wheelchair. A new design that uses similar principles is being made to touch up on dimensions and aesthetic.

1

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Progress_report_6_-_Low-Interference_Wheelchair_Footrest.pdf (199 kB)

Progress Report 7

JAYSON O'HALLORAN - May 03, 2024, 7:33 PM CDT

BME Design 301

Title: Low-Interference Wheelchair Footrest

Date: 3/15/2024

Client: Dan Dorszynski
Advisor: Dr. John Puccinelli
Team:

Charles Maysack-Landry — Leader	maysacklandr@wisc.edu
Jayson O'Halloran — Communicator	ohalloran2@wisc.edu
Haoming (Bobby) Fang — BPAG	hfang45@wisc.edu
Sam Tan — BWIG	stan68@wisc.edu

Problem statement:

The project aims to innovate 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, enhancing the wheelchair user's comfort, and allows interactions with surroundings through the footrest.

Brief status update

- Preliminary report completed
- Materials Order initiated

Difficulties / advice requests

- Begin Fabrication

Current design:

Current design is a footrest on 2 linear actuators that will be controlled by a button on the wheelchair to move back and forth under the wheelchair.

1

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Progress_report_7_-_Low-Interference_Wheelchair_Footrest.pdf (363 kB)

Progress Report 8

JAYSON O'HALLORAN - May 03, 2024, 7:33 PM CDT

BME Design 301

Title: Low-Interference Wheelchair Footrest

Date: 3/22/2024

Client: Dan Dorszynski
Advisor: Dr. John Puccinelli
Team:

Charles Maysack-Landry — Leader maysacklandr@wisc.edu
Jayson O'Halloran — Communicator ohalloran2@wisc.edu
Haoming (Bobby) Fang — BPAG hfang45@wisc.edu
Sam Tan — BWIG stan68@wisc.edu

Problem statement:

The project aims to innovate 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, enhancing the wheelchair user's comfort, and allows interactions with surroundings through the footrest.

Brief status update

- Cardboard prototype completed
- Materials Ordered
- Fabrication can start

Difficulties / advice requests

Current design:

Current design is a footrest on 2 linear actuators that will be controlled by a button on the wheelchair to move back and forth under the wheelchair.

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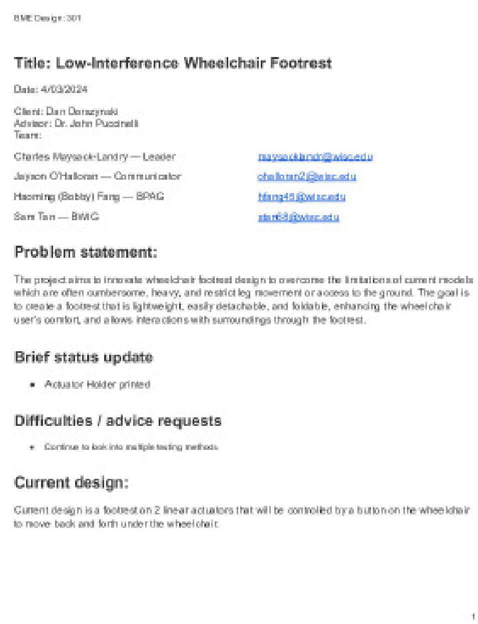
Progress_report_8_-_Low-Interference_Wheelchair_Footrest.pdf (695 kB)

Progress Report 9

JAYSON O'HALLORAN - May 03, 2024, 7:33 PM CDT



BME Design 301

Title: Low-Interference Wheelchair Footrest

Date: 4/03/2024

Client: Dan Dorszynski
Advisor: Dr. John Puccinelli
Team:

Charles Maysack-Landry — Leader	maysacklandr@wisc.edu
Jayson O'Halloran — Communicator	ohalloran2@wisc.edu
Haoming (Bobby) Fang — BPAG	hfang45@wisc.edu
Sam Tan — BWIG	stan68@wisc.edu

Problem statement:

The project aims to innovate 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, enhancing the wheelchair user's comfort, and allows interactions with surroundings through the footrest.

Brief status update

- Actuator Holder printed

Difficulties / advice requests

- Continue to look into multiple testing methods.

Current design:

Current design is a footrest on 2 linear actuators that will be controlled by a button on the wheelchair to move back and forth under the wheelchair.

1

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Progress_report_9_-_Low-Interference_Wheelchair_Footrest.pdf (695 kB)

Progress Report 10

JAYSON O'HALLORAN - May 03, 2024, 7:33 PM CDT

BME Design 301

Title: Low-Interference Wheelchair Footrest

Date: 4/12/2024

Client: Dan Dorszynski
Advisor: Dr. John Puccinelli
Team:

Charles Maysack-Landry — Leader	maysacklandr@wisc.edu
Jayson O'Halloran — Communicator	ohalloran2@wisc.edu
Haoming (Bobby) Fang — BPAG	hfang45@wisc.edu
Sam Tan — BWIG	stan68@wisc.edu

Problem statement:

The project aims to innovate 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, enhancing the wheelchair user's comfort, and allows interactions with surroundings through the footrest.

Brief status update

- Front and back Actuator Holder reprinted/modified
- Circuit put together
- Footrest cut and started welded

Difficulties / advice requests

- Continue to look into multiple testing methods

Current design:

Current design is a footrest on 2 linear actuators that will be controlled by a button on the wheelchair to move back and forth under the wheelchair.

1

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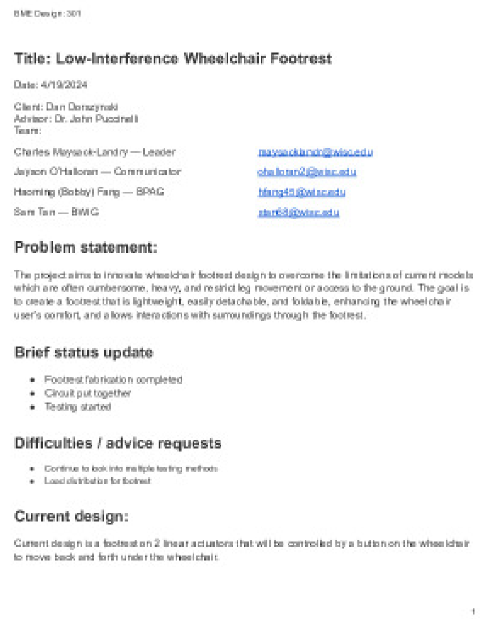
Progress_report_10_-_Low-Interference_Wheelchair_Footrest.pdf (5.89 MB)

Progress Report 11

JAYSON O'HALLORAN - May 03, 2024, 7:33 PM CDT



BME Design 301

Title: Low-Interference Wheelchair Footrest

Date: 4/19/2024

Client: Dan Dorszynski
Advisor: Dr. John Puccinelli
Team:

Charles Maysack-Landry — Leader maysacklandr@wisc.edu
Jayson O'Halloran — Communicator ohalloran2@wisc.edu
Haoming (Bobby) Fang — BPAG hfang45@wisc.edu
Sam Tan — BWIG stan68@wisc.edu

Problem statement:

The project aims to innovate 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, enhancing the wheelchair user's comfort, and allows interactions with surroundings through the footrest.

Brief status update

- Footrest fabrication completed
- Circuit put together
- Testing started

Difficulties / advice requests

- Continue to look into multiple testing methods
- Load distribution for footrest

Current design:

Current design is a footrest on 2 linear actuators that will be controlled by a button on the wheelchair to move back and forth under the wheelchair.

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Progress_report_11_-_Low-Interference_Wheelchair_Footrest.pdf (6.27 MB)

Progress Report 12

JAYSON O'HALLORAN - May 03, 2024, 7:34 PM CDT

BME Design 301

Title: Low-Interference Wheelchair Footrest

Date: 4/26/2024

Client: Dan Dorszynski
Advisor: Dr. John Puccinelli
Team:

Charles Maysack-Landry — Leader maysacklandr@wisc.edu

Jayson O'Halloran — Communicator ohalloran2@wisc.edu

Haoming (Bobby) Fang — BPAG hfang45@wisc.edu

Sam Tan — BWIG stan63@wisc.edu

Problem statement:

The project aims to innovate 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, enhancing the wheelchair user's comfort, and allows interactions with surroundings through the footrest.

Brief status update

- Poster presentation completed
- All fabrication and testing completed for the semester

Difficulties / advice requests

- Talk with client and advisor about future works

Current design:

Current design is a footrest on 2 linear actuators that will be controlled by a button on the wheelchair to move back and forth under the wheelchair.

1

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Progress_report_12-_Low-Interference_Wheelchair_Footrest.pdf (6.27 MB)

Progress Report 13

JAYSON O'HALLORAN - May 03, 2024, 7:34 PM CDT

BME Design 301

Title: Low-Interference Wheelchair Footrest

Date: 5/03/2024

Client: Dan Dorszynski
Advisor: Dr. John Puccinelli
Team:

Charles Maysack-Landry — Leader maysacklandr@wisc.edu
Jayson O'Halloran — Communicator ohalloran2@wisc.edu
Haoming (Bobby) Fang — BPAG hfang45@wisc.edu
Sam Tan — BWIG stan68@wisc.edu

Problem statement:

The project aims to innovate 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, enhancing the wheelchair user's comfort, and allows interactions with surroundings through the footrest.

Brief status update

- Final deliverables completed

Difficulties / advice requests

- None

Current design:

Completed design below

1

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Progress_report_13-_Low-Interference_Wheelchair_Footrest.pdf (1.01 MB)

2024/16/02-Design Matrix

CHARLES MAYSACK-LANDRY - Feb 16, 2024, 11:22 AM CST

Title: "Design Matrix"

Date: 02/16/2024

Goals: Create matrix to determine best design

Content:

- **Low Interference Wheelchair Footrest - BME 301 Section 302**

Design Matrix

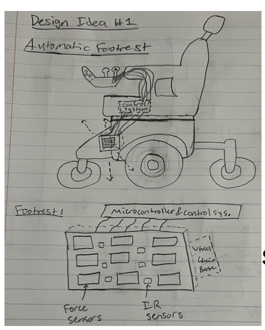
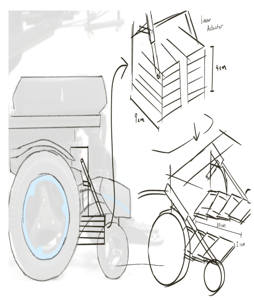
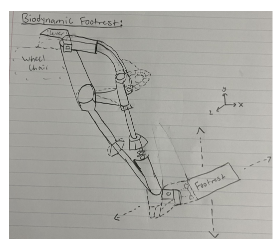
February 13, 2024

Client: Dan Dorzynsky

Advisor: John Puccinelli

Team:			
	Sam Tan	stan68@wisc.edu	BWIG
	Charles Maysack-Landry	maysacklandr@wisc.edu	Team Leader
	Haoming Fang	hfang45@wisc.edu	BPAG
	Jayson O'Halloran	ohalloran2@wisc.edu	BSAC/Communicator

Design Matrix:

Criteria (Weight %)	Design 1: Automatic Footrest	Design 2: Slider Footrest	Design 3: Biodynamic Footrest
			
Ease of Usage (15)	85	74	65
Size and Portability (15)	90	77	80
Durability (15)	86	82	72
Adjustability (15)	81	70	68
Cost (10)	62	87	93

Ease of Fabrication (10)	60	83	84
Weight (10)	94	75	69
Ergonomics (5)	91	89	85
Aesthetic and Design Integration (5)	87	84	79
Total = 100			

Design Matrix Criteria:

- Size and Portability
  - This criterion is given a weighting of 15% because size is one of the biggest issues with the current design, as the larger size of the current market footrest directly interferes with the daily tasks of our client. Making the footrest smaller will allow the targeted patients to have more maneuverability when using the wheelchairs, significantly improving the quality of their lives. Also, the design should be easily removable and can be packed for traveling, as requested by the client.
- Weight
  - This criterion is given a weighting of 10% because of the client specific medical condition, the design requires a precise control on the overall weight. The design aims to balance sturdiness with lightness, targeting a range of 3-5 lbs. This is crucial for users who may have to disassemble and reassemble the footrest regularly. The weight criterion is thus a reflection of the footrest's practicality and the user's ability to handle it, aligning with the overarching goal of enhancing the user's independence and ease of mobility.
- Ease of Usage
  - Ease of Use is a crucial aspect, especially for users with limited muscle strength, such as those with muscular dystrophy. It commands a 15% weight in our scoring because a footrest that is difficult to manipulate could deter use, lead to user frustration, and ultimately compromise health. Ensuring that the footrest can be handled effortlessly by users with limited strength is essential for their independence and daily comfort, making this criterion vital in our evaluation process.
- Durability
  - For 15% of the scoring, durability is paramount in the design of our wheelchair footrest, particularly as the previous group's attempt failed significantly in this area. The footrest must withstand the rigors of outdoor use and frequent handling, including being packed and unpacked multiple times.
- Ease of Fabrication
  - Ease of fabrication is given 10% of the weighing. The design must allow for the footrest to be manufactured using readily available materials and straightforward production techniques. By focusing on manufacturability, we can streamline the production process, control costs, and facilitate any necessary repairs or replacements in the future.
- Adjustability
  - Adjustability is a key aspect of our wheelchair footrest design, given 15% of the scoring. The goal is to ensure not only height customization to cater to individual user needs but also compatibility with a wide

range of wheelchair models. By accommodating both height variations and wheelchair model differences, our design aims to enhance user experience and accessibility, making it a versatile solution for a broader audience.

- Cost
    - Cost consists of 10% of the total score. Managing cost is vital in our wheelchair footrest design to ensure affordability without compromising quality. The final product should be accessible to a broad range of users while still adhering to our high standards for durability, ergonomics, and functionality. Balancing these factors is crucial to deliver a product that not only meets our client's specific needs but also represents a cost-effective solution in the market

- Ergonomics
    - Ergonomics is given 5%. The footrest should support the client's legs and feet comfortably. It should provide enough support without raising extra pressure

- Aesthetics and integration
    - Aesthetics is given the final 5% of scoring. Its appeal and design integration are essential to our wheelchair footrest project, emphasizing the need for a product that not only functions optimally but also aligns seamlessly with the wheelchair's overall look.

- **Design 1:**
- The automatic footrest design uses a sophisticated electronic setup consisting of several many different key components. The DC motor serves as the primary mover, regulated by a motor controller acting as the brain of the system. Users command the footrest via a control interface, which transmits signals to a microcontroller, functioning as an intermediary between the control input and the motor control. The integration of sensors, such as infrared or pressure sensors, enhances safety and functionality by providing feedback on obstacles or footrest position. A rechargeable battery powers the entire system, ensuring mobility. The intricate network of wiring connects these components, often organized on a circuit board. Safety features, including emergency stop mechanisms and collision detection, contribute to a secure user experience, making the wheelchair footrest movement both controlled and user-friendly.

- **Design 2: Slider Footrest**
- The slider footrest design uses 4-5 overlapping, thin, and tracked slide platforms to achieve low interference. When used, each platform slides to extend forward using a linear actuator or motor with similar design. Each slider platform can only slide a certain distance forward to ensure proper strength. The overall weight of the design could potentially become the downside but with careful consideration of materials, removal of excess materials, this design could achieve greater goals.

- **Design 3:**
- The biodynamic footrest design incorporates innovative features for enhanced adjustability and user comfort. The footrest is designed with multiple joints, allowing dynamic movement in various directions. Ball and socket joints enable a greater range of motion, accommodating different leg positions and providing optimal support. The footrest includes a locking mechanism at each joint, ensuring stability when the user desires a fixed position. Additionally, a lever system is integrated, allowing users to pull the footrest out to their desired height and axis with ease. This lever mechanism provides a user-friendly and adjustable experience, promoting adaptability to diverse user preferences and ensuring a personalized and comfortable fit for individuals utilizing the electric wheelchair. The combination of joint flexibility, locking features, and the lever system creates a biodynamic footrest design that prioritizes both functionality and ergonomic considerations in the pursuit of optimal user satisfaction and convenience.

Conclusions/action items:

CHARLES MAYSACK-LANDRY - Feb 16, 2024, 11:19 AM CST

ASEE Paper ID #20619

Design and Development of a Novel Wheelchair with Lifting and Flattening Capabilities

Dr. Jahangir Ansari, Virginia State University

Jahangir Ansari is Associate Professor of Manufacturing Engineering at Virginia State University. He received his M.S. degree in Mechanical Engineering in 1979 and Ph. D. degree in Mechanical Design and Production Engineering in 1983 both from Seoul National University. He joined the faculty at VSU in 2002. His research interests include Structural Vibration, FEM, CAD/CAM/CAE, and Virtual Manufacturing.

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design-and-development-of-a-novel-wheelchair-with-lifting-and-flattening-capabilities.pdf (1.1 MB)

2024/02/21- Footrest Extension Design

Sam TAN - Feb 21, 2024, 9:57 PM CST

Title: Footrest Extension Motor Design

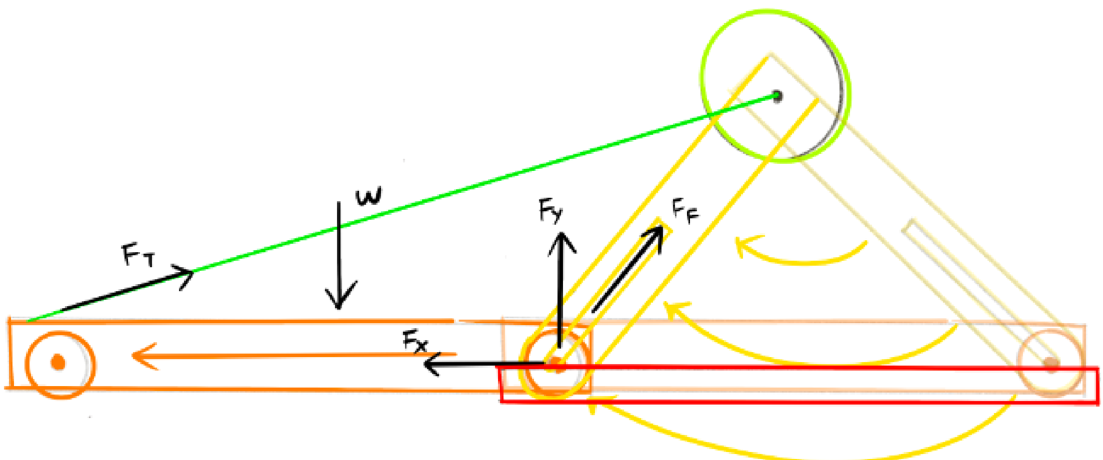
Date: 2/21/24

Content by: Bobby/Sam

Present: Bobby/Sam

Goals: Figure out a way to extend the footrest out using a motor design

Content:



This design consist of a motor swing arm. The yellow piece is the swing arm with track cut out to allow connection to the footrest piece (orange). The footrest itself is connected with wheels, on the track on the side (red). The Green wire is providing tension to overcome the large moment produced by the weight. This is still a preliminary design and not perfectly though through.

Forces label are specific to the orange footrest piece.

F_T: cable tension

W: Subject leg weight (one limb)

F_F: Force provided by the swing arm.

Conclusions/action items:

Further modification is needed, such as the motor position, motor power, thickness of pieces, wire strength, wheel

2024/27/02-Design Matrix Electric vs Manual

CHARLES MAYSACK-LANDRY - Feb 27, 2024, 2:11 PM CST

Title: Design Matrix Electric vs Manual

Date: 2/27/2024

Content:

	Design 1:		Design 2:	
Criteria (Weight %)	**Electric Footrest**		**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**	

Conclusions/action items:

2024/03/22- Linear Actuator Holder CAD

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Sam TAN - Mar 22, 2024, 1:17 AM CDT

Title: Linear Actuator Holder CAD

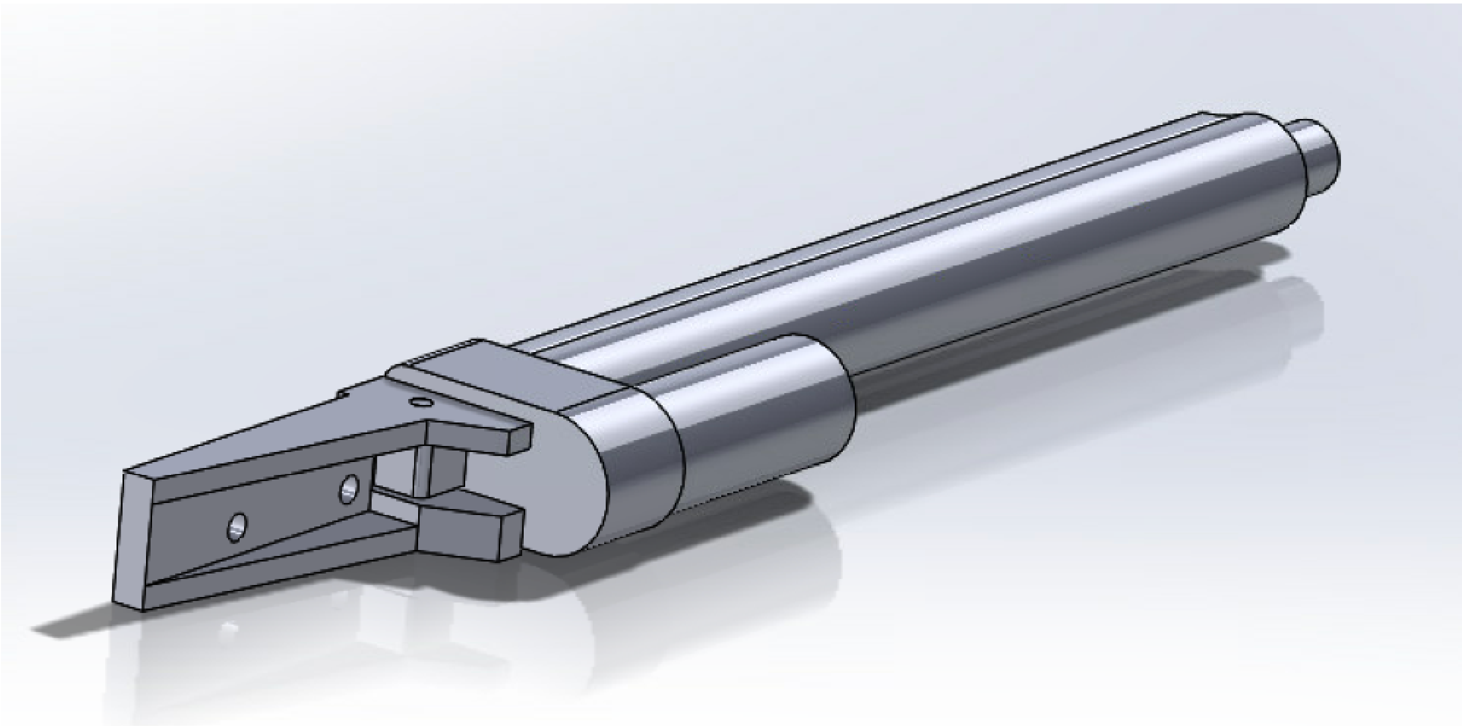
Date: 3/21/24

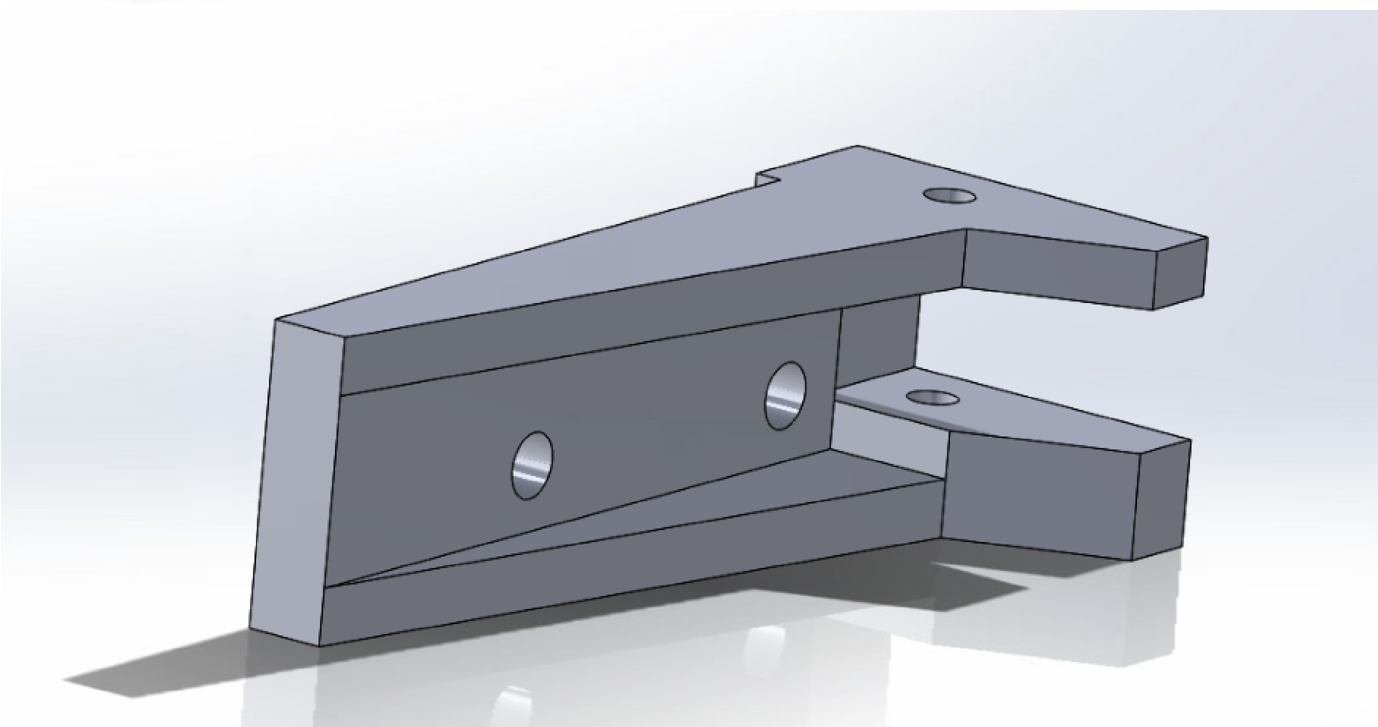
Content by: Sam

Present: All

Goals: CAD for print

Content:





Conclusions/action items:

Print test piece and try dimension. Make modifications needed for fit prototype (linear actuator and wheelchair)

2024/03/22- Footrest Plate

Sam TAN - Mar 22, 2024, 1:24 AM CDT

Title: Footrest Plate V1

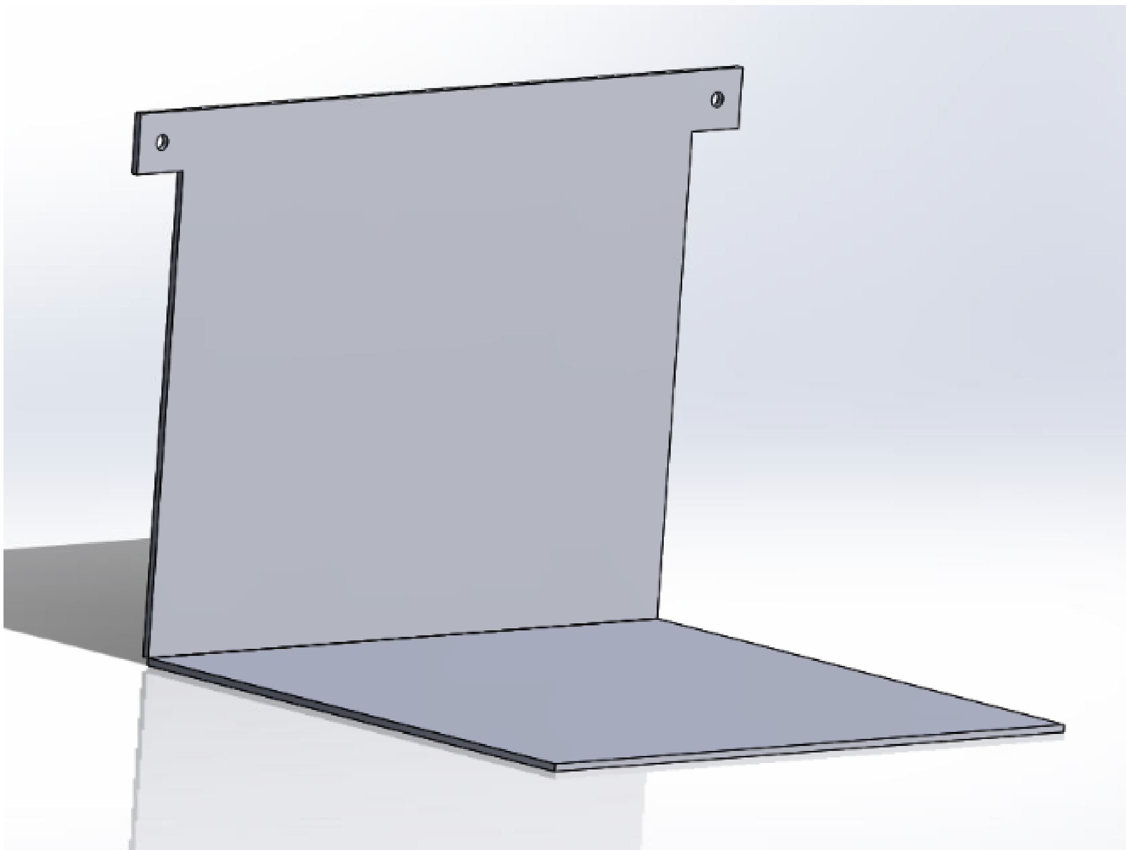
Date: 3/22/24

Content by: Sam

Present: All

Goals: Footrest CAD V1

Content:



Conclusions/action items:

Fabrication using welding and mills.

2024/03/29- Linear Actuator backholder CAD

Sam TAN - Mar 29, 2024, 8:12 PM CDT

Title: Linear Actuator Back holder CAD

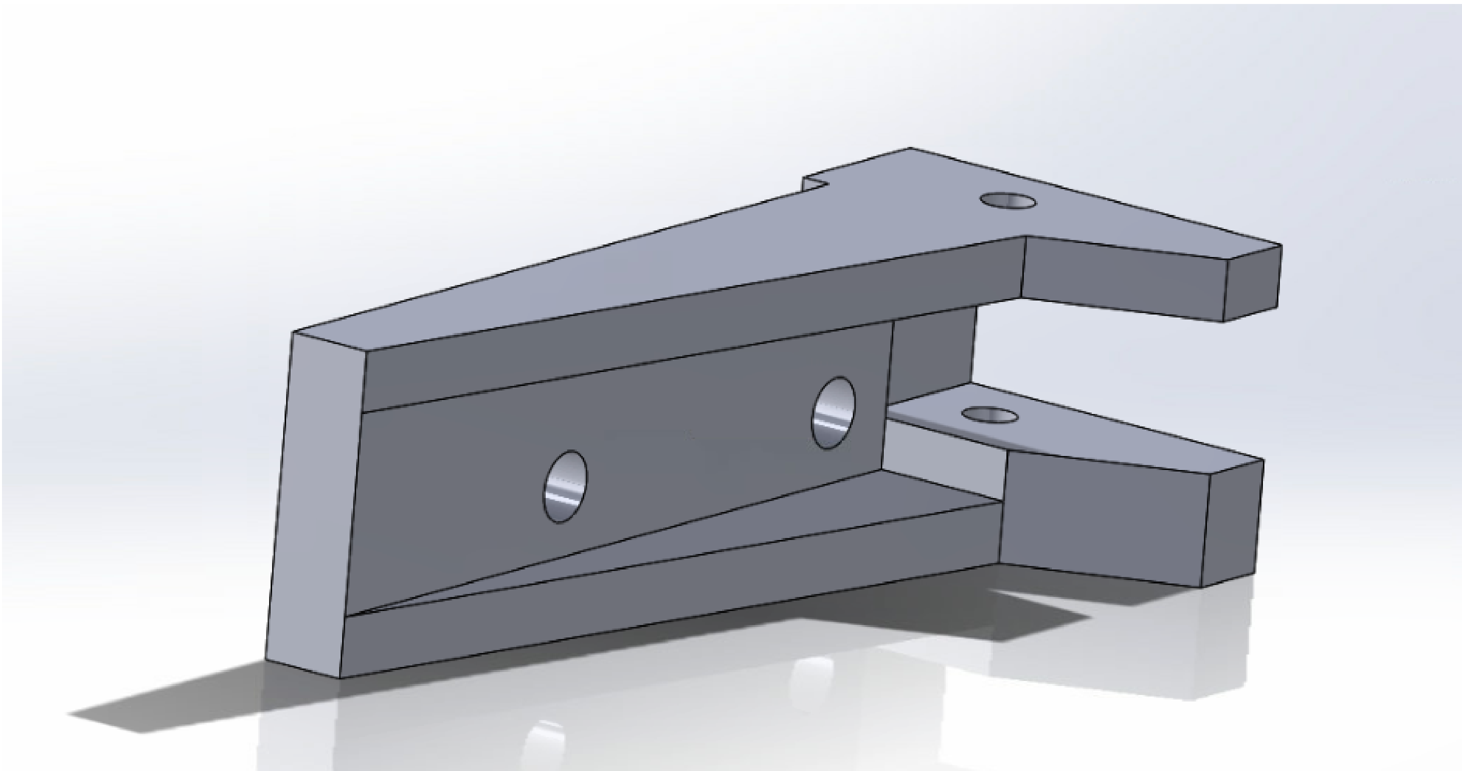
Date: 3/29/24

Content by: Sam

Present: Sam

Goals: N/A

Content:



Conclusions/action items:

Slight modifications were made: Increase hole diameter, size refinement.

2018/01/16-Entry format

Christa Wille - Jan 22, 2018, 8:51 AM CST

Use this as a guide for every entry

- Every text entry of your notebook should have the **bold titles** below.
- Every page/entry should be **named starting with the date** of the entry's first creation/activity, subsequent material from future dates can be added later.

You can create a copy of the blank template by first opening the desired folder, clicking on "New", selecting "Copy Existing Page...", and then select "2018/01/16-Template")

Title: Descriptive title (i.e. Client Meeting)

Date: 1/16/2018

Content by: The one person who wrote the content

Present: Names of those present if more than just you (not necessary for individual work)

Goals: Establish clear goals for all text entries (meetings, individual work, etc.).

Content:

Contains clear and organized notes (also includes any references used)

Conclusions/action items:

Recap only the most significant findings and/or action items resulting from the entry.

2024/03/29- Printed Backholder V1

Sam TAN - Mar 29, 2024, 8:15 PM CDT

Title: back holder

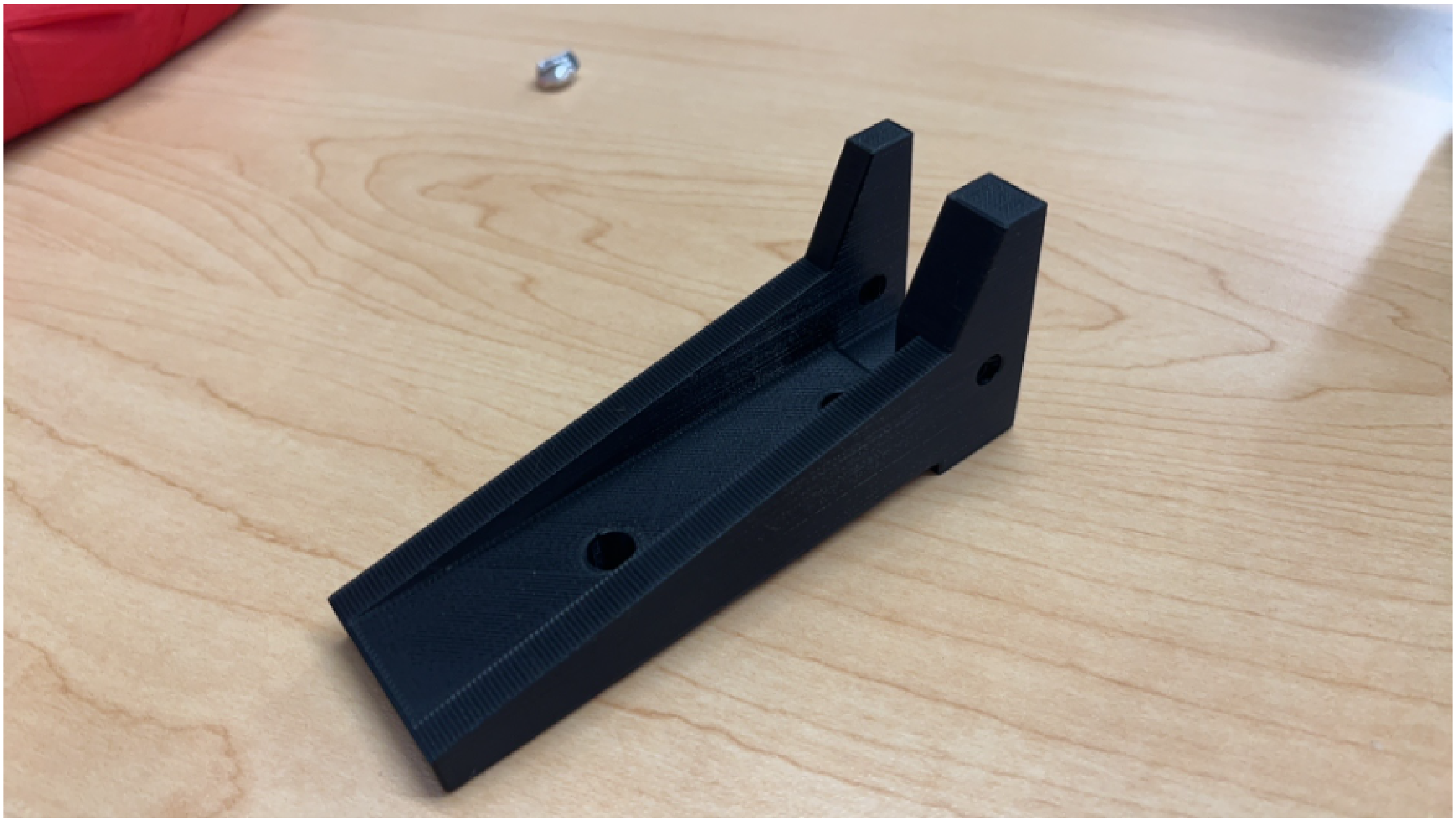
Date: 03/27/24

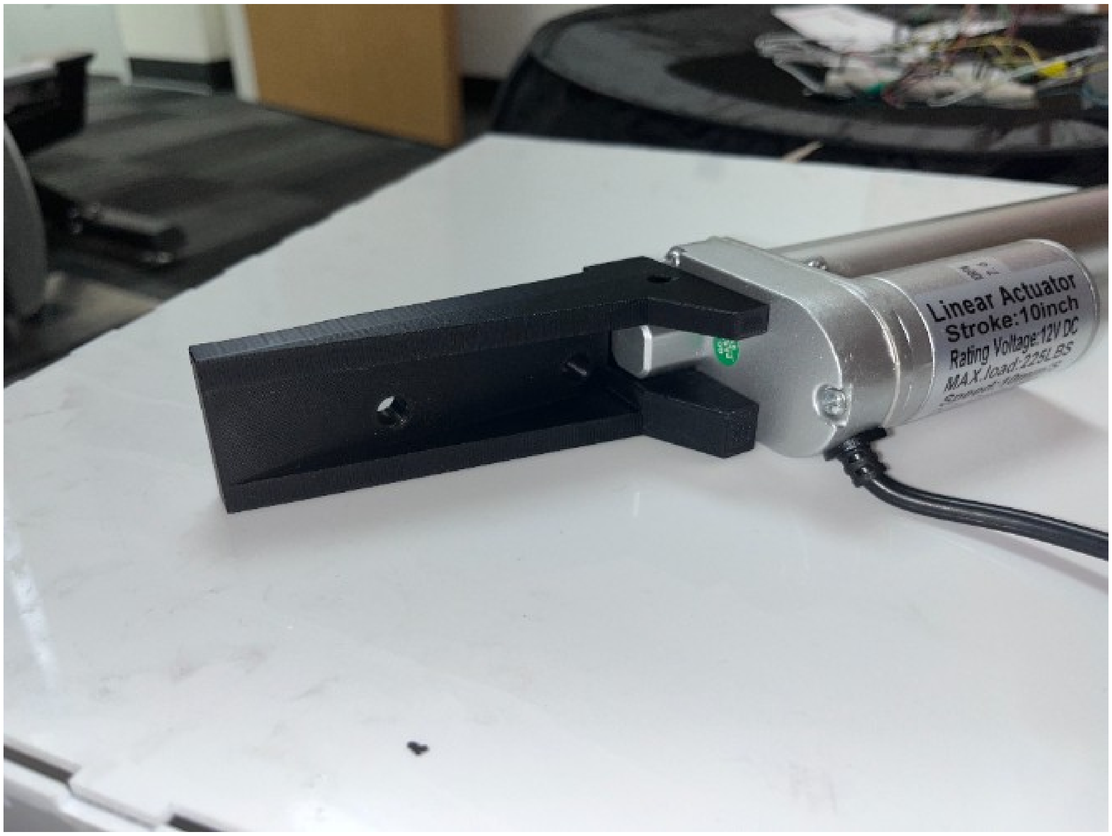
Content by: Sam

Present: Sam

Goals: N/A

Content:





Conclusions/action items:

The first version have some issues with dimensions. Due to some error during printing and post-processing (removing supports), the hole size isn't ideal. Further modifications are needed to fit linear actuator.

2024/03/29- Printed Backholder V2

Sam TAN - Mar 29, 2024, 8:18 PM CDT

Title: back holder v2

Date: 03/29/24

Content by: Sam

Present: Sam

Goals: N/A

Content:

Conclusions/action items:

The hole size is accurate. Dimensions fits the linear actuator. Next step is the front holder and replicate to the other side as well. Note: since the left/right pieces are not super imposable, a mirror image need to be 3D model out, this means that we can't use the same piece on both sides.

