Product Design Specifications Document:

Secondary Mobility Device for Airline Travel

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Function:

Currently, airplane travel for handicapped passengers is a very difficult and arduous process, involving multiple wheelchair transfers, the assistance of untrained airline workers, and multiple times and sites of possible injury or embarrassment. The current procedures in place are so inefficient and tedious that many wheelchair-bound people refrain from flying at all. This procedure involves the lifting of the passenger from their wheelchair to a small, specially designed aisle wheelchair, and then another transfer from the aisle chair to the passenger's seat. This device will work to eliminate one of the two transfers that are currently required when moving a handicapped passenger from the jetway, through the aisle, and to their seat.

Client requirements:

- Minimize number of transfers during boarding process (or identify other places to simplify handicapped travel process in general throughout the entire airport ie. security checkpoint)
- Minimize the number of airline workers/outside help involved during transfers
- Some level of foldability/stowability for when device is not in use

Design requirements:

- Must keep within current FAA and U.S Access Board Guidelines for Aircraft Boarding Chairs (detailed below in Standards and Specifications section)
- Proper safety belts/harness must be in place
- Chair height should be approximately equivalent to height of airline seats

1. Physical and Operational Characteristics

a. Performance requirements:
Our device needs to be able to effectively roll and withstand the 250lbs weight of our client for up to multiple hours at a time. The device should be able to conveniently fold or condense to be stowed in a reasonable manner. This device will be used approximately three to four times a year, the approximate number of times the client flies per year.

b. Safety:
The structure of our device must be able to withstand a load of 723lbs, the 99th percentile for male body weight. It must have a factor of safety of 3.0 as well [8]. Safety straps will be necessary to hold the traveler in place in case of any accidental incorrect movements. The client prefers a lap belt to other types of straps.

c. Accuracy and Reliability:
It is critical that our design preform consistent with the needs of our client. Failure to consistently support upwards of 250 pounds and maintain our clients stability could result in undue attention to our client, and could injure him as well. This performance includes supporting his weight, maintaining its' balance, and allowing for easy transfers. The device must allow for an easy safe transfer during every use as well to prevent potential injury to the client.

d. Life in Service:
Our secondary device should maintain mechanical stability, and be able to traverse a variety of surfaces for extended length and time durations for as long as the client needs to use the device. This will typically include attaching it to his regular chair at home, traveling to the airport with it, and moving all the way to the gate with it where it will then detach and act separately from the primary wheelchair. The time used will vary depending on his distance traveled from home to the airport of departure and from the airport of arrival to his destination. This should be able to support our client for several hours.

e. Shelf Life:
The secondary device should maintain its' ability to withstand our client's weight over long periods without use. It should require minimal to no maintenance during periods without use. Ideally our device would be ready for use whenever our client requires it.

f. Operating Environment:
The secondary device should be able to support upwards of 250 pounds. It should be available for use predominantly in an indoor environment, while also having the ability to be used in the outdoors as necessary. This requires it to maintain its stability when exposed to snow and rain, in addition to operating between the temperatures of 0 and 100 degrees fahrenheit. It should be able to move our client effectively on a variety of flooring surfaces including wood, tile, concrete, and carpeting.

g. Ergonomics:

It is important that the secondary device be comfortable for our our client to use over extended durations of travel. This comfort factor can include the use of similar seat padding, and a similar seat height to that of the client's wheelchair for comfort and to make transfers as easy as possible. The padding should be around 2 inches thick and the seat height should be between 18 and 21 inches [6]. The device should also incorporate at least 1 strap for our clients stability while being moved.

h. Size:

Based on the nature of our device, size is an important restriction. The design must be able to transit a variety of plane aisles. This requires that the device have a maximum width of 15 inches from the floor to a height of 25 inches, and a maximum width of 20 inches from 25 inches in height and taller. If we choose to make the device compact enough to be a carry on it should be able to compress down to be smaller than 9"x22"x14" [2] , [3].

