LOW-INTERFERENCE WHEELCHAIR FOOTREST

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Abstract

- Out of all wheelchair users in the world, nearly one fourth have the capability to walk a quarter of a mile, and even more have some degree of ability to utilize their legs.
- The proposed prototype aims to create a wheelchair footrest that can retract and extend at the user's desire, allow for translation to another wheelchair, and be lightweight and compact for storage purposes.

Background and Impact

- In the U.S. there are about 5.5 million people who use wheelchairs, and 6.6 percent of them are ambulatory, which means that they still have function in their lower limbs [1]
- An increase of 2 million people will be in wheelchairs every year [2]
- High demand for modifiable footrests.
- Customized wheelchair accessories are hard to find, and are often custom to that company's model.

Figure 1: Image of wheelchair footplates with a fold-away design, where the footplates can be easily folded back. However, the supporting bar remains completely stationary and can only be detached entirely from the device for removal therefore restricting maximum space for movement.

Problem Statement

- Currently on the market, there are no known wheelchairs that allow for users who have remaining function in their legs to maintain use of their feet in everyday life.
- A revised wheelchair footrest should:
  - Adapt to the user's lifestyle and abilities
  - Be easily removable and attachable
  - Function as a traditional footrest while in the original position

Figure 2: Quickie Q700M wheelchair model [3]

Design Criteria

- The Footrest should be able to completely fold and condense out of the way as to not hinder the leg movement of the client.
- No parts of the mechanism should be sharp or be able to catch on clothing or other materials to avoid injury.
- The footrest should have a lifespan of 3-5 years (equal to the general lifespan of an electric wheelchair) [4]
- The footrest cannot take up too much room on the sides to avoid clearance issues in doors or the car.
- The footrest should be easy to move as the client is sitting in the wheelchair.
- The footrest should be relatively easy to detach from the wheelchair.
- The wheelchair will be used both indoors and outdoors so materials must be able to withstand everyday wear and tear from normal conditions as well as mild weather conditions.
- The wheelchair footrests should be at a slant to support blood flow to the feet and help reduce swelling.

Final Design and Prototype

Final Design Summary

- The device is mounted on the side rails of the wheelchair where each footrest can slide backwards and forwards on the rail (horizontally), locking via a seat belt buckle.
- The telescoping sections that extend from the side rail to the footplate can extend and fold to adjust length.
- A cable attached to the footplate folds the telescopic assembly when the assembly is pulled back.
- Wheels on the bottom of the footplate support weight and take strain off of the frame.

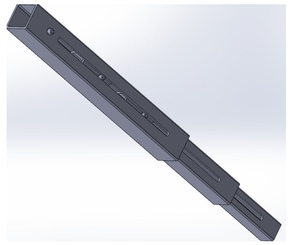

Figure 4: The CAD model of the telescoping rod setup.

Wheelchair Attachment

- Device is attached to the wheelchair using a metal plate welded to the telescoping segments and attached to a rail.
- The rail contains small free-sliding blocks to which the screws are attached, allowing the whole assembly to move horizontally.
- The cable which is attached to the footplate is screwed into a block with a washer, holding it in place and preventing sliding.

Figure 3: A bottom view of the footrest with the wheel attached.

Telescoping Assembly

- 3 square aluminum segments machined to fit inside each other to allow for telescoping movement.
- Each rod has an ultimate tensile strength of 38000 pounds per square inch [5]
- Segments were machined with a groove for a bolt lock, a hole was made, and a metal dowel was inserted to stop the segments from separating as the dowel catches.
- Footplate is welded to the bottom segment where the cable is looped through holes at the bottom and run through the rods.

Figure 5: Side view of the wheelchair with the telescoping rod attachment and locking mechanism

Testing

Testing Purpose

- Prototype's success was based on the speed of extension and retraction of the footrests, as well as ease of use.
- The footrests were also tested on the amount of weight that could be held without deflection.

Methods

1. Force Test: to ensure structural integrity and strength with various loads and to measure the deformation of the footplate angle as weight is added.
2. Speed Test: measured the time taken to extend and retract one side of the footrests for convenience and ease of use.

Figure 6: Top view of the right footrest during the Speed test

Results

Testing Purpose

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- The footrests were also tested on the amount of weight that could be held without deflection.

Methods and Results

Trial	Time to extend (s)	Time to retract (s)
1	7.57	6.42
2	5.85	5.85
3	8.87	5.32
4	5.92	7.09
Avg	7.05	6.17

Figure 7: Data table of the times recorded extending and retracting, as well as the average over four trials

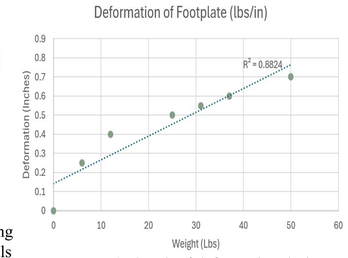

Figure 8: Graph of deformation during force test from six to fifty pounds

Conclusions

- The average time to fully extend and retract the footrests is 13.22 seconds.
- The footrest plates are able to take a significant amount of load with minimal deformation to the angle of the footrest, therefore compromising structural integrity.

Discussion and Future Work

- **Strengths of Design**
  - This design is able to condense against the side of the wheelchair to allow for more space for the client's leg when the footrest is not in use.
  - The double foot plate allows the client to easily move the feet off the footplate before retracting the footrest up the telescoping rods.
- **Weakness of Design**
  - This design is not very secure to the wheelchair.
  - The wheels on the footplate, while helping carry more weight, are not the best type of wheels for this specific project.
- **Future Work**
  - A better design of attachment to the wheelchair must be put in place to help overall stability of the footrest.
  - A wheel consisting of a ball and a socket should be used instead of wheels designed for suitcases.

Acknowledgements

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References

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