2024/04/04- Backholder v2 assembly

Sam TAN - Apr 04, 2024, 9:46 PM CDT

Title: Backholder assembly (only one side)

Date: 4/4/24

Content by: Sam

Present: Sam

Goals: Assemble the back holder with the linear actuator/wheelchair

Content:

Conclusions/action items:

Work on Front holder

2024/04/17- Front holder in place

Sam TAN - Apr 17, 2024, 2:04 PM CDT

Title: Printed front holder

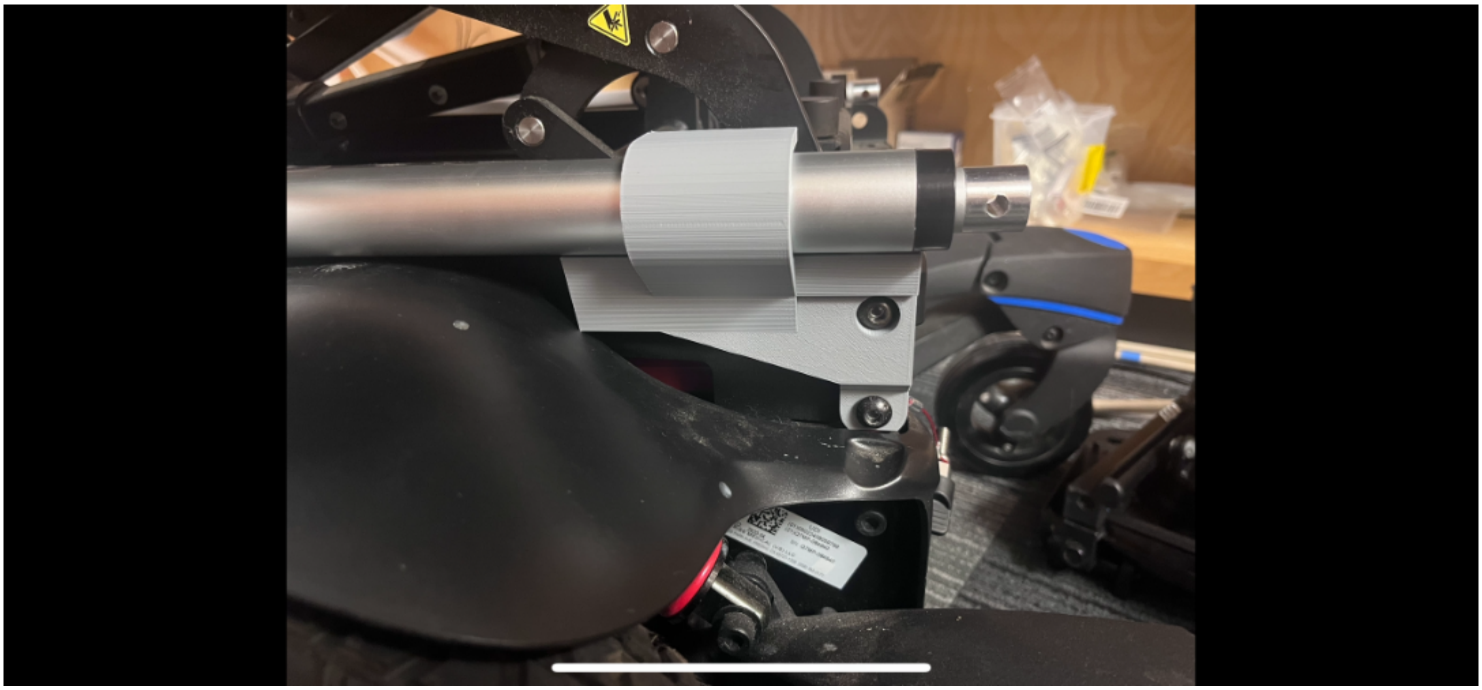
Date: 4/17/24

Content by: Sam

Present: Sam, Charles

Goals: N/A

Content:



Conclusions/action items:

N/A

2024/04/17- Back Holder and All together

Sam TAN - Apr 17, 2024, 2:08 PM CDT

Title: Back holder reprint and put together

Date: 4/17/24

Content by: Sam

Present: N/A

Goals: N/A

Content:

Conclusions/action items:

N/A

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2024/04/19 Footrest assembly

Sam TAN - Apr 19, 2024, 2:52 PM CDT

Title: Footrest Assembly

Date: 04/19

Content by: BOBBY

Present: All

Goals: To assemble the plates together to make the footrest

Content:

The waterjetted top and bottom aluminum plates are welded together, and an additional bar are screwed to the back of the top plate to be fitted on the wheelchair.

Conclusions/action items:

2024/04/24-Footrest fabrication

CHARLES MAYSACK-LANDRY - May 03, 2024, 2:03 PM CDT

Title: Footrest fabrication

Date: 4/24/2024

Content by: Charles Maysack-Landry

Goals: Fabricate and test footrest to figure out best configuration

Content:

Units of drawings are in inchs

Started with two 12inx12in aluminum 6061 plates. Cut to shape with the water jet at the Makerspace. The water jet can handle up to 12 by 12 items, so it was maxed by the size of the plates leading to complications during set up. The figures below show the desired shapes and sizes modeled in solid works.

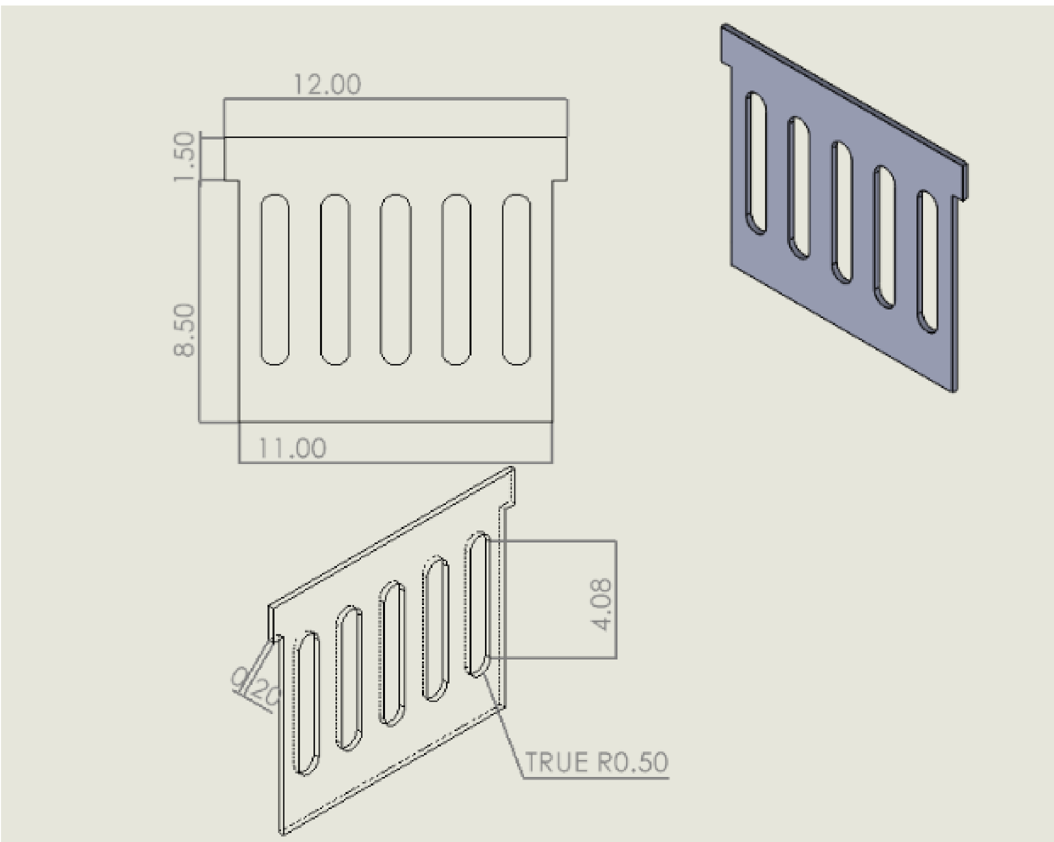
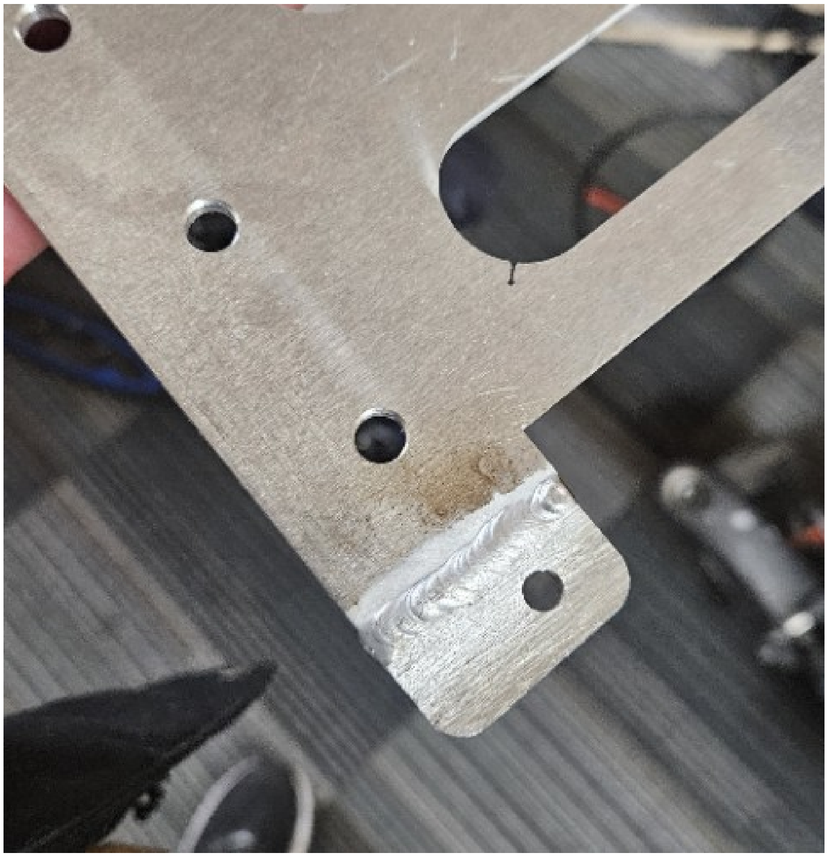
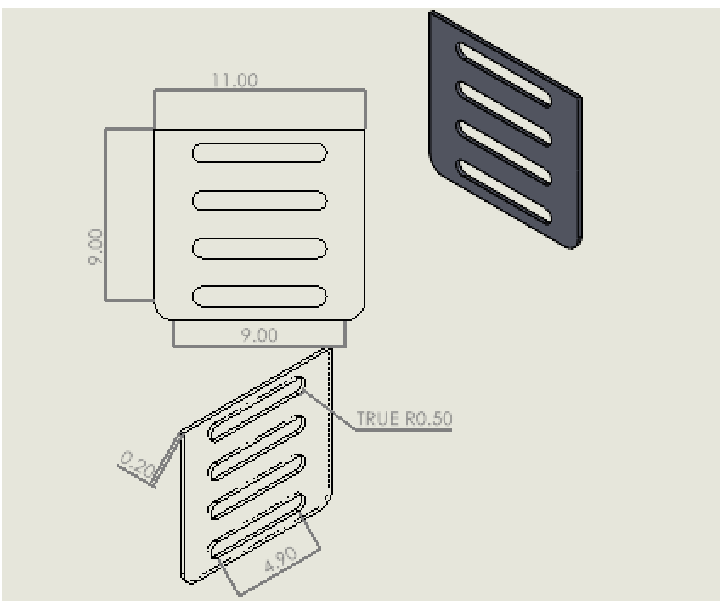


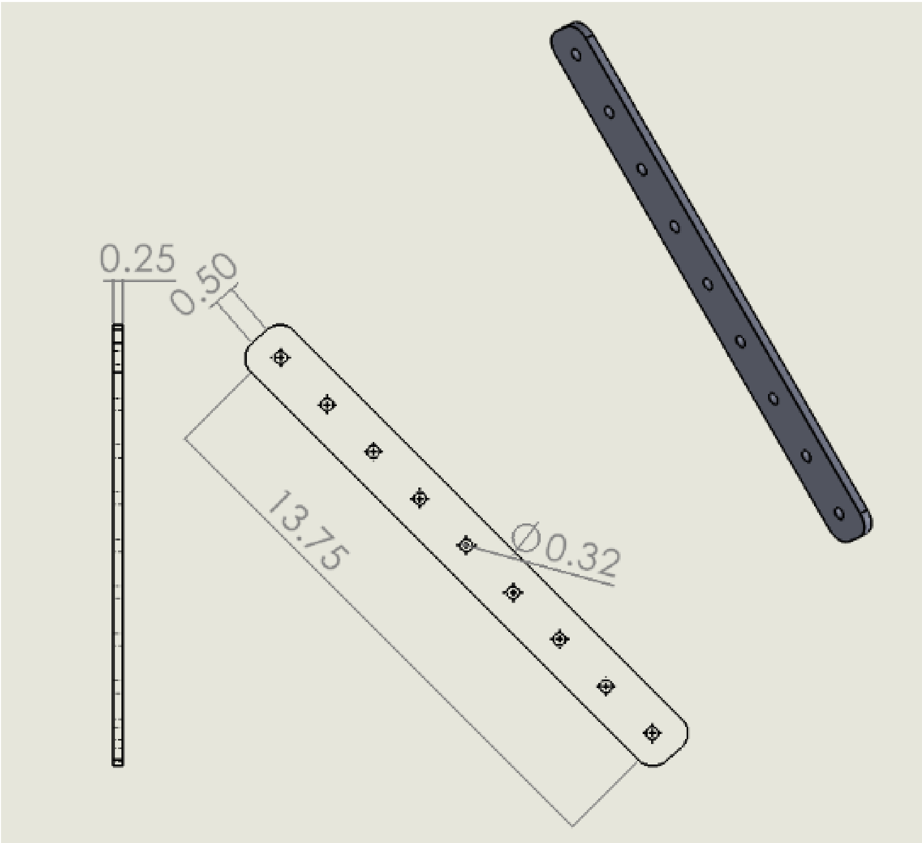
Figure above is the back that connects to the footrest, originally designed to be welded to small tabs that had holes in them like below

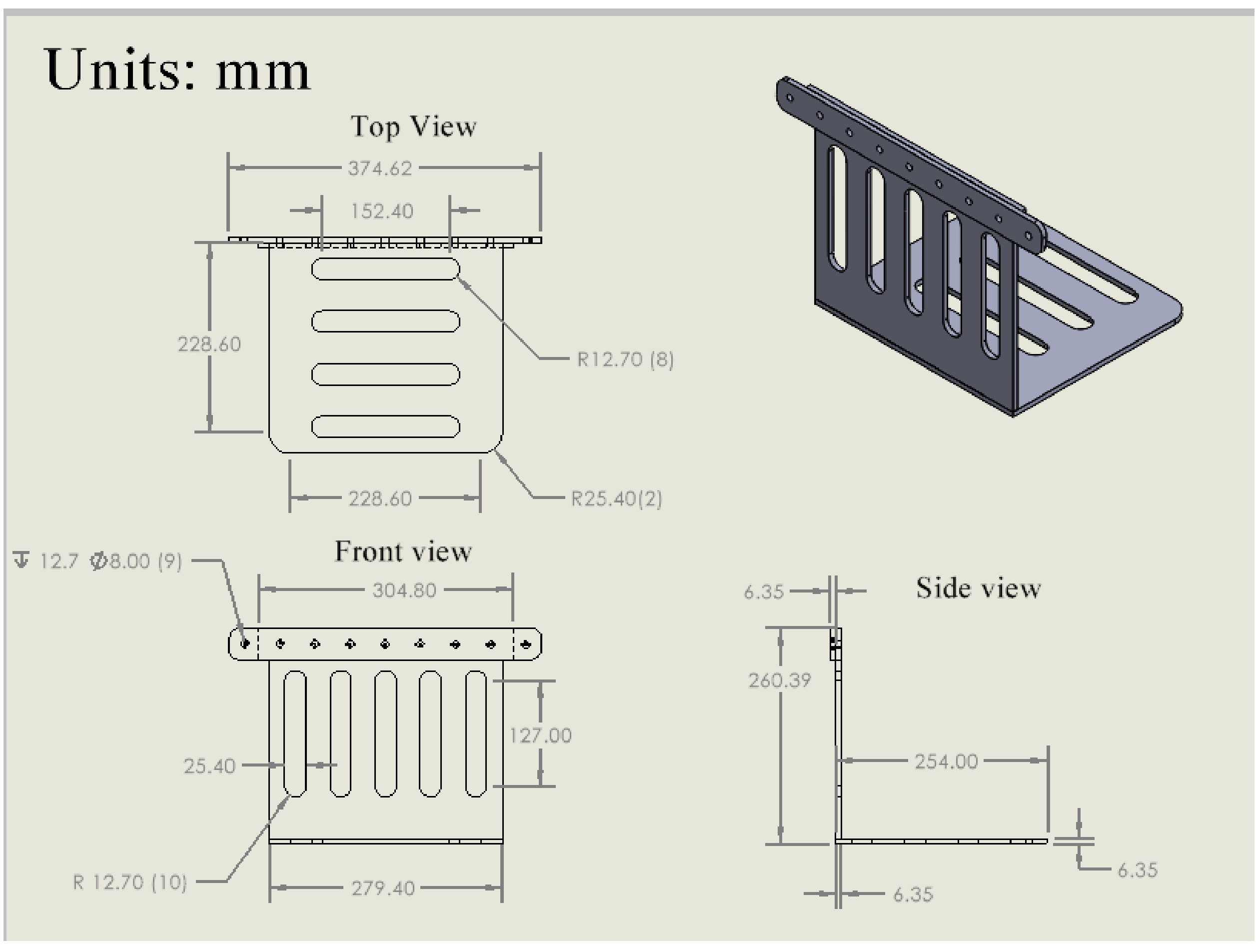




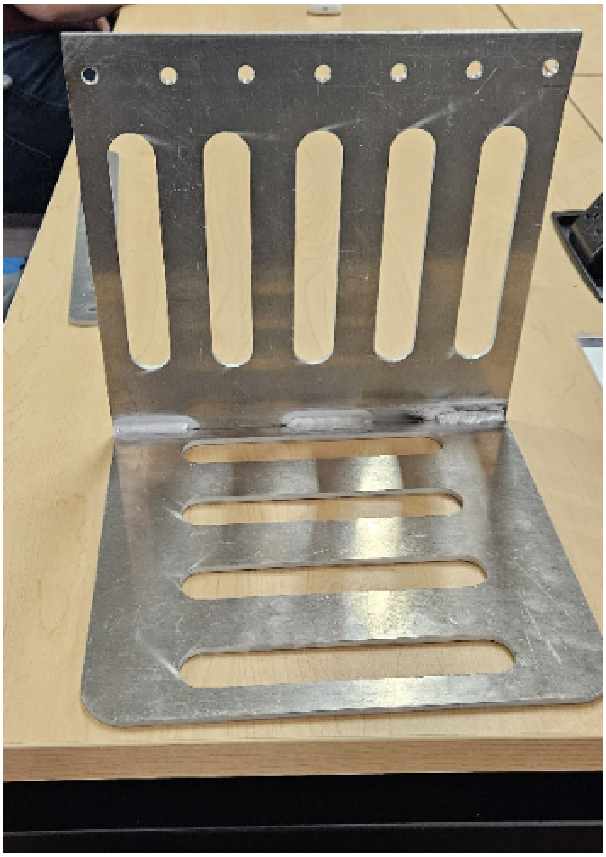
The figure above is the bottom of the footrest that the feet are placed on

The two plates are welded together and a bar was added to the back plate for more support. The tabs were sawed off with a band saw. Holes in the back plate for 8mm screws were added to connect the bar to the foot rest as shown below. The bar was water jetted and the lined up with the back plate to tap lead holes for the screws that will match up. A drop drill was used for the holes.





The final prototype before the bar was added and connected to the wheelchair is shown below.



Conclusions/action items:

Test the final prototype

2024/04/24- Bracket changes and fabrication

CHARLES MAYSACK-LANDRY - Apr 24, 2024, 11:59 AM CDT

Title: Bracket fabrication

Date: 4/24/2024

Content by: Charles Maysack-Landry

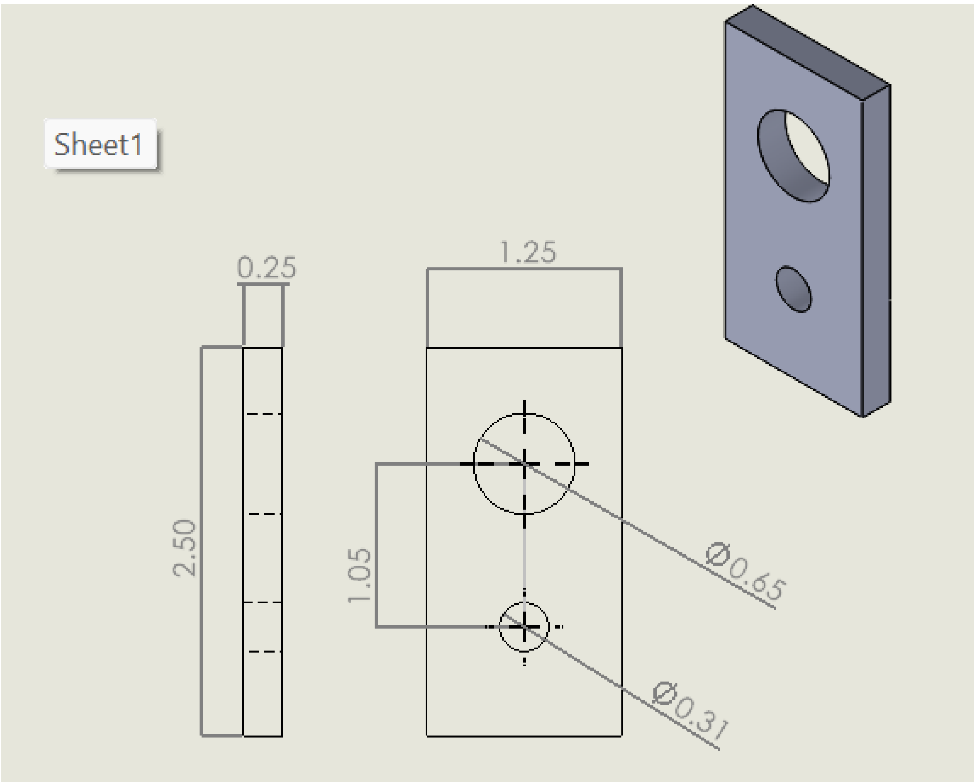
Goals: Fabricate and test brackets to figure out best configuration

Content:

The brackets used originally had too much space between the actuator and the footrest and would fail under very little stress. The space can be seen below.

To remedy this issue the brackets were cut with a steel band saw to hug the actuator cap much closer to reduce the space and bending ability. Then carefully measured holes were drilled with a drop drill to but a screw through the actuator cap.

This solution still left a lot of bending at the bracket cap. It was then realized that the actuator caps can unscrew from the rest of the actuator. So a new idea was formed to make a custom bracket from the left over aluminum that would be kept in place between the actuator and the cap as shown below. Units are in inchs.



The bigger hole connects to the actuator and the smaller hole connects to the bar of the footrest and the lack of distance between the holes doesn't allow for much bending at the connection point.

Conclusions/action items:

Test the final prototype

2024/04/24- Circuit Fabrication

CHARLES MAYSACK-LANDRY - Apr 24, 2024, 11:58 AM CDT

Title: Circuit fabrication

Date: 4/24/2024

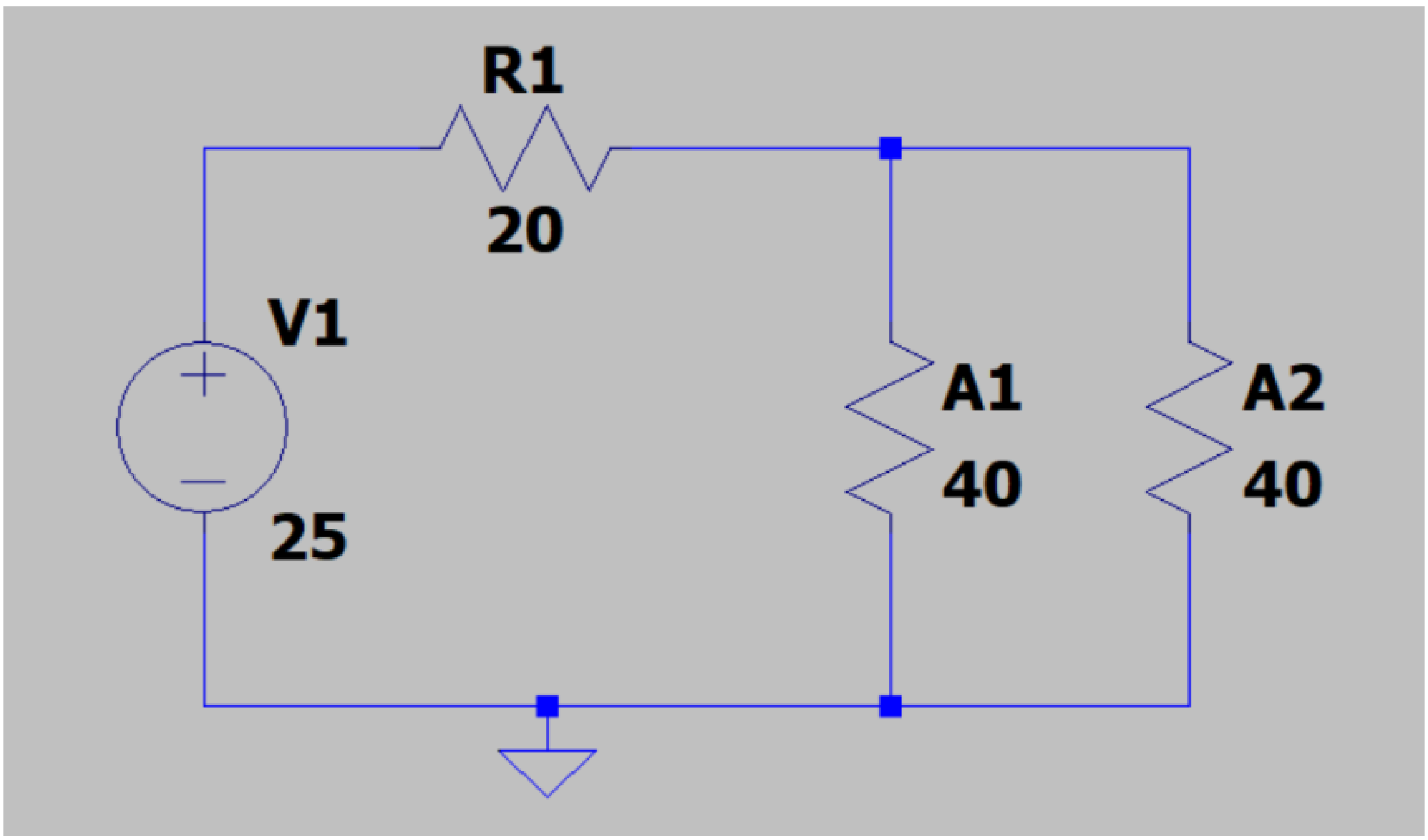
Content by: Charles Maysack-Landry

Goals: Fabricate and test possible circuits to figure out best configuration

Content:

The battery of the wheelchair is 25V and the actuators are rated for 12 volts and 4.6 maximum amps. Both actuators need to be in parallel to get equal power and move at the same time and speed. A voltage drop of 50% is needed, this can be achieved with a resistor that is equal to the equivalent resistance of the linear actuators in parallel. This will be approximately a voltage divider circuit after simplifying the dc motor in the actuator to just the internal resistor. This can be done because the inductance is shorted at constant DC voltage, which the battery is, and the back emf is negligible compared to the battery. The measured resistance of the actuators in 40 ohms so in parallel they are a total of 20 ohms. The power rating of our resistors is .25 watts, 12.5 volts will drop over the resistors. The equation for power in a resistor is V^2/R. So one twenty ohm resistor will fry. If we set up the equation to find a useable resistance, .25W = 12.5V^2/R we can find that the safest and lowest option available is 1000 ohms. 50 of this resistors in parallel give us the 20 ohms needed for the circuit.

A simplified circuit diagram is shown below



a more full schematic is shown below

Conclusions/action items:

Test the final prototype

2024/04/24- Circuit Box Fabrication

CHARLES MAYSACK-LANDRY - Apr 24, 2024, 12:09 PM CDT

Title: Circuit box fabrication

Date: 4/24/2024

Content by: Charles Maysack-Landry

Goals: Fabricate a box to hold the circuit and connect to the wheelchair.

Content:

To have a place to keep the circuit and wires away from the wheels of the wheelchair a plastic box the size of the bread board is used. A place to put the box needed to be decided and a screw hole on the back of the wheel chair was used to connected the box. A hole for the screw, and hole for the actuator wire connects and a hole for the power cable were needed. A drop drill with an 8mm drill bit was used for holes on the side for the screw and actuators. Four 2mm holes were drilled into the lid were drilled with the drop drill and a wire hand saw was used to saw a rectangular hole for the rectangle connection cable used in the circuit.

Conclusions/action items:

Test the final prototype

2024/04/19- Bending test protocol draft 1

Sam TAN - Apr 19, 2024, 2:31 PM CDT

Title: Bending test protocol, initial draft v1

Date: 4/19/24

Content by: Sam, Bobby

Present: All

Goals: Testing protocol for linear actuator bending properties and evaluate force, displacement, support, and elongation of materials

Content:

Materials: linear actuators (assembled), video taking cameras (iPhone), loads (with known mass, this can be switched based on the discretion of the test, unless otherwise states, keep to consistent masses and available resources to the maximum extend).

Software: Image J

Testing procedure:

1. With the linear actuators assembled to the wheelchair, holders in place, securely screwed, assemble the footrest and attach to the linear actuators as shown in fabrication.

2. Place one of the video taking camera less than one meter away, in the sagittal plane (side view), and allow the camera frame to capture the entire linear actuator on one side as shown in figure1 below.

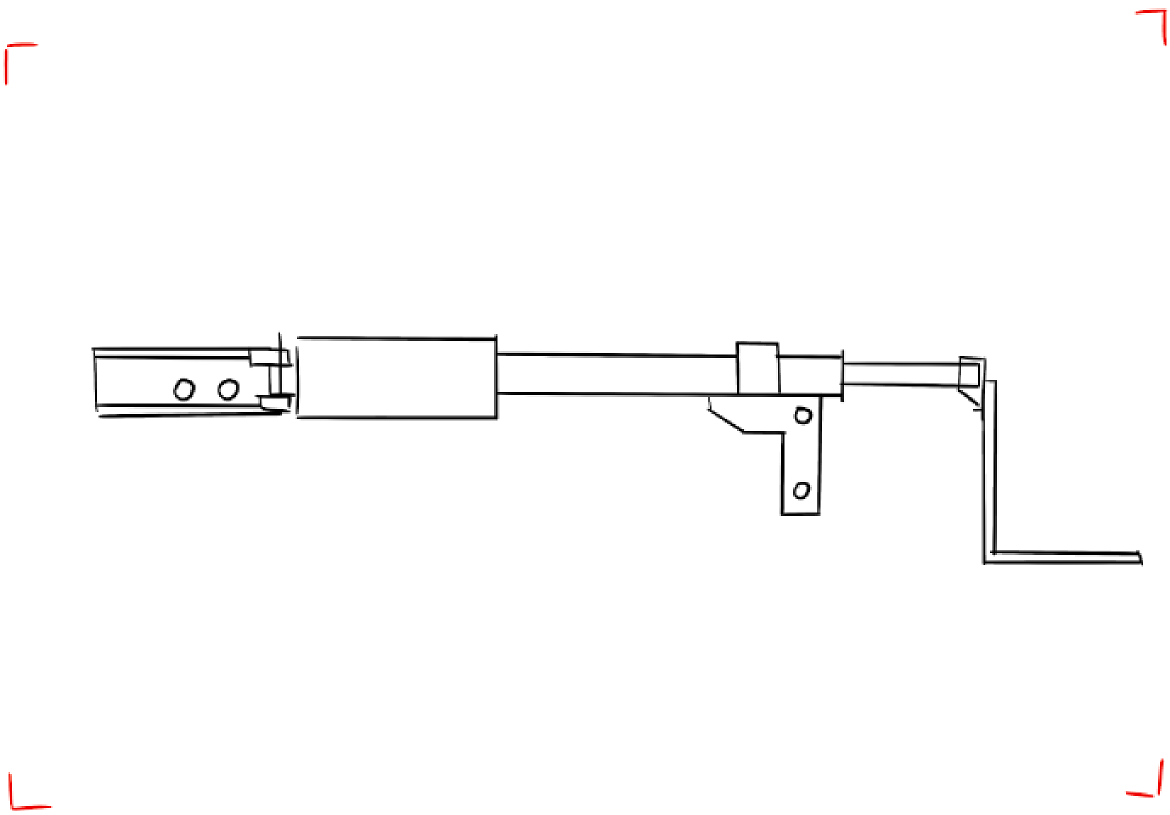


Figure 1

3. Place one of the video taking camera less than one meter away, in the sagittal plane (side view), and allow the camera frame to capture only half of the linear actuator, as shown in the figure2 below.

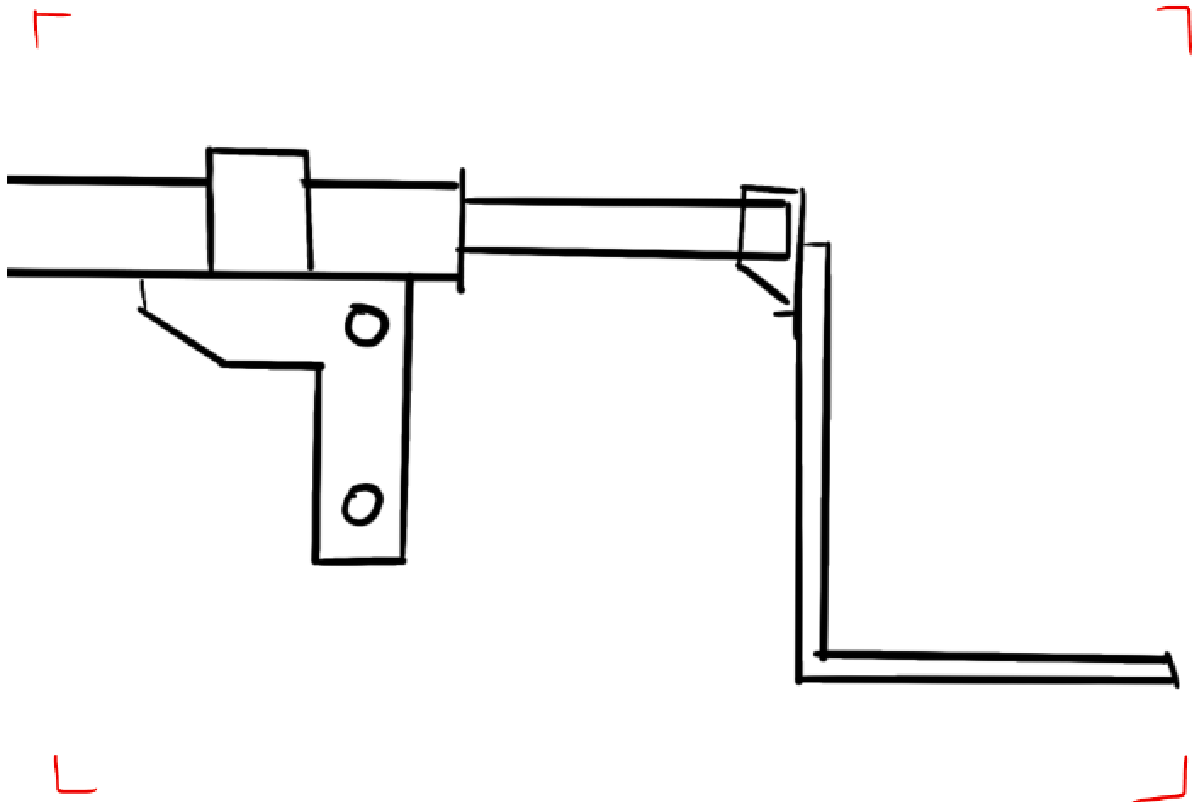


Figure 2

4. After the cameras are set up, check if videos is running and start recording.

5. Extend the footrest to the optimal position (the position where the patient is comfortable using with)

6. Gradually place the known masses (loads) onto the footrest, with consistent increments between each loads until the sum of the loads reached a value desired (determined by the factor of safety), or the bending on the linear actuator starts to exceed its limit visually.

7. Unload all the masses from the footrest and stop video recording.

Analysis procedure:

1. With the video open, take snapshot of the video at the time after each mass is placed on the footrest.

2. Upload snapshot to ImageJ.

3. Use the line tool to line up a known dimension in the snapshot, in analysis, set scale to the known dimension with units.

4. Measure the deflection of the linear actuator and record the deflection in a spreadsheet.

5. Plot the data and determine the relationship between deflection and mass applied.

Conclusions/action items:

N/A

2024/04/19 Extension & Retraction vs Time Testing Protocol

JAYSON O'HALLORAN - May 03, 2024, 7:37 PM CDT

Protocol

Materials: Quickie Q700 M Wheelchair, completely assembled body with interfaced actuators, actuator holders, and footrest.

Measuring devices: A stopwatch of some sort, could be a traditional stopwatch or an app on a phone. A ruler that can measure 0 to 24 inches.

Testing procedure:

Step 1: Turn on the wheelchair using the control button on the top right hand side near where one's arm would rest.

Step 2: Place feet on the foot rest comfortably.

Step 3: Press the legs button to begin extending the footrest. Once clicked, begin the timer.

Step 4: Once the actuators are fully extended, click the reverse button under legs and retract the linear actuators. The timer should be going still at this point.

Step 5 (Optional): If the actuators stop short of the required distance, pause the timer and measure the distance. Record and then begin retracting the actuator. The actuator should still go the distance in the opposite direction, once fully retracted multiply the distance you originally had by two to get the total distance traveled by the actuators. The actuators shouldn't stop if they are the right voltage power and have the load capabilities of lower extremities, hence this step is usually not needed, but in case it happens, the actuators will need to be replaced.

Step 6: Repeat the process various times and collect data of time (s) and extension & retraction distance (mm).

Step 7: Record data in a table of your choice and create a plot using excel, python, google sheets, etc.

Download

Extension_Retraction_vs_Time_Testing_Protocol.pdf (53.1 kB)

2024/03/13-Fabrication Protocol

CHARLES MAYSACK-LANDRY - Mar 19, 2024, 11:43 PM CDT

Title: Fabrication Protocol

Date: 3/19/2024

Content by: Group

Present: All

Goals: Develop a protocol to follow while fabricating the product

Content:

Fabrication Protocol Low Interface Wheelchair Footrest

Date: 3/19/2024

Goal: To specify a protocol on how to manufacture the low interference footrest and connect it to the Quickie Q700 M wheelchair.

Purpose: A low interference wheelchair footrest serves to enhance user comfort, accessibility, safety, and stability. By minimizing obstructions and increasing the retraction distance of the footrest, it provides ample space for the user's feet while facilitating easier transfers in and out of the wheelchair. By having this feature, the footrest can serve its purpose when needed, and be able to not hinder the user's abilities to move.

Materials:

- Quickie Q700 M Power Wheelchair (referred to as wheelchair)
- OnlineMetals Part #: 1250_18_18 Aluminum Alloy 6061 - 18” x 0.5” x 18” (length x width x height)
- Ultimaker Tough PLA 3D printed linear actuator front holder (2)
- Ultimaker Tough PLA 3D printed linear actuator back holder (2)
- 10 inch 12 volt Demotor Performance Linear Actuator (2)
- 8mm 1.25 std screw and cap (referred to as 8mm screw) (16)
- 5mm allen wrench (comes with wheelchair)
- Linear actuator BRK-14 mounting bracket (2)

Method:

1. Using a water jet, cut an aluminum plate that is 16’’ x 0.5’’ x 6’’ (L x W x H), with two screw holes in opposite corners on a longside (16’’), this side is now the “top” of the plate. Each hole is 1 inch over and down from its respective corner, and both measure 8mm 1.25 std. (1st plate)
2. Using the water jet, cut another aluminum plate, this time measuring 16’’ x 0.5’’ x 10’’, with no screw holes in this plate. (2nd plate)
3. Weld the plates together along the long side without the screw holes, the top of the 2nd plate should be perpendicular to the bottom of the 1st plate.

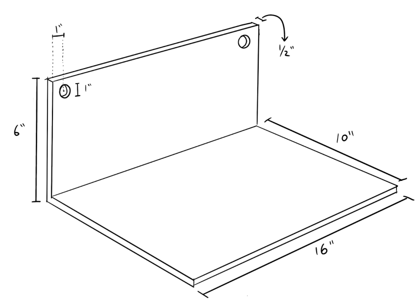


Figure 1 Footrest

4. After replicating the solidworks drawing of the holder, print both the back and front of each linear actuator holder using Tough PLA on the Ultimaker 3 3D printer with an infill of 80%.

5. Using the 5mm allen wrench, screw one 8mm screw through the back of each linear actuator and into the back holder, as shown in figure 2, then use the cap to secure the linear actuator.

6. Line up the holes in the linear actuator back holder (referred to as back holder) to the screw holes shown in the left of figure 2,3 below. Use the 8mm screws, cap, and 5mm allen wrench to tighten the back holder to the wheelchair. Line up the holes on the linear actuator front holder (referred to as front holder) to the screw holes in the right figure 2,3 and tighten them similarly. Do this on both sides of the wheelchair. The tip of the linear actuator should sit on top of the front holder, and tight to the back holder.

7. Now both linear actuator's wider faces are parallel with the seat of the wheelchair. The motor should be pointing away from the center of the wheelchair, and the extensors should point towards the front. In this position, the smooth shaft of the actuators should line up directly to the front of the wheelchair base. Using two more 8mm screws, attach each linear actuator to the wheelchair on their respective sides, capping after to ensure a snug fit.

8. After the actuator is attached to the wheelchair and secure, the linear actuator bracket can then be attached to the screw hole on the smooth shaft. Using the side with two holes on the actuator bracket, attach a 8mm screw through and then cap it. Repeat this process on the other actuator.

9. The actuator brackets are now attached and are ready to be screwed to the footrest. Insert two 8mm screws into the open holes on the footrest near the top of plate 1. Once the screws are through, cap both of them tight, connecting the footrest to the actuator bracket.

10. Upon connection of the wheelchair base, linear actuators, and the footrest, plug each of the DC motors (on each linear actuator) to the wheelchairs power supply using the white 6 pin connector. When connecting the wiring, even though the wires are insulated, make sure the wheelchair’s power is off.