i. Weight:

There are no restrictions on weight, as long as the device can be easily pushed or pulled by an adult of average strength with a passenger. The device also has to be light enough to be folded and stowed for when the device is not in use. However, the overall weight should be minimized in accordance with airline boarding chair regulations [8].

j. Materials:

Any materials may be used as long as the parts comply with FAA guidelines. The FAA currently prohibits assistive devices wheelchair devices that do not compress and that rely on batteries from being carry ons [7]. This device must comply with these regulations. We may try to make a device with no metal so the client can easily pass through security, but we are more likely going to use metal parts for a secondary wheelchair.

k. Aesthetics, Appearance, and Finish:

As of now the primary concern is constructing a device that fits the functional requirements. Aesthetics and appearance are less crucial as long as the device works. However, our client mentioned his favorite color is green and he likes the color of his current black wheelchair.

2. Production Characteristics

a. Quantity:

We are designing one unit for the client

b. Target Product Cost:

Our client gave us a relative budget of $500, but he mentioned that if we have a major breakthrough he would not mind us going over. The cost of a current airplane transfer chairs retail for anywhere from $86 to over $2000, so $500 should suffice.

3. Miscellaneous

a. Standards and Specifications:

FAA Operational Standards for Aircraft Boarding Chairs:

- Support passenger weighing 328 kg
- Equipped with braking level that stops all forward and backward movement
- Follow U.S Access Board Guidelines for Aircraft Boarding Chairs

U.S Access Board Guidelines for Aircraft Boarding Chairs:

- Seat height should match aircraft seat height, 43-48 cm
- Restraints securely support the torso, pelvis, knees and feet
- Footrests adjustable 41 to 74 cm from front of seat

b. Customer:

The customer's main concern is the transfers between wheelchairs, and would like us to focus on this issue to minimize transfers and the dangers that go along with them. Ideally, the client would like a device that goes over his existing wheelchair, which would reduce the number of transfers to two. If possible, he would like to a device that uses no metal, so that he can pass through metal detectors at security instead of being patted down. The very basics of what the customer wants is a device he owns that can be used on airplanes.

c. Patient-related concerns:

The device will be able to be cleaned easily, however does not need to be cleaned between uses.

d. Competition:

- The Karman Healthcare Airplane Aisle Chair sells for around $2,000. It is designed with detachable wheels that are 61 cm in diameter. When these wheels are detached, the width of the chair decreases to 35.5 cm. Smaller wheels attached to bottom of wheelchair are utilized when larger wheels are detached [1].
- The Columbia Medical Aislemaster Unfoldable Boarding Chair costs around $2,500. It has a width of 33 cm and features padded seat, backrest and headrest, as well as flip-up armrests for ease of transfer [4].
- The Columbia Medical Aislemaster TransportMate Compact Wheelchair was originally designed for an on-flight wheelchair under the 1986 Air Carrier Access Act. It collapses compactly to a height of 18 cm from an unfolded height of 85 cm. It has a width of 41 cm including the wheels [5].

References:

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[4] (2017). *Columbia Medical Aislemaster Unfoldable Boarding Chair*. [Online] Available: http://www.1800wheelchair.com/product/aislemaster-unfoldable-boarding-wheelchair/

[5] (2017). *Columbia Medical Aislemaster TransportMate Compact Chair*. [Online]. Available: http://www.1800wheelchair.com/product/aislemaster-transportmate-compact-wheelchair/

[6] Sunrise Medical. (2017). *QUICKIE S-636 Electric Power Wheelchair*. [Online] Available: http://www.sunrisemedical.com/power-wheelchairs/quickie/rear-wheel-drive/s-6-series

[7] FAA (2017, July 25). *Pack Safe*. [Online] Available: https://www.faa.gov/about/initiatives/hazmat_safety/

[8] National Transportation Library (1987). *Guidelines for Aircraft Boarding Chairs.* [Online] Available: https://ntl.bts.gov/DOCS/T10.html