Low-Interface Wheelchair Footrest, Team Wheelies, BME 200/300

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Function:

There are currently no wheelchairs on the market which allows those who are not paralyzed to perform helpful movements, such as opening doors with their feet or being able to pick up objects from the floor. In addition, current footrest models are heavy, bulky, and not easily able to be removed and stored when not in use. While footrests are crucial for support if the wheelchair tilts or reclines, it is imperative to design a wheelchair footrest that allows for more foot mobility- should the user require it- and for easier storage of said footrests. The updated footrests should be able to adapt to a person's abilities, should be easily able to remove and store them when not in use, and be lighter and less bulky, while still providing the benefits of a footrest when necessary.

Client requirements:

I. Combined weight between 3-4 lbs
II. Ability to fold footrest up or be able to easily remove and store them
III. If removable, a place to store them so they are accessible but not a hindrance
IV. Ability to move with wheelchair (i.e. move with the rest of the chair when chair tilts backwards)
V. Have calf support

Design requirements:

1. Physical and Operational Characteristics

a. *Performance requirements*:

I. The wheelchair footrests must have an equivalent lifespan of wheelchair base (between 4-5 years [1]). Production cost should not exceed $200 to maintain reproducibility and combined weight may not exceed 4 lbs. The footrests should also be able to be stored on the wheelchair.

b. *Safety*:

I. Any materials used to construct wheelchair footrests must not include sharp edges.

II. Footrests should hinder the user's foot and leg from sliding backwards into the base of the wheelchair as to ensure comfort and safety.

III. Footrest accessories must be removable or swing away in order to clear a path and avoid accidents

when the user transfers into/out of the wheelchair seat.

c. *Accuracy and Reliability*:

I. The footrest must be able to connect to the base of the wheelchair safely and securely every time it is attached.

d. *Life in Service*:

I. Footrest should have the same lifespan as a typical wheelchair base, which is an average of 4-5 years [1].

e. *Shelf Life*:

I. The footrest must be able to last as long as the client will be using the specific wheelchair that the footrest will attach to, 5 years. [2]

f. *Operating Environment*:

I. The footrest must be able to operate both indoor and outdoors. The footrest should be able to withstand all weather conditions.

II. The footrest must also be able to support the force of the client's feet. The force that the client can exert on the footrest will be determined at a subsequent meeting.

g. *Ergonomics*:

I. The footrest must be able to support the client's feet while also not restricting leg movement or the client's ability to put their feet on the ground.

h. *Size*:

I. The footrest, if two separate pieces, should accommodate wider than the shoe's width, but can be shorter while supporting the majority of the foot's length. The size of our footrest should accommodate a variety of sizes and can be based on average shoe sizes. Based on the average men's shoe being a 10.5 with measurements of 11.645 by 4.25 inches [3], the footrest's dimensions can be around 7 by 5 inches.

II. The footrest, if one piece, should accommodate for a shoulder width apart orientation of feet.

i. *Weight*:

I. The weight of our entire design should be a maximum of 3-4 lbs, per client's request.

j. *Materials*:

I. The footrest design should be constructed of a durable long lasting material that is able to withstand stress causing forces, and a variety of weather conditions. Potential materials include Aluminum Alloy (7075-T6 or 6061-T6), stainless steel, plastic, or polyvinyl chloride (PVC).

k. *Aesthetics*, *Appearance, and Finish:*

I. The final configuration of the footrest can not impede any other relevant functions of the wheelchair or user safety

II. The aesthetics and appearance aspects of the product are not relevant to the final design so long as they meet the other requirements detailed in this document.

2. Production Characteristics

a. *Quantity*:

I. The client requires a single prototype to be used as an attachment to his current wheelchair. With successful creation of one prototype, more could be created for a larger population.

b. *Target Product Cost*:

I. The target cost of the product provided by the client is within $200.

3. Miscellaneous

a. *Standards and Specifications*

I. ISO 7176: This standard states testing guidelines for various mechanical components off the wheelchair. Parts 1 and 2 [4][5] refer to static and dynamic stability of the wheelchair movement. Other parts refer to wheelchair dimensions, maneuvering space, durability, etc. Since the apparatus would affect the physical properties of the wheelchair itself, these are important to note.

b. *Customer*:

I. The customer for this product is our client Mr. Dan Dorszynski. He dislikes the current footrest options that restrict his ability to use his feet for small everyday actions, such as opening a door. We are currently discussing which specific aspects of the footrest he finds restricting and what aspects he can overcome.

II. While this product is being designed with a specific customer in mind, if similar frustrations are faced by other wheelchair users with degrees of mobility, the final product could potentially be utilized in other similar situations.

c. *Patient-related concerns*:

I. The final product is one such that it may require some modification or attachment to the clients wheelchair. As the wheelchair is a necessary component of our clients everyday life, it is essential that any building, testing, and final product allow all other functions of the wheelchair to remain intact.

d. *Competition*:

I. There are many other wheelchair footrests on the market today with varying design elements. These include, but are not limited to, models from Drive Medical [3], Invacare Corporation [6], Comfort Company [7], and Therafin Corporation [8].

II. Prices generally start at $40 and range upwards of $300 [9].

References

any quantitative information without references came directly from the client, Mr. Dan Dorszynski

[1] Ngamwongsa-Nguan, Panya & Arayawichanon, Preeda & Manimmanakorn, Nuttaset. (2017). Manual Wheelchair Longevity and Related Factors among Spinal Cord Lesion Patients. Asia-Pacific Journal of Science and Technology. 22. 1-6.

[2] Quickie Q700 M / Q700 M HD - Sunrise Medical, www.sunrisemedical.com/getattachment/f2db9ac9-1c2b-4dcc-903e-cafdbacb5111/Quickie-Q700-M-Owner-s-Manual.aspx. (Accessed 22 Sept. 2023).

[3] "Brannock Device® Foot-Measuring Device User Guide" by The Brannock Device Co., Inc.

[4] ISO. (2014). Wheelchairs — Part 1: Determination of static stability. https://cdn.standards.iteh.ai/samples/56817/abc81b2284d1465f91679e4588c269be/ISO-7176-1-2014.pdf

[5] ISO (2014). Wheelchairs — Part 2: Determination of dynamic stability of electrically powered wheelchairs. https://cdn.standards.iteh.ai/samples/57753/61ac15402fd74aee98b3aa1803400f2b/ISO-7176-2-2017.pdf

[6] “Invacare Footrest Assembly,” Quickie Wheelchairs. https://www.quickie-wheelchairs.com/Wheelchair-Parts-Accessories/Assorted-Wheelchair-Parts/Footrests-Legrests/Invacare-Footrest-Assembly-3-1-8-Pin-Spacing-Pair/24518p (accessed Sep. 20, 2023).

[7] “Comfort Calf Protector,” Quickie Wheelchairs. https://www.quickie-wheelchairs.com/Wheelchair-Positioning/Lower-Extremity/Comfort-Calf-Protector/27557p (accessed Sep. 20, 2023).

[8] “Ankle Supports - Velcro Closures’ Quickie Wheelchairs. Ankle Supports - Velcro Closures | Lower Extremity (quickie-wheelchairs.com) (accessed Sep. 20, 2023).

[9] “Drive Medical Swing Away Footrests,” Vitality Medical. https://www.vitalitymedical.com/wheelchair-swing-away-footrests-stds3j24sf.html (accessed Sep. 20, 2023).