11. Once connected, test that the footrest extends and retracts by using the legs button on the wheelchair controller.

Figure 4 Wheelchair Control Buttons

2024/04/21- Test (solidworks)- backholder

Sam TAN - Apr 21, 2024, 11:14 PM CDT

Title: Backholder force test

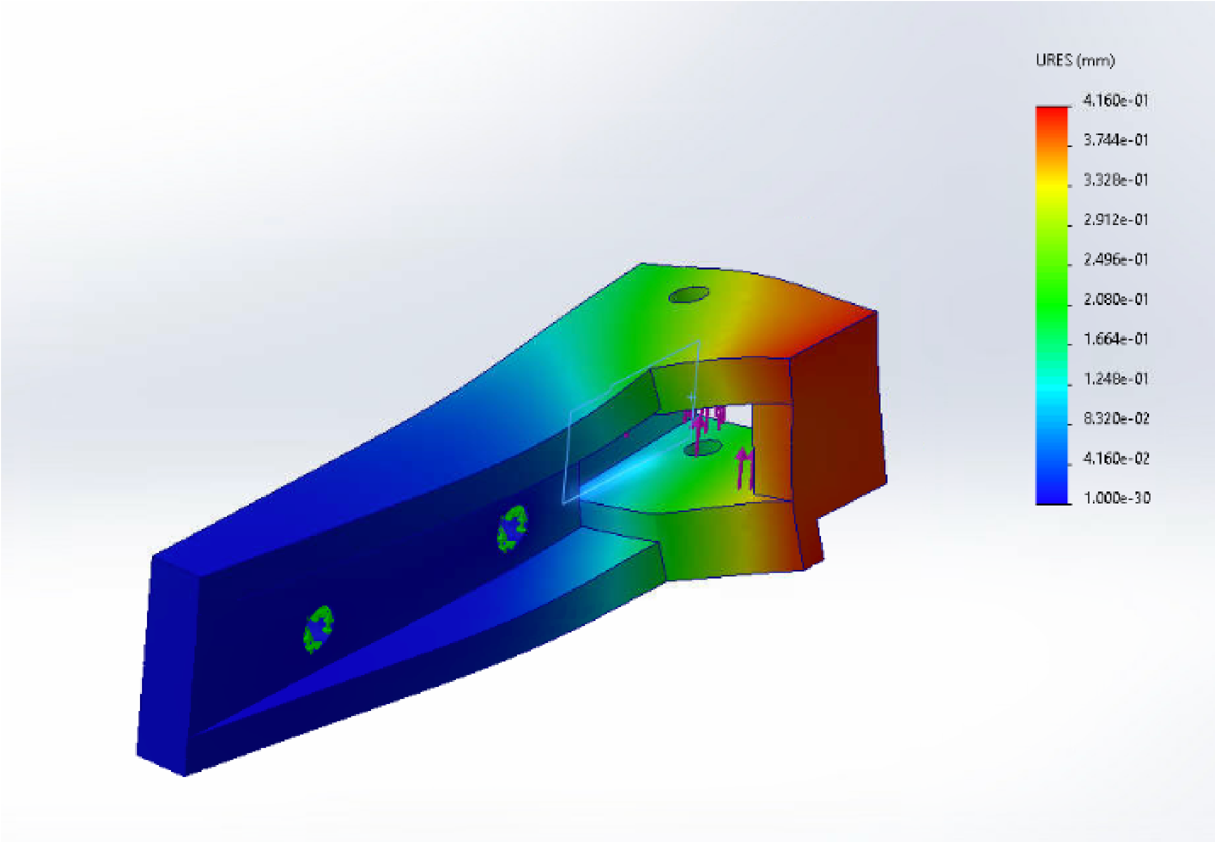
Date: 4/21/24

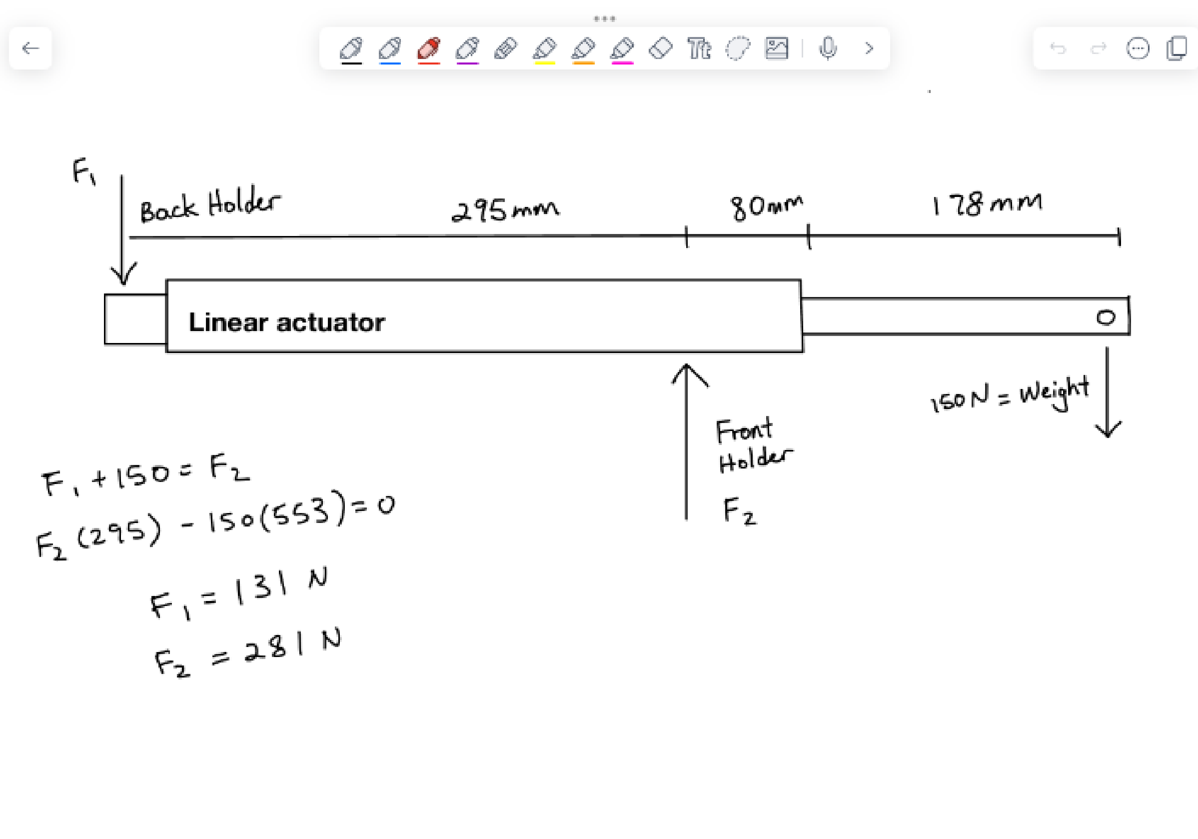
Content by: Sam

Present: N/A

Goals: Test the handling of force of back holder

Content:





Conclusions/action items:

Force is 131N, as determined by the static equilibrium diagram.

2024/04/23- Bend Test Results

Sam TAN - Apr 26, 2024, 9:43 PM CDT

Title: Bending test results

Date: 4/23/24

Content by: Sam

Present: All

Goals: Measure deflection and rotation angle

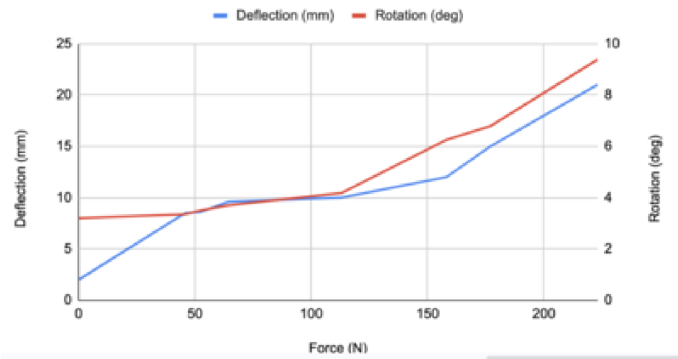
Content:

Force (N)	Deflection (mm)	Rotation (deg)
0	4	2.4
45.8	8	3.31
52.4	8.2	3.7
64.4	9.6	4
113.0	10	4.18
158	12	6.25
117	15	6.79
223	21	9.38

Conclusions/action items:

Graph

Sam TAN - Apr 26, 2024, 9:44 PM CDT



Download

Screenshot_2024-04-26_at_21.44.07.png (251 kB)

2024/5/3- Solidwork Stress Analysis

Sam TAN - May 03, 2024, 4:16 PM CDT

Title: Solidwork holder analysis

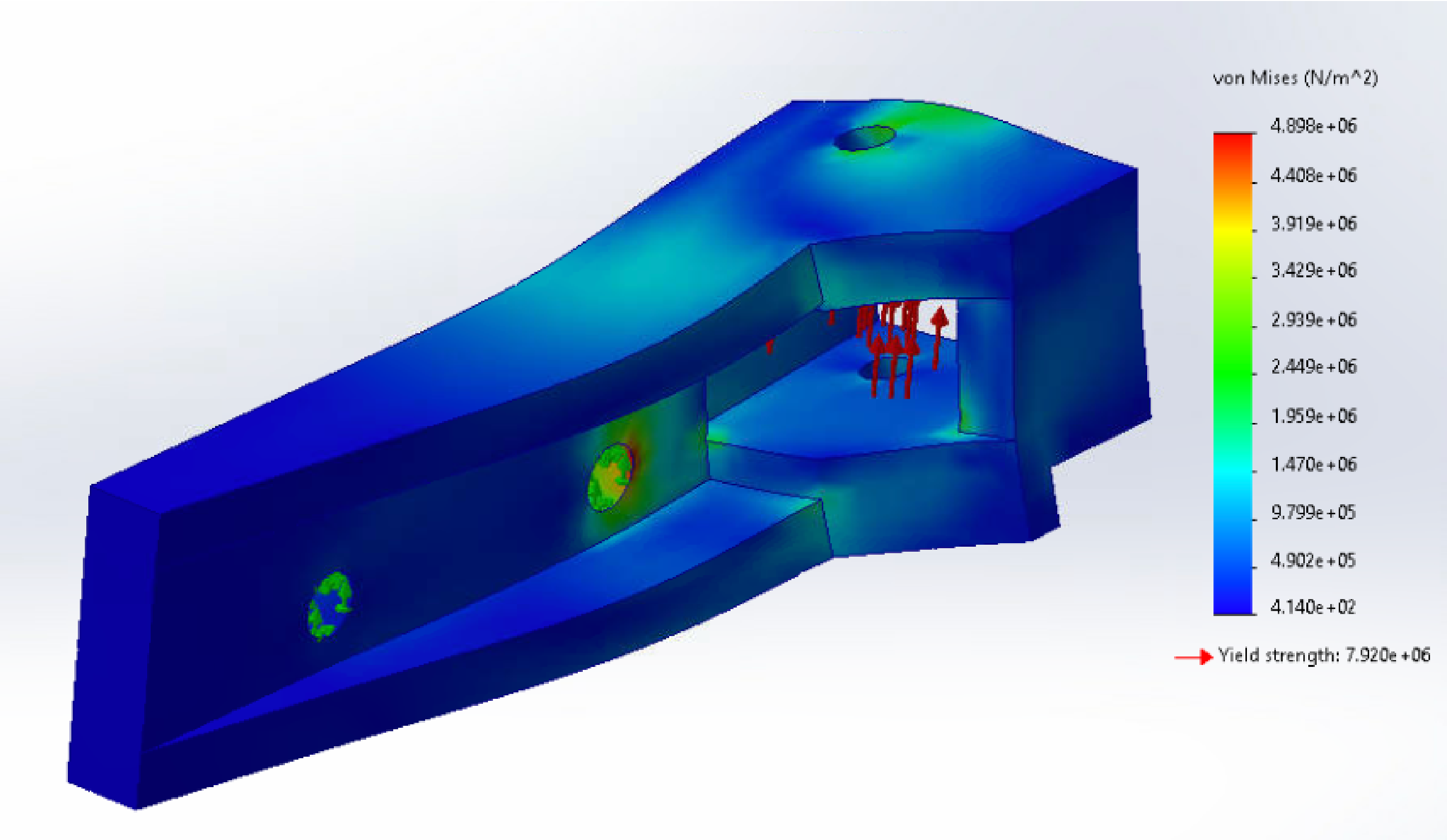
Date: 4/30/24

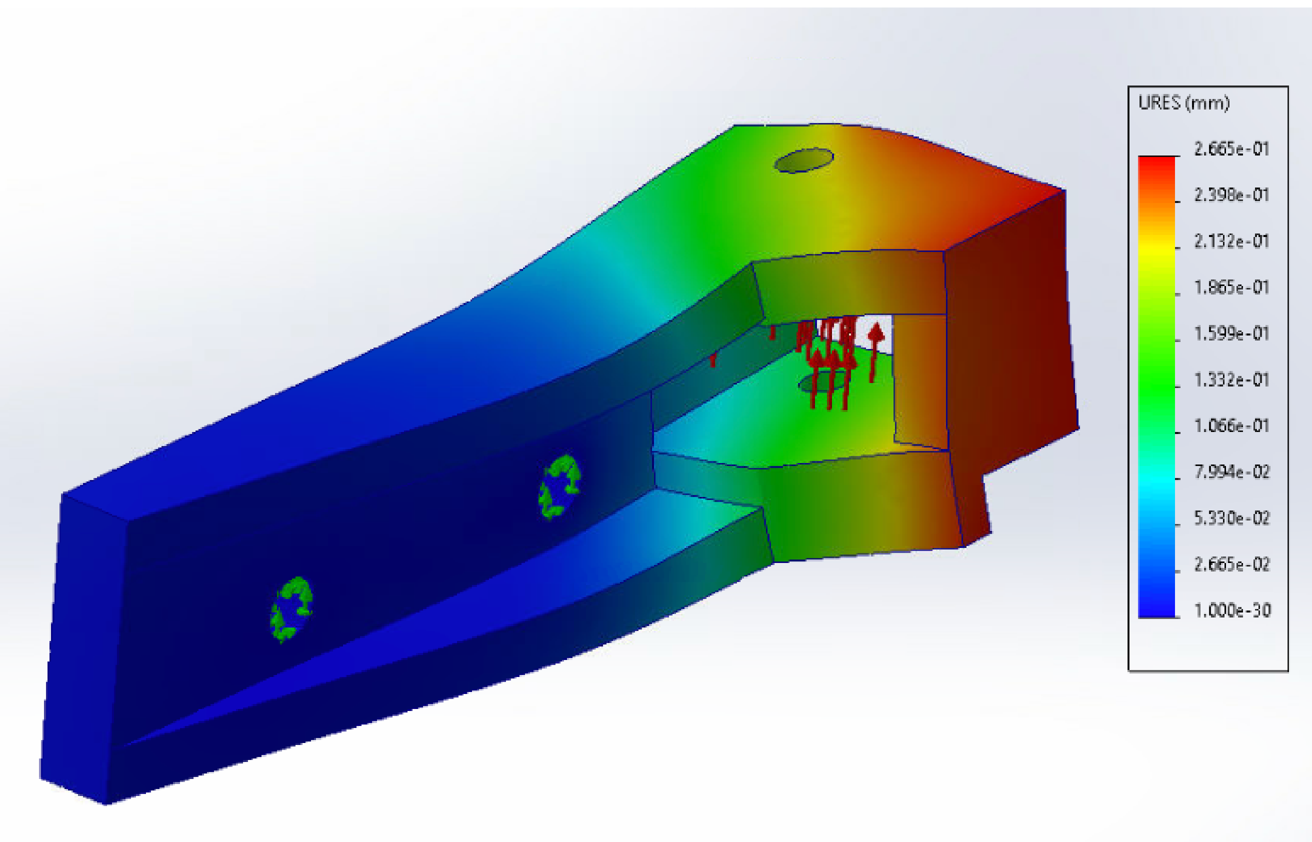
Content by: Sam

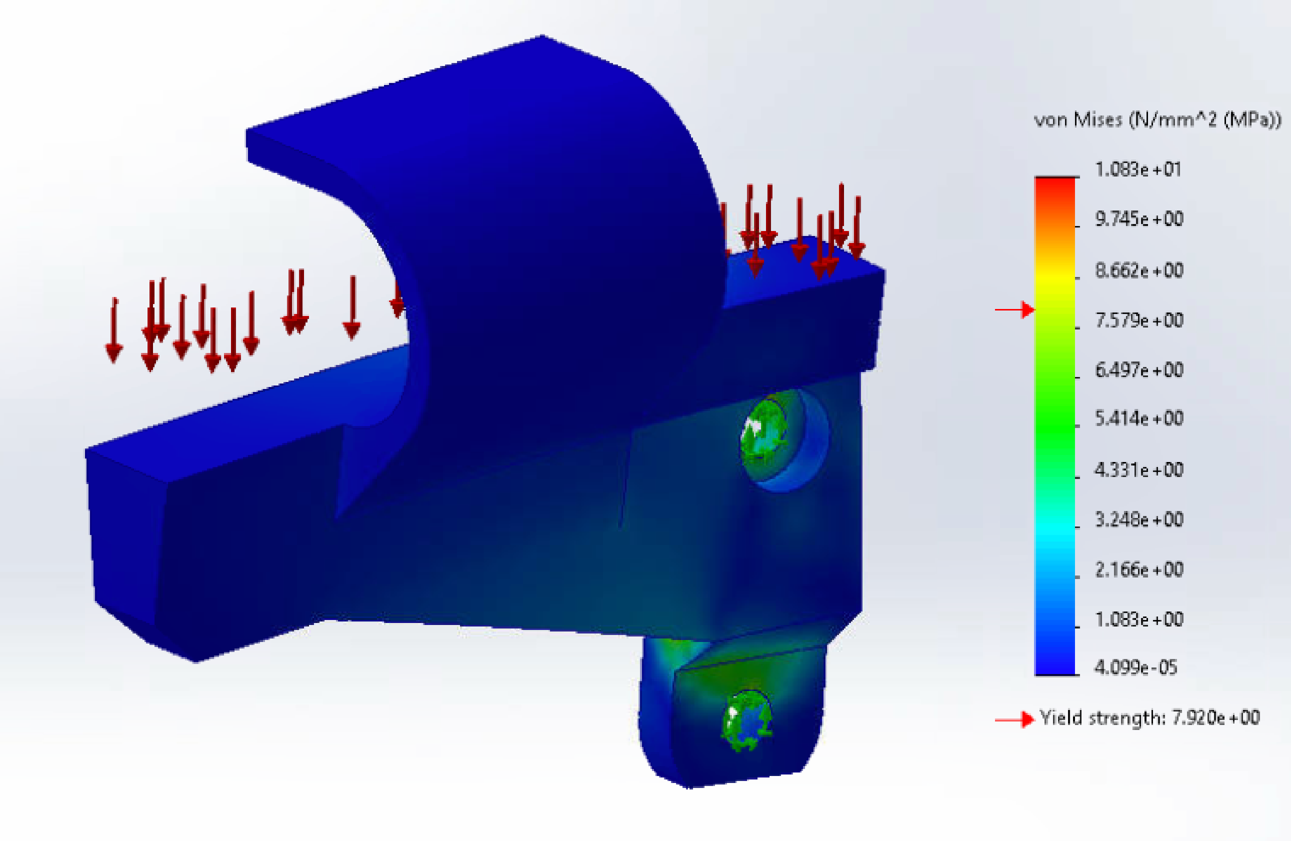
Present: N/A

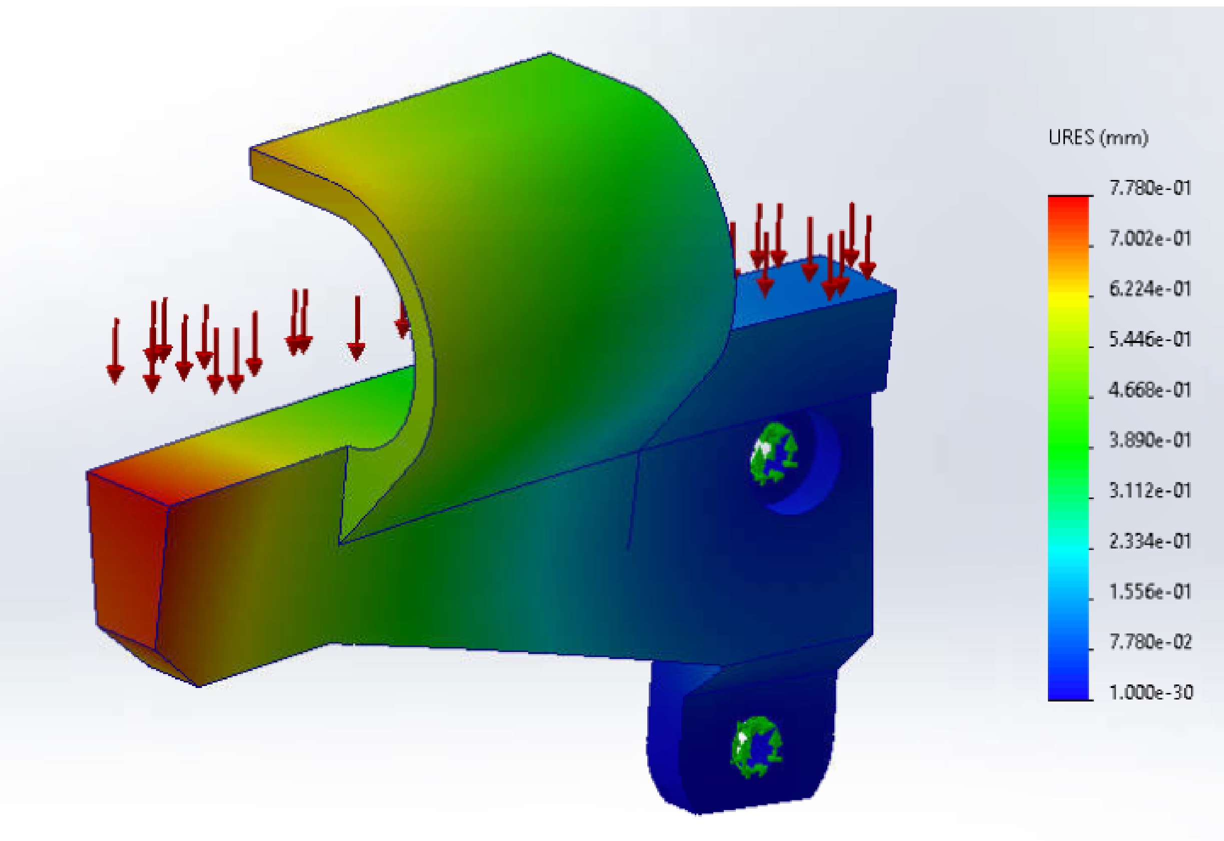
Goals: Visualize deformation and stress on the holders using solidworks and static equilibrium.

Content:


von Mises (N/m^2)
4.898e+06
4.408e+06
3.919e+06
3.429e+06
2.939e+06
2.449e+06
1.959e+06
1.470e+06
9.799e+05
4.902e+05
4.140e+02
Yield strength: 7.920e+06

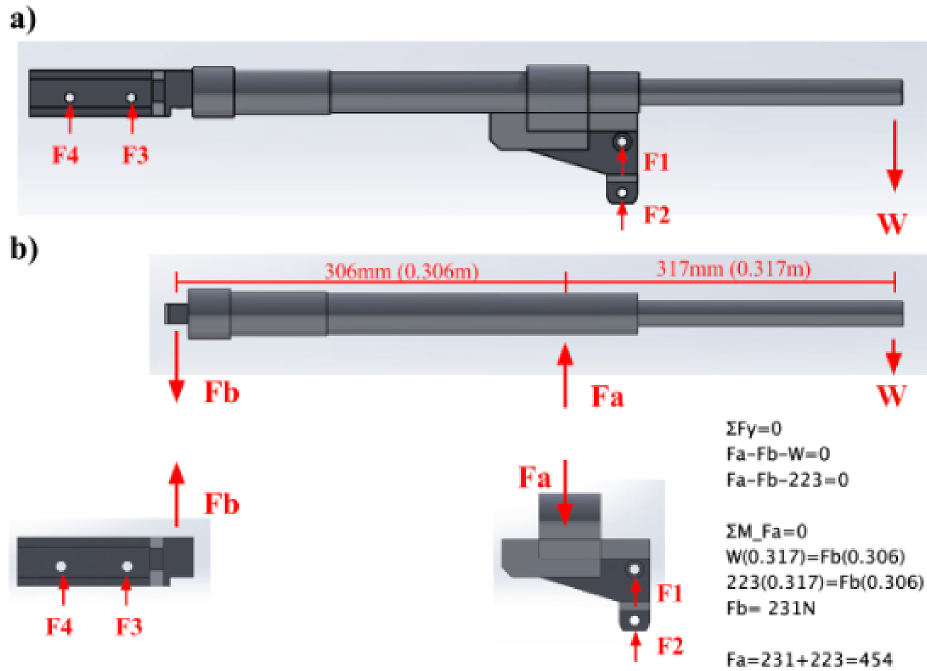

URES (mm)
2.665e-01
2.398e-01
2.132e-01
1.865e-01
1.599e-01
1.332e-01
1.066e-01
7.994e-02
5.330e-02
2.665e-02
1.000e-30





Material is a customized plastic with young's modulus of around 7GPa and ultimate strength around 1MPa.

Force is determined by the static equilibrium analysis of weights.



FigureX- force distribution of the linear actuator and holder support system (both actuators). a) single body force distribution b) force distribution by parts. Note: this is only a visual representation of the scenario and thus the extension of the linear actuator is not exactly to scale and the only supports are the front and back holder. W=223N (maximum applied force from bending test to both linear actuators). Fa=454N and Fb=231N. F1-4 are arbitrary.

Conclusions/action items:

As the pictures showed, PLA isn't the best material due to the deformation occurred. However, the analysis assumes that all weights are supported by the holders. In reality, the holders are supported partially by the wheelchair, specifically on the wheel covers.

2024/03/12 - Material ordering meeting 1

HAOMING FANG (hfang45@wisc.edu) - Mar 12, 2024, 5:27 PM CDT

Title: Lecture Activity

Date: 3/12/24

Content by: Bobby

Present: Bobby, Jayson, Charles

Goals: Touch base on what we'll need for our first ordering request

Content:

- Linear Servo Actuator: https://www.youtube.com/watch?v=Fde2lwK3yqU (https://www.youtube.com/watch?v=Fde2lwK3yqU)
- Choice of commercial servo actuator: https://www.3dprintronics.com/products/V-Slot-NEMA-17-Linear-Actuator-Belt-Driven-p625256215
- Either have the footrest design fold up or extend
- Up and down adjustability may be out of the scope for this semester, primary focus on extension and retraction
- For the footrest we will use mostly Aluminum
- Support mechanism will be built with steel
- separate mounting mechanism with support for more versatility

Conclusions/action items:

Discuss with Advisor and Client and start material ordering.

2024/03/22-Show and Tell

HAOMING FANG (hfang45@wisc.edu) - Mar 22, 2024, 12:42 PM CDT

Title: Show and Tell notes

Date: 03/22/2024

Content by: Bobby

Present: All

Goals: record potentially useful ideas

Content:

1. Using L-shape brackets instead of welding for the manufacturing of the actual footrest
2. Using rack and pinion instead of linear actuator
3. use a waterjet to cut holes in the footrest plate to lower the weight and reduce build-up of dirt
4. 1/2 inch is too heavy
5. bending may also be an option for the aluminum plate
6. machining the connection bracket instead of 3D printing, so the holder can be made of metal instead
7. Force analysis might not be enough, solidwork simulation may be better
8. using a rail on the other side instead of another actuator?

Reduce weight on the aluminum plate: Use different mesh: semicircle, semicircle with cut outs.
Do force analysis in SolidWorks to see which is better.

Conclusions/action items:

Plan on manufacturing soon.

2024/02/02-"Duchenne and Becker Muscular Dystrophies"

CHARLES MAYSACK-LANDRY - Feb 02, 2024, 12:13 PM CST

Title: "Duchenne and Becker Muscular Dystrophies"

Date: 02/02/2024

Content by: Charles Maysack-Landry

Present: N/A

Goals: Learn more about muscular dystrophy

Search Terms: PubMed: Becker muscular dystrophy

Citation:

Flanigan KM. Duchenne and Becker muscular dystrophies. Neurol Clin. 2014 Aug;32(3):671-88, viii. doi: 10.1016/j.ncl.2014.05.002. PMID: 25037084.

Link:

https://pubmed.ncbi.nlm.nih.gov/25037084/

Content:

- Duchenne and Becker muscular dystrophies are due to mutations in the DMD gene
- Mutational analysis of blood samples can diagnos 95% of a dystrophinopathy cases, muscle biopsy needed sometimes
- Use corticosteroids prednisone and deflazacort therapy, initiated by 5 years old
- Management of the side effects of corticosteroids is a challenge.
- Optimal management of DMD requires neurology, cardiology, pulmonary, physical medicine and rehabilitation, nutrition, physical therapy, and occupational therapy.
- A variety of promising therapies are being developed
- BMD milder than DMD
- DMD wipes out dystrophin, BMD has some dystrophin
- Usually fond by 2-5 due to walking problems, but some studies show symptoms as early as infant motor functions
- Will grow stronger through 6 or 7, but wheelchair bound by 12 without therapies for DMD
- BMD is usually reserved for wheelchair bond after age 12 or sometimes after age 15
- IMD is sometimes used for between 12 -15
- BMD is a wide verity of phenotypes

Conclusions/action items:

Explore: Dystrophin, corticosteroids prednisone and side affects, deflazacort, Gower maneuver

CHARLES MAYSACK-LANDRY - Feb 02, 2024, 11:57 AM CST

ASEE

Paper ID #20619

Design and Development of a Novel Wheelchair with Lifting and Flattening Capabilities

Dr. Jahangir Ansari, Virginia State University

Jahangir Ansari is Associate Professor of Manufacturing Engineering at Virginia State University. He received his M.S. degree in Mechanical Engineering in 1979 and Ph. D. degree in Mechanical Design and Production Engineering in 1983 both from Seoul National University. He joined the faculty at VSU in 2002. His research interests include Structural Vibration, FEM, CAD/CAM/CAE, and Virtual Manufacturing.

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design-and-development-of-a-novel-wheelchair-with-lifting-and-flattening-capabilities.pdf (1.1 MB)

2024/09/02-" Corticosteroids for the treatment of Duchenne muscular dystrophy"" - Copy

CHARLES MAYSACK-LANDRY - Feb 09, 2024, 12:55 PM CST

Title: "Corticosteroids for the treatment of Duchenne muscular dystrophy"

Date: 02/09/2024

Content by: Charles Maysack-Landry

Present: N/A

Goals: Learn more about muscular dystrophy treatments

Search Terms: PubMed: Corticosteroids prednisone

Citation:

Flanigan KM. Duchenne and Becker muscular dystrophies. Neurol Clin. 2014 Aug;32(3):671-88, viii. doi: 10.1016/j.ncl.2014.05.002. PMID: 25037084.

Link:

https://pubmed.ncbi.nlm.nih.gov/27149418/

Content:

- Strong evidence of increased strength over 6 months, some evidence over 2 years
  - 0.75 mg/kg/day prednisone or prednisolone
- No difference between weekly and daily
- side affects: excessive weight gain, behavioral abnormalities, cushingoid appearance, and excessive hair growth
  - cushingoid is some sort of hormonal condition, need more research
  - side affects are "common"
- Intermitted treat mean, 10 days on 10 days off, is less effect but has less chance of side affects

Conclusions/action items:

Explore: Dystrophin, corticosteroids prednisone and side affects, deflazacort, Gower maneuver

CHARLES MAYSACK-LANDRY - Feb 09, 2024, 12:47 PM CST

ASEE

Paper ID #[illegible]

Design and Development of a Novel Wheelchair with Lifting and Flattening Capabilities

Dr. Jahangir Ansari, Virginia State University

Jahangir Ansari is Associate Professor of Manufacturing Engineering at Virginia State University. He received his M.S. degree in Mechanical Engineering in 1979 and Ph. D. degree in Mechanical Design and Production Engineering in 1983 both from Seoul National University. He joined the faculty at VSU in 2002. His research interests include Structural Vibration, FEM, CAD/CAM/CAE, and Virtual Manufacturing.

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design-and-development-of-a-novel-wheelchair-with-lifting-and-flattening-capabilities.pdf (1.1 MB)

2024/15/02-"People Who Need Electric Wheel Chairs"

CHARLES MAYSACK-LANDRY - Feb 16, 2024, 12:27 PM CST

Title: "Population who Need Wheelchairs"

Date: 02/15/2024

Content by: Charles Maysack-Landry

Present: N/A

Goals: Learn more about who need electric wheelchairs and why. To determine demographics for our designs

Search Terms:

Citation:

Link:

https://www.redmanpowerchair.com/disabilities-that-require-wheelchairs/

Content:

Our design will only be useful for people who don't require help to transition into beds and such, as any foot rest can be moved by another person.

- Alzheimer's 1 in 14 people over age 65 have Alzheimer's, and 1 in 6 over the age of 80 no cure late-stage patients require a wheelchair for mobility
- Amputations: surgically removing toes, feet, or legs Our product can be applied to those with amputation condensed to only one side since they have their other leg should be mobile The specialized wheelchairs especially can provide comfort and movement Wheelchairs as an assistive tool has the main goal of providing patients with more mobility, especially for those who can't or don't want prosthetics
- Amyotrophic Lateral Sclerosis (ALS) 16,000 people, no cure neurodegenerative disease that impacts the nerve cells in the brain and spinal cord this impacts the motor neurons which die and the patient loses the ability to control the muscles across their entire body As a result impacts the patient's mobility, leading to the requirement for wheelchairs As the disease progresses, it can lead to total paralysis our device can help those who are in their earlier stages of ALS and provide them with more opportunities to move and function progression can vary though electric wheelchairs offer the best support
- Cerebral Palsy (CP) Who uses wheelchairs Nearly 800,000 CP results from brain damage occurring from childbirth Effects on the brain and its motor functions Symptoms include limited muscle control, reflex problems, and lack of coordination and control, including oral motor. standing electric wheelchairs prove more useful due to better circulation
- Diabetes disease affecting the body's production and use of insulin insulin helps glucose (digested from food intake) to the cells for energy though Type 1 inhibits the production of insulin, hindering this process More common type, Type 2 is where the body has trouble using insulin properly Half of the diagnosed type 1 patients experience nerve damage (diabetic neuropathy) Foot complications can also result like ulcers and poor circulation, which can lead to amputation wheelchairs provide better health and mobility
- Multiple Sclerosis (MS) Estimated 1 million people in the U.S. and 2.5 million worldwide disease in which the body's immune system attacks its central nervous system affects the brain, spinal cord, and optic nerves symptoms include muscle spasms, stiffness, fatigue, walking difficulties, tremors, dizziness, and seizures in severe cases walking and standing are hard or impossible, so electric wheelchairs provide independence
- Muscular Dystrophy 16-25 / 100,000 people no cure however therapy and medication can slow the progression disease that leads to muscle loss and progressively weakens the body gene mutations affect the production of proteins that make muscles commonly occurs in childhood frequently in boys but some present in adulthood The most common form is Duchene type (DMD) which is associated with difficulty with motor activities (walking and sitting up), muscle stiffness, pain, frequent falling
- Parkinson's Disease more than 10 million more likely in men and older individuals (after age 60) progressive nervous system disorder impacts movement and motor functions is common for muscles on one side of the body to be affected first recommended to use a tilting and reclining chair to help circulation and blood pressure. or a standing power chair to help slow the progression
- Rheumatoid Arthritis (RA) 1.5 million people in the U.S progressive autoimmune and inflammatory disease where the immune system attacks itself mostly joints, can be debilitating requiring a wheelchair
- Scoliosis curvature of the spine that can be problematic 3 % of adolescents develops most often during the accelerated growth period right before puberty can also be a result of Muscular dystrophy or cerebral palsy Not all cases are disabling however spine deformities become progressively more severe in children/ adolescents as they grow in the more severe cases wheelchairs are needed for mobility and comfort
- Spina Bifida Birth defect that causes improperly forming with the spine and spinal cord when the neural tube (formed early in pregnancy) fails to develop or close properly early treatment like surgery can resolve the problem completely however complications can follow and cause difficulty walking and hinder mobility nerves used to control the leg muscles don't function properly The nervous system is compromised muscle weakness in the legs and sometimes paralysis Manual or electric wheelchair depending on the condition's severity and needs
- Spinal cord injuries Most common disability that requires a wheelchair though this one coincidently might apply the least to our project *** injuries can lead to different range of impairments depending on the area affected quadriplegia = loss of function of arms legs and

body (doesn't apply to our design) paraplegia = loss of function to lower extremities, legs, and lower body motorized wheelchairs are most effective and sometimes standing one

- Traumatic brain injury (TBI) "According to the Centers for Disease Control and Prevention (CDC), about 166 Americans die from TBI-related injuries each day." Results from a physical blow, jolt, or bump to the head/body or in some cases a penetrating object to the brain (ex: bullet or knife) which compromises the brain severity ranges mild forms temporarily impact cognitive ability Severe forms result in bruising, torn tissues, and bleeding and can result in long-term symptoms or death can experience losing the ability to walk or independent mobility some require specialized power wheelchairs standing, tilting, or reclining, electric chairs are also commonly used depending on severity and needs

Conclusions/action items:

Our design will only be useful to someone with a lack of mobility/strength in the legs but not to the point that they already require help to transition into bed and always have assistance. So certain traumatic brain injuries, paraplegia, Spina Bifida, Scoliosis. Diseases like Alzheimer's that usually require assistance before they reach the severity to need a wheel chair are not in our scope. Diseases like Cerebral palsy that require standing wheel chairs are also not going to get any use from footrests like ours.

2024/02/02-"Design and Development of a Novel Wheelchair with Lifting and Flattening Capabilities"

CHARLES MAYSACK-LANDRY - Feb 02, 2024, 11:55 AM CST

Title: "Design and Development of a Novel Wheelchair with Lifting and Flattening Capabilities"

Date: 02/02/2024

Content by: Charles Maysack-Landry

Present: N/A

Goals: Research competing ideas and find some inspiration for moving wheelchair footrests

Search Terms: Scopus: Wheelchair AND footrest, filtered for engineering

Citation:

J. Ansari, “Design and development of a novel wheelchair with lifting and flattening capabilities,” presented at the ASEE Annual Conference and Exposition, Conference Proceedings, 2017. [Online]. Available: https://www.scopus.com/inward/record.uri?eid=2-s2.0-85030566221&partnerID=40&md5=a1a349b8b735402e376a68cd0316f36b

Link:

https://www-scopus-com.ezproxy.library.wisc.edu/record/display.uri?eid=2-s2.0-85030566221&origin=resultslist&sort=plf-f&src=s&sid=e30bed04d04996956abeefe9dd090185&sot=b&sdt=b&cluster=scosubjabbr%2C%22ENGI%22%2Ct&s=TITLE-ABS-KEY%28wheelchair+AND+footrest%29&sl=33&sessionSearchId=e30bed04d04996956abeefe9dd090185&relpos=8

Content:

- Senior project from Virginia State University
- Wheelchair with the ability that can lift the person and incline
- lift 200 lbs 12 inches
- Ideas of scissor lift, an airbag, and power screw lift, they decided on the power screw lift
- Two ideas for moving the footrest, pulley and belt or four bar linkage
- The four bars seem like a promising idea, allowing for a mechanical solution to allow the wheelchair occupant to easily control the height of the foot rest

Conclusions/action items:

This paper doesn't go into great detail, but has several good ideas to start brain storming will.

CHARLES MAYSACK-LANDRY - Feb 02, 2024, 11:56 AM CST

ASEE

Paper ID #20610

Design and Development of a Novel Wheelchair with Lifting and Flattening Capabilities

Dr. Jahangir Ansari, Virginia State University

Jahangir Ansari is Associate Professor of Manufacturing Engineering at Virginia State University. He received his M.S. degree in Mechanical Engineering in 1979 and Ph. D. degree in Mechanical Design and Production Engineering in 1983 both from Seoul National University. He joined the faculty at VSU in 2002. His research interests include Structural Vibration, FEM, CAD/CAM/CAE, and Virtual Manufacturing.

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2024/08/02-"Fall 2023 Low-Interference Lab Note Book" - Copy

CHARLES MAYSACK-LANDRY - Feb 09, 2024, 12:43 PM CST

Title: "Design and Development of a Novel Wheelchair with Lifting and Flattening Capabilities"

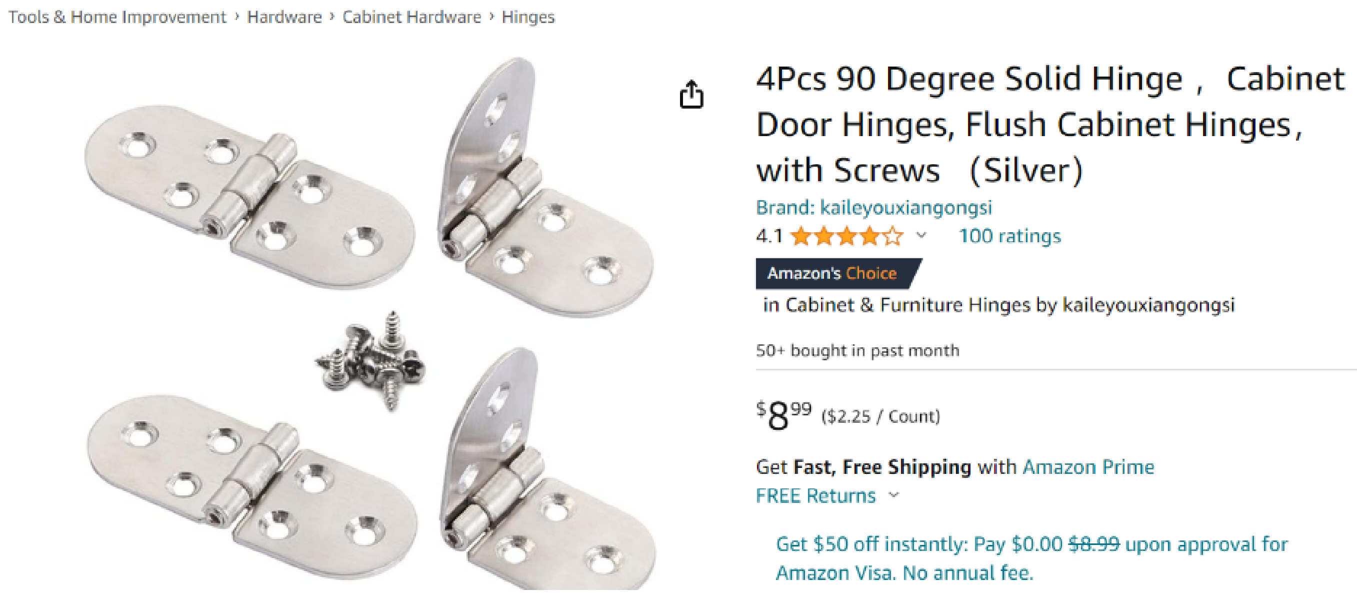
Date: 02/08/2024

Content by: Charles Maysack-Landry

Present: N/A

Goals: Learn what last semesters group did

Content:

- Footrest vs Leg rest, we need a leg rest (calf support), long footrest when knees extended, shorter when bent. Needs to be lightweight, foot rest size should be easily adjustable.
- links for hinges https://www.amazon.com/Degree-%EF%BC%8CCabinet-Cabinet-Hinges%EF%BC%8C-%EF%BC%88Silver%EF%BC%89/dp/B07Z32NWR3/ref=sr_1_10?keywords=90+degree+hinge&qid=1697682753&sr=8-10


-
- List of different hinges https://www.thisoldhouse.com/doors/21594142/types-of-hinges
- Dragon Skin Rubber, customizable
- competing design, comfy but bulky:https://www.amazon.com/NYOrtho-Wheelchair-Footrest-Extender-Rest/dp/B005DTOF0Y/ref=sr_1_9?,

-
- Miracle Mobility Silver 6000 Plus Folding Electric Wheelchair, doesn't recline or fold but is small

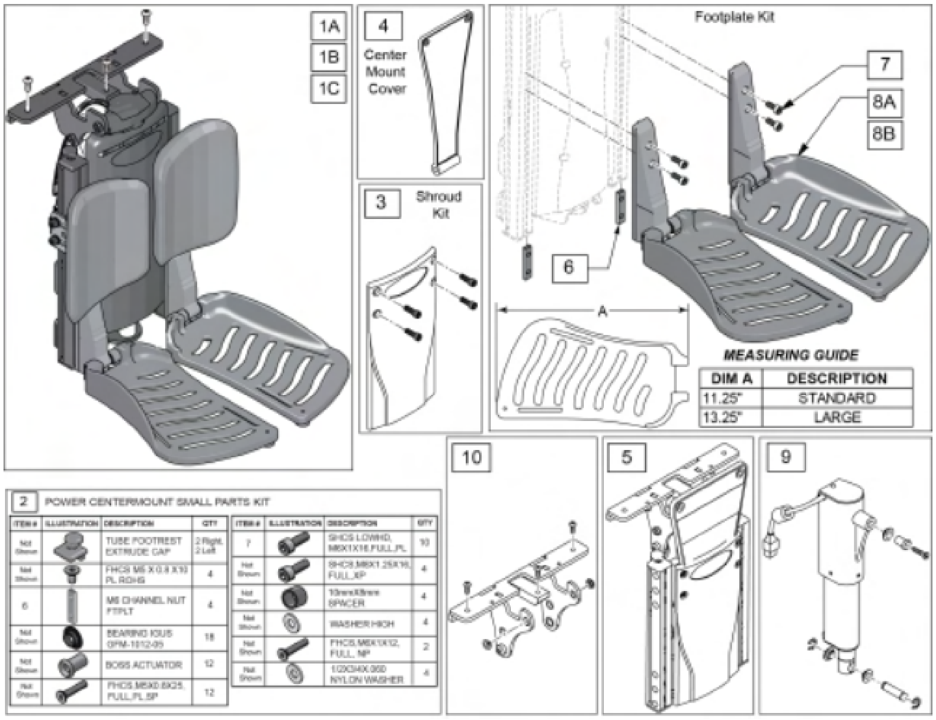
-
- Design Ideas: motorized footrest out of wheel chair, or a box with a lever to automatically unclasp the wheel chair, piston pushing the foot rest, flipable foot rest on a hinge that connects to the seat of the wheel chair
- Material research: aluminum or plastic. Aluminum is the best of the two given its durability and tensile strength. We just have to keep weight in mind and hopefully using aluminum can still meet our design specifications for weight.   .
- client has the Quickie Q700M wheel chair

Model Name: Quickie q700m

- 

Product Width:	25"
Product Length:	36.5"
Seat Width:	• SEDEO PRO ADVANCED: 16" to 22" • SEDEO PRO: 16" to 26" • SEDEO LITE: 15" to 20" • Captain Seat: 16", 18", 20"
Seat Depth:	• SEDEO PRO ADVANCED: 15" to 20" • SEDEO PRO: 14" to 22" • SEDEO LITE: 16" to 22" • Captain Seat: 16" to 22" Note: Back cushion can cause 2" loss of effective depth.
Seat-to-Floor Height:	16.5" to 19"
Back Height:	• SEDEO PRO ADVANCED: 21" to 28" • SEDEO PRO: 21" to 30" • SEDEO LITE: 18" to 30" • Captain Seat: 25"
Turning Radius:	23.5"
Ground Clearance:	3"

-  
- Current prosses of footrest attachment



-
  -
- Drive Elevating Legrest for drive Power Wheelchair seems like a good design

-
- They swing apart to allow for more mobility

Conclusions/action items:

This paper doesn't go into great detail, but has several good ideas to start brain storming will.

CHARLES MAYSACK-LANDRY - Feb 09, 2024, 11:55 AM CST

BME Design-Fall 2023 - Lael Warren
Complete Notebook

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2024/02/02-"Finite Analysis of Commercial Wheelchairs"

CHARLES MAYSACK-LANDRY - Feb 02, 2024, 11:38 AM CST

Title: "Finite Analysis of Commercial Wheelchairs"

Date: 02/02/2024

Content by: Charles Maysack-Landry

Present: N/A

Goals: Gain some understanding of how forces are applied throughout a wheelchair

Search Terms: Scopus: Wheelchair AND footrest, filtered for engineering

Citation:

[1]L. S. Marques, R. R. Magalhães, D. A. de Lima, J. E. Tsuchida, D. C. Fuzzato, and E. T. de Andrade, “Finite element analysis of a commercial wheelchair,” *Disability and Rehabilitation: Assistive Technology*, vol. 16, no. 8, pp. 890–901, 2021, doi: 10.1080/17483107.2020.1749893.

Link:

https://www-scopus-com.ezproxy.library.wisc.edu/record/display.uri?eid=2-s2.0-85083561054&origin=resultslist&sort=plf-f&src=s&sid=e30bed04d04996956abeefe9dd090185&sot=b&sdt=b&cluster=scosubjabbr%2C%22ENGI%22%2Ct&s=TITLE-ABS-KEY%28wheelchair+AND+footrest%29&sl=33&sessionSearchId=e30bed04d04996956abeefe9dd090185&relpos=3

Content:

- 15% of people worldwide have some sort of disability
- increased rate of motor disabilities as the population grows, and more people age longer
- footrests exceeded Von Mises stress limit values by 189.4%

Conclusions/action items:

This paper was more about proving the usefulness of finite element analysis, but it had interesting background info and mentioned some Brazilian wheelchair standards such as "ABNT NBR ISO 7176" that I will try and find U.S. counterparts or versions of.

CHARLES MAYSACK-LANDRY - Feb 02, 2024, 11:38 AM CST

Taylor & Francis

RESEARCH ON PRODUCTS AND DEVICES

Finite element analysis of a commercial wheelchair

Leonar Santos Marques, Ricardo Rodrigues Magalhães, Danilo Alves de Lima, Jefferson Esquina Tsuchida, Diego Cardoso Fuzzato and Ednilton Tavares de Andrade

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FiniteElementWheelchairAnalysis.pdf (4 MB)

2024/08/02-"Wheel chair life Span"

CHARLES MAYSACK-LANDRY - Feb 08, 2024, 12:48 AM CST

Title: "Wheel Chair lifespan"

Date: 02/08/2024

Content by: Charles Maysack-Landry

Present: N/A

Goals: Learn about the life span of wheel chairs

Search Terms: How long does an electric wheel chair last

Citation:

[1] https://www.facebook.com/GilaniEngineering, "How Long Does a Power Wheelchair Last," *Gilani Engineering*, Feb. 17, 2023. https://www.gilaniengineering.com.au/how-long-does-a-power-wheelchair-last/#:~:text=The%20lifespan%20of%20Power%20Wheelchair,-Typically%20the%20lifespan&text=A%20top%2Dquality%20wheelchair%20with,between%203%20to%207%20years. (accessed Feb. 08, 2024).

Link:

https://www.gilaniengineering.com.au/how-long-does-a-power-wheelchair-last/#:~:text=The%20lifespan%20of%20Power%20Wheelchair,-Typically%20the%20lifespan&text=A%20top%2Dquality%20wheelchair%20with,between%203%20to%207%20years.

Content:

- Wheel chairs last up to 10 years depending on quality, and how they are maintained or used

Conclusions/action items:

N/a

CHARLES MAYSACK-LANDRY - Feb 08, 2024, 12:44 AM CST

ASEE Paper ID #20619

Design and Development of a Novel Wheelchair with Lifting and Flattening Capabilities

Dr. Jahangir Ansari, Virginia State University

Jahangir Ansari is Associate Professor of Manufacturing Engineering at Virginia State University. He received his M.S. degree in Mechanical Engineering in 1979 and Ph. D. degree in Mechanical Design and Production Engineering in 1983 both from Seoul National University. He joined the faculty at VSU in 2002. His research interests include Structural Vibration, FEM, CAD/CAM/CAE, and Virtual Manufacturing.

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design-and-development-of-a-novel-wheelchair-with-lifting-and-flattening-capabilities.pdf (1.1 MB)

2024/20/03-Elevator Pitch

CHARLES MAYSACK-LANDRY - Mar 20, 2024, 1:49 PM CDT

Title: Elevator Pitch

Date: 3/20/2024

Content by: Charles Maysack-Landry

Goals: How to craft a short pitch to inform someone on what they need to know and what you want from them.

Content:

Use terms understandable to your crowd

Short intro: context and background info "We are working on project X"

Value proposition: give the problem "We are having trouble with Y"

Call to Action: "What could we use to solve Y"

Dos: Maintain eye contact, concise and focused, tailor your pitch

Don'ts: Don't overwhelm with unnecessary details, don't forget to listen and engage with the audience, don't sound robotic

Say more with less

Conclusions/action items:

2024/06/03-Patent and Standards Lecture

CHARLES MAYSACK-LANDRY - Mar 06, 2024, 2:11 PM CST

Title: Patent and Standards Lecture

Date: 3/6/2024

Content by:

Present: N/A

Goals: Learn how to find standards and patents

Content:

Tech(need slides)

IBISWorld Industry Reports - market research

Lens.org to find patents and scholarly articles, very easy and free

Find keywords in patents to broaden search for more information

Use cited, and citing patents and classification codes to find related patents

Patent examiners evaluate : Usefulness, Novelty, and Non-Obvious

The patent should not be the next step, but has to be different and new

Look at claims piece by piece

The claims are split between independent and dependent, make sure to take dependent claims in the context of the independent claims

Conclusions/action items:

Find patents related to wheelchairfootrests

2024/3/4-WARF Lecture

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CHARLES MAYSACK-LANDRY - Apr 03, 2024, 2:09 PM CDT

Title: WARF, Intellectual property

Date: 4/3/2024

Content by: WARF

Goals: Learn about WARF and Intellectual property

Content:

WARF helps enable UW Madison to solve world problems

Moves IPs to other entities usually with the objective of making money

IP licenses, industry sponsored research, consulting arrangements, Fee for services (renting equipment)

IPs: patents (most common for WARF), copyrights(second highest for WARF), trademarks, trade secrets

WARF IP: Biomaterials, technique and know how, data

Copyright: Creative works, usually code for WARF

Trademarks: protection for name, marks, logos, dress. Trademarks requires the trademarked thing to be in commerce

Trade Secret: protects anything of value that isn't common knowledge. They Never End. Such as a receipt or list of contacts. Things that can't be reverse engineered.

Patents: Property right granted by governmental agency, 20 years from when filed, must give up how to create the thing when applying for the patent. Having a patented doesn't mean you can can make something, if you use a patented thing in your patent you have to license the other patent before making your patent

The US has three different types : Design (15 years how the thing looks), Plant (20 years), Utility(Provisional 1 year placeholder, Non Provisional 20 year term)

Patents are used for new and useful process, machine, manufacture, or composition of matter or useful improvements to a patent

2-5 years to issue filling, 30K fee mostly for patent attorney's, WARF pays for attorney fees

Eligible: not a product of nature, abstract idea or natural phenomenon

Novel: must be new

Non-Obvious: it cannot be simple combination or modification or exciting concepts

Enabled and Described: most provide enough detail to teach others how to make or use the invention

WARF website has a form to submit about the invention, then set up a meeting

Poster session is the first public discloser

WARF will consider if the patent will be able to make money, will people want to license this patent to make this product

WARF find companies to make contracts to make that cash!!!

AI cannot invent expect in south Africa (for patents)

AI can assist in inventing probably, but its an evolving area (for patents)

Putting things into ai counts as public discloser

After public discloser you have 1 year to file for a patent

Copyrights are only for original human authorship, you have to do enough work if using an AI to be able to copyright the work

Conclusions/action items:

2024/16/02-"Piston controlled Footrest"

CHARLES MAYSACK-LANDRY - Feb 16, 2024, 12:28 PM CST

Title: **"**Piston controlled Footrest**"**

Date: 02/16/2024

Content by: Charles Maysack-Landry

Goals: Brainstorm design ideas

Content:

Connect the footrest to the outside of the wheelchair, on the rails to allow for movement back and forth

Attach piston to back of wheelchair to push/pull the foot rest into and out of empty space under the wheel chair

possibly attach motor to automatically raise foot rest as it is retracted

a big enough piston might be hard to fit onto side of wheelchair/ might make it too wide

Conclusions/action items:

Use the rail will limit the amount of wheelchairs that our device can work on

2024/16/02-"Truss controlled Footrest"

CHARLES MAYSACK-LANDRY - Feb 16, 2024, 12:12 PM CST

Title: "Truss controlled Footrest**"**

Date: 02/16/2024

Content by: Charles Maysack-Landry

Goals: Brainstorm design ideas

Content:

Connect the footrest to the outside of the wheelchair, on the rails to allow for movement back and forth

Attach two thin pieces of metal to the footrest with a motor to rotate the back piece which would bring the front piece connected to the footrest back

possibly attach motor to automatically raise foot rest as it is retracted

reduces width and may not need to be as long as the piston

Conclusions/action items:

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2024/16/02-"Around the World Footrest"

CHARLES MAYSACK-LANDRY - Feb 16, 2024, 12:35 PM CST

Title: "Truss controlled Footrest**"**

Date: 02/16/2024

Content by: Charles Maysack-Landry

Goals: Brainstorm design ideas

Content:

Connect the footrest all the way around the wheelchair so it is held on by the back

You would simply place it on, with footrest on a tread that can be spun back and forth to move footrest in and out of the way

Conclusions/action items:

2014/05/04 - Footrest water jet cuts

CHARLES MAYSACK-LANDRY - Apr 05, 2024, 12:49 PM CDT

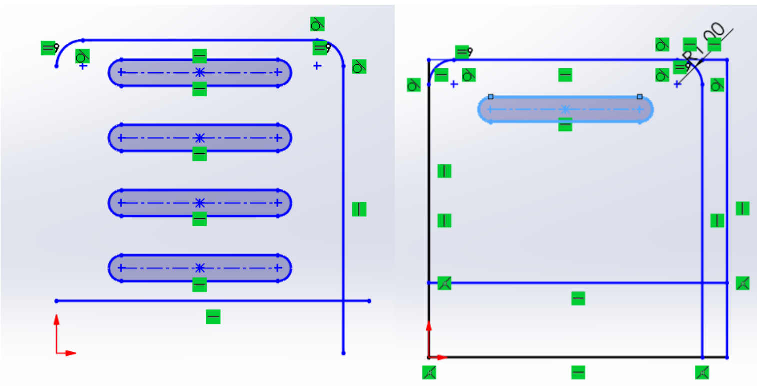
Title: Footrest Water Jet Cut

Date:

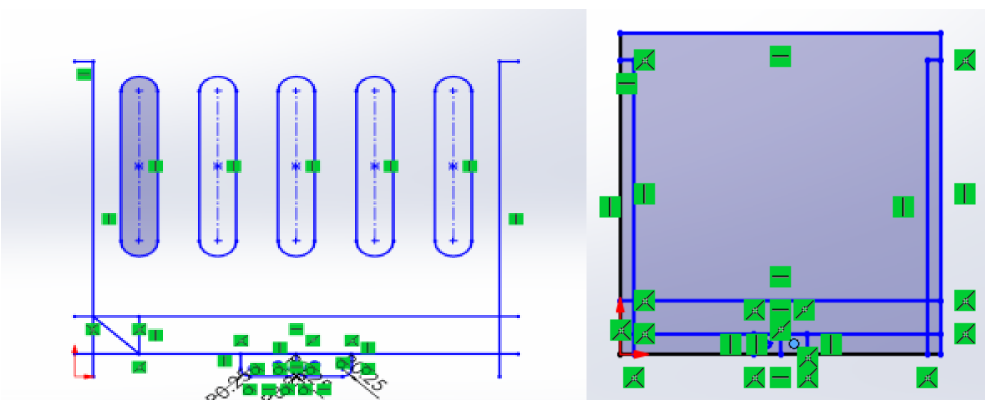
Content by: Charles Maysack-Landry

Goals: Create SolidWorks designs for the water jet to cut.

Content:



The bottom of the footplate. Left is just the cuts for the water jet, the right is some of the cuts with a model of the square plate.



The top of the footrest. The left is the cuts of the water jet, the right has the model of the square plate, without the holes cut in.

Conclusions/action items:

Go to the reserved water jet time and cut the plates into these shapes.

CHARLES MAYSACK-LANDRY - Apr 05, 2024, 12:49 PM CDT

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FootresttopJustCuts.SLDPRT (82.9 kB)

CHARLES MAYSACK-LANDRY - Apr 05, 2024, 12:49 PM CDT

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BottomFootrestJustCuts.SLDPRT (68.8 kB)

CHARLES MAYSACK-LANDRY - Apr 05, 2024, 12:49 PM CDT

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BottomFootrest.SLDPRT (63 kB)

CHARLES MAYSACK-LANDRY - Apr 05, 2024, 12:49 PM CDT

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Footresttop.SLDPRT (70.4 kB)

2024/01/31- Footrest Balancing

Title: The Effect of Footrests on Sitting Balance in Paraplegic Subjects

Date: 1/31/23

Content by: Sam

Present: All

Link: https://search.library.wisc.edu/openurl?sid=Elsevier:Scopus&_service_type=getFullTxt&issn=00039993&isbn=&volume=83&issue=5&spage=642&epage=648&pages=642-648&artnum=&date=2002&id=doi:10.1053%2fapmr.2002.32437&title=Archives+of+Physical+Medicine+and+Rehabilitation&atitle=The+effect+of+footrests+on+sitting+balance+in+paraplegic+su Potten

Citation: Y. J. Janssen-Potten, H. A. Seelen, J. Drukker, F. Spaans, and M. R. Drost, “The effect of footrests on sitting balance in paraplegic subjects,” Archives of Physical Medicine and Rehabi doi:10.1053/apmr.2002.32437

Goal: To learn the effectiveness of wheelchair footrest contributing to an overall body balance

Search Terms: Pubmed: wheelchair, footrest

Content:

Key Goal: to test the hypothesis that footrest contributes to the balancing of wheelchair users.

Method:

The study involved the participation of thirty individuals, with ten clinically diagnosed with a complete low thoracic spinal cord injury and another ten diagnosed with a complete lumbar spinal cor completed their active rehabilitation programs at least 6 months before joining the study. None of the subjects exhibited secondary pathologies commonly associated with spinal cord injury such cardiovascular, or pulmonary problems.

To provide a comparative baseline, a control group comprising ten able-bodied individuals was included. The three groups were carefully matched in terms of age, gender, height, weight, and ha determined based on the availability of individuals with spinal cord injury meeting the inclusion criteria and their willingness to participate in the study, rather than a specific power analysis.

Results:

There was no significant difference observed in the maximal reaching distance in the anterior direction, where participants could reach without table support, between the two chair configuration and without injury.

The presence of a solid footrest did not impact the overall performance of participants, as evidenced by no decrease in maximal unsupported reaching distance. However, in individuals without s controlling sitting balance. It facilitated quicker forward-reaching movements and allowed for greater forward acceleration of the center of mass without compromising sitting balance. In contrast injury seemed to derive benefits from the absence of a solid footrest. They demonstrated the ability to control more forward acceleration of the center of mass at the initiation of forward-reaching

Conclusions/action items:

Continue Researching

Sam TAN - Jan 31, 2024, 4:06 PM CST


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- Cited by (34)

Archives of Physical Medicine and Rehabilitation

Volume 83, Issue 5, May 2002, Pages 642-648

Download

S0003999302231524.html (301 kB)

Sam TAN - Feb 07, 2024, 12:48 PM CST

Correction: date should be 2024

2024/01/31-Muscular Dystrophy Wheelchair

Sam TAN - Jan 31, 2024, 3:42 PM CST

Title: Electric powered wheelchairs for those with muscular dystrophy: problems of posture, pain and deformity

Date: 1/31/23

Content by: Sam

Present: All

Goal: To understand problems faced by patients with muscular dystrophy and interaction with the wheelchair.

Link: https://pubmed.ncbi.nlm.nih.gov/19199130/

Citation: M. Richardson and A. O. Frank, “Electric powered wheelchairs for those with muscular dystrophy: Problems of posture, pain and deformity,” Disability and Rehabilitation: Assistive Technology, vol. 4, no. 3, pp. 181–188, Jan. 2009. doi:10.1080/17483100802543114

Search Term: Pubmed: wheelchair, footrest

Content:

The study presented in the document is the first to review the difficulties in electrical powered wheelchair provision for muscular dystrophy individuals since these wheelchairs were made available on the national health service; and to investigate the problems faced by users of the service with muscular dystrophy during the first 4 years of the wheelchair service.

Muscular Dystrophy:

-Patients with muscular dystrophy ultimately need wheelchair assistance, but it can be challenging for management and skills. Postural problems of muscular dystrophy develops over time.

-Difficulties controlling the wheelchair through arm weakness. This leads to client specific problem. Since lower leg is not paralyzed, the footrest can serve as an functional platform replacing the arm's role on a wheelchair.

Key notes:

"Nearly one third of users complained of pain at some stage during the period of the study". This suggested that generalized wheelchair causes different degrees of pain to users and it is not solved through a customized manner.

Achieving optimal functioning relies on effectively utilizing both postural support and balance. This involves ensuring proper pelvic alignment and providing suitable support for the spine, head, and limbs. In individuals with significant weakness in their upper limbs, the positioning of the arms becomes crucial to maximize the use of remaining strength. This finding highlight the need for adjustments to the support mechanisms within the wheelchair for some users. A footrest could potentially be a solution to the problem since the patient isn't fully paralyzed.

The service did not account for the pace of disease advancement. The majority of clients were attended to when their condition worsened, rather than proactively addressing it. Scheduled evaluations within a year seem crucial for teenagers dealing with muscular dystrophy, considering the challenges posed by both rapid maturation and the progressive nature of the disease.

Conclusions/action items:

Continue Researching on physiological applications

Sam TAN - Jan 31, 2024, 3:28 PM CST

RESEARCH PAPER

Electric powered wheelchairs for those with muscular dystrophy: Problems of posture, pain and deformity

MARION RICHARDSON & ANDREW O. FRANK

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retrieve.pdf (177 kB)

Sam TAN - Feb 07, 2024, 12:48 PM CST

correction: date should be 2024

2024/02/09- Muscular Dystrophy Wheelchair 2

Sam TAN - Feb 09, 2024, 11:24 PM CST

Title: Longitudinal stability control of electric wheelchairs for persons with severe disability

Date: 2/9/24

Content by: Sam

Present: N/A

Goals: Learn about stability control of wheelchair user.s

Content:

The paper explores a 'Force-detecting interface' strategy for individuals with muscular dystrophy, aiming to enhance the operation of electric wheelchairs. It focuses on a disturbance removal method and a longitudinal stability control system to alleviate the physical and mental strain of wheelchair use. Key findings include the identification of disturbances during wheelchair operation, the proposal of a disturbance removal system for automatic operation without physical strain, and the use of a simplified electrical wheelchair model for motion behavior analysis and control system design. The study underscores the effectiveness of a state feedback compensator for improving longitudinal stability. The authors express a future interest in evaluating the real-world benefits of the proposed system for individuals with muscular dystrophy in electric wheelchair maneuverability.

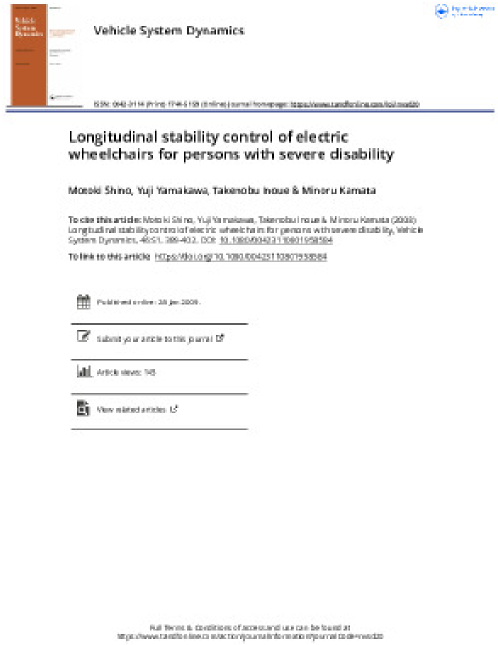
Focused on FBD analysis of moments and forces to achieve results.

"-The disturbance, which influences an operation system and a vehicle behaviour with respect to operation intention, was clarified while operating the wheelchair.
-The disturbance removal system for the interface was proposed to recognise the operation intention while operating automatically without physical burden.
- The simplified electrical wheelchair model, which consists of two caster models and a vehicle model, was proposed to analyse the motion behaviour and to design the control system.
- The effectiveness of the state feedback compensator of yaw motion was clarified to improve longitudinal stability with respect to the disturbance."

Conclusions/action items:

Research on electrical powered wheelchairs.

Sam TAN - Feb 09, 2024, 11:25 PM CST


Vehicle System Dynamics

Longitudinal stability control of electric wheelchairs for persons with severe disability

Motoki Shino, Yuji Yamakawa, Takenobu Inoue & Minoru Kamata

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Longitudinal_stability_control_of_electric_wheelchairs_for_persons_with_severe_disability.pdf (884 kB)

2024/02/09- Body Posture

Sam TAN - Feb 09, 2024, 11:44 PM CST

Title: Body Segments in Controlling posture

Date: 2/9/24

Content by: Sam

Present: N/A

Goals: Body posture during sitting in wheelchair

Content:

The study aimed to develop a system for decoupled adjustment of body segments in a wheelchair and create a predictive model for computing angular chair configurations for desired body postures.

Key findings:

- The researchers designed a wheelchair that allows independent alignment of the trunk, pelvis, and thighs by aligning the axes for angular chair adjustments with the axes for body segments rotation.

- The study found linear relations between angular chair adjustments and body segment rotations. The computed slope coefficients and coefficients of determination indicated the strength and variability of these relationships.

- While the designed system aimed for independent adjustments, moderate couplings were observed between some body segments during chair modifications. The couplings were particularly noticeable between the backrest and trunk, seat parts and trunk, and parallelogram and lumbar spine.

- Minimal sliding was observed during posture adjustments, particularly in the sagittal direction. The design features aimed at reducing shear forces and maintaining comfort during posture changes.

- Despite observed couplings, the study developed a predictive algorithm that seems applicable to compute angular chair configurations for desired body postures when the initial body-chair configuration is known.

The study provides insights into the challenges and possibilities of designing wheelchairs that allow more dynamic and personalized adjustments for individuals with mobility limitations. Further validation on impaired individuals and consideration of clinical factors are suggested for future research.

Conclusions/action items:

N/A

Sam TAN - Feb 09, 2024, 11:45 PM CST

Article preview

- Abstract
- Introduction
- Section snippets
- References (14)
- Cited by (33)

Journal of Biomechanics

Volume 41, Issue 16, 5 December 2008, Pages 3419-3425

Download

S0021929008004788.html (282 kB)

2024/01/31- Elements of Commercial Wheelchair

Sam TAN - Jan 31, 2024, 4:30 PM CST

Title: Finite element analysis of a commercial wheelchair.

Date: 1/31/23

Content by: Sam

Present: All

Link: https://web-p-ebscohost-com.ezproxy.library.wisc.edu/ehost/detail/detail?vid=3&sid=6b0788bf-8317-42c5-a3ce-105538e40f18%40redis&bdata=JkF1dGhUeXBlPWlwLHVpZCZzaXRlPWVob3N0LWxpdmUmc2NvcGU9c2l0ZQ%3d%3d#AN=152491111&db=aph

Citation: L. S. Marques et al., “Finite Element Analysis of a commercial wheelchair,” Disability and Rehabilitation: Assistive Technology, vol. 16, no. 8, pp. 890–901, Apr. 2020. doi:10.1080/17483107.2020.1749893

Goal: To learn about the features of a wheelchair

Search Terms: Scopus: wheelchair, features, footrest

Content:

Reasoning:

Given the structural limitations inherent in wheelchairs designed for individuals with motor disabilities, it becomes crucial to comprehend and guarantee their optimal functioning to enhance the quality of life for these users. The primary aim of this study is to employ the finite element method to scrutinize the stresses and displacements within a wheelchair. Through simulations, the study seeks to assess both the functional and structural aspects of the wheelchair. The evaluation is influenced by normative techniques that take into account ergonomic, anthropometric, and biomechanical factors. These considerations are essential to verify the compliance of the wheelchair with current standards, ensuring that it meets the necessary criteria for effective use by individuals with motor disabilities.

"The standard NBR ISO 7176 part 1 determines that the wheelchair, when occupied, must be worked in a static regime, respecting some limits of the inclination of the chair tipping axis. This
limit is bounded around the centre of gravity of the chair."

The numerical analysis of wheelchairs was carried out in accordance with the Brazilian ABNT NBR ISO 7176 standard. The study adhered to the guidelines and functionality requirements specified in the standard to conduct testing procedures. A commercial model of one of the top-selling wheelchairs in Brazil was chosen for the analysis, and its 3D geometry served as the basis for the simulations. The intricate features of this particular model were meticulously reproduced to ensure the accuracy and reliability of the numerical analysis.

"The mechanical analysis of he footrest aims to describe the behaviour of the parts attached by bonded contacts when the user gets on and off the wheelchair (Figure 9(a)). For this analysis, the NBR ISO 7176 standard – Part 8 suggests the values as references for the load intensity parameter. A load of 1000 N was adopted in this study based on the chair configurations designed by the manufacturer and applied".

This study introduces a novel approach to evaluate new wheelchair designs through numerical simulations, potentially expediting the certification process. The models employed in the simulations underwent validation through mesh convergence analysis for each component, ensuring compliance with specified criteria for each model. Future research endeavors could extend the application of numerical analysis to electric wheelchairs, aiming to establish guidelines and methodologies for assessing designs using finite elements. Additionally, there is a call to develop enhanced protection and reinforcement systems for conventional wheelchairs through finite element analysis, with the potential to enhance the quality of existing devices in the market.

Conclusions/action items:

Continue Researching

Sam TAN - Feb 07, 2024, 12:48 PM CST

Correction: date should be 2024

2024/01/31- Wheelchair Footrest design

Sam TAN - Jan 31, 2024, 4:33 PM CST

Title: Design and evaluation of footrests for hospital wheelchairs

Date: 1/31/23

Content by: Sam

Present: All

Link: https://pubmed.ncbi.nlm.nih.gov/2395360/

Citation: T. G. Frank and E. W. Abel, “Design and evaluation of Footrests for hospital wheelchairs,” Journal of Biomedical Engineering, vol. 12, no. 4, pp. 333–339, Jul. 1990. doi:10.1016/0141-5425(90)90009-c

Goal: Wheelchair evaluation

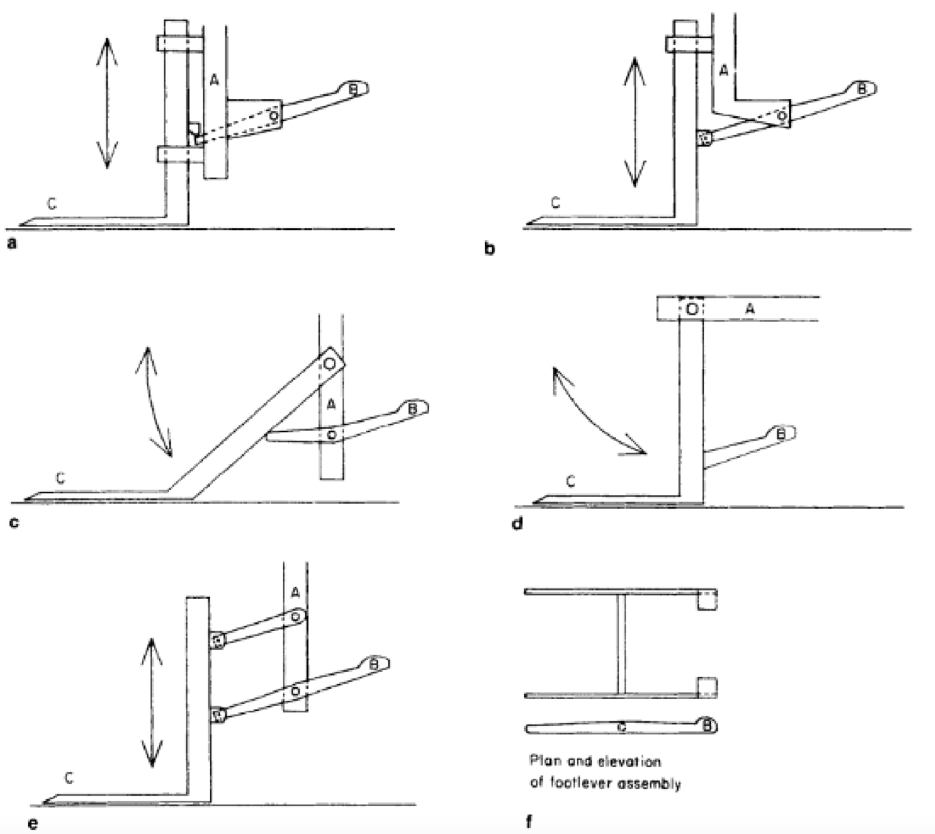
Search Term: Pubmed: Wheelchair, footrest

Content:

Key findings:

Two types of wheelchairs use in hospital. Ward chair and transit chair. The transit chair is larger and more robust, featuring larger wheels, making it heavier. These chairs have more substantial upholstery, necessitated by the extended duration patients may spend in them. However, significant challenges arise during patient transfers into or out of these chairs, primarily attributable to shortcomings in the design of the footrest. Two additional problems can arise, potentially resulting in accidents. Firstly, if a patient attempts to stand up while the footrest is in place, the chair has the potential to tip forward. Secondly, the front of the chair lacks stability and may shift as the patient applies pressure on the armrests while exiting the chair.

"A mechanism permitting movement of the footrest can be such that either the footrest moves independently, or else in conjunction with some other part of the chair to which it is rigid1 connected. The main
design possibilities for independent movement include a sliding mechanism that allows vertical movement, a four-bar link, or a hinge."



The study revealed that a footrest that lowers onto the ground effectively resolves the challenge of placing a patient's feet onto the footrest and prevents unintended movement of the chair during patient transfers. While the described footrest was found to function well, certain considerations could be taken into account for further improvement.

Conclusions/action items:

Continue Researching

Sam TAN - Jan 31, 2024, 4:30 PM CST

Design and evaluation of footrests for hospital wheelchairs

T.G. Frank and E.W. Abel

School of Biomedical Engineering, University of Dundee, Dundee

INTRODUCTION

FOOTREST TRIALS

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1-s2.0-014154259090009C-main.pdf (828 kB)

Sam TAN - Feb 07, 2024, 12:47 PM CST

Correction: Date should be 2024

2024/02/14- Footrest Biomechanics

Sam TAN - Feb 14, 2024, 10:54 PM CST

Title: Biomechanical analysis of legrest support of occupied wheelchairs: comparison between a conventional and a compensatory legrest

Date: 2/14/24

Content by: Sam

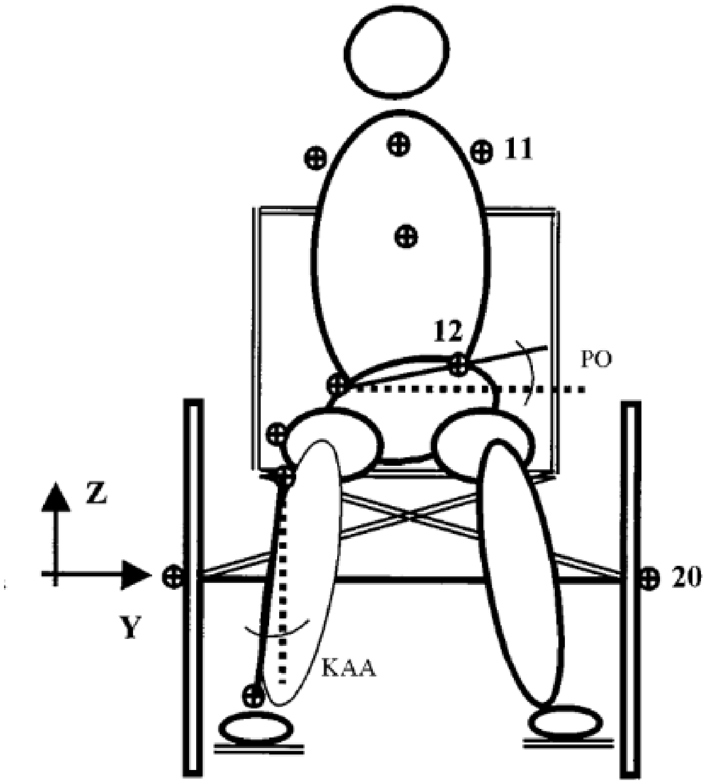
Present: N/A

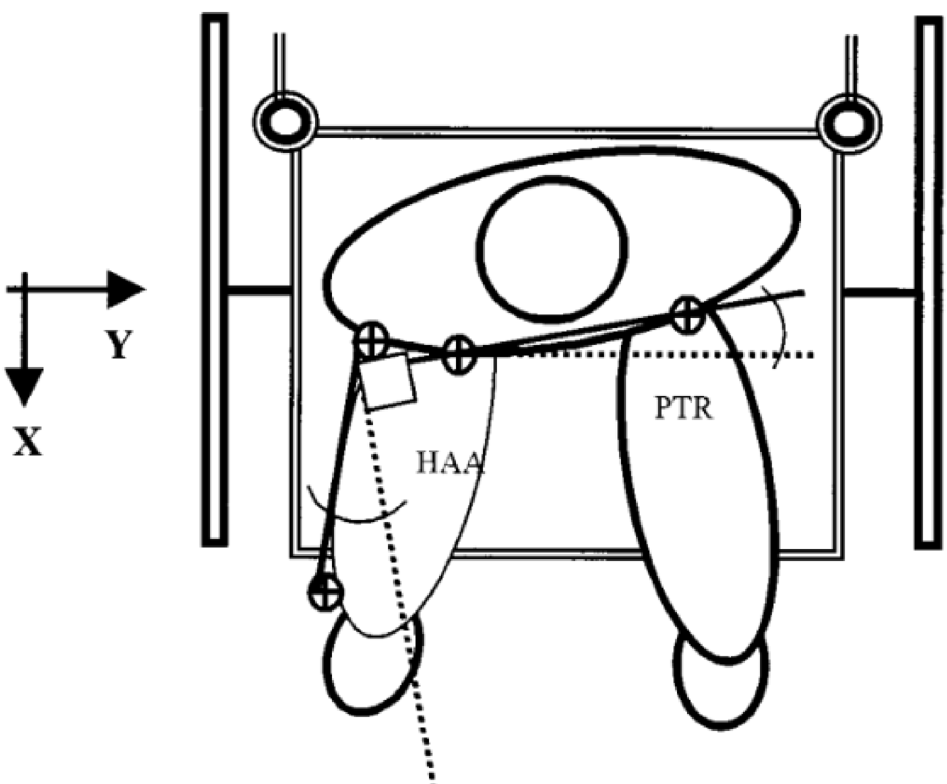
Goals: Learn about the biomechanics side of legrest

Citation: R. Aissaoui, S. Heydar, J. Dansereau and M. Lacoste, "Biomechanical analysis of legrest support of occupied wheelchairs: comparison between a conventional and a compensatory legrest," in IEEE Transactions on Rehabilitation Engineering, vol. 8, no. 1, pp. 140-148, March 2000, doi: 10.1109/86.830958.
keywords: {Wheelchairs;Leg;Foot;Kinematics;Knee;Thigh;Orthopedic surgery;Testing;Pressure measurement;Senior citizens},

Content:

This study investigates the effects of elevating legrests on posture and pressure distribution in a group of ten able-bodied individuals using manual wheelchairs. Two types of legrests are compared: a conventional elevating legrest with a fixed axis of rotation and a compensatory elevating legrest with a moving axis of rotation. A three-dimensional kinematics analysis, combined with pressure measurement data, is employed to assess body posture and pressure distribution. The compensatory legrest, designed to lengthen the foot support as the legrest proclines, shows beneficial effects in minimizing pelvic and thigh motion and reducing pressure under seat and foot supports. In contrast, the conventional legrest significantly modifies the subject's posture and increases pressure under ischial tuberosities in a procline position. The study suggests that the compensatory legrest is advantageous, especially for disabled and elderly individuals requiring frequent lower leg elevation. The hypothesis that the compensatory legrest preserves initial posture and reduces pressure distribution is supported.





The study focuses on a compensatory legrest designed to lengthen when elevated, with a specific focus on the biomechanical analysis of legrest support for occupied wheelchairs. The compensatory legrest allows for a more natural knee extension and minimizes pelvic and thigh motion compared to a conventional legrest. Static analysis reveals differences at a 150-degree legrest angulation, primarily affecting the knee joint. Dynamic conditions demonstrate advantages of the compensatory legrest, maintaining consistent pressure distribution under the seat and foot during leg movement. The study recommends using the compensatory legrest for its positive effects on posture and pressure distribution, especially for individuals needing frequent lower leg elevation. Further research with disabled individuals is suggested for validation. The acknowledgment section expresses gratitude to individuals and resources contributing to the study.

Conclusions/action items:

Design Sketch

Sam TAN - Feb 15, 2024, 10:36 AM CST

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Biomechanical_analysis_of_legrest_support_of_occupied_wheelchairs_comparison_between_a_conventional_and_a_compensatory_legrest.pdf (637 kB)

2024/02/11- Linear Actuator

Sam TAN - Feb 11, 2024, 10:13 PM CST

Title: Linear Actuator Research

Date: 2/11/24

Content by: Sam

Present: N/A

Goals: Learn about linear actuator

Website: https://www.iqsdirectory.com/articles/linear-actuator.html

Content:

A linear actuator is a device that converts rotational motion into linear motion, enabling multiple applications such as lifting and pulling, with respect to extending and retracting. Electric linear actuators utilize DC or AC motors, gears, and lead screws to move the main rod shaft, with motor sizes ranging from 12v DC to 48v DC. Load capacity in linear actuators is characterized by dynamic and static variables. Dynamic load capacity measures the force applied when the actuator is in motion, while static load capacity assesses its ability to hold a load without moving.

Mechanical actuators, such as ball screw, leadscrew, rack and pinion, belt-driven, and cam actuators, are fundamental devices that convert rotary motion into linear motion. These mechanisms, exemplified by products from Venture Mfg. Co. in Dayton, Ohio, find application in diverse settings. Each type, whether utilizing screws, belts, or cams, brings its own advantages and is tailored for specific requirements.

Hydraulic actuators operate through hydraulic cylinders and an incompressible liquid, generating unbalanced pressure on a piston for linear displacement. Pneumatic actuators, on the other hand, leverage compressed air to swiftly produce low to medium force, employing a piston, cylinder, and valve/port system for either linear or rotary motion. Lastly, piezoelectric actuators utilize the piezoelectric effect, converting pressure and latent heat into an electromechanical interaction between mechanical and electrical states. These various actuator types cater to a wide array of industrial and technological needs, offering solutions that range from simplicity in mechanical systems to efficiency and precision in hydraulic, pneumatic, and piezoelectric applications.

Linear actuators play a crucial role in automating processes, as illustrated by an adhesive applicator in the provided diagram, replacing manual operations. These devices can exert forces for tension, compression, or both, with load capacity determined by their ability to move and securely hold a load. Dynamic load capacity undergoes testing to assess the actuator's fatigue, considering factors like flaking on rolling elements and the rated life of these elements. The International Organization of Standards (ISO) standard 14728-1:2017 outlines guidelines for assessing load fatigue in linear actuators. The dynamic or lifting load capacity represents the force applied when the actuator is in motion, while static load capacity measures the actuator's ability to hold a load stationary without back driving or damage.

Conclusions/action items:

N/A

2024/02/25- Triangular Support Beam

Sam TAN - Feb 25, 2024, 10:25 PM CST

Title: Triangular Support

Date: 02/25/24

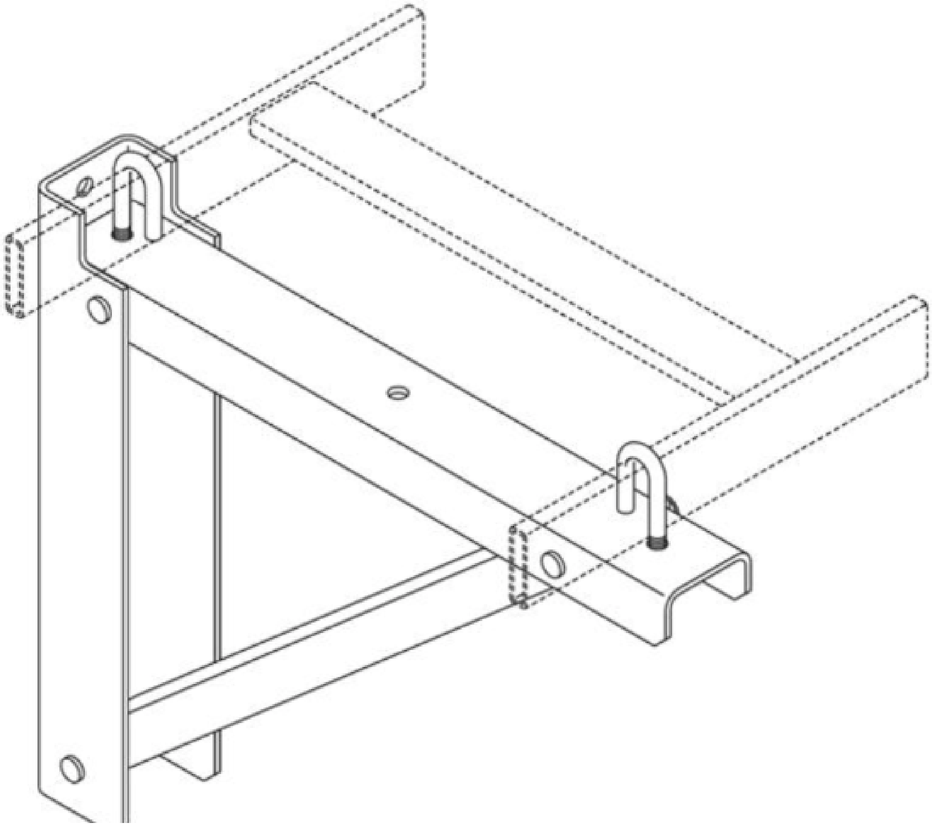
Content by: Sam

Present: N/A

Goals: N/A

Content:

https://www.chatsworth.com/en-us/products/cable-pathway/cable-runway/support-product/triangular-support-bracket-steel



These kinds of triangular support structure best support forces created by the footrest and the weight of the leg. Through analysis found in design ideas in 2/24/24, forces distributed would be the best.

Conclusions/action items:

Further research on the material.

2024/03/07- Force update

Sam TAN - Mar 07, 2024, 10:17 AM CST

Title: Update

Date: 3/7/24

Content by: Sam

Present: N/A

Goals: Update on force

Content:

From further discussion with the client, we got an client specific weight. We'll use that and the average weight of an individual to determine the best amount of force on the support system.

We'll use 70N for each support when only considering leg segments. We'll use 1200N for whole body weight.

From this, we can find the force within each beam structure. However, this brings the number to around 3000N in each beam, that is only a few centimeters thick. This is not ideal thus we need to modify the supporting structure by adding more beams in support, making factor of safety, and overall weight manageable.

Conclusions/action items:

Compute force.

2024/02/08- Summary of Previous works

Sam TAN - Feb 08, 2024, 1:52 PM CST

Title: Summary of success and failures of previous design

Date: 2/8/24

Content by: Sam

Present: N/A

Goals: Learn from previous work.

Content:

Success:

- The use of aluminum as main structural material yield great strength

- Able to remove and put back on

Failures/needed improvements:

- The hinge and joints of the design were considered a major need for improvement. A more proper strength of structure can distribute stress more evenly and better enhance loadings.

-Support mechanisms for castor cap

- Velcro straps

- Testing done over client wheelchair to get better/accurate data for analysis.

- The process of taking on/off the footplate seems to have a very low rating. The mechanism behind this can be work on and improve.

Conclusions/action items:

Evaluate and consider further improvements

2024/02/09- Force Plate, Initial Idea

Sam TAN - Feb 09, 2024, 11:20 PM CST

Title: Force plate Design

Date: 2/9/2024

Content by: Sam

Present: All

Goals: Initial written idea of the force plate design

Content:

Using force plate as the footrest. Allowing center of pressure to be calculated and monitored. If center of pressure shift to a certain direction, some function would occurs. Including (but not limited to):

- Extension/retraction of a side rod to help open door.

- Other easy tasks accomplishable by simple mechanics and electrical circuits.

Pros:

- Have more function only using footrest.

Cons:

- Could be hard to remove and reassemble. Due to the nature of the force plate, weight could be a huge problem.

In order for proper movements, and avoid unwanted motion, a button needs to be pressed and hold to have any action generated.

Conclusions/action items:

Further discussion on the design.

2024/02/11- Sliding Footrest Design

Sam TAN - Feb 11, 2024, 9:57 PM CST

Title: Sliding Footrest Design

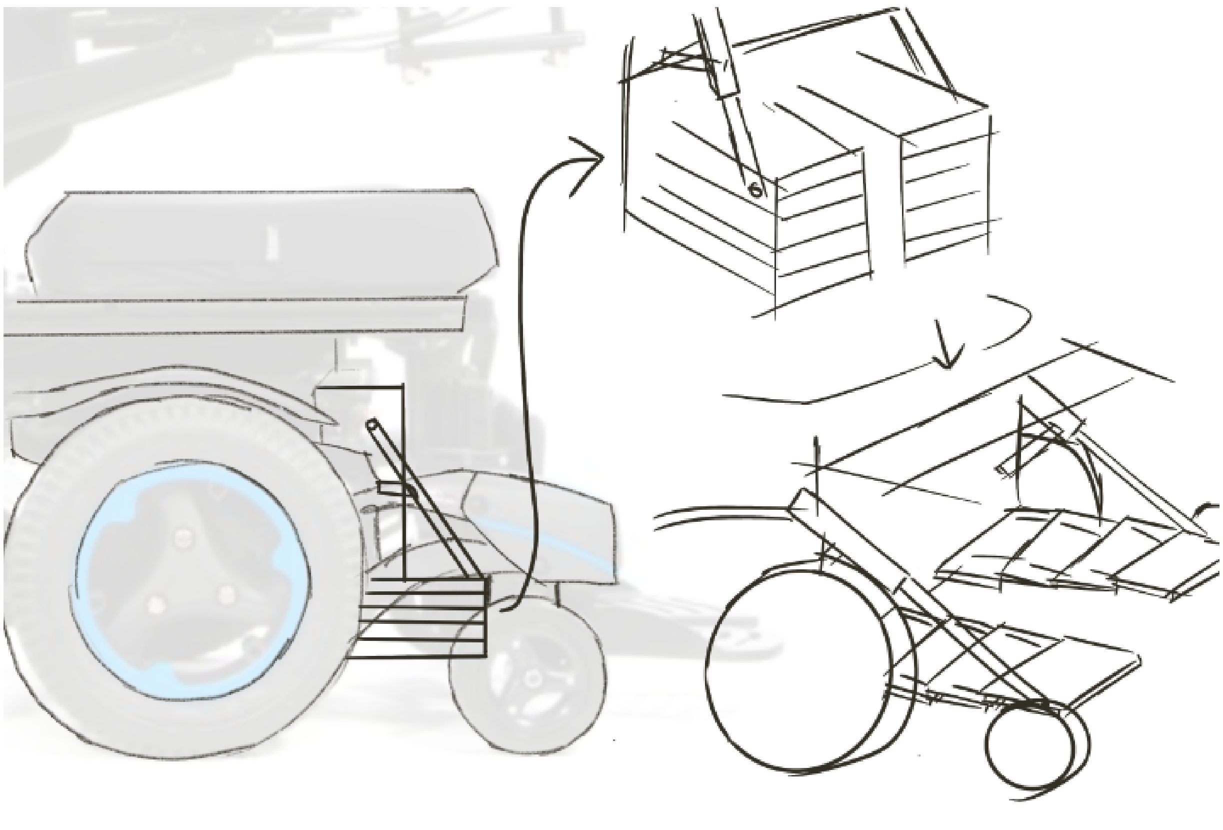
Date: 2/11/24

Content by: Sam

Present: N/A

Goals: Design brainstorming.

Content:



The layers of footrest slide on top of each other to extend. Retracts when not needed. All things will be placed underneath the chair and not interfere with the user.

Downsides: Could be heavy and hard to remove. Overall weight could be ideal but hard to say without starting to build.

Conclusions/action items:

Modify if needed. Brainstorm more design ideas if needed.

2024/02/14- Sliding Footrest Design Update

Sam TAN - Feb 14, 2024, 10:44 PM CST

Title: Sliding Footrest Design

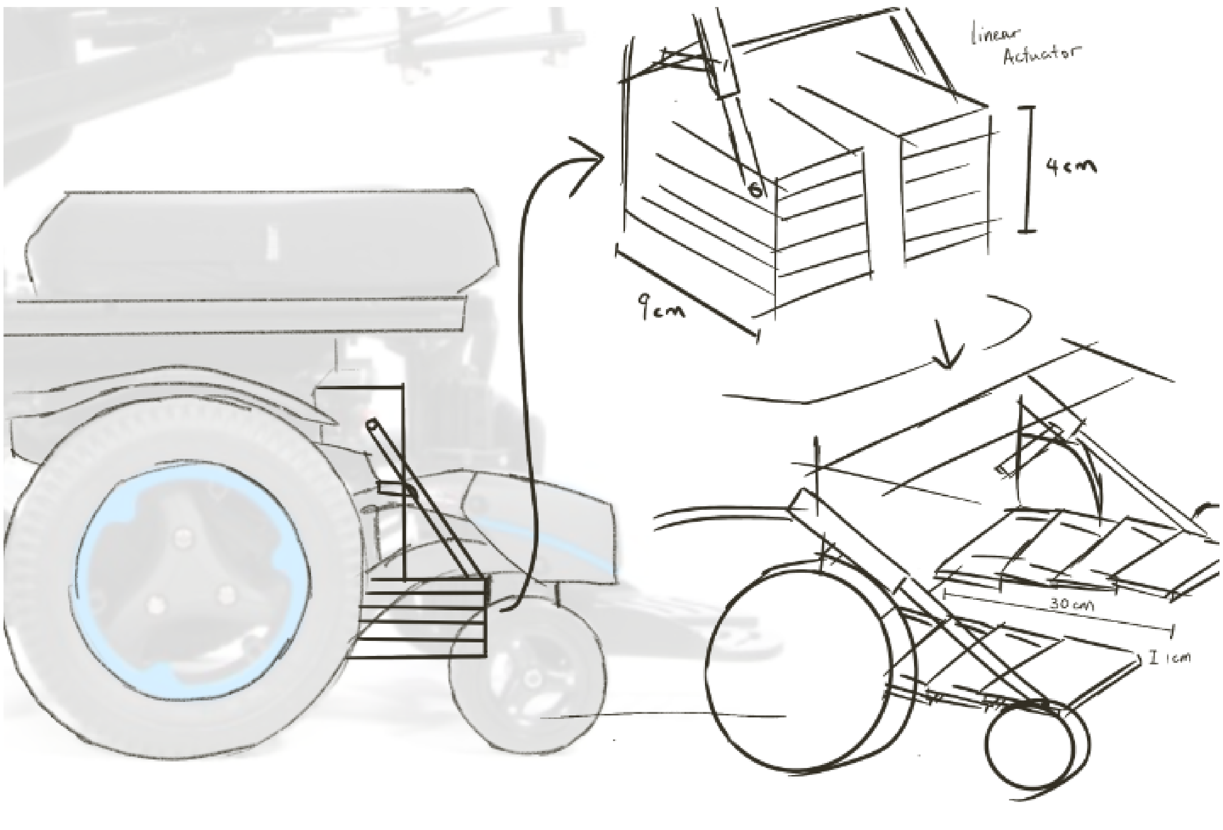
Date: 2/14/24

Content by: Sam

Present: N/A

Goals: Add dimensions on design

Content:



Conclusions/action items:

This isn't the 'presentation' design. This initial sketch will be refined and improved for better quality for presentation. More dimensions and modifications on details will be updated soon.

2024/02/14- Design Matrix Idea

Sam TAN - Feb 14, 2024, 10:59 PM CST

Title:

Date:

Content by:

Present:

Goals:

Content:

Personal Design:

Slider Footrest: The slider footrest design uses 4-5 overlapping, thin, and tracked slide platforms to achieve low interference. When used, each platform slides to extend forward using a linear actuator or motor with similar design. Each slider platform can only slide a certain distance forward to ensure proper strength. The overall weight of the design could potentially become the downside but with careful consideration of materials, removal of excess materials, this design could achieve greater goals.

I personally think that size/weight can be combined to create one criterion. This is because they're very related in some ways. For example, weight will increase if size increases. If our team can cut down size, I think that weight would go down as well. And they relates to portability as well. So all three criteria are very closely related and inter-changable. However, I still put them as separate criteria because it allows more dynamic evaluation and precision making that distinguishes design from design. This better evaluates all designs and can better identify the most achievable design.

Size-
This criterion is given a weighting of 25% because of the client specific request. As stated in the title of the project, size plays an important role in being low interference. The design must account for dimensions by client specific request and is weighted the most among all criteria.

Weight-
This criterion is given a weighting of 20% because of the client specific medical condition, the design requires a precise control on the overall weight. Weight limitations need to strictly follow the PDS for quality assurance.

Conclusions/action items:

Evaluate design matrix.

2024/02/20- Design Dimensions and Some Sketches

Sam TAN - Feb 20, 2024, 9:53 PM CST

Title: Some design dimensions

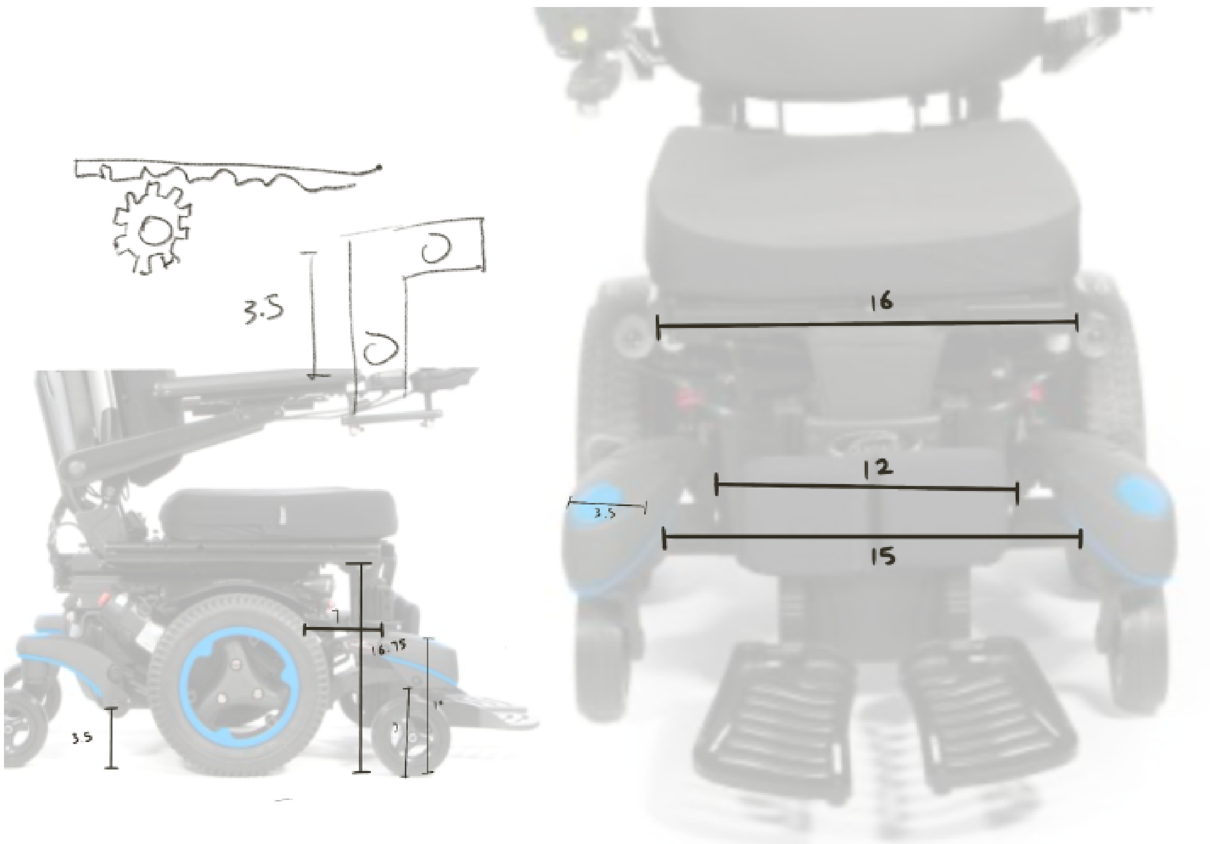
Date: 2/20/24

Content by: Sam and Bobby

Present: Sam and Bobby

Goals: Get dimensions for design ideas

Content:



Units: inch

Conclusions/action items:

N/A

2024/02/21- Design Ideas CAD V1

Sam TAN - Feb 22, 2024, 12:33 AM CST

Title: Design CAD

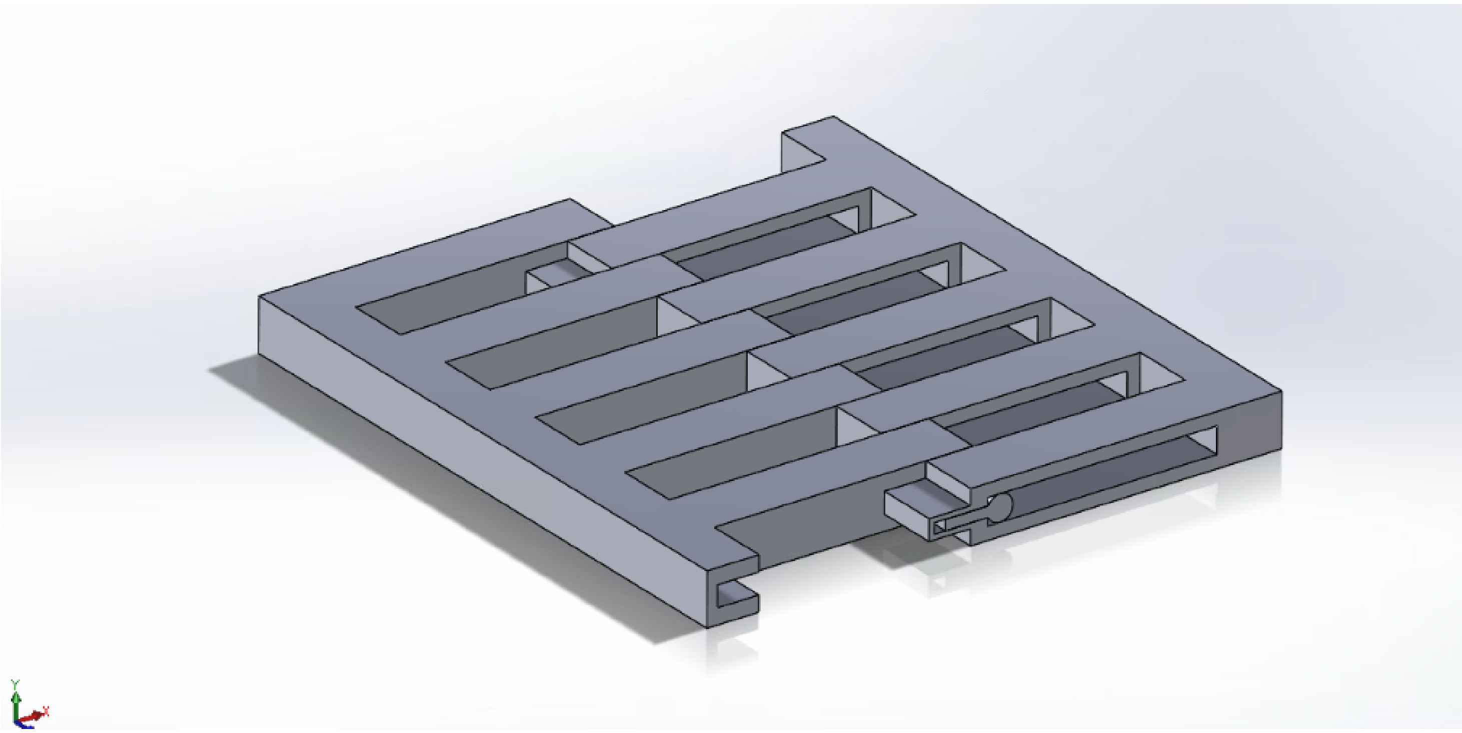
Date: 2/21/24

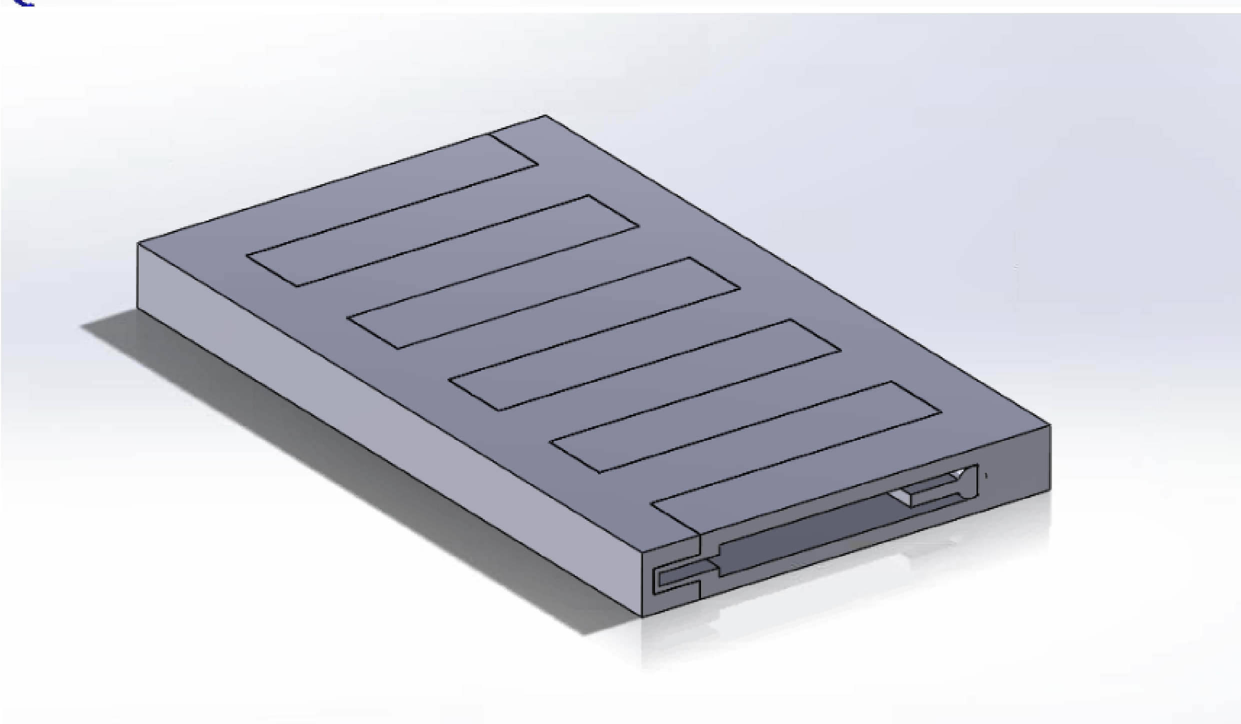
Content by: Sam/Bobby

Present: N/A

Goals: CAD

Content:





Extension footrest design. V1, not motor or other pieces attached.

Conclusions/action items:

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N/A

2024/02/24- Force Distribution Analysis

Sam TAN - Feb 24, 2024, 9:38 PM CST

Title: Some force distribution to the support structure

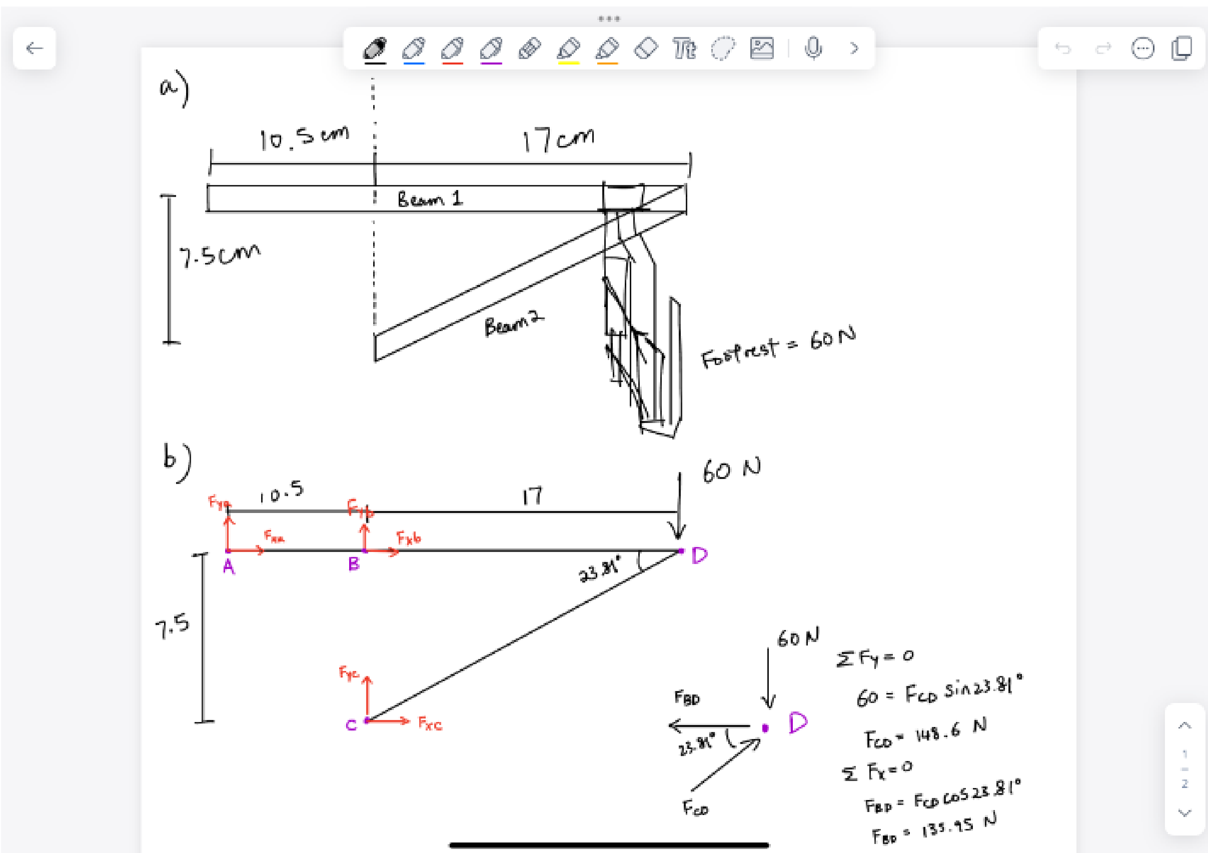
Date: 2/24/24

Content by: Sam

Present: N/A

Goals: Analyze force within the designed structure to determine which material could give a better factor of safety.

Content:



In this triangular support design, which uses two beams oriented in a triangle to support the footrest itself, and the leg+foot weight from the patient. It is determined that there will be two similar design, one on each side of the wheelchair for symmetrical purposes. One design must held 60 newtons of force at the end point. Using static equilibrium analysis, it is found that beam 1 is in 136N of tension, and beam 2 in 150N of compression. Shear stress in both is unknown and need to be solved.

Conclusions/action items:

Research on materials that would be the best to use in the design, and the shear stress in both beams.

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2024/02/27- Sliding Mechanism

Sam TAN - Feb 27, 2024, 8:06 PM CST

Title: Sliding Mechanism, Idea1

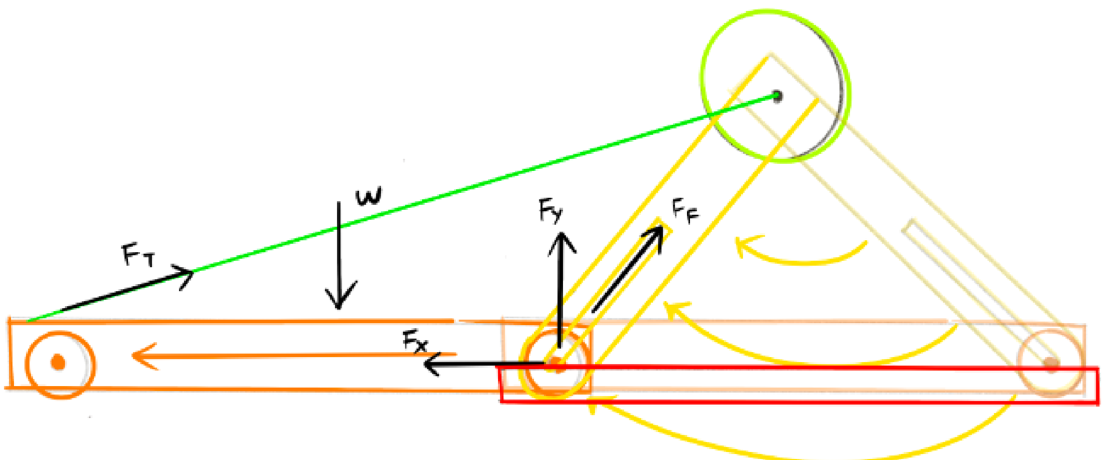
Date: 2/27/23

Content by: Sam

Present: Bobby Sam

Goals: Sliding Mechanism

Content:



Conclusions/action items:

N/A

2024/03/18- Design Updates

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Sam TAN - Mar 18, 2024, 11:03 PM CDT

Title: Update

Date: 3/18/24

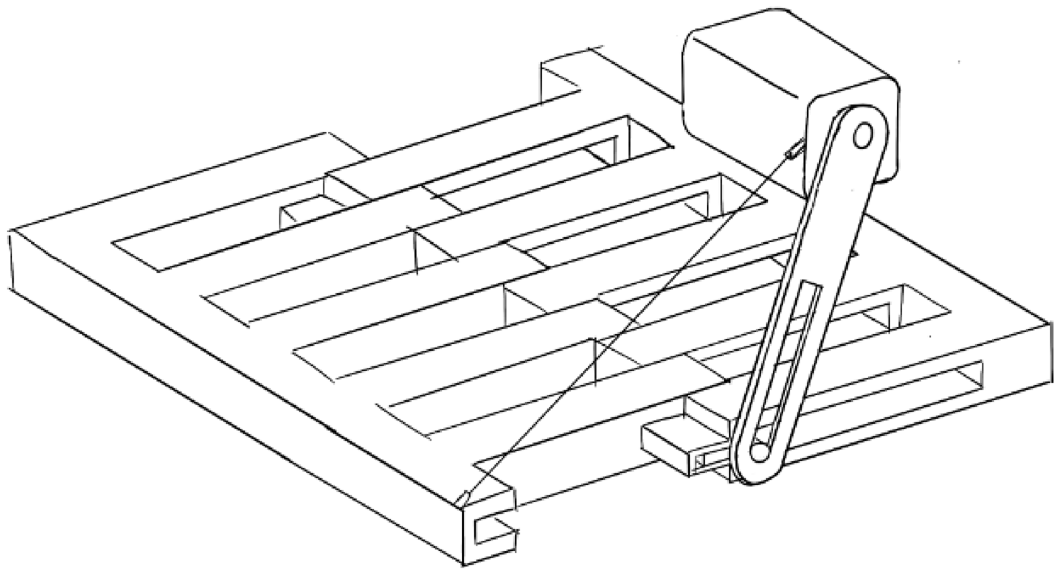
Content by: Sam

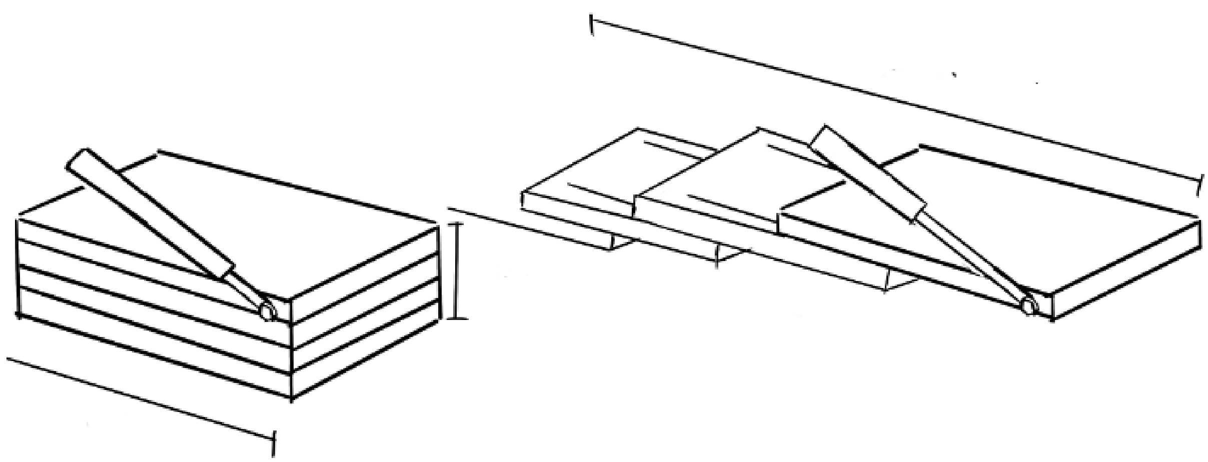
Present: N/A

Goals: N/A

Content:

Loading [MathJax]/extensions/Safe.js





Conclusions/action items:

N/A

Loading [MathJax]/extensions/Safe.js

2024/03/18- Design Updates 2

Sam TAN - Mar 18, 2024, 11:07 PM CDT

Title: Some sliding mechanism update

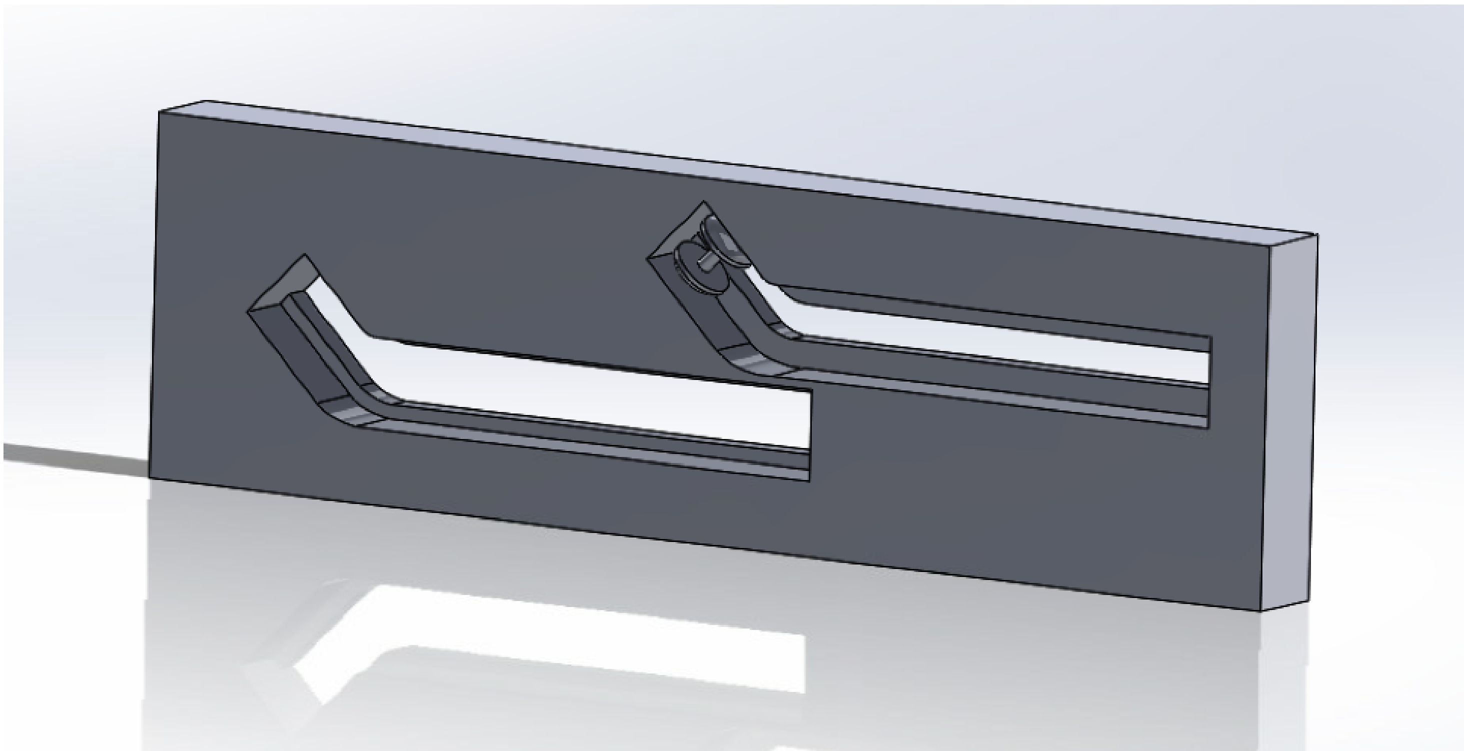
Date: 3/18/24

Content by: Sam

Present: Sam, Charles, Bobby

Goals: N/A

Content:



Conclusions/action items:

N/A

2024/03/22- Linear Actuator Holder Design, Initial

Sam TAN - Mar 22, 2024, 1:10 AM CDT

Title: Linear Actuator Holder

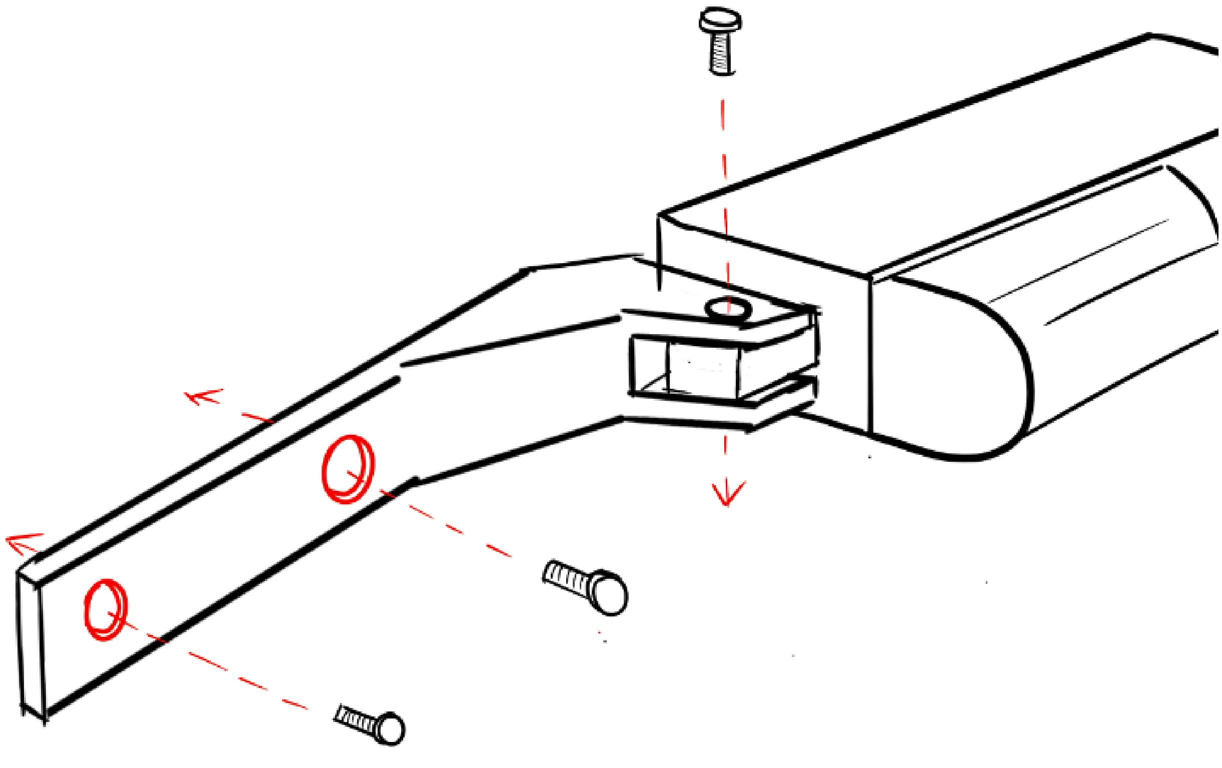
Date: 3/20/24

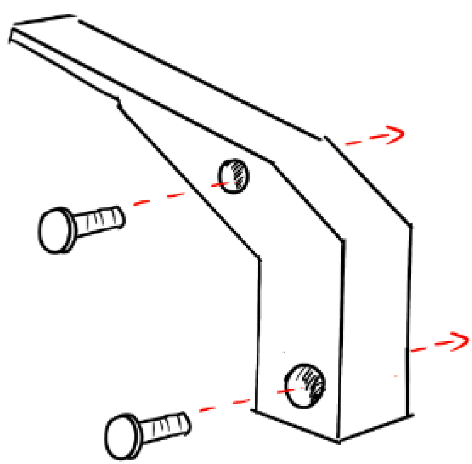
Content by: Sam

Present: N/A

Goals: Attach linear actuator to chair

Content:





First image is the back holder, which uses screws already on the wheelchair for attachments. The holder lines up with these holes and connects to the linear actuator.

The Bottom image is the front holder (support only), that is not anchored to the wheelchair. Instead, it acts as a holder/support to counteract any force provided on the footrest.

