Portable Elevating and Transfer Seat for Wheelchair Users

TEAM: Aaron Wagner, Hayley Raj, Tim Madigan, Nicholas Pauly, Bob Meuler

CLIENT: Mr. Dan Dorszynski

ADVISOR: Dr. Darilis Suarez-Gonzalez, PhD, Department of Biomedical Engineering – University of Wisconsin - Madison

Abstract

Throughout the world there is a large population of people that are physically impaired which require the use of a wheelchair. In an effort to keep their independence and perform daily tasks wheelchairs are used to the best of their abilities but there are still limitations. One aspect of being in a wheelchair that these patients struggle with is transferring onto higher surfaces without the help of others. There are currently no affordable devices on the market that attach to wheelchairs and provide vertical and lateral assistance when transferring. This team's goal is to create a device that effectively raises and laterally moves a wheelchair seat for a patient with muscular dystrophy. The final design uses a scissor lift, guide rails, and a comfortable cushion to meet the design specifications. The device was evaluated based on the number of cranks needed to raise the seat and the forces needed to move the seat laterally.

Background

Motivation

- People who use non elevating wheelchairs have difficulty manually transferring to surfaces of varying heights
- Manual transfer is also one of the most strenuous and pain-causing activities for people who use wheelchairs [1]
- Elevating wheelchairs exist, but not everyone receives insurance coverage to pay for them [2]
- Transfer boards are intended to provide a bridge between surfaces, but they often provide inadequate support during transfer

Current Models

A. Transfer board

B. Elevating Wheelchair

Figure 1: Current products on the market that assist with wheelchair transfer. **A.** A transfer board. This is a flat board that can be attached to the wheelchair and an adjacent surface; the user can slides over the transfer board to move to the target surface. **B.** A wheelchair with an elevaring feature built-in.

Design Specifications

Client Requirements

- Fit current wheelchair
- Elevate 15.24 cm (6 in)
- Support and raise/lower 113.4 kg (250 lbs) safely
- Transfer laterally 10.16 cm (4 in)
- Fit through doors and hallways

Budget: $250 (Final cost $151)

Final Design

Fabrication Procedure:

1. Cut plywood board to specified size
2. Drill holes in plywood board and scissor lift corresponding to needed bolt size
3. Connect guide rails to plywood board and scissor lift with bolts and nuts
4. Add string to the end of the rail and plywood for over extension

Materials:

1. Extreme Max Motorcycle Lift
2. Guide Rails (32")
3. Plywood Board (14.5"x18")
4. Seat Cushion
5. Bolts (.25" dia., .125" long) with washers and nuts
6. Bolts (.125" dia., .75" long) with washers and nuts
7. Socket Wrench (.375") with socket (.875") and extender
8. Cotton String
9. C-clamps (2")

Figure 6: Scissors lift

Figure 7: 20 inch guide rail

Figure 8: Ratchet (socket wrench)

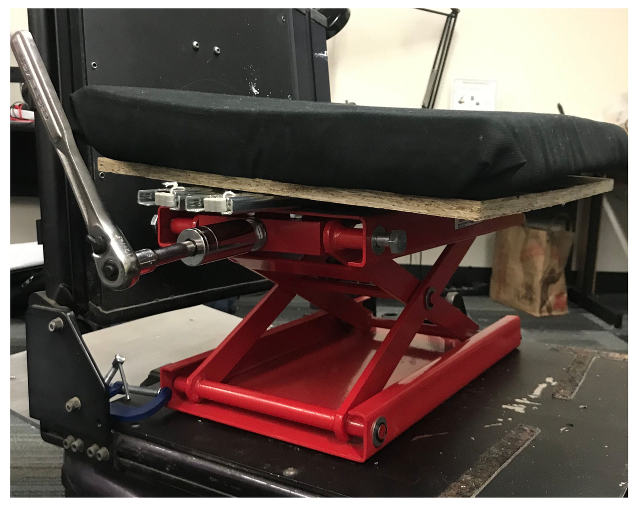


Figure 9: Finished design on wheelchair

Figure 10: Lateral movement of finished design

Testing

Tests Performed:

- Number of cranks required to reach maximum and minimum seat height
  - 5 healthy subjects were observed while raising and lowering the seat by 9 in.
- Force required to move seat laterally
  - 10 different weights were placed on the seat and a Newton force meter was used to measure the force necessary to pull the seat laterally

Important Results:

- On average, 6 cranks are needed to raise the seat by 1 inch
- Using a line of best fit, it would require 35.889 newtons of force to move the seat laterally 3.5 inches with a 250lb person sitting

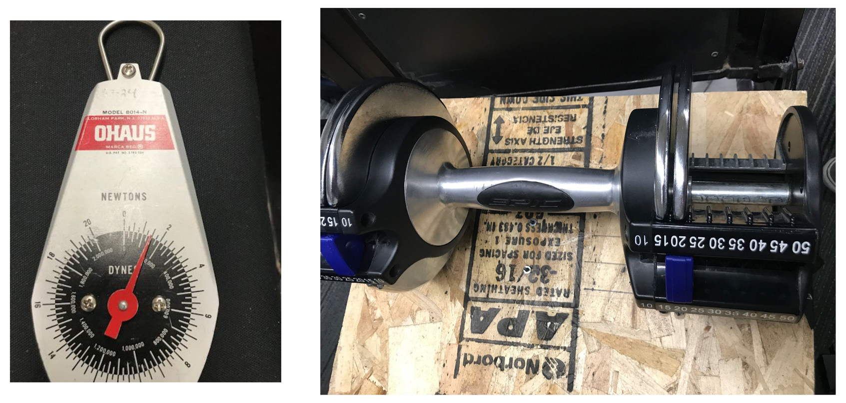


Figure 4: The first picture shows the Newton force meter used to measure the force required laterally. The second picture shows weight on the device.

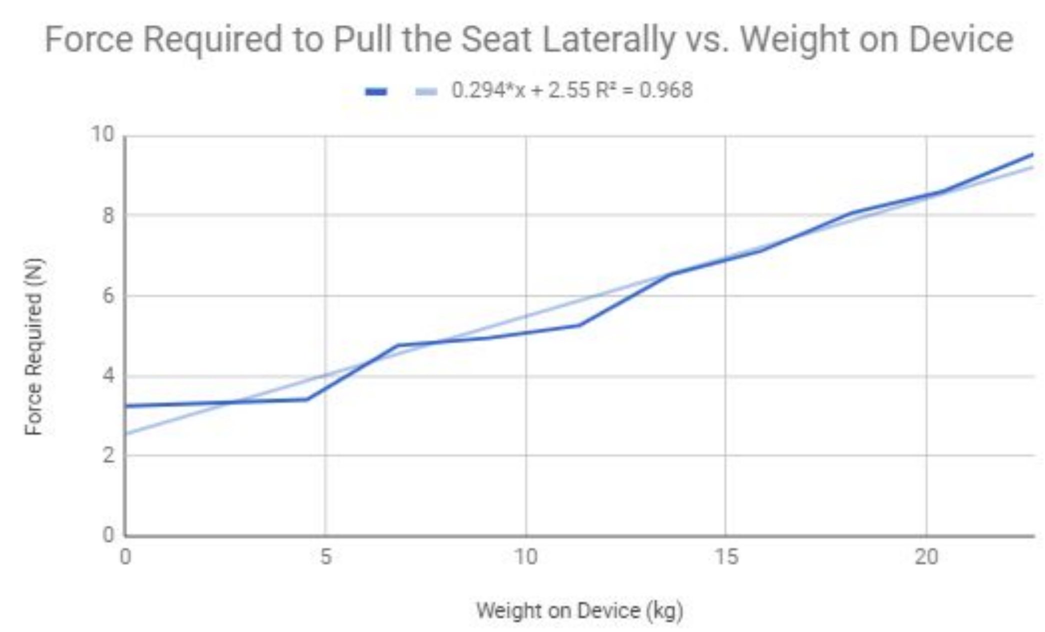
