Secondary Airline Mobility Device

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Abstract

Currently, there is a need for a device capable of simplifying transportation for wheelchair-bound individuals during airline travel. This device would shorten the overall time required during wheelchair transfers throughout travel. The design utilizes a steel frame with multiple hinges to enable to device to fold down to a size compatible with a standard overhead bin. This semester's work built on the previous prototype with the goal of providing additional functionality and safety. Seat cushions were revamped, and a seatbelt and footrests were added to the design. We tested the device based on the Business and Institutional Furniture Manufacturer's Association chair standards. After completing the tests the device was found to be safe, durable, and structurally adequate.

Problem Definition

Project Motivation

- Airline travel for handicapped individuals is inefficient and stressful[1]
  - Passengers are frequently dropped between wheelchair transfers, which are conducted by untrained staff[2]
- Long transfer times results in frequently missed flights

Background

- Client's career involves travelling 3-4 times each year, with flying the only viable option
- The client's wheelchair may not be used on airplanes due to size and use of lithium ion battery.
- Current devices are robust and expensive, but do not solve issues with transferring passengers.

Figure 1: CarryLite Evacuation Chair[3]

Limitations of Fall Prototype

- Backrest does not fold, preventing ease of storage
- Overall comfortability is lacking
- Safety features are non-existent
- Lack of sturdiness

Design Criteria

- Design should eliminate as many transfers as possible
- Support up to 720 pounds
- Require minimal upkeep and maintenance
- Straightforward operation, lightweight
- Should be collapsible and stowable
- Adhere to current FAA and U.S Access Board Guidelines for Aircraft Boarding Chairs
- Proper safety belts/harnesses

Final Design

Fall 2017 Prototype

- Dimensions: 14" wide, seat height of 18", total height of 36"
- Rear legs attached on hinges allows for a flush fold with seat frame
- 4" diameter caster wheels
  - Brakes on front wheels
- Loads: 305 lbs (static) and 200 lbs (mobile)


Figure 2 & 3. Fall 2017 prototype close up of locking mechanism and final prototype on a electric wheelchair

Final Design

Final design

- The final prototype has the steel frame with the seat cushion
- It also has a seatbelt to provide safety to the users
- Is collapsible into a flat layer about 6 inches thick
  - Hinges assist with the folding of the legs and backrest
- Takes ~30 seconds to collapse device fully

Figure 4. The final design

Frame

- Made of MIG welded carbon steel tubing
- Backrest and legs use locking hinges to maintain stability in use, while also increasing stowability
- Steel bar in between both front and back legs to provide better stability
- 4" diameter caster wheels
  - Front wheels locked in forward position

Figure 5. Locking hinges attaching the seat to the backrest

Figure 6. Steel frame of chair

Seat Cushion

- ¾ inch plywood base
- Layered with carpet padding and a final layer of headliner foam
- Wrapped in marine vinyl

Dimensions

- Expanded: 22" length, 14" width, and height of 42"
- Folded: 22" in length, 14" width, and height of 7"

Figure 7. CAD rendering of wheelchair

Testing

The wheelchair was tested following the Business and Institutional Furniture Manufacturer's Association (BIFMA) chair standards tests, including:

- Back Strength Functional Load: 150 lbs
- Back Strength Proof Load: 250lbs
- Stability Test (Backwards): 173 lbs
- Stability Test (Forward): 12 lbs
- Chair Leg Strength Functional Load (Side): 115 lbs
- Chair Leg Strength Proof Load (Side): 115lbs
- Chair Drop Functional Load: 440 lbs
- Chair Drop Proof Load: 305 lbs

- All these tests evaluate the safety, durability, and the structural integrity of the chair
- SolidWorks Assembly Stress Test

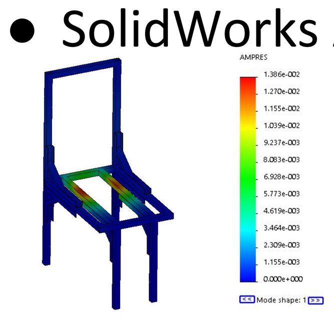

Figure 8. SolidWorks testing

Figure 9. Chair Leg Strength Proof Load

Figure 10. Chair Drop Proof Load Test

Figure 11. Chair Leg Strength Functional Load

Results

The wheelchair sufficiently passed each of the tests without sudden failure or indication of structural failure. Chair drop tests included allowing a 205 lb load to free fall directly onto the center of the seat, and showed complete structural integrity throughout the test. The wheelchair was also able to hold a load of 440 lbs with no structural damage. SolidWorks analysis of the steel frame were conducted following the protocol for a buckling test with a 400 lb load, displaying no signs of buckling or bending. The wheelchair was found to be safe, durable, and structurally adequate.

Future Work

- Improve durability of design by adding a surface coating to frame
- Client test through use during airline travel
- Further material research to find areas of possible improvement
- Demonstrate design at conferences, determine potential for expansion of design
- Attach footrest for safer travel

References

[1] Rita.dot.gov. (2017). Data Analysis | Bureau of Transportation Statistics. [online] Available at: https://www.rita.dot.gov/bts/sites/rita.dot.gov.bts/files/publications/freedom_to_travel/html/data_analysis.html

[2]US Department of Transportation. (2017). Passengers with Disabilities. [online] Available at: https://www.transportation.gov/airconsumer/passengers-disabilities

[3] http://www.1800wheelchair.com/category/wheelchairs-for-airplanes/