Conclusions/action items:

N/A

2024/03/22- Linear Actuator CAD

Sam TAN - Mar 22, 2024, 1:15 AM CDT

Title: CAD for linear actuator

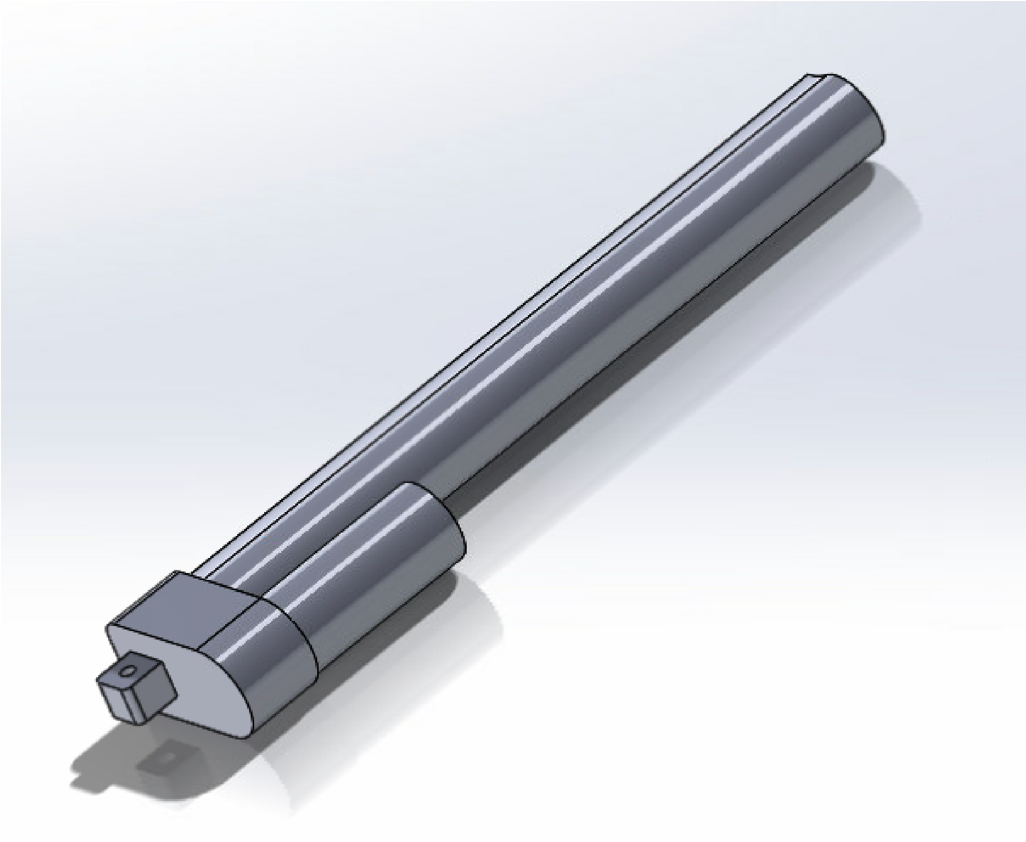
Date: 3/21/24

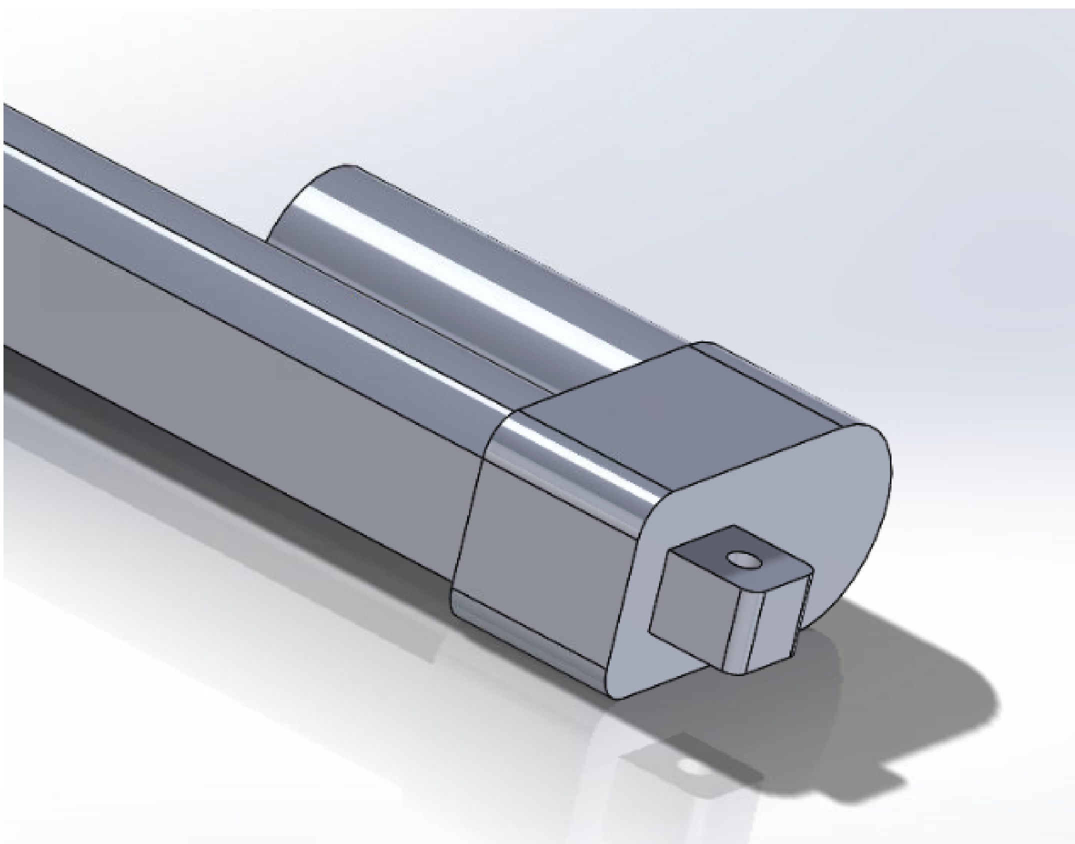
Content by: Sam

Present: All

Goals: CAD using dimensions given from supplier. Goal is to assemble to the holder to better visualize how to design the holder better.

Content:





Conclusions/action items:

Create Assembly

2024/04/04- Front holder

Sam TAN - Apr 04, 2024, 9:56 PM CDT

Title: Initial idea for front holder

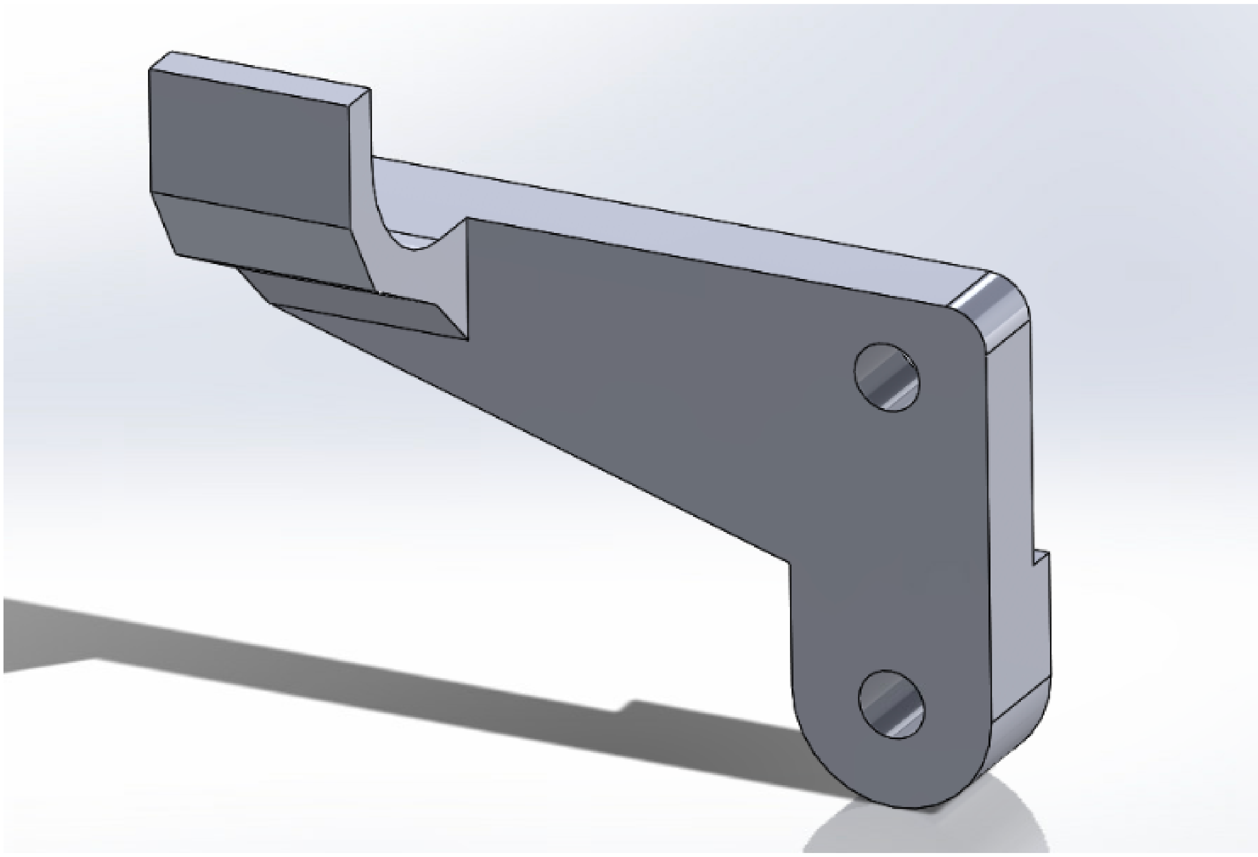
Date: 4/4/24

Content by: Sam

Present: N/A

Goals: Design actuator holder for front support

Content:



Conclusions/action items:

Print and evaluate effectiveness

2024/04/30- Final holder (in team folder)

Sam TAN - Apr 30, 2024, 10:08 AM CDT

Title: Final prototype

Date: N/A

Content by: Sam

Present: N/A

Goals: N/A

Content:

See team folder-fabrication

Conclusions/action items:

N/A

2024/05/03- Drawings of 3D models

Sam TAN - May 03, 2024, 9:35 PM CDT

Title: 3D model drawings with dimensions

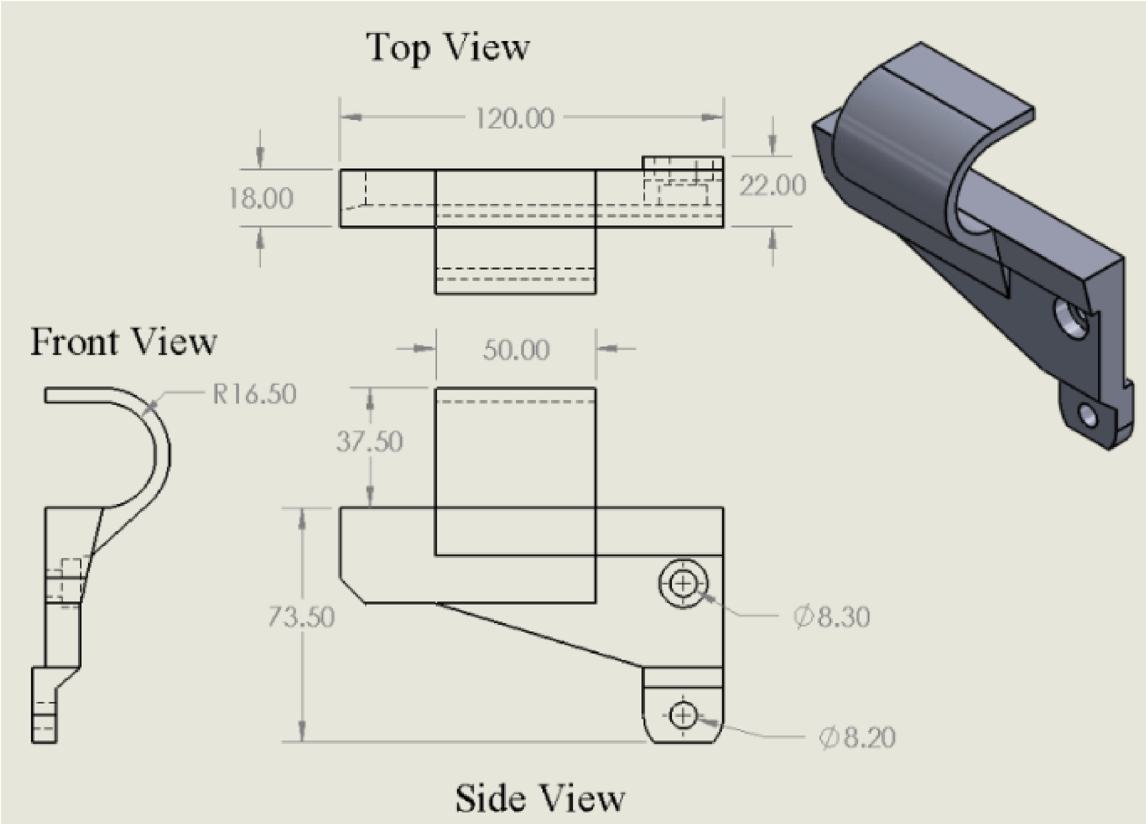
Date: 4/25/24

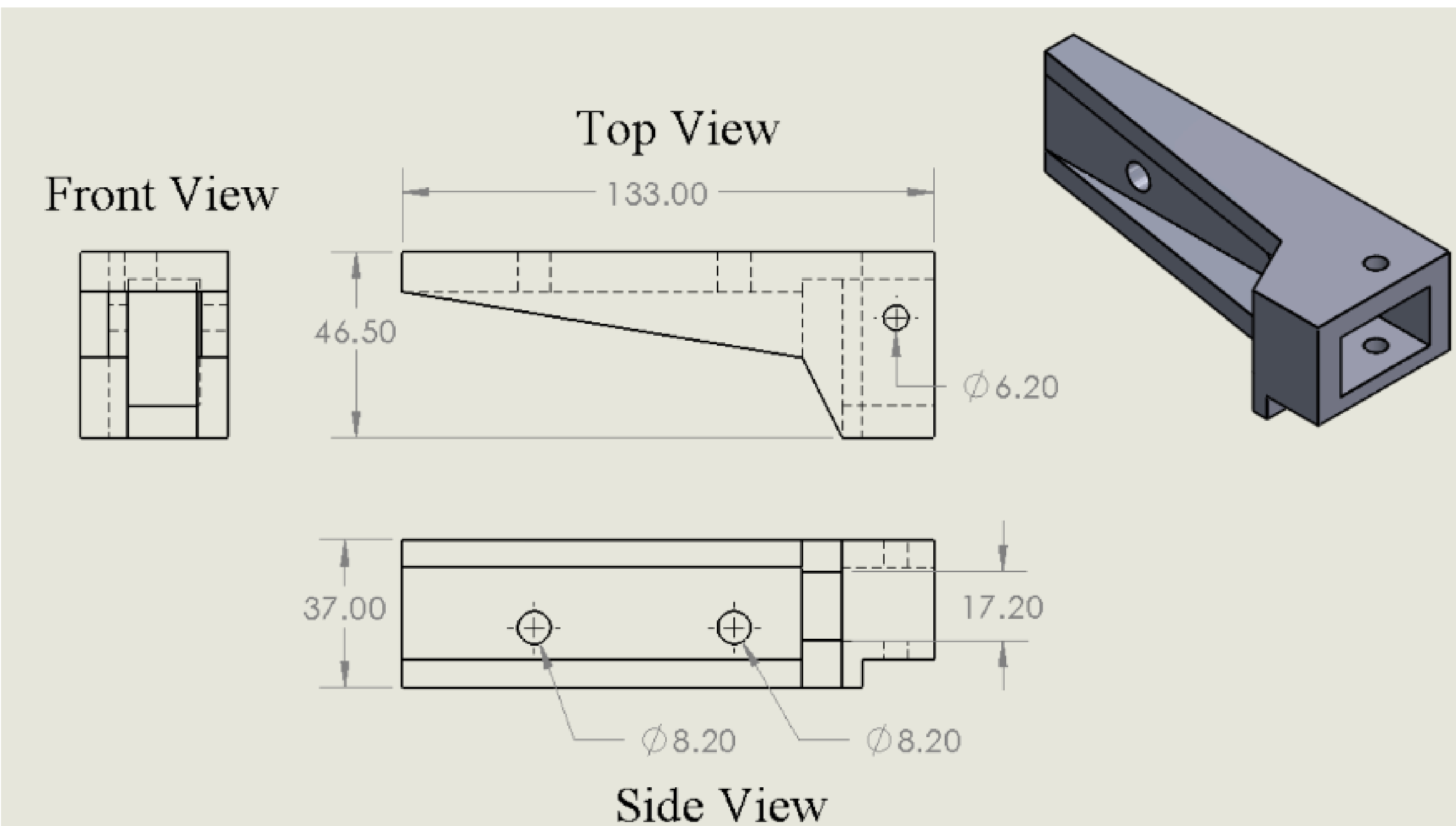
Content by: Sam

Present: N/A

Goals: Dimensions on drawings

Content:





Conclusions/action items:

Front holder and back holder

1/28/2024 Introductory Research I

Title: Introductory Research I Finite element analysis of a commercial wheelchair

Date: 1/28/24

Content by: Jayson O'Halloran

Resources: [1] Marques LS;Magalhães RR;de Lima DA;Tsuchida JE;Fuzzato DC;de Andrade ET;, "Finite Element Analysis of a commercial wheelchair," Disability and rehabilitation. Assistive technology, https://pubmed.ncbi.nlm.nih.gov/32255715/ (accessed Jan. 28, 2024).

Goals: To understand the meaning of a Low-interference wheelchair footrest and gain some insight into the elements that make up a wheelchair.

Content:

The paper above [1] underscores the importance of ensuring the proper functioning of wheelchairs for users with motor disabilities to enhance their quality of life. It aims to analyze stresses and displacements in wheelchairs using the finite element method (FEM) to evaluate both functional and structural aspects through simulations. The research integrates ergonomic, anthropometric, and biomechanical factors to assess compliance with current standards. Results indicate that the wheelchair analyzed did not meet adequacy criteria based on simulation outcomes and INMETRO reports. The study discusses the evolution of wheelchair analysis using FEM and highlights the necessity of adhering to established standards for wheelchair design and safety. Furthermore, it emphasizes the importance of numerical validation via FEM to meet these requirements efficiently. The paper concludes by proposing further research to address normative aspects and structural design of wheelchairs, focusing on stability, collision analysis, and mechanical behaviors of various components. Additionally, it outlines Brazilian standards for wheelchairs, detailing methods for testing brake and lever efficiency, static loads, impact, and fatigue.

The Brazilian ABNT NBR ISO 7176 standard was utilized for numerical analysis of wheelchairs, adhering to its guidelines and functionality requirements. A commercial model of a popular wheelchair in Brazil was used for 3D geometry, with simulation steps including wheelchair geometric modeling, material definition, mesh generation, and load application. The simulations were based on a 3D model of a wheelchair for adults weighing between 75 kg and 100 kg, using ASTM A36 steel for the wheelchair frame and high-density polyethylene (HDPE) for the footrest. The structural division focused on the frame, footrest, handles, and brake lever. Mesh convergence analysis was conducted to ensure reliability, and static angular stability analysis was performed to assess stability under varying ramp angles. Collision analysis evaluated stresses and displacements during impact against a rigid wall, considering a maximum speed of 6 km/h and a safety factor of 1.5 over 25 milliseconds. The study aimed to determine the wheelchair's safety and compliance with standards, providing insights into structural performance under various conditions. What I have found from this article is that many traditional wheelchairs are confined in space, limiting the users' potential to have wanted movements in the sitting position. This is also paired with the wheelchairs experiencing the capability to not reach the maximum stress and or strains applied to the materials and have a slightly lower factor of safety (FOS) of 1.6 on average instead of the proposed 2.

Conclusions/action items:

In conclusion, this study introduced a novel approach for evaluating new wheelchair designs through numerical simulations, aiming to expedite the certification process. The simulation models underwent validation via mesh convergence analysis, adhering to specifications outlined in the NBR 7176 standard. Results revealed that the chair frame exceeded von Mises stress limits by 6.5%, collision analysis by 72.1%, and footrest by 189.4%, considering a safety factor of 1.5 for structural collision. Comparison with previous analyses showed that the wheelchair still falls short of meeting the minimum requirements set by the NBR 7176 standard. Notably, results aligned with those of practical studies conducted by INMETRO, indicating consistency in evaluation methods. Future research should extend the numerical analysis to electric wheelchairs, establishing guidelines for finite element assessment. Moreover, there's a call for developing new protection and reinforcement systems for conventional wheelchairs through finite element analysis to enhance the quality of existing devices in the Brazilian market.

- Do more research and find out the specs of wheelchairs in the USA's market.

1/30/2024 Foldable Carbon Composite Frame Research II

JAYSON O'HALLORAN - Feb 02, 2024, 1:01 PM CST

Title: Foldable Carbon Composite Frame Research II

Date: 1/30/2024

Content by: Jayson O'Halloran

Resources: [2] W. S. Chong, M. Y. Shin, and C. H. Yu, “STRUCTURAL ANALYSIS OF CARBON COMPOSITE FRAME FOR FOLDABLE ELECTRIC WHEELCHAIR DEVELOPMENT,” Journal of Mechanics in Medicine & Biology, http://www.worldscinet.com/jmmb (accessed Jan. 30, 2024).

Goals: To understand more about the frame needed for a foldable footrest for an electric wheelchair.

Content:

A carbon composite was used as the material for the frame of the foldable electric wheelchair model. This material is a woven type carbon sheet that can be woven into various patterns and used with plastics to create lightweight and durable composite materials. Considering the manufacturing cost of the carbon composite material, the frame structure was designed to be so simple that it can be assembled using the joints. An aluminum material was used for the joint and wheel shaft of each frame. Young’s modulus of carbon composite material is 70,000 MPa, Poisson’s ratio is 0.13 and Density is 1480 kg/m3. Al6061 is used as an aluminum material. Young’s modulus of Al6061 is 68,900 MPa, Poisson’s ratio is 0.33 and density is 2700 kg/m3.

Interest in rehabilitation assistive devices, particularly lightweight and safe electric wheelchairs, is increasing globally due to the aging population. These devices are crucial for improving the quality of life of the elderly and disabled by enhancing mobility and facilitating social integration. However, existing manual and electric wheelchairs have limitations that hinder independence and social activities. In regions like China, Taiwan, and Korea, there's a growing market for electric wheelchairs, but proper domestic development is lacking in some areas.

Public transportation and special transportation methods like taxis often fail to accommodate wheelchair users adequately, leading to inconvenience and limited mobility. There's a need for electric wheelchairs that are lightweight, safe, and compatible with existing transportation infrastructure. To address this, a study proposes a foldable electric wheelchair design made of aluminum and carbon composite materials, ensuring structural safety and ease of loading into conventional vehicles. This innovation aims to enhance mobility and independence for wheelchair users, thereby improving their overall quality of life.

Conclusions/action items:

The study concludes that the application of a foldable design to an electric wheelchair, along with the use of carbon composite materials for the body frame, improves mobility and portability for elderly and disabled users. Structural analysis confirmed the safety of the wheelchair, with high safety factors indicating structural integrity. While the design was based on international standards and didn't consider specific physical differences between Asians and Westerners, future research aims to address this gap. The foldable electric wheelchair is expected to facilitate smoother transportation experiences and enhance the quality of life for elderly and disabled users by providing greater mobility options.

- For action items we as a team need to meet with our advisor and client following 2/02/2024.

- BSAC meeting 2/02/24.

1/31/2024 Motion Electronics Design Research III

Title: Motion Electronics Research III

Date: 1/31/2024

Content by: Jayson O'Halloran

Resources: [3] N. Corporation, “Motion control and electronics design,” Motion Electronics Design, https://www.newport.com/n/motion-electronics-design (accessed Jan. 31, 2024).

Goals: To understand more about motion electronics.

Content:

Motion electronics design involves the integration of motion controllers, motor drivers or amplifiers, and motion devices to create effective motion control systems. These systems are crucial in various applications such as robotics, conveyor belts, and stages where precise motion control is essential.

Key Components:

1. **Motion Controllers:** These devices control the dynamics of motion devices like stages and actuators. They receive signals from position, velocity, or torque sensors, comparing actual values to desired ones and then making corrective actions. Motion controllers can operate in three control methods: position control, velocity control, and torque control.

2. **Motor Drivers:** Motor drivers receive signals from the motion controller and convert them into power signals to drive the motor. Different types of motor drivers exist, including those for stepper motors, DC servo motors, and brushless DC motors.

3. **Motion Devices:** These are mechanical devices actuated by a motor to provide motion. They often include feedback devices like encoders, tachometers, or torque/force sensors for providing information such as position and velocity to the motion controller.

Control Methods:

- **Position Control:** Used for precise positioning, often employing encoders for feedback.

- **Velocity Control:** Applied in applications where regulating speed is critical, using tachometers for feedback.

- **Torque Control:** Used in applications like robotics, requiring accurate control of applied torque, often utilizing torque/force sensors for feedback.

Advanced Motion Controllers:

- **Additional Functions:** Some controllers offer features such as trajectory generation, user interfaces for configuration, safety monitoring, digital input/output lines for synchronization, and memory for running on-board motion programs.

Motion Controller Output Configurations:

- **Stepper Motors:** Controlled using step and direction signals or plus and minus pulses, with or without position feedback.

- **DC Servo Motors:** Receive analog voltage signals (DAC control signals) for accurate positioning, requiring position feedback.

- **Brushless DC Servo Motors:** Controlled using two DAC control signals, with some systems capable of self-commutation.

Motor Drivers:

- **Stepper Motor Drives:** Apply current to move the motor in steps, with advanced micro-stepping for higher resolution.

- **DC Servo Motor Drives:** Convert analog control signals to drive the motor with position feedback.

- **Brushless DC Motor Drives:** Convert control signals to drive the motor, with options for different types, including those that self-commutate.

Feedback Devices:

- **Encoders:** Provide position feedback.

- **Tachometers:** Offer velocity feedback.

- **Optical or Mechanical Switches:** Indicate end-of-travel information.

- **Index Signals:** Establish a fixed reference position.

- **Hall Effect Sensors:** Provide phase information for brushless motors.

Conclusions/action items:

In conclusion, motion electronics design involves the integration of three main components: motion controllers, motor drivers or amplifiers, and motion devices. The primary goal is to create effective motion control systems utilized in various applications, including robotics and conveyor belts. Motion controllers play a central role by controlling the dynamics of motion devices such as stages and actuators. They operate in three control methods: position control for precise positioning using encoders, velocity control for regulating speed with tachometers, and torque control for applications like robotics using torque/force sensors. Advanced motion controllers offer additional functions such as trajectory generation, user interfaces, safety monitoring, and memory for running onboard motion programs. The output of motion controllers is configured based on the type of motor used, such as stepper motors, DC servo motors, or brushless DC servo motors. Motor drivers receive signals from controllers and convert them into power signals to drive the motor, with various types available for different motor technologies. Feedback devices, including encoders, tachometers, switches, index signals, and Hall effect sensors, provide crucial information to the motion controller for accurate control of the motion device.

2/01/2024 R & D Electronic Footrest Prototype Research IV

JAYSON O'HALLORAN - Feb 02, 2024, 11:45 AM CST

Title: Research-and-Development-of-an-Electronic-Footrest-Prototype-Tested-with-the-Disabled

Date: 2/01/2024

Content by: Jayson O'Halloran

Resources: [4] R. LS, J. E. dos S, P. D. CL, S. HP, and R. GC, "Research and development of an electronic footrest prototype tested with the disabled," Scholarena, https://article.scholarena.com/Research-and-Development-of-an-Electronic-Footrest-Prototype-Tested-with-the-Disabled.pdf (accessed Feb. 1, 2024).

Goals: To understand more about how electronic footrests can be used to help the disabled.

Content:

The article discusses the research and development of an electronic footrest prototype designed to improve the quality of life for wheelchair users by reducing problems associated with a sedentary lifestyle, particularly foot edema. The study emphasizes ergonomic and inclusive design to address the limitations faced by individuals with disabilities. The experimental research involved 14 wheelchair users to test the prototype's effectiveness in reducing foot edema through involuntary foot movements induced by the device. The findings revealed a decrease in foot edema for most participants, demonstrating the potential of ergonomic design to enhance the well-being of product users and improve the quality of life for individuals with physical disabilities.

The backbone of the article dives into the nature of ergonomics, highlighting its applications in various sectors such as health, education, transportation, and leisure, particularly addressing the needs of minorities, including elderly, obese, and disabled individuals. The development process of the electronic foot support involved a comprehensive design approach, considering the technical features, components, and configuration of footrests, as well as the classification of assistive technologies. The prototype's technical features included an electric motor-driven mechanism to provide passive, involuntary foot movements, aiming to reduce foot edema and improve venous hemodynamics.

For the footrest, the summary is as follows: It is driven by a bi-volt power source at 110 and 220V. The energy is transferred from a connecting rod that achieves the required input movements. The movement of the feet was tracked by control circuits that had taken feedback from a potentiometer circuit. The article did not go into much detail about the circuitry, which indicates that I will have to dive into more later.

Conclusions/action items:

Overall, the document underscores the significance of inclusive and ergonomic design in addressing the accessibility and usability needs of individuals with disabilities, particularly in developing assistive technologies that can enhance their daily lives. The findings of the research not only confirm the effectiveness of the electronic foot support prototype in reducing foot edema but also shed light on the potential of ergonomic design to mitigate the adverse effects of a sedentary lifestyle for wheelchair users

2/06/2024 Wheelchair Footrest Sensors Research V

JAYSON O'HALLORAN - Feb 09, 2024, 12:32 PM CST

Title: Wheelchair footrest sensors Research V

Date: 2/06/2024

Content by: Jayson O'Halloran

Resources: [5] S. J. A. Majerus et al., "Power wheelchair footplate pressure and positioning sensor," Annual International Conference of the IEEE Engineering in Medicine and Biology Society. IEEE Engineering in Medicine and Biology Society. Annual International Conference, https://www.ncbi.nlm.nih.gov/pmc/articles/PMC8091137/ (accessed Feb. 6, 2024).

Goals: To understand more about how sensors can be integrated into wheelchair footrests.

Content:

Key takeaways:

1) Power wheelchair users, particularly those with spinal cord injuries, face severe injury risks due to foot mis-positioning on the footplate during wheelchair use.

2) The proposed solution is the Footplate Pressure and Positioning Sensor (FoPPS), designed to monitor foot position in real-time and alert users to potential risks.

3) The FoPPS utilizes an array of force-sensing resistors and infrared distance sensors on the footplate to detect pressure and location of the foot during wheelchair operation.

4) Sensor arrays with 23 force sensors and 14 infrared sensors per foot were fabricated on printed circuit boards and encapsulated for environmental resistance.

5) The system transmits foot pressures and position data at 10 Hz via Bluetooth Low Energy to an iOS app, providing real-time alerts to users.

6) The design allows for the detection of foot movements and pressures, indicating potential pressure ulcer risk or poorly-fitted power wheelchair.

7) The FoPPS system demonstrated functionality in static conditions and with a prosthetic limb representing realistic force distributions.

8) The wireless readout electronics and smartphone app provide a user-friendly interface for real-time detection of foot positions and alerts.

9) The study concludes by stating that the FoPPS is ready for next-stage clinical trials with power wheelchair users to assess natural foot movements and user satisfaction with the system.

10) FoPPS sensors are read out with a row-column multiplexed scheme. All FSRs are measured with a simple voltage divider using a reference resistor. A ratiometric measurement using a 10-bit analog-to-digital converter (ADC) is used.

Conclusions/action items:

In conclusion, the Footplate Pressure and Positioning Sensor (FoPPS) marks a significant breakthrough in addressing safety concerns for power wheelchair users, especially those with spinal cord injuries. By utilizing a combination of force-sensing resistors and infrared distance sensors on the footplate, the FoPPS provides real-time monitoring of foot position during wheelchair use, to prevent severe injuries resulting from misaligned feet. The system's sturdy design, encased in durable thermoplastic urethane, wirelessly transmits crucial foot pressure and position data to an iOS app via Bluetooth Low Energy. Rigorous testing, including scenarios involving a prosthetic limb, has showcased the FoPPS's functionality. The user-friendly smartphone app interface, coupled with the system's ability to detect potential pressure ulcer risks and issues with wheelchair fit, enhances its practicality. As the study concludes, the FoPPS is now ready for the next phase of clinical trials, offering a promising solution to improve the safety and well-being of power wheelchair users, ultimately contributing to enhanced mobility independence and overall quality of life.

Action Items:

- Finish PDS

- Advisor meeting 2/9/24

- Have a client in-person meeting on 2/10/24

- Begin looking at competing designs and come up with an initial design

2/11/24 Previous BME 200/300 Teams Work Background Research

JAYSON O'HALLORAN - Feb 16, 2024, 12:01 PM CST

Title: Previous Team Takeaways

Date: 2/11/2024

Content by: Jayson O'Halloran

Resources: https://bmedesign.engr.wisc.edu/projects/f23/super_footrest/file/view/5c9a6d82-df09-4c4a-8f66-eed8a8fe23c9/Wheelies-%20Final_Report%20%281%29.pdf

Goals: Dive into the previous teams' work and get a better understanding of their trial and error.

Content:

Key Summary:

All designs were mechanical, with no electronic integration.

Existing wheelchair foot support devices fall into two main categories: footrests and leg rests. Footrests typically consist of hangers and footplates, with adjustable features for accommodating different leg lengths. Leg rests, less common, include calf-support pads and are often bulkier. Current market offerings from companies like Drive Medical and Invacare Corporation generally follow traditional designs with removable components and adjustable features.

The problem statement highlights the limitations of existing designs, which are often heavy, bulky, and not easily removable, hindering users' independence and mobility. There is a need for a wheelchair footrest that allows for greater accessibility, increased range of motion, ease of use, and efficient storage when not in use. The goal is to design a footrest that adapts to users' abilities, is lightweight, easily removable, and provides necessary support when needed, addressing the current shortcomings in the market.

The project involved designing a wheelchair footrest specifically for Quickie Power wheelchairs, aiming to overcome the limitations of competing footrests. The design consists of an aluminum footplate attached to a 3D-printed castor cap with a 100-degree hinge. Ethical considerations revolve around safety, ensuring no interference with wheelchair functions, and not affecting the client's transfer on and off the wheelchair.

Testing revealed issues with the castor cap, cracking under force, impacting the footrest's stability and safety. Changes are suggested, such as adding support bars, increasing cap thickness, and improving the design for a better fit. Despite meeting certain design specifications, the prototype faced challenges in supporting weight, ease of removal, and reattachment.

Potential errors in measurements and testing were acknowledged, including variations in force application and testing with able-bodied individuals. The conclusion emphasizes the need for design improvements, especially in the hinge strength, support mechanisms, and cap fit. The aluminum footplate and overall design concept are considered effective and lightweight alternatives, with plans for future revisions to enhance strength, functionality, and usability based on testing data from actual wheelchair users.

Conclusions/action items:

When it comes to wheelchair foot support devices, there are two predominant categories: footrests and leg rests. Current designs, exemplified by manufacturers like Drive Medical and Invacare Corporation, typically incorporate features like removable components and adjustability. However, these designs have inherent limitations—they tend to be heavy, bulky, and pose challenges for independent attachment and removal. Recognizing these drawbacks, there arises a demand for a wheelchair footrest that is not only more accessible and adaptable but also user-friendly.

The problem statement emphasizes the inadequacies of current footrests, highlighting their incapacity to facilitate useful movements like opening doors or picking up objects with the feet. Furthermore, the existing models are critiqued for their weight, bulkiness, and lack of convenient removal and storage options. The overarching objective is to pioneer a footrest design that not only grants users greater foot mobility but is also easily removable, storable, and lighter while ensuring essential support when needed.

Key areas for improvement include prioritizing accessibility and adaptability to different user abilities, enhancing ease of use and storage options, and working towards reducing the weight and bulkiness of the footrest. To elevate the design further, electronic circuit integration is proposed to bring about smart adjustments, remote control or app integration for wireless control, sensors for adaptive support based on user movements, user feedback and monitoring systems, and safety features such as automatic adjustments in recline situations. These enhancements aim to not only address existing drawbacks but also usher in a new era of innovation, customization, and improved user experience in wheelchair foot support devices.

2/12/2024 Automated Electronic Wheelchair System Research VI

JAYSON O'HALLORAN - Feb 16, 2024, 11:30 AM CST

Title: Automated Electronic Wheelchair System Research VI

Date: 2/12/2024

Content by: Jayson O'Halloran

Resources: [6] Luma Carolina Gradim, Santana, Marcelo Archanjo José, Marcelo Knörich Zuffo, and R. de, "An automated electronic system in a motorized wheelchair for telemonitoring: IoT Concepts based on User-Centered Design (Preprint)," JMIR formative research, vol. 7, pp. e49102–e49102, Nov. 2023, doi: https://doi.org/10.2196/49102 (Accessed Feb 12, 2024)

Goals: To understand more about how electronics can be integrated into wheelchair systems

Content:

The electronic system for wheelchairs presented in the text is designed with a focus on user-centered development and IoT architecture. The key components include both hardware and software elements. The hardware incorporates sensors from an inertial measurement unit (IMU), specifically designed to monitor and control the tilt and recline functions of the wheelchair. These sensors play a crucial role in offering alternative methods for wheelchair users to adjust their positions autonomously. The system also features a cloud IoT technology controlling up to three motorized wheelchair actuators and inhibiting sensors for each seat function. Additionally, it includes a sensor module with the MPU-6050 IMU, equipped with a 3-axis gyroscope sensor and a 3-axis accelerometer on the same chip.

On the software side, the electronic system integrates with a smartphone app, enabling users to monitor and control their wheelchair positions seamlessly. The app serves as a user-friendly interface for adjusting the tilt and recline functions, providing real-time feedback, and enhancing the overall user experience. This comprehensive electronic system not only addresses the biomechanical parameters and usability of the technology but also considers the daily context of wheelchair users, making it adaptable and transportable for practical use in preventing pressure on the seat.

The methodological process comprised stages such as designing experiments, developing assessment protocols, user experience assessments through questionnaires, formative assessment interviews, and final assessments of prototypes. The protocol included ethical considerations and data analysis methods, involving the application of the System Usability Scale (SUS) and After-Scenario Questionnaire (ASQ). The study culminated in the development of the CONTAV and MOVITA prototypes, demonstrating an interdisciplinary approach involving an occupational therapist and engineers specializing in interactive technologies. The prototype architecture integrates IMU sensors, cloud technology, and an embedded computer for processing and transmitting data, creating an intelligent system for telemonitoring motorized wheelchair positions.

Limitations of the study include the preliminary nature of methods and assumptions, suggesting that technical assessment from a causal perspective might be more suitable for long-term observational data in the real world than clinical trials. The proposed components for monitoring through an electronic system were preliminarily assessed with a simple evaluation method based on a typical clinical prescription, providing relatively objective results. However, the study acknowledges potential weaknesses, such as the absence of an assessment of the system in actual practice with wheelchair users and the need for large-scale evaluations. The study emphasizes the importance of considering the daily life characteristics of users beyond technical specifications for effective assistive technology systems.

Conclusions/action items:

In conclusion, the technologies employed in the proposed system, particularly IMU sensors in an IoT solution, were highlighted for their role in providing alternatives for tilting and reclining functions in wheelchairs via a smartphone app. The study suggests potential benefits for telemonitoring and real feedback, enhancing the quality of health services for wheelchair users. The preliminary results indicate the need for further studies, focusing on the influence of constant monitoring on rehabilitation, user behavior regarding pressure injury prevention, and the effects of postural changes on wheelchair functionality. The study emphasizes ongoing user experience improvement, co-design approaches, and plans to implement the system in a larger wheelchair-user community.

Action Items:

- Client Meeting 2/17/24

- Advisor meeting 2/17/24

- Organize team meetings more efficiently

- Begin looking at materials selection, cost analysis, and circuit integration

2/15/2024 Postural Control Research VII

Title: Postural Control Research VII

Date: 2/15/2024

Content by: Jayson O'Halloran

Resources: [7] Gouwanda, Darwin, and et.al. "Determining Level of Postural Control in Young Adults Using Force-Sensing Resistors | IEEE Journals & Magazine | IEEE Xplore." Ieeexplore.ieee.org, 2017, ieeexplore.ieee.org/abstract/document/5744119?casa_token=JDc8-kqdVI4AAAAA:QXub4y6TOWTpNeGoBrKT3zbQZWpFLXfuLYPF7-f0sJXgyVXv99p3WFkduhe3GmMOhc_QKtXbmA. Accessed 15 Feb. 2024.

Goals: To understand more about postural control in wheelchair users, along with how a dynamic footrest sensor integrates postural control into its interface.

Content:

Key Points:

1. Signal Conditioning and Switching Circuit:

- Force-sensing resistors (FSRs) output was connected to noninverting operational amplifiers for signal amplification.

- Amplifiers were organized into four quadrants on the board, each controlled by a multiplexer for switching channels.

- The overall architecture of the signal conditioning and switching circuit interfaced with the host computer.

2. Data Acquisition:

- The host computer sampled the instrumented platform using a data-acquisition card (National Instrument's PCI-MIO-16E-1).

- Analog signals were digitized at 200 Hz with a data resolution of 12 bits.

- Data logging was facilitated through an interactive graphical user interface (IGUI) in LabVIEW, and post-acquisition analysis was conducted in MATLAB.

3. BOSU Balance Training Platform:

- The BOSU balance trainer is a device for balance training, with technical drawings provided.

- The force-sensing platform (FSP) was mounted on the BOSU surface for assessing human postural control in dynamic conditions.

4. Functionality and Data Storage:

- Fig. 3 summarizes the functionality (online and offline) and data storage capability of the system.

- Data-acquisition files are stored in spreadsheets (tab-delimited) for further analysis.

5. Real-Time and Offline Data Representation:

- Real-time visual feedback used a rainbow color scale for qualitative assessment of postural control and pressure points.

- Moving average filtering was applied for real-time data smoothing.

- Off-line analysis involved retrieving stored signals and applying a thresholding algorithm to identify redundant data points and foot boundaries.

6. Post-acquisition Analysis:

- Pressure concentration regions (Weighted Center of Applied Pressure, COP) were identified using coordinates in both ML (Medio-Lateral) and AP (Antero-Posterior) anatomical planes.

- COP coordinates were calculated per data sweep (122 sensors) and monitored throughout the entire dataset.

7. Visualization and Interpretation:

- Fig. 4 shows a snapshot of the IGUI displaying real-time foot patterns and a reproduced foot boundary with the migration of the weighted center of applied pressure over time.

- Fig. 5 provides a sectioned view of the FSP, illustrating the arrangement of four FSRs and the resultant force (Fy) when FSRs are pressed.

Conclusions/action items:

The results obtained demonstrated the sensitivity of the developed system toward changes made in the postural control system. This makes the FSP a reliable device for measuring proprioceptive control of individuals (in static and dynamic conditions). The FSP can be readily incorporated as part of a balanced exercise to monitor performance optimization, injury prevention, and rehabilitation. Individuals with or without balance disorder could benefit by relying on the measurements of the system to identify, correct, monitor, and suggest improvements for problems with the proprioception response of the feet, which influences postural control and occurrences of foot-related injuries.

Action Items:

- Client Meeting 2/17/24

- Advisor meeting 2/17/24

- Organize team meetings more efficiently

- Begin looking at materials selection, cost analysis, and circuit integration

2/20/2024 Muscular Dystrophy Research VIII

JAYSON O'HALLORAN - Feb 23, 2024, 2:00 PM CST

Title: Muscular Dystrophy Research VIII

Date: 2/20/2024

Content by: Jayson O'Halloran

Resources: [8] Mayo Clinic, “Muscular Dystrophy - Symptoms and Causes,” Mayo Clinic, Feb. 11, 2022. https://www.mayoclinic.org/diseases-conditions/muscular-dystrophy/symptoms-causes/syc-20375388

Goals: To understand more about muscular dystrophy.

Key Points about Muscular Dystrophy:

1. Overview:

- Group of diseases causing progressive muscle weakness and loss of mass.
- Abnormal genes interfere with protein production for healthy muscles.
- Various types, with symptoms appearing in childhood or adulthood.

2. Symptoms:

- Main sign is progressive muscle weakness.
- Duchenne type: Common in boys, signs include falls, difficulty rising, waddling gait.
- Becker type: Similar symptoms, milder and slower progression, often starting in teens.
- Other types affect specific muscle groups and have varied onset times.

3. Causes:

- Genetic mutations in genes involved in muscle fiber protection.
- Each type caused by a specific genetic mutation, often inherited.

4. Risk Factors:

- Occurs in both sexes and all ages and races.
- Duchenne type more common in young boys.
- Family history increases the risk.

5. Complications:

- Progressive muscle weakness leads to walking and arm-use difficulties.
- Contractures, breathing problems, scoliosis, heart issues, and swallowing problems are potential complications.

6. Management:

- No cure, but medications and therapy can help manage symptoms and slow disease progression.

Conclusions/action items:

In conclusion, muscular dystrophy, a group of genetically linked diseases causing progressive muscle weakness, lacks a cure but can be managed through medications and therapy. Timely medical intervention, genetic understanding, and counseling play vital roles in addressing this condition. The complications associated with muscle weakness underscore the need for comprehensive care, highlighting the importance of ongoing research and medical advancements. While challenges persist, resources from institutions like Mayo Clinic offer valuable support, contributing to an improved quality of life for those affected. Collaborative efforts within the medical community remain essential in the pursuit of effective treatments and, ultimately, a potential cure for this challenging set of disorders.

Action Items:

- Client Meeting the following week

- Advisor meeting 2/27/24

- Team meeting 2/27/24

- Preliminary Presentation

2/23/2024 Materials Selection Research IX

JAYSON O'HALLORAN - Feb 27, 2024, 11:15 AM CST

Title: Materials Selection Research IX

Date: 2/23/2024

Content by: Jayson O'Halloran

Resources: [9] “Footrest Options to Support Function and Mobility,” www.motioncomposites.com. https://www.motioncomposites.com/en_us/community/blog/tips-and-tricks/footrest-options-to-support-function-and-mobility#:~:text=Materials%20range%20from%20ABS%20and (accessed Feb. 27, 2024).

Goals: To dive into the materials selection process for wheelchair footrests.

Content:

Footrests play a crucial role in wheelchair seating, positioning, and functional independence. Proper footrest length is essential for distributing weight evenly across the seat cushion to prevent pressure injuries. If the footrest is too short, pressure can concentrate on bony prominences like the ischial tuberosities, increasing the risk of pressure ulcers. Conversely, if it's too long, it can compromise posture and stability, leading to discomfort and potential sliding forward in the chair, which increases the risk of pressure ulcers on other bony prominences like the coccyx.

Proper footrest length not only ensures optimal seating and positioning but also impacts stability and the ability to perform activities of daily living (ADLs) independently. Improper foot support can lead to discomfort, poor posture, and decreased function, requiring additional stabilization efforts during functional activities.

Footrest selection should consider the wheelchair configuration and transfer styles. Features like swing-away, flip-up, and flip-back footrests accommodate various transfer methods, promoting safety and independence. Adjustable footrests with features like anterior and posterior tilt, medial and lateral tilting, depth adjustment, and height adjustment fine-tune support for lower limbs, accommodating anatomical variations and specific needs.

Materials like ABS, aluminum, carbon fiber, and steel offer durability and varying degrees of support. Motion Composites provides a range of footrest configurations tailored to individual needs, including options for rigidity, folding, and specialty requirements like high mount or residual limb support. These features ensure users receive optimal support without unnecessary additions.

Footrests can be fixed or removable. To shorten the length of the wheelchair in tight spaces such as elevators, it is better that they are removable. If there are no space problems it is more advisable that the footrests will be fixed as they are less fragile. The ideal position places the ankle in an anatomical position of 90º. However, in adults, the feet can interfere with the rotation of the front wheel rotation, so the angle tends to reduce. The most frequent angles are 90º, 70º and 60º.

Elevating leg support elevates the set of the leg, to adopt more comfortable postures. They are widely used in wheelchairs with reclining backrests. The footrest platforms are usually composite. They may be doubles or a single platform, with or without straps (for the heel or the forefoot). Usually, the angle between the footrest and the platforms is 90º, but many platforms have the possibility of adjusting this angle to adapt to the specific needs of the users.

Material Propeties:

ABS (Acrylonitrile Butadiene Styrene):

- Tensile Strength: 40 - 60 MPa
- Yield Strength: 35 - 50 MPa
- Elongation at Break: 2% - 50%
- Flexural Modulus: 1,500 - 3,000 MPa
- Hardness (Rockwell): R100 - R110
- Density: 1.04 - 1.07 g/cm³

Aluminum (Aluminum Alloy 6061-T6):

- Tensile Strength: 310 MPa
- Yield Strength: 276 MPa
- Elongation at Break: 8%
- Flexural Modulus: 68.9 GPa
- Hardness (Brinell): 95 HB
- Density: 2.70 g/cm

Carbon Fiber:

- Tensile Strength: 1,700 - 3,500 MPa (varies with fiber type and orientation)
- Yield Strength: Typically does not exhibit a distinct yield point (elastic modulus is more commonly used)
- Elongation at Break: 0.5% - 2.5%
- Flexural Modulus: 70 - 300 GPa (varies widely based on fiber content and orientation)
- Density: 1.5 - 1.8 g/cm³ (depends on the resin matrix and fiber content)

Steel (ASTM-36)

- Tensile Strength: 400 - 550 MPa
- Yield Strength: 250 MPa (min)
- Elongation at Break: 20% (in 200 mm)
- Modulus of Elasticity (Young's Modulus): 200 GPa
- Brinell Hardness: 119 - 162 HB
- Density: 7.85 g/cm³

Conclusions/action items:

In conclusion, as of right now, a combination of ABS (Acrylonitrile Butadiene Styrene) & Aluminum stands as the best material for our low interface wheelchair footrest designed with electronics. Its combination of moderate strength, impact resistance, and lightweight properties make it well-suited for supporting proper seating and positioning without compromising mobility. Considering our client's needs and affordability, we as a team need to utilize the best material that has good mechanical properties and can easily be transported/folded. ABS's flexibility and resilience cater to the user's comfort and safety, while its adaptability facilitates seamless integration of electronic components. The material's durability ensures a longer lifespan for the footrest, making ABS a balanced and pragmatic choice that aligns with the specific requirements of a low interface wheelchair footrest aiming to enhance both mechanical functionality and electronic adaptability.

Action Items:

- Client Meeting the following week

- Advisor meeting 2/27/24

- Team meeting 2/27/24

- Preliminary Presentation & Report

2/29/2024 Muscular Dystrophy II Research X

JAYSON O'HALLORAN - Mar 08, 2024, 11:43 AM CST

Title: Muscular Dystrophy II Research X

Date: 2/29/2024

Content by: Jayson O'Halloran

Resources: [10] P. K. Thada, J. Bhandari, and K. K. Umapathi, “Becker Muscular Dystrophy,” PubMed, 2022. https://www.ncbi.nlm.nih.gov/books/NBK556092/#:~:text=Becker%20muscular%20dystrophy%20(BMD)%20is (accessed Feb 29 2024)

Goals: To learn more about Becker's Muscular Dystrophy.

Key Points about Becker's Muscular Dystrophy:

0. Abstract: Becker Muscular Dystrophy (BMD) is an X-linked recessive disorder caused by a dystrophin gene mutation, leading to progressive muscle degeneration, particularly affecting the proximal lower limb muscles. It is less severe than Duchenne Muscular Dystrophy (DMD), with later onset of symptoms, ranging from 5 to 60 years of age. BMD is managed through supportive care, and rehabilitative measures are crucial for maintaining long-term function.

1. Pathophysiology and Symptomatology: BMD results from mutations in the dystrophin gene, causing dystrophin deficiency or dysfunction. This leads to muscle weakness and degeneration, with symptoms appearing later than in DMD.

2. Etiology: BMD is an X-linked recessive disorder with gene mutations in the dystrophin gene located on the Xp21.2 chromosome. Mutations result in in-frame changes, leading to a broader phenotypic presentation compared to DMD.

3. Epidemiology: BMD is a rare disease, predominantly affecting males. Its prevalence ranges from 0.1 to 1.8 per 10,000 male individuals globally. It is considered less common and less severe than DMD.

4. Clinical Presentation: Symptoms include exercise-induced muscle weakness, fatigue, and progressive muscle weakness. Onset varies, with some individuals remaining ambulant until adulthood. Cardiomyopathy, joint contractures, and respiratory failure may develop in later stages.

5. Evaluation: Diagnosis involves assessing proximal limb muscle weakness, elevated creatine kinase (CK) levels, and genetic analysis for dystrophin gene mutations. Other tests may include electromyography, muscle biopsy, and imaging studies.

6. Treatment/Management: There is no cure for BMD. Supportive therapy includes corticosteroids to delay cardiomyopathy onset, and rehabilitation is essential for preserving muscle function. Surgical interventions may be considered for scoliosis or joint contractures. Emerging treatments and gene therapy are under investigation.

7. Prognosis: BMD has a milder course than DMD, but survival decreases with disease progression.

8. Complications: Potential complications include loss of ambulation, cognitive dysfunction, growth impairment, fractures, cardiomyopathy, joint contractures, scoliosis, and respiratory failure.

9. Deterrence and Patient Education: Genetic counseling is crucial for families with known dystrophin gene mutations. Education on family planning options and inheritance patterns is essential. Regular follow-ups, immediate treatment for new symptoms, and understanding treatment options and potential side effects are emphasized.

10. Wheelchair Usage: Wheelchair usage is important in BMD, especially as the disease progresses and ambulation becomes challenging. Collaborative, multidisciplinary care involving physical, speech, recreational, and occupational therapy is crucial to optimize patient outcomes and improve their quality of life.

Conclusions/action items:

In conclusion, Becker Muscular Dystrophy (BMD) poses a complex challenge necessitating a multidisciplinary approach for comprehensive management. With its roots in dystrophin gene mutations, BMD manifests as progressive muscle degeneration, impacting individuals later in life compared to its more severe counterpart, Duchenne Muscular Dystrophy (DMD). This paper underscores the pivotal role of early genetic analysis in diagnosis and highlights the importance of ongoing supportive care, including rehabilitative interventions and pharmacological therapies. Collaborative efforts among healthcare professionals are crucial in addressing the varied clinical presentations and complications associated with BMD. While emerging treatments and gene therapies offer hope for the future, the current focus remains on personalized care, emphasizing an interdisciplinary approach to enhance the quality of life for those living with Becker Muscular Dystrophy.

Action Items:

- Preliminary Presentation 3/01/24

-Client Meeting 3/02/24.

3/03/2024 Linear Actuator Research XI

JAYSON O'HALLORAN - Mar 08, 2024, 11:58 AM CST

Title: Linear Actuator Research XI

Date: 3/03/24

Content by: Jayson O'Halloran

Resources: [11]“Linear Actuators 101 - Everything You Need to Know About Linear Actuators,” Firgelli Automations. https://www.firgelliauto.com/blogs/actuators/linear-actuators-101 (accessed March 3 2024)

Goals: To understand the complete mechanism of a Linear Actuator

Content:

A linear actuator is a device that transforms the rotational motion of an AC or DC motor into linear motion, capable of providing both push and pull movements. This versatile tool finds applications in various scenarios, ranging from industrial settings to home automation. Electric linear actuators consist of a motor, gears, and a lead screw, with applications ranging from motorized hatches to kitchen appliance lifts. Lifting columns, a subtype of linear actuators, offer extended strokes and integrated linear guiding. Micro-linear actuators, on the other hand, are suitable for limited spaces and small strokes (possibly including our design project). This article emphasizes the advantages of electric linear actuators over hydraulic systems, citing their energy efficiency, low maintenance, and precise motion control. Examples of real-world applications include damper control, height-adjustable workstations, and home automation tasks like moving TVs or projectors. The importance of limit switches in linear actuators is highlighted, preventing overextension and motor damage. Factors influencing actuator failures, such as improper loading and installation, are discussed, along with synchronization challenges in using multiple actuators. When it comes to linear actuators there seems to be a future in using them in more settings such as smart sensors, advanced control systems, wireless connectivity, energy harvesting, self-diagnostic capabilities, and noise reduction, to enhance performance, convenience, sustainability, and safety.

Example of a Linear Actuator:

Conclusions/action items:

Conclusions related to our design project:

- Enhanced Mobility: Linear actuators can play a pivotal role in improving the mobility of wheelchairs by enabling precise and customizable adjustments, particularly in footrest positioning.

- Seamless Adjustments: The technology's ability to convert rotational motion into linear movement allows for effortless forward and backward adjustments, providing wheelchair users with a smooth and controlled experience.

- Customizable Experience: Electric linear actuators contribute to a more personalized and comfortable user experience, allowing individuals to tailor the position of footrests according to their specific needs and preferences.

- Ease of Installation: Linear actuators offer a user-friendly installation process, especially when compared to hydraulic or pneumatic systems. Their compact design and minimal space requirements make them a practical choice for wheelchair applications.

- Energy Efficiency: In contrast to hydraulic systems, electric linear actuators are energy-efficient, contributing to a longer lifetime with little to no maintenance. This ensures a low total operating cost, making them a cost-effective solution for wheelchair design.

- Future Advancements: Future features such as smart sensors, advanced control systems, wireless connectivity, energy harvesting, and self-diagnostic capabilities hold the potential to further enhance the performance, convenience, sustainability, and safety of linear actuators in wheelchair applications.

Action Items:

- Preliminary Report 3/08/24

- Team meeting 3/08/24

- Advisor meeting 3/08/24

3/09/2024 Water Jet Research XII

JAYSON O'HALLORAN - May 02, 2024, 10:54 PM CDT

Title: Water Jet Research XII

Date: 3/09/24

Content by: Jayson O'Halloran

Resources: [12] "The Process of Water Jet Cutting Explained," www.performancewaterjet.com.au. https://www.performancewaterjet.com.au/how-waterjet-works (accessed Mar 9, 2024)

Goals: To understand how water jetting can be used to cut metal.

Content:

Steps

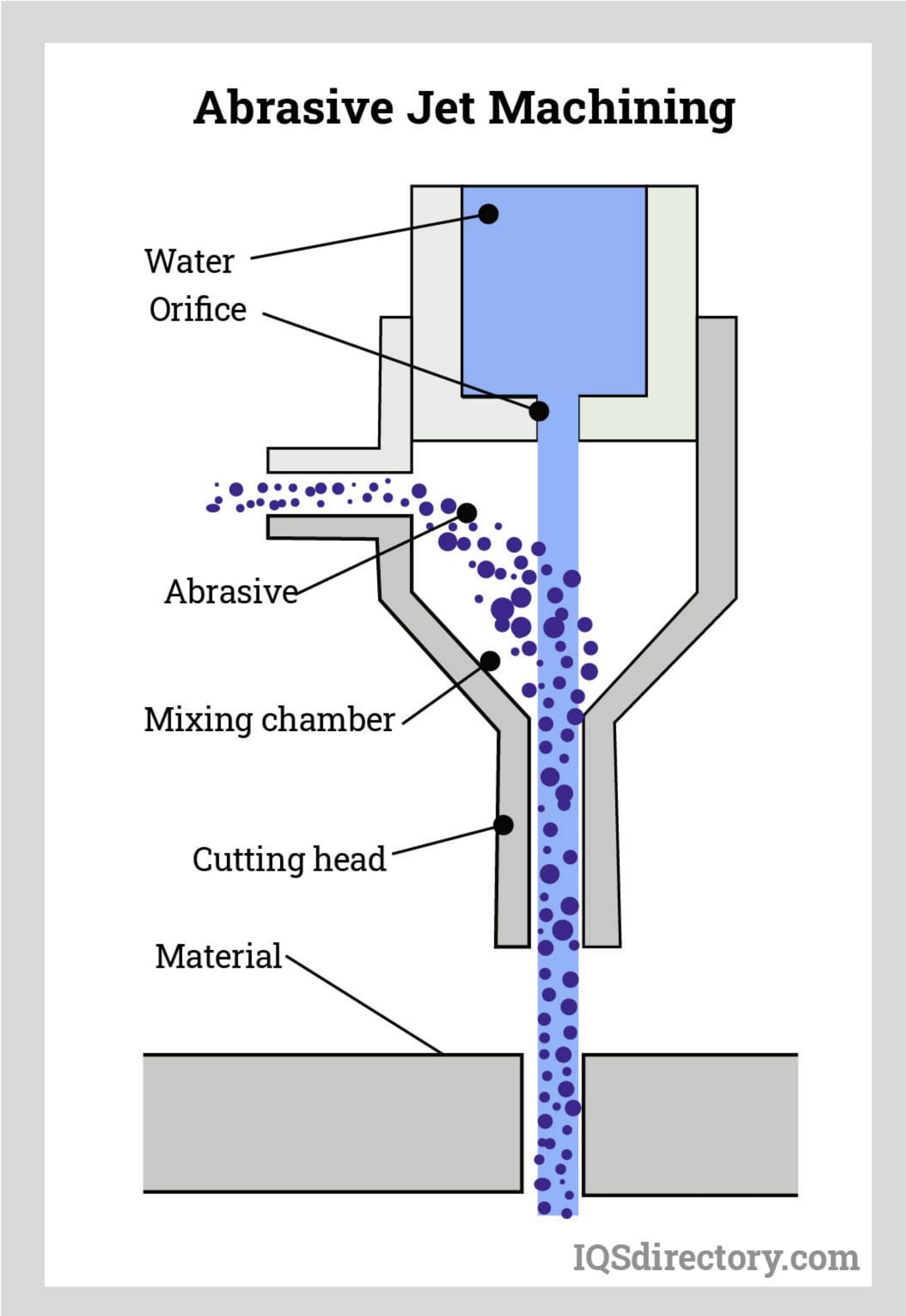
Water jet cutting is an efficient method for precisely cutting aluminum sheets that are 1/4 inch thick. To begin, one needs to ensure the water jet cutting machine is accurately calibrated for aluminum cutting, utilizing a specialized nozzle for metal cutting and potentially incorporating abrasive materials like garnet into the water stream to enhance cutting efficiency.

Before cutting, thoroughly cleanse the aluminum surface to eliminate any contaminants that could impede the process, guaranteeing a smooth and precise cut. Subsequently, create your cutting design using computer-aided design (CAD) software, allowing for the generation of precise shapes and dimensions. Transfer the finalized design to the control software of the water jet cutting machine.

Adjust the cutting parameters based on the aluminum thickness and desired cutting speed. In our case, our 12-inch by 12-inch sheet that is 1/4 1/4-inch aluminum, a higher cutting speed might be appropriate to maintain efficiency while ensuring a clean cut. Position the aluminum sheet securely on the cutting bed to prevent displacement during cutting.

Initiate the cutting process, and the water jet machine will accurately trace the programmed design, directing a high-pressure stream of water mixed with abrasive material onto the aluminum sheet. The abrasive water jet swiftly penetrates the aluminum, leaving behind a precise edge.

Upon completion of the cutting process, cautiously remove the cut aluminum pieces from the cutting be and if necessary, deburr to eliminate any sharp edges.



Conclusions/action items:

In conclusion, water jet cutting emerges as an excellent choice for cutting aluminum due to its precision, efficiency, and versatility. By leveraging high-pressure water streams augmented with abrasive materials, water jet machines can accurately cut aluminum sheets measuring 1/4 inch in thickness, producing smooth and clean edges. This method offers advantages such as minimal material distortion, reduced heat-affected zones, and the ability to create intricate shapes with ease. Additionally, water jet cutting eliminates the need for secondary finishing processes, saving time and resources. Overall, the use of water jet cutting for aluminum proves to be a cost-effective and reliable solution for a wide range of applications in various industries.

Action Items:

- Preliminary Report is finished

- Materials finalizing

3/18/2024 Wheelchair Types Research XIII

JAYSON O'HALLORAN - May 02, 2024, 11:10 PM CDT

Title: Wheelchair types Research XIII

Date: 3/18/24

Content by: Jayson O'Halloran

Resources: [13] Author 1800WheelChair, "The Different Types of Wheelchairs Explained," Wheelchair & Mobile Scooter Info | 1800wheelchair.com |, Aug. 26, 2022. https://www.1800wheelchair.com/news/the-different-types-of-wheelchairs-explained/ (accessed Mar 20, 2024).

Goals: To understand the different types of wheelchairs and their applications.

Content:

The wheelchair industry has evolved significantly, offering a wide array of designs and functionalities to cater to diverse needs. Understanding the various types of wheelchairs can streamline the selection process, ensuring individuals find the most suitable option. Wheelchairs are broadly categorized into manual, power, and transport wheelchairs, each serving distinct purposes and demographics.

Manual wheelchairs encompass lightweight models like the featherweight wheelchair, ideal for effortless transportation and storage. Standard weight options like the Invacare Tracer EX2 provide durability and versatility while reclining models such as the Pro Basics offer added comfort and positioning options. Heavy-duty variants like the featherweight wide seat HD wheelchair combine strength with a lightweight design, enhancing maneuverability and convenience.

Specialized manual wheelchairs cater to specific needs, such as the Quickie 5R for rigid ultra-lightweight performance and the Quickie Titanium Match Point for sports like tennis (similar to the wheelchair we are using this semester for our design project). For outdoor activities, beach wheelchairs like the Mobi-Chair offer mobility on sand and in water, while pediatric models like the Ziggo Lightweight cater to children's unique requirements.

Innovative designs like the Aquatic Ocean Ergo shower chair commode enhance accessibility in bathroom settings. Commercial-use wheelchairs like the heavy-duty transport wheelchair ensure reliable mobility in transit environments.

Power wheelchairs provide enhanced independence, with lightweight options such as the featherweight electric wheelchair offering portability and convenience. Folding/portable models like the Move Lite Folding Power Chair are compact and travel-friendly, while outdoor variants like the eVolt Traveler excel in navigating rough terrain. Heavy-duty power chairs like the Golden Compass prioritize comfort and durability for daily use.

Transport wheelchairs offer lightweight and compact solutions for easy transportation, with options like the Drive Aluminum Transport Wheelchair designed for comfort and convenience. Travel chairs like the Nissin Lightweight Travel Chair are ideal for frequent travelers, while heavy-duty models like the Nova Transport Chair ensure durability and stability.

When selecting a wheelchair, factors such as manual vs. electric operation, budget, and comfort must be considered. Footrests play a crucial role in ensuring comfort and support, particularly during extended periods of use. Prioritizing comfort, researching options, and trying out different models can help individuals find the perfect wheelchair to meet their specific needs and enhance their quality of life.

Conclusions/action items:

In conclusion, the diverse range of wheelchairs available today offers tailored solutions to meet the unique needs of individuals with mobility challenges. Whether it's lightweight manual options for easy transport, power chairs for enhanced independence, or transport wheelchairs for compact mobility solutions, there's a wheelchair suited for every lifestyle. By considering factors such as comfort, functionality, and intended use, individuals can make informed decisions to improve their mobility and quality of life. With footrests playing a significant role in ensuring comfort and support, the comprehensive variety of wheelchairs empowers individuals to find the perfect fit for their specific requirements, enabling greater mobility and independence.

Action Items:

- Order materials after spring break

4/05/2024 Codes and Standards Final Research XIV

JAYSON O'HALLORAN - May 02, 2024, 11:27 PM CDT

Title: Codes and Standards Final Research XIV

Date: 4/5/24

Content by: Jayson O'Halloran

Resources: [14] R. Russotti, “Assistive Device Standards for Wheelchairs,” The ANSI Blog, Nov. 18, 2015. https://blog.ansi.org/assistive-device-standards-for-wheelchairs/ (accessed Apr 5, 2024).

Goals: To understand the different types of codes and standards when it comes to electrically powered wheelchairs.

Content:

Standards

1. ISO 7176-1:2014 - Determination of static stability: This standard outlines test methods for assessing the static stability of wheelchairs, including manual and electric models. It covers aspects such as tipping angles and requirements for test reports.

2. ISO 7176-2:2017 - Determination of dynamic stability of electric wheelchairs: This standard specifies test methods for evaluating the dynamic stability of electrically powered wheelchairs, including scooters. It ensures these devices meet safety standards during operation.

3. ISO 7176-3:2012 - Determination of effectiveness of brakes: This standard provides test methods for measuring the effectiveness of brakes on both manual and electric wheelchairs. It ensures these devices can safely stop and prevent accidents.

4. ISO 7176-4:2008 - Energy consumption of electric wheelchairs: This standard outlines methods for determining the theoretical distance range of electrically powered wheelchairs based on energy consumption. It helps users understand the wheelchair's battery life and capacity.

5. ISO 7176-5:2008 - Determination of dimensions, mass, and maneuvering space: This standard specifies methods for determining wheelchair dimensions, mass, and maneuvering space required for daily life activities. It ensures wheelchairs are appropriately sized and maneuverable for users' needs.

Codes:

1. ANSI/RESNA WC/VOL. 1: Section 19 - Requirements for Power Wheelchairs: This ANSI/RESNA standard provides comprehensive requirements for the design, construction, and performance of power wheelchairs, ensuring they meet safety and quality standards for users.

2. ANSI/RESNA WC/VOL. 2: Section 21 - Requirements and Test Methods for Wheelchair Seating: This standard addresses the requirements and test methods for wheelchair seating, including those used in motorized wheelchairs. It ensures proper support and comfort for users during operation.

3. ANSI/RESNA WC/VOL. 3: Section 21 - Requirements and Test Methods for Wheelchair Support Surfaces: Focused on support surfaces used in wheelchairs, including motorized ones, this standard sets requirements and test methods to ensure these surfaces promote user comfort and prevent pressure injuries.

4. ANSI/RESNA WC/VOL. 4: Section 21 - Requirements for Power and Control Systems for Wheelchairs: This standard covers the requirements for power and control systems specifically designed for motorized wheelchairs. It ensures the reliability and safety of these systems during operation.

5. ANSI/RESNA WC/VOL. 5: Section 20 - Requirements for Wheelchair Transportation: Addressing the transportation of wheelchairs, including motorized ones, this standard sets requirements for securing wheelchairs during transportation to ensure user safety and accessibility.

Conclusions/action items:

In conclusion, standards and codes play a very important role in ensuring the safety, quality, and accessibility of motorized wheelchairs. Standards such as ISO 7176 and ANSI/RESNA WC/VOL address various aspects of wheelchair design, including stability, braking effectiveness, energy consumption, dimensions, and seating. These standards provide guidelines for manufacturers to adhere to, ensuring that motorized wheelchairs meet rigorous safety and performance criteria. By following these standards and codes, manufacturers can produce wheelchairs that offer users reliable mobility, comfort, and independence, ultimately improving their quality of life.

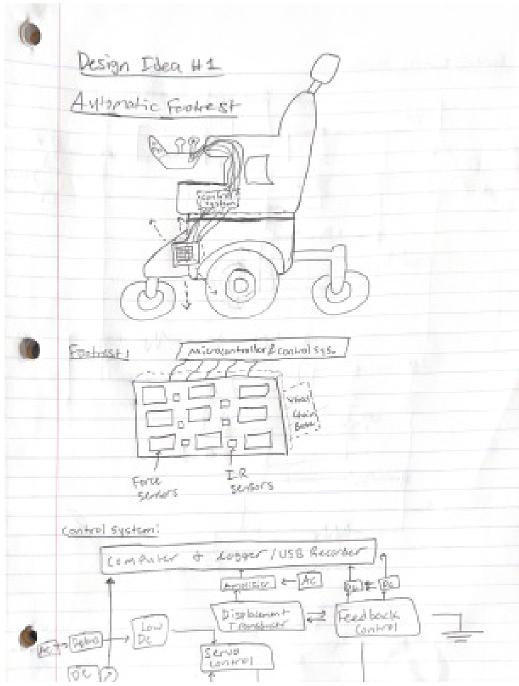
Action Items:

- Continue to get materials

- Finish fabrication before 4/18/24

2/09/24: Design Idea I Automatic Footrest

JAYSON O'HALLORAN - Feb 16, 2024, 12:11 PM CST



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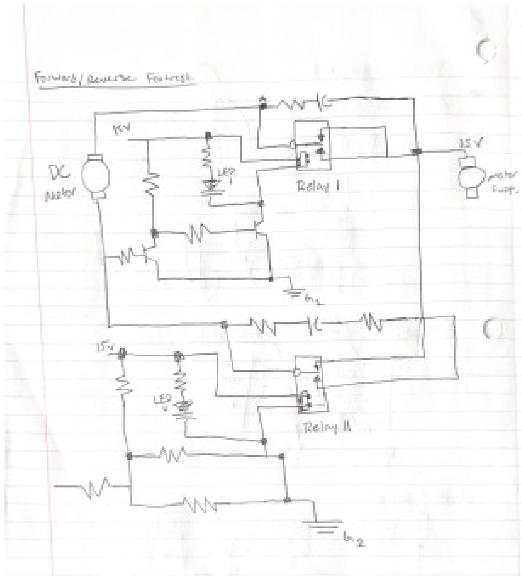
Design_I_.pdf (1.59 MB)

2/09/24: Design Idea I Forward/Reverse Circuit

JAYSON O'HALLORAN - Feb 16, 2024, 12:11 PM CST

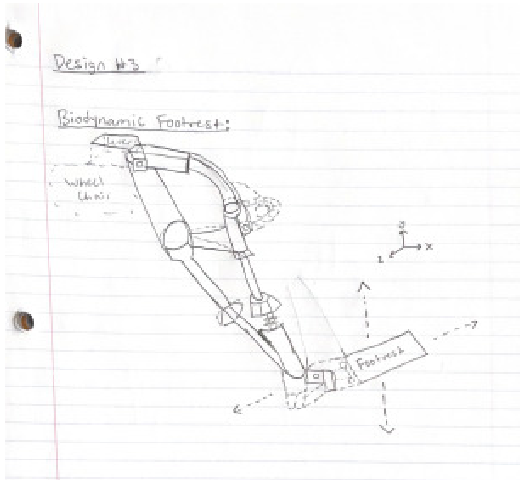


Download

Design_I_Circuit_.pdf (816 kB)

2/09/24 Design Idea II Biodynamic Footrest

JAYSON O'HALLORAN - Feb 16, 2024, 12:11 PM CST



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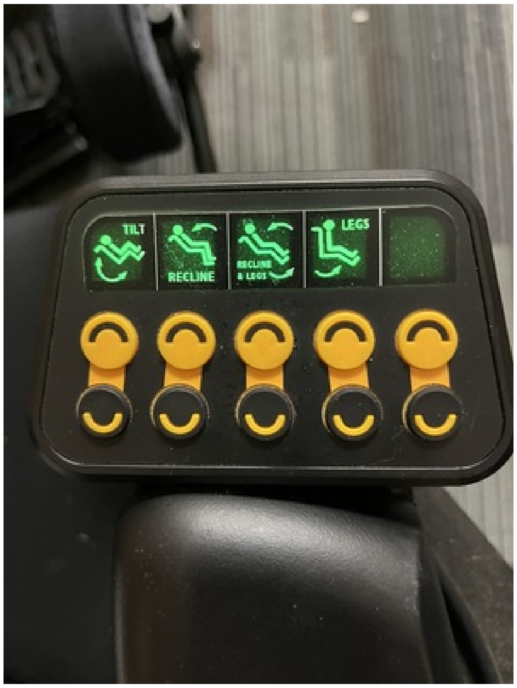
Design_III.pdf (785 kB)

2/15/24 Wheelchair Control Buttons

JAYSON O'HALLORAN - May 02, 2024, 11:04 PM CDT



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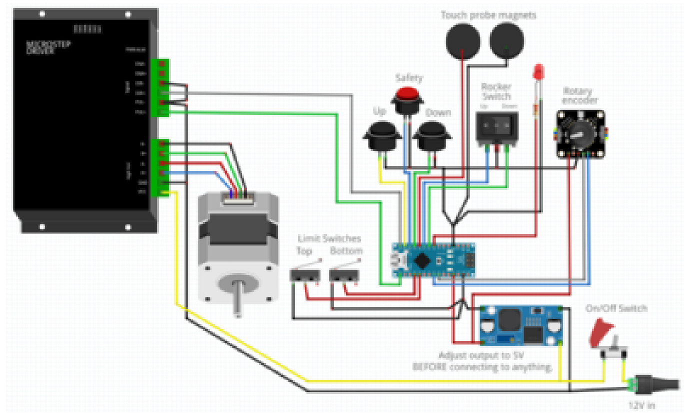
IMG_5277.jpg (2.66 MB)

2/25/24: Design Idea I Updated, Up and Down Movement Schematic

JAYSON O'HALLORAN - Feb 27, 2024, 1:53 PM CST

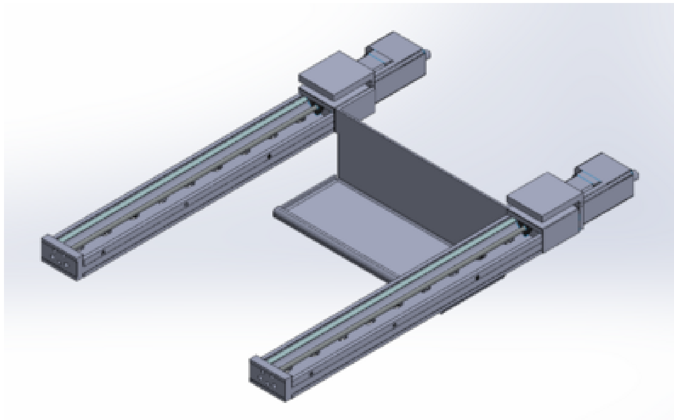


Download

Up_Down_Schematic.png (325 kB)

2/29/24: Design Idea III Linear Actuator Footrest (Old)

JAYSON O'HALLORAN - Mar 08, 2024, 11:33 AM CST



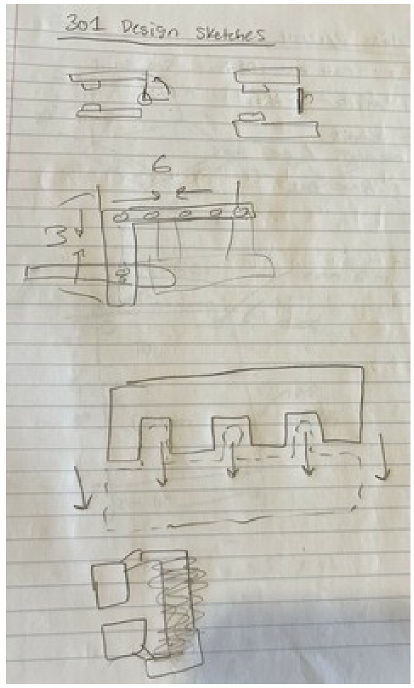
Download

Screenshot_231_.png (116 kB)

3/07/24: Design Idea IV New Linear Actuator Rail Design

3/13/24 Footrest Design(s) I

JAYSON O'HALLORAN - Apr 03, 2024, 2:12 PM CDT



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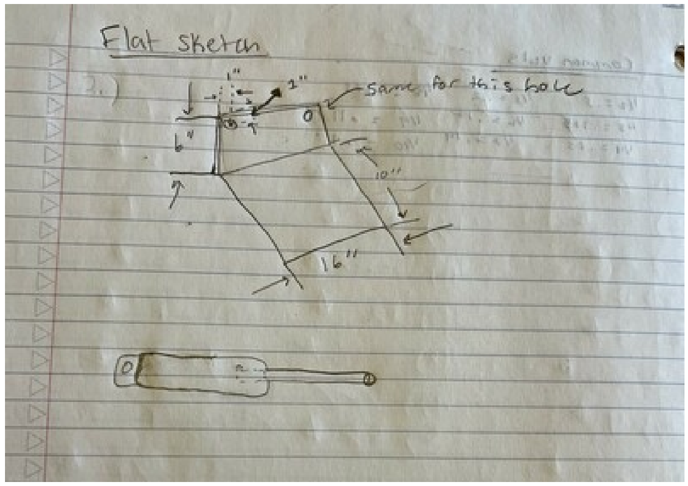
IMG_5397.jpg (1.33 MB)

3/13/24 Footrest Design(s) II

JAYSON O'HALLORAN - Apr 03, 2024, 2:12 PM CDT



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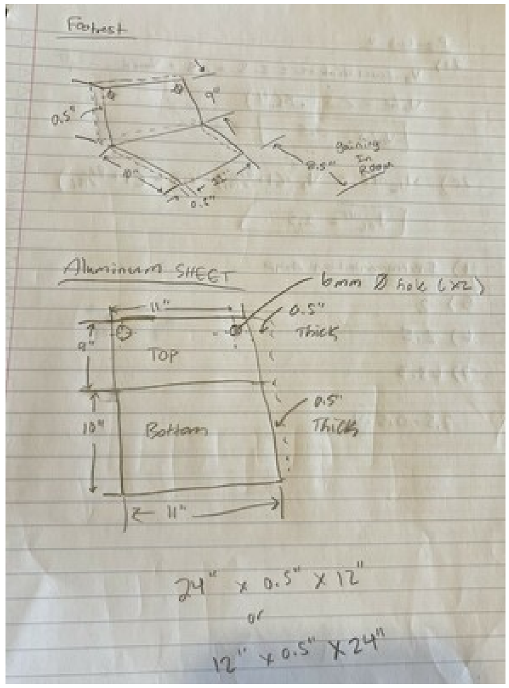
3/15/24 Footrest Design(s) III

JAYSON O'HALLORAN - Apr 03, 2024, 2:13 PM CDT



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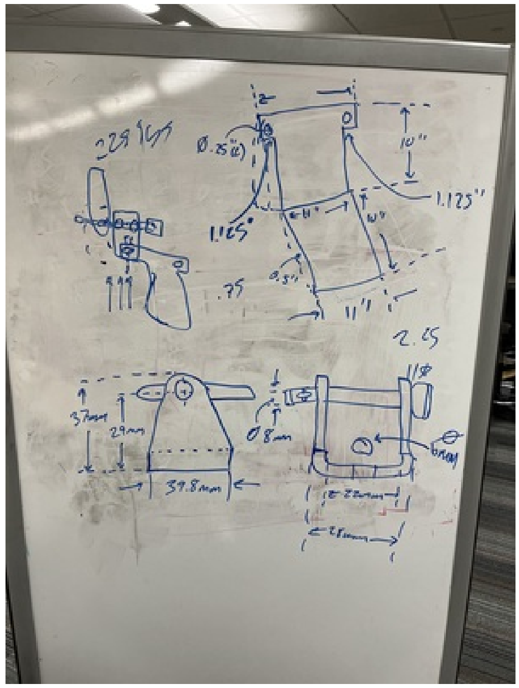
3/19/24 Whiteboard Design Sketch I

JAYSON O'HALLORAN - Apr 03, 2024, 2:14 PM CDT



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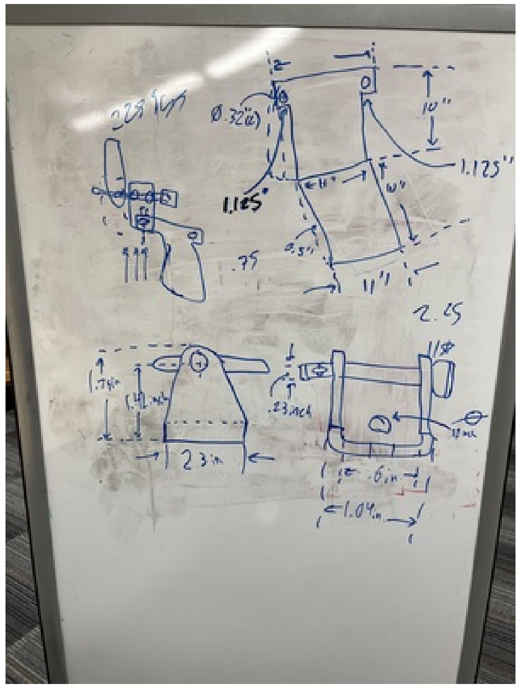
IMG_5358.jpg (3.46 MB)

3/19/24 Whiteboard Design Sketch II

JAYSON O'HALLORAN - Apr 03, 2024, 2:15 PM CDT



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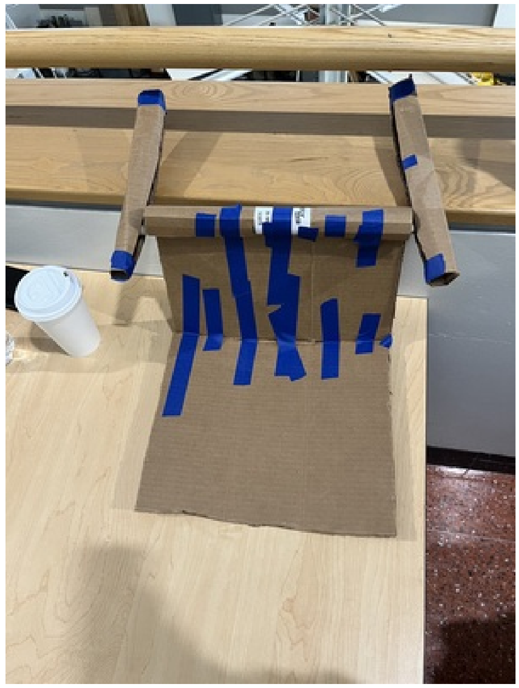
IMG_5359.jpg (3.41 MB)

3/20/24 Prototype Image I

JAYSON O'HALLORAN - Apr 03, 2024, 2:16 PM CDT



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IMG_5361.jpg (4.03 MB)

3/20/24 Prototype Image II

JAYSON O'HALLORAN - Apr 03, 2024, 2:18 PM CDT

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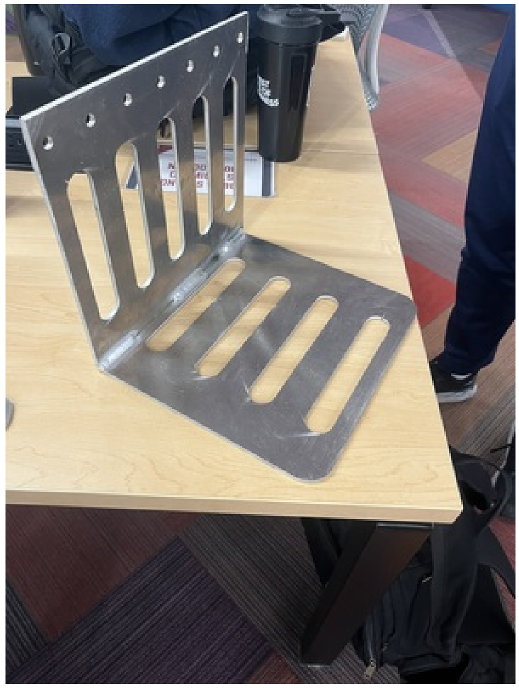
IMG_5362.jpg (3.54 MB)

4/10/24 Aluminum Footrest Image I

JAYSON O'HALLORAN - May 02, 2024, 10:58 PM CDT



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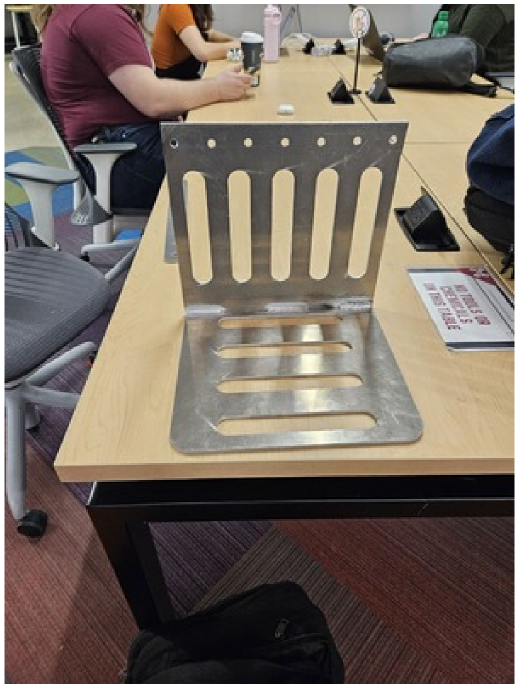
4/10/24 Aluminum Footrest Image II

JAYSON O'HALLORAN - May 02, 2024, 10:59 PM CDT



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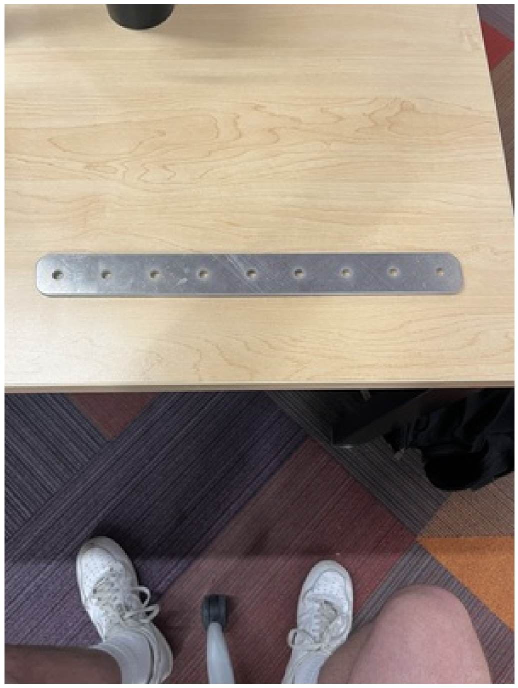
Footrest_301.jpeg (380 kB)

4/10/24 Footrest to Wheelchair Connecting Piece

JAYSON O'HALLORAN - May 02, 2024, 11:01 PM CDT



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IMG_5446.jpg (3.85 MB)

4/11/24 Circuit Box

JAYSON O'HALLORAN - May 02, 2024, 11:02 PM CDT

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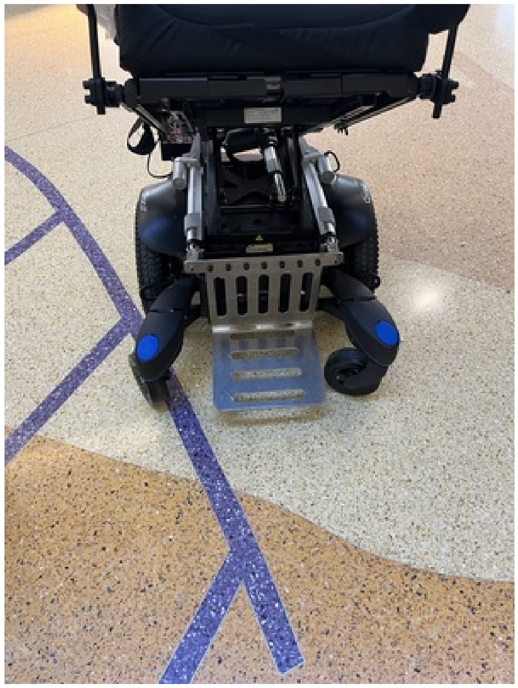
IMG_5442.jpg (1.87 MB)

4/17/24 Final Footrest Design

JAYSON O'HALLORAN - May 02, 2024, 11:03 PM CDT



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IMG_5458.jpg (5.31 MB)

4/19/2024 Testing Code for Extension & Retraction vs Time

JAYSON O'HALLORAN - May 03, 2024, 7:41 PM CDT

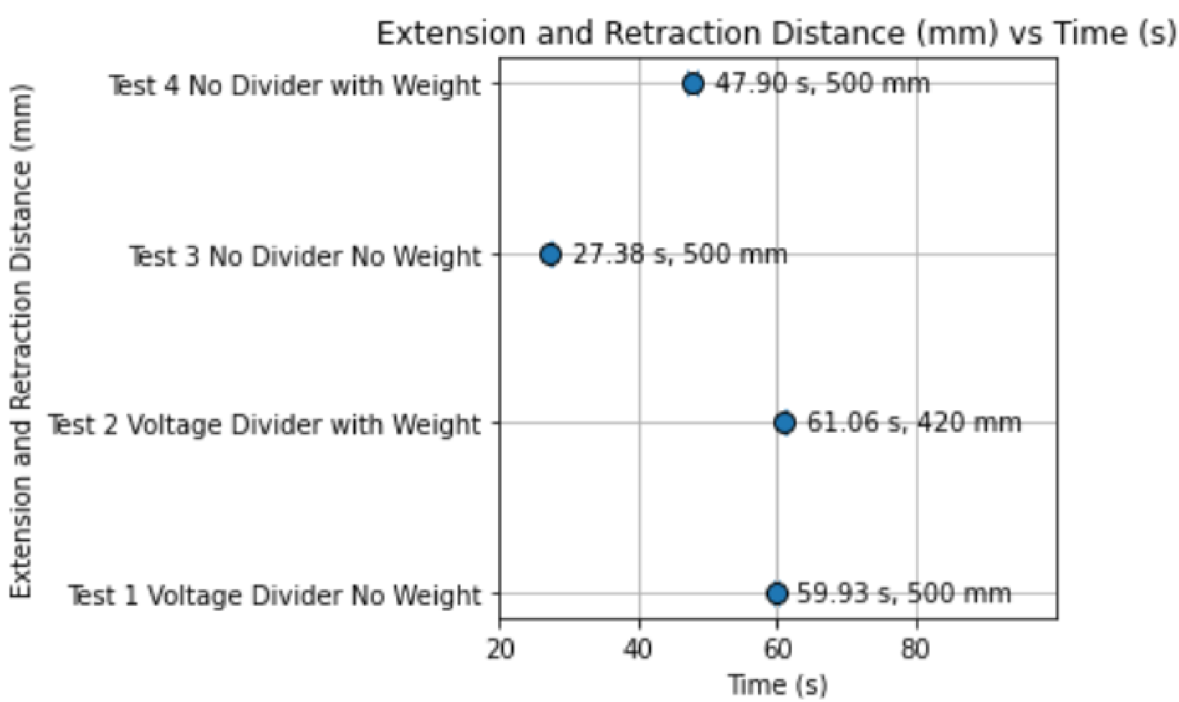
Title: Testing Python Code

Date: 4/19/24

Content:

```
# Plots for BME 301

import numpy as np

import matplotlib.pyplot as plt

from scipy import stats


# Data for each test

test_data = {

    'Test 1 Voltage Divider No Weight': {'distances': [500, 500, 500], 'times': [60, 60.5, 59.3]},

    'Test 2 Voltage Divider with Weight': {'distances': [420, 420, 420], 'times': [61, 60.75, 61.42]},

    'Test 3 No Divider No Weight': {'distances': [500, 500, 500], 'times': [27.4, 27, 27.73]},

    'Test 4 No Divider with Weight': {'distances': [500, 500, 500], 'times': [48, 46.6, 49.1]}

}


# Calculates means and confidence intervals for each test

means = []

std_errs = []


for test, data in test_data.items():

    mean_time = np.mean(data['times'])

    mean_distance = np.mean(data['distances'])

    std_err = stats.sem(data['times'])

    means.append(mean_time)

    std_errs.append(std_err)
```

```
# Plotting

plt.errorbar(means, range(1, 5), xerr=std_errs, fmt='o', capsize=5, markersize=8, markeredgewidth=1,
markeredgecolor='black', linestyle='None')

plt.title('Extension and Retraction Distance (mm) vs Time (s)')

plt.xlabel('Time (s)')

plt.ylabel('Extension and Retraction Distance (mm)')

plt.yticks(range(1, 5), list(test_data.keys()))

plt.xlim(20, 100)

plt.xticks(np.arange(20, 100, 20))

for i, test in enumerate(test_data):

    plt.text(means[i] + 3, i + 1, f'{means[i]:.2f} s, {np.mean(test_data[test]["distances"]):.0f} mm', ha='left', va='center',
fontsize=10)

plt.grid(True)

plt.tight_layout()

plt.show()
```



footrest height

HAOMING FANG (hfang45@wisc.edu) - Feb 02, 2024, 1:16 PM CST

Title: research notes on influences of footrest height

Date: 02/02/2024

Content by: Bobby

Present: NA

Goals: Explore how footrest height affects sitting pressures in paraplegic wheelchair users.

Content:

The article investigates the impact of wheelchair footrest height on sitting pressures in individuals with paraplegia. It demonstrates that elevating the footrest height increases pressure in the ischial tuberosities, which could lead to a higher risk of pressure ulcers. The study utilized 17 manual wheelchair users, examining average pressure, contact surface, and pressures on the left and right ischial tuberosities. Results showed significant increases in pressure with footrest elevation, suggesting the importance of optimizing footrest position to minimize pressure ulcer risk.

Peterson and Adkins suggest setting the footrest slightly higher than the lowest position that allowing the heels to touch, by about half an inch, for proper support. Current guidelines also emphasize the importance of positioning the footrest to ensure both feet and thighs are well supported, with the thighs parallel to the seat, for leg stability and to minimize pressure on the ischial tuberosities. Common issues with footrest positioning often stem from not following the manual's guidance and the absence of professional checks on wheelchair setup by healthcare experts.

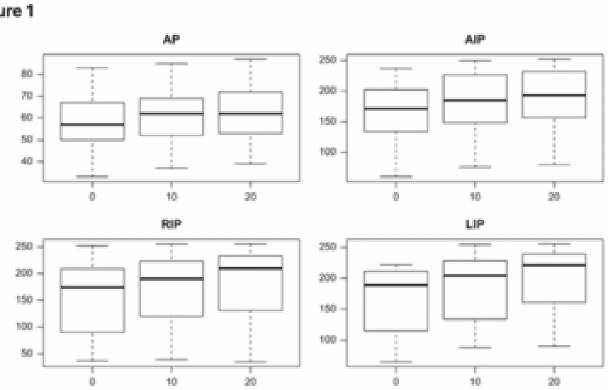
Citation: [1] P. Tederko et al., “Influence of wheelchair footrest height on ischial tuberosity pressure in individuals with paraplegia,” Nature News, https://www.nature.com/articles/sc2014242 (accessed Feb. 2, 2024).

Conclusions/action items:

Elevating the height of wheelchair footrests consistently led to an increase in average interface pressure (AIP), yet the variation in pressure between the left and right sides fluctuated, indicating that the elevation of footrests may lead to an uneven rise in the risk of developing pressure ulcers.

HAOMING FANG (hfang45@wisc.edu) - Feb 02, 2024, 1:11 PM CST

Figure 1



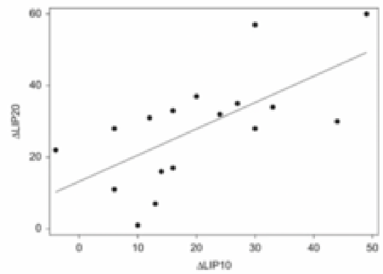
Plots illustrating increases of averaged pressure (AP), averaged ischial pressure (AIP), right ischial pressure (RIP) and left ischial pressure (LIP) between the positions p0, p10 and p20.

Download

螢幕截圖_2024-02-02_下午1.10.26.png (731 kB)

HAOMING FANG (hfang45@wisc.edu) - Feb 02, 2024, 1:12 PM CST

Figure 2



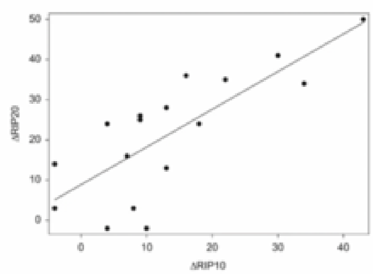
Correlation of relative changes in pressures on the left ischial tuberosity between the footrest position 0 and +10 (ΔLIP10) and 0 and +20 (ΔLIP20). Pearson's correlation coefficient r=0.66 (P=0.04).

[Download]

螢幕截圖_2024-02-02_下午1.12.26.png (431 kB)

HAOMING FANG (hfang45@wisc.edu) - Feb 02, 2024, 1:12 PM CST

Figure 3



Correlation of relative changes in pressures on the right ischial tuberosity between the footrest position 0 and +10 (ΔRIP10) and 0 and +20 (ΔRIP20). Pearson's correlation coefficient r=0.77 (P=0.003).

[Download]

螢幕截圖_2024-02-02_下午1.12.42.png (450 kB)

FDA regulation 21CFR890.3920

HAOMING FANG (hfang45@wisc.edu) - Feb 09, 2024, 1:29 PM CST

Title: FDA regulations for footrest

Date: 2024/02/09

Content by: Bobby

Present: NA

Goals: research on FDA regulations regarding wheelchair footrest

Citation: Wheelchair component, 21CFR890.3920(1983)

Content:

These are the FDA regulations regarding wheelchair components. A wheelchair component is defined as a medical device that’s an integral part of a wheelchair, including those sold separately, which applies to our design. These devices are not required to undergo the premarket notification process, subject to limitations.

Conclusions/action items:

No premarket approval needed.

Parkinson's Disease

HAOMING FANG (hfang45@wisc.edu) - Feb 16, 2024, 12:02 AM CST

Title: Research Notes on Parkinson's Disease

Date: 02/15/24

Content by: Bobby

Present: NA

Goals: To determine what other audiences our design may be targeted to

Citation:“Parkinson’s disease: Causes, symptoms, and treatments,” National Institute on Aging, https://www.nia.nih.gov/health/parkinsons-disease/parkinsons-disease-causes-symptoms-and-treatments (accessed Feb. 15, 2024).

Content:

Parkinson's Disease is characterized by symptoms such as tremors, stiffness, difficulty with balance and coordination, and changes in gait, such as a tendency to lean forward and take small, quick steps. As the disease progresses, patients may have increasing difficulty walking and talking, making the use of a wheelchair more likely.

Tremors: Involuntary shaking which can complicate the use of devices that require precise movements. A footrest design would need to be easy to position without requiring fine motor control.

Muscle Stiffness: Difficulty in muscle movement means that adjustable footrests need to be easily manipulated, possibly with one hand or with minimal force.

Bradykinesia (Slowness of Movement): Slow movements necessitate a design that can be adjusted without requiring swift actions.

Postural Instability: Problems with balance could be alleviated with a footrest that provides a stable platform and reduces the risk of falls when transferring in and out of the wheelchair.

Gait and Coordination Issues: A footrest should accommodate the unique gait patterns of Parkinson's patients, such as the tendency to take small, shuffling steps, and should assist in safe sitting and standing.

Conclusions/action items:

Based on the information provided about Parkinson's Disease, our footrest design would likely be applicable and beneficial to patients with this condition.

Multiple sclerosis

HAOMING FANG (hfang45@wisc.edu) - Feb 16, 2024, 12:02 AM CST

Title: Research notes on Multiple sclerosis

Date: 02/15/24

Content by: Bobby

Citation: “Multiple sclerosis,” Mayo Clinic, https://www.mayoclinic.org/diseases-conditions/multiple-sclerosis/symptoms-causes/syc-20350269 (accessed Feb. 15, 2024).

Present:

Goals: To research on potential audiences for the design

Content:

Multiple sclerosis (MS) is a chronic neurological condition characterized by damage to the myelin sheath, the protective covering that surrounds nerve fibers in the central nervous system. This damage disrupts communication between the brain and the body, leading to a range of symptoms that can vary greatly in severity. Common symptoms include numbness or weakness in limbs, partial or complete loss of vision, double or blurry vision, tingling, pain, electric-shock sensations, muscle stiffness, unsteady gait, fatigue, slurred speech, cognitive difficulties, mood disturbances, and problems with bladder, bowel, and sexual function.

Conclusions/action items:

Depending on how developed is the MS condition, our footrest design may be applicable to some of the patients with more movability.

2024/02/27-ADA regulations

HAOMING FANG (hfang45@wisc.edu) - Feb 27, 2024, 4:14 PM CST

Title: Research notes on ADA(Americans with Disabilities Act) regulations

Date: 02/27/24

Content by: Bobby

Present: NA

Goals:

Content:
The ADA requires that people with disabilities who use manual or power wheelchairs or scooters, and manually-powered mobility aids such as walkers, crutches, and canes, must be allowed into all areas where members of the public are allowed to go.
The term “wheelchair” is defined in the new rules as “a manually-operated or power-driven device designed primarily for use by an individual with a mobility disability for the main purpose of indoor or of both indoor and outdoor locomotion”.
Covered entities must also allow people with disabilities who use other power-driven mobility devices into their facilities unless a particular type of device cannot be accommodated because of legitimate safety requirements.

Conclusions/action items:

2024/04/30 - Aluminum research

HAOMING FANG (hfang45@wisc.edu) - Apr 30, 2024, 1:49 PM CDT

Title: Aluminum chemical properties

Date: 2024/04/30

Content by: Bobby

Present: NA

Goals: Research note for Aluminum as material for footrest

Citation: https://www.thyssenkrupp-materials.co.uk/does-aluminium-rust

Content:

Aluminium does not rust because it does not contain iron; however, it does corrode. When exposed to air, water, or soil, aluminium reacts with oxygen to form a thin, protective layer of aluminium oxide on its surface. This layer prevents further corrosion and does not flake off like rust. Despite this protective oxide, aluminium can still suffer from galvanic corrosion when it comes in contact with other metals, forming an electrical circuit that weakens the aluminium. Additionally, extreme pH levels can disrupt this oxide layer, making the aluminium susceptible to corrosion. To minimize corrosion, it is advisable to use aluminium in environments with a pH between 4.5 and 8.5 and avoid conditions where it can physically damage the oxide coating.

Conclusions/action items:

Ideal for outdoor usage

2024/04/30 - Aluminum physical properties

HAOMING FANG (hfang45@wisc.edu) - Apr 30, 2024, 1:54 PM CDT

Title: Aluminum physical properties

Date: 2024/04/30

Content by: Bobby

Present: NA

Goals: Research note for Aluminum as material for footrest

Citation: ASM material data sheet, https://asm.matweb.com/search/SpecificMaterial.asp?bassnum=ma6061t6 (accessed Mar. 7, 2024).

Content:

Aluminum 6061, available in T6 and T651 tempers, belongs to the 6000 series of aluminum alloys. This metal is primarily composed of aluminum (95.8 - 98.6%), with smaller amounts of magnesium (0.8 - 1.2%), silicon (0.4 - 0.8%), and copper (0.15 - 0.4%), along with traces of chromium, iron, and other elements. It is well-known for its excellent joining characteristics, good acceptance of coatings, high strength, good workability, and high resistance to corrosion. The T6 and T651 tempers of Aluminum 6061 offer varying benefits, with certain tempers providing better chipping characteristics. This alloy is commonly used in applications such as aircraft fittings, camera lens mounts, bike frames, and various types of hardware and valves. Aluminum 6061 exhibits a typical density of 2.7 g/cc and has good mechanical properties, including a typical ultimate tensile strength of about 310 MPa and a yield strength of about 276 MPa. It also features moderate machinability and good fatigue strength.

Conclusions/action items:

Ideal for stress bearing component

2024/04/30 - DEMOTOR PERFORMANCE Linear Acutator

HAOMING FANG (hfang45@wisc.edu) - Apr 30, 2024, 1:57 PM CDT

Title: DEMOTOR PERFORMANCE Linear Acuator

Date: 2024/04/30

Content by: Bobby

Present: NA

Goals: Research note on choices for linear actuator

Citation: https://www.amazon.com/Linear-Actuator-Stroke-Output-12-Volt/dp/B00VFXIRW4?th=1

Content:

The DEMOTOR PERFORMANCE linear actuator is constructed from high-quality aluminum alloy, making it sturdy and durable. It features a stroke length of 250mm, with a retracted length of 355mm and an extended length of 605mm. The actuator operates with a travel speed of 10 mm/s and can draw a maximum current of 4.6 Amps while supporting a maximum dynamic load of 225 lbs. It operates quietly, producing less than 60db of noise, making it suitable for various environments. This actuator is also waterproof, rated at IP55, which ensures it is sealed against dust, water, and corrosion, and thus appropriate for outdoor applications. It is widely used across several fields including automotive, home furniture, medical devices, industrial construction, and agricultural machinery.

Conclusions/action items:

For our budget this is a really good option, rigid design

2024/02/27-Wheelchair users

HAOMING FANG (hfang45@wisc.edu) - Feb 27, 2024, 10:36 AM CST

Title: Research note on demographic of wheelchair users

Date: 24/02/27

Content by: Bobby

Present: NA

Goals: to research how many wheelchair users are there in the US

Citation: "Wheelchair users," Physiopedia, https://www.physio-pedia.com/Wheelchair_Users#cite_note-4 (accessed Feb. 27, 2024).

Content: In the United States of America there are an estimated 3.3 million wheelchair users, with an estimated 1.825 million of those users aged 65 and older, and the number increasing every year with an expected 2 Million new wheelchair users every year. In Canada, there are approximately 288,800 community-dwelling wheelchair and scooter users aged 15 years and over, representing 1.0% of the Canadian population. This includes 197,560 manual wheelchair users but does not include any individuals in residential or long-term care, so the true prevalence of wheelchair users in the total population in Canada is likely to be higher.

Conclusions/action items:

Although we don't have more detailed data on specific mobility of individual wheelchair users, over half of wheelchair users are using wheelchairs not because of disability but because of old age, indicating they may have some mobility with lower body, hence could benefit from our design.

2024/03/08 further research on wheelchair users

HAOMING FANG (hfang45@wisc.edu) - Mar 08, 2024, 11:06 AM CST

Title: Research note on demographic of wheelchair users

Date: 24/03/08

Content by: Bobby

Present: NA

Goals: to research what other patients may also benefits from our design

Citation: “Wheelchair users,” Physiopedia, https://www.physio-pedia.com/Wheelchair_Users (accessed Mar. 8, 2024).

Content: Besides patients with muscular dystrophy, other wheelchair users with a higher level of mobility and could also benefit with a footrest design that is less interfering. For example, individuals with partial paraplegia may have some degree of leg function and could use their feet for certain tasks; patients with conditions like Multiple Sclerosis or Spina Bifida, where lower limb weakness is present but not complete and may also benefit from the design; Some individuals with heart conditions use wheelchairs to prevent overexertion but can still use their feet; and last but not least, some elderly individuals use wheelchairs for mobility assistance but can still use their feet for tasks.

Conclusions/action items:

Although we don't have specific number of specific mobilities of individual patients, but there are a variety of people who may benefit.

2024/02/21-Slide out footrest design

HAOMING FANG (hfang45@wisc.edu) - Feb 22, 2024, 1:57 AM CST

Title: Slide out footrest design

Date: 24/02/21

Content by: Bobby

Present: Sam

Goals: The current design goal is to utilize the space under the wheelchair seat to store the footrest when not in use. However, the usable horizontal space is only 7 inches, which is smaller than some shoe sizes. To make the design usable to more individuals, a way to extend the footrest somehow is necessary. We worried that with limited muscle strength and mobility, folding designs may be difficult to use because it require the user to lift their feet up, which may not be convenient for all users. This design provides an alternative method.

Content:

The footrest will consist of 2 parts, as shown in blue and red below. In storage states, the 2 parts fit together to stay under 7 inches. The footrest is attached to sliding tracks on both sides(Not shown). When being extended from under the seat to in front of the seat, the red rods on both sides will receive the pushing force from the extension mechanism(the design is not finished yet), extending the entire red part forward. When the rod reaches the end of the blue groove Figure 4, it will pull the blue part forward as well, until both parts are in front of the seat, as shown in Figure 5. The end of the middle grooves are designed to fit rectangular plates, providing a counterforce to the force applied to the red part, ensuring rotational moment will be zero. This is a preliminary sketch.

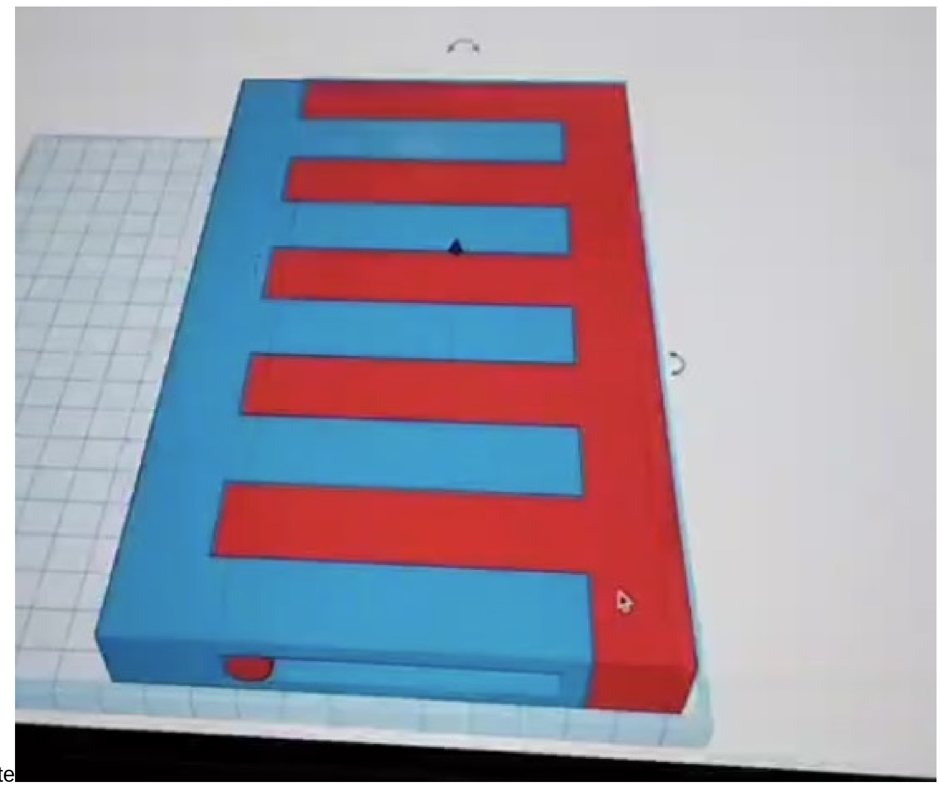
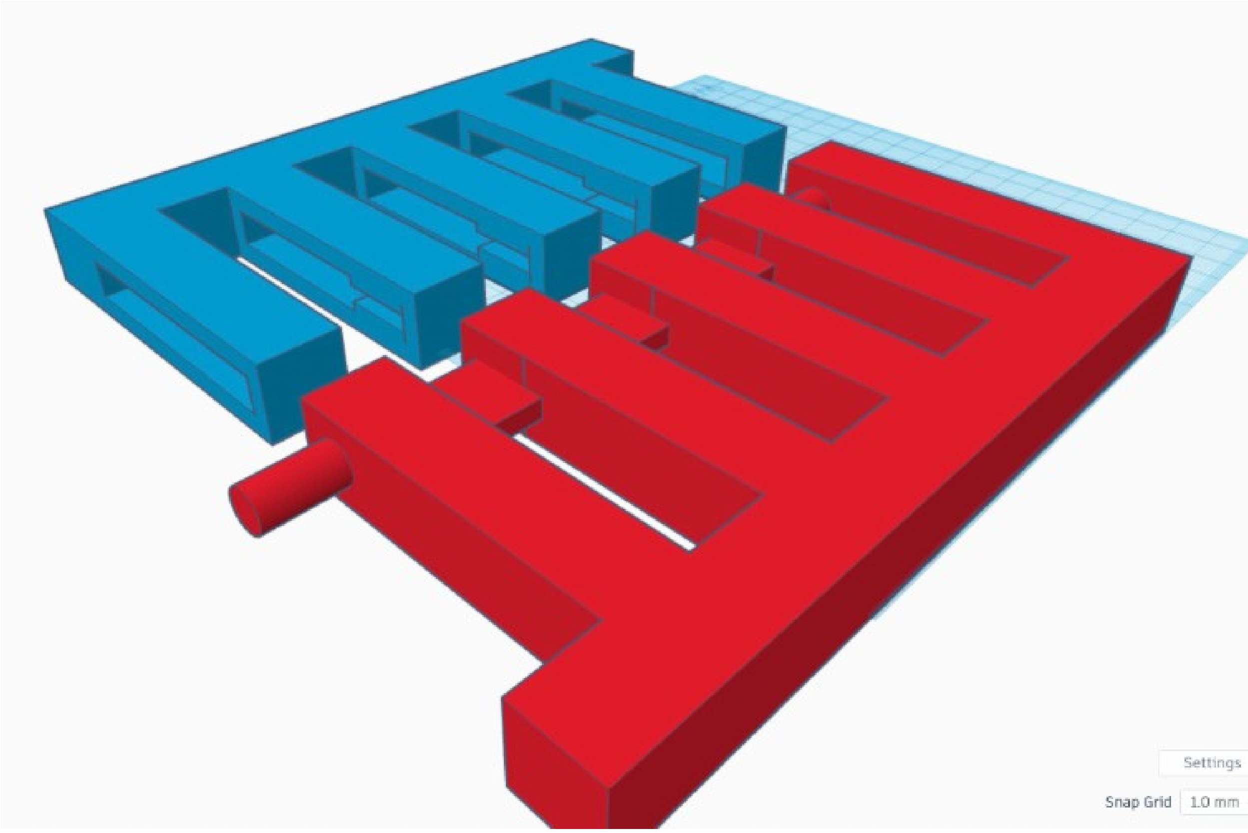


Figure 1: storage state

Figure 2&3: separated parts



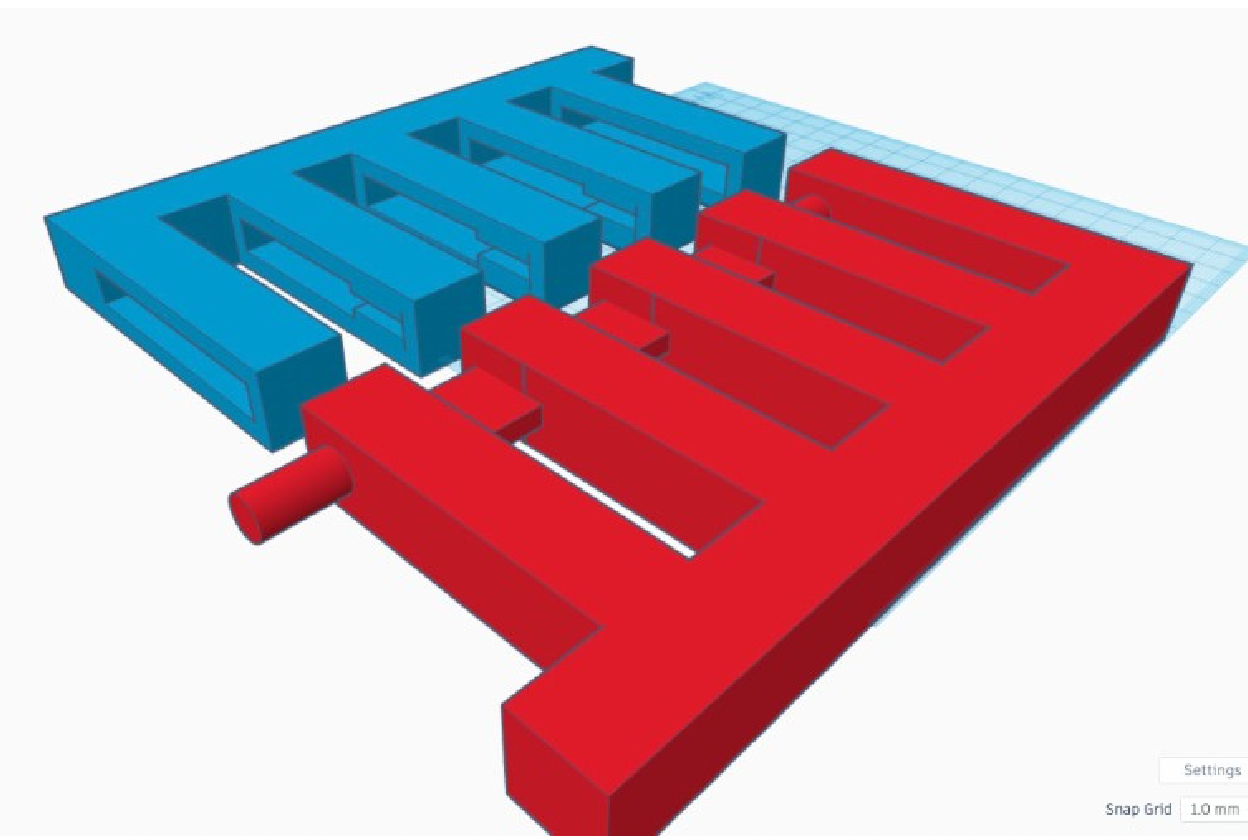


Figure 4: extended

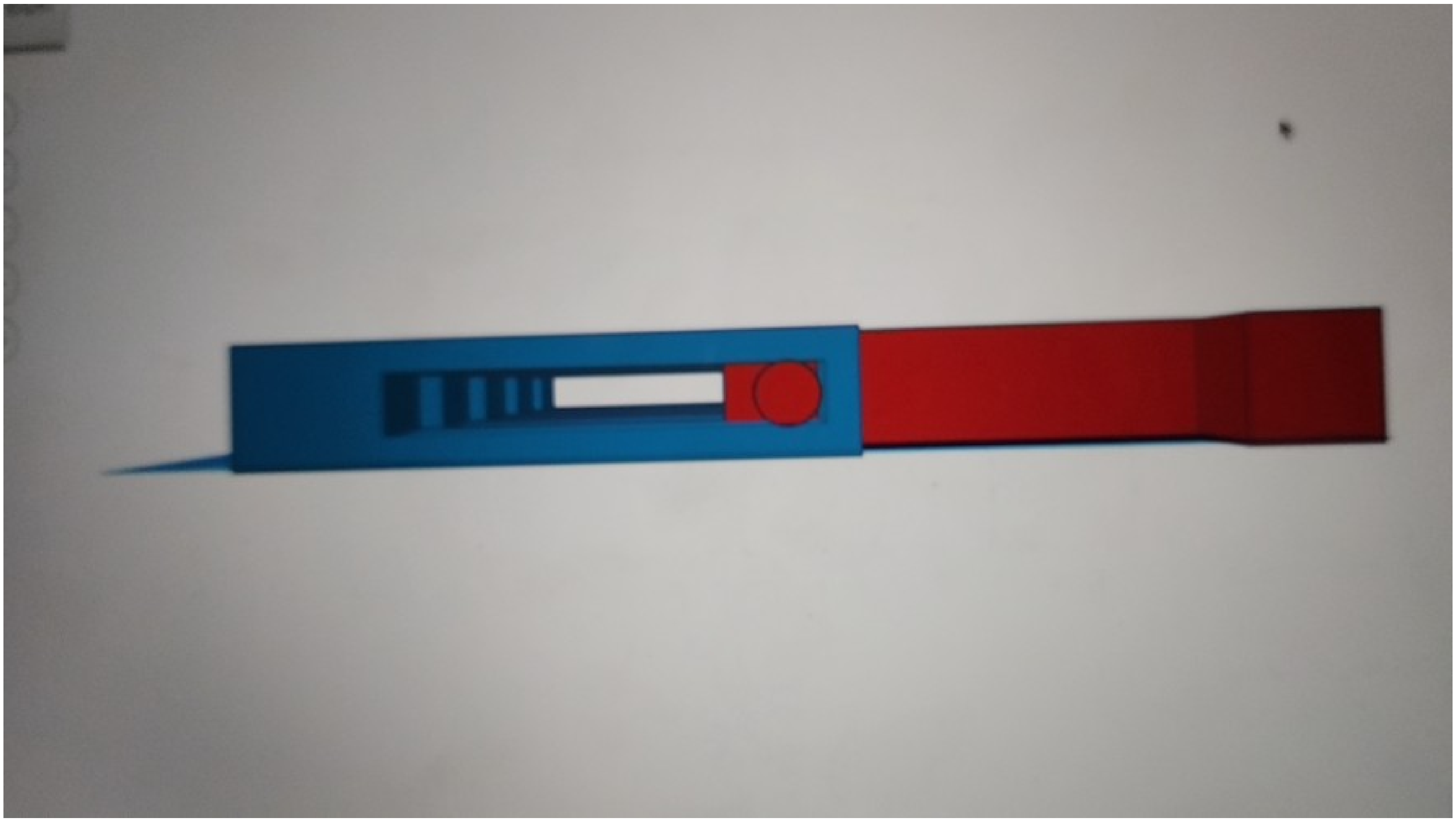
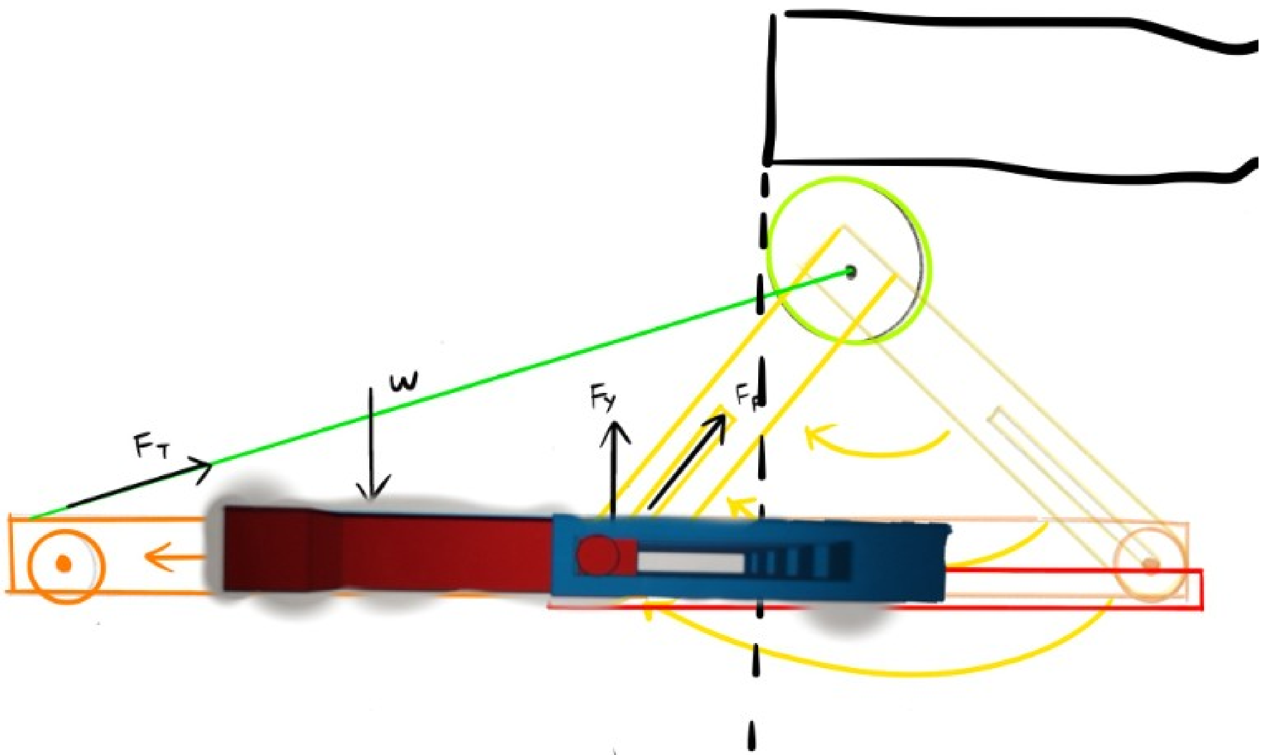


Figure 5: attachment to other structure



Conclusions/action items:

Design Matrix criterias

HAOMING FANG (hfang45@wisc.edu) - Feb 15, 2024, 10:00 PM CST

Title: Design Matrix

Date: 02/15/24

Content by: Bobby

Present: All

Goals: To determine which design to go with

Content:

Size and Portability
This criterion is given a weighting of 15% because size is one of the biggest issues with the current design, as the larger size of the current market footrest directly interferes with the daily tasks of our client. Making the footrest smaller will allow the targeted patients to have more maneuverability when using the wheelchairs, significantly improving the quality of their lives. Also, the design should be easily removable and can be packed for traveling, as requested by the client.

Weight
This criterion is given a weighting of 10% because of the client specific medical condition, the design requires a precise control on the overall weight. The design aims to balance sturdiness with lightness, targeting a range of 3-5 lbs. This is crucial for users who may have to disassemble and reassemble the footrest regularly. The weight criterion is thus a reflection of the footrest's practicality and the user's ability to handle it, aligning with the overarching goal of enhancing the user's independence and ease of mobility.

Ease of Usage
Ease of Use is a crucial aspect, especially for users with limited muscle strength, such as those with muscular dystrophy. It commands a 15% weight in our scoring because a footrest that is difficult to manipulate could deter use, lead to user frustration, and ultimately compromise health. Ensuring that the footrest can be handled effortlessly by users with limited strength is essential for their independence and daily comfort, making this criterion vital in our evaluation process.

Durability
For 15% of the scoring, durability is paramount in the design of our wheelchair footrest, particularly as the previous group's attempt failed significantly in this area. The footrest must withstand the rigors of outdoor use and frequent handling, including being packed and unpacked multiple times.

Ease of Fabrication
Ease of fabrication is given 10% of the weighing. The design must allow for the footrest to be manufactured using readily available materials and straightforward production techniques. By focusing on manufacturability, we can streamline the production process, control costs, and facilitate any necessary repairs or replacements in the future.

Adjustability
Adjustability is a key aspect of our wheelchair footrest design, given 15% of the scoring. The goal is to ensure not only height customization to cater to individual user needs but also compatibility with a wide range of wheelchair models. By accommodating both height variations and wheelchair model differences, our design aims to enhance user experience and accessibility, making it a versatile solution for a broader audience.

Cost
Cost consists of 10% of the total score. Managing cost is vital in our wheelchair footrest design to ensure affordability without compromising quality. The final product should be accessible to a broad range of users while still adhering to our high standards for durability, ergonomics, and functionality. Balancing these factors is crucial to deliver a product that not only meets our client's specific needs but also represents a cost-effective solution in the market.

Ergonomics
Ergonomics is given 5%. The footrest should support the client's legs and feet comfortably. It should provide enough support without raising extra pressure.

Aesthetics and integration
Aesthetics is given the final 5% of scoring. Its appeal and design integration are essential to our wheelchair footrest project, emphasizing the need for a product that not only functions optimally but also aligns seamlessly with the wheelchair's overall look.

Conclusions/action items:

2014/11/03-Entry guidelines

John Puccinelli - Sep 05, 2016, 1:18 PM CDT

Use this as a guide for every entry

- Every text entry of your notebook should have the **bold titles** below.
- Every page/entry should be **named starting with the date** of the entry's first creation/activity, subsequent material from future dates can be added later.

You can create a copy of the blank template by first opening the desired folder, clicking on "New", selecting "Copy Existing Page...", and then select "2014/11/03-Template")

Title: Descriptive title (i.e. Client Meeting)

Date: 9/5/2016

Content by: The one person who wrote the content

Present: Names of those present if more than just you (not necessary for individual work)

Goals: Establish clear goals for all text entries (meetings, individual work, etc.).

Content:

Contains clear and organized notes (also includes any references used)

Conclusions/action items:

Recap only the most significant findings and/or action items resulting from the entry.

2014/11/03-Template

John Puccinelli - Nov 03, 2014, 3:20 PM CST

Title:

Date:

Content by:

Present:

Goals:

Content:

Conclusions/action items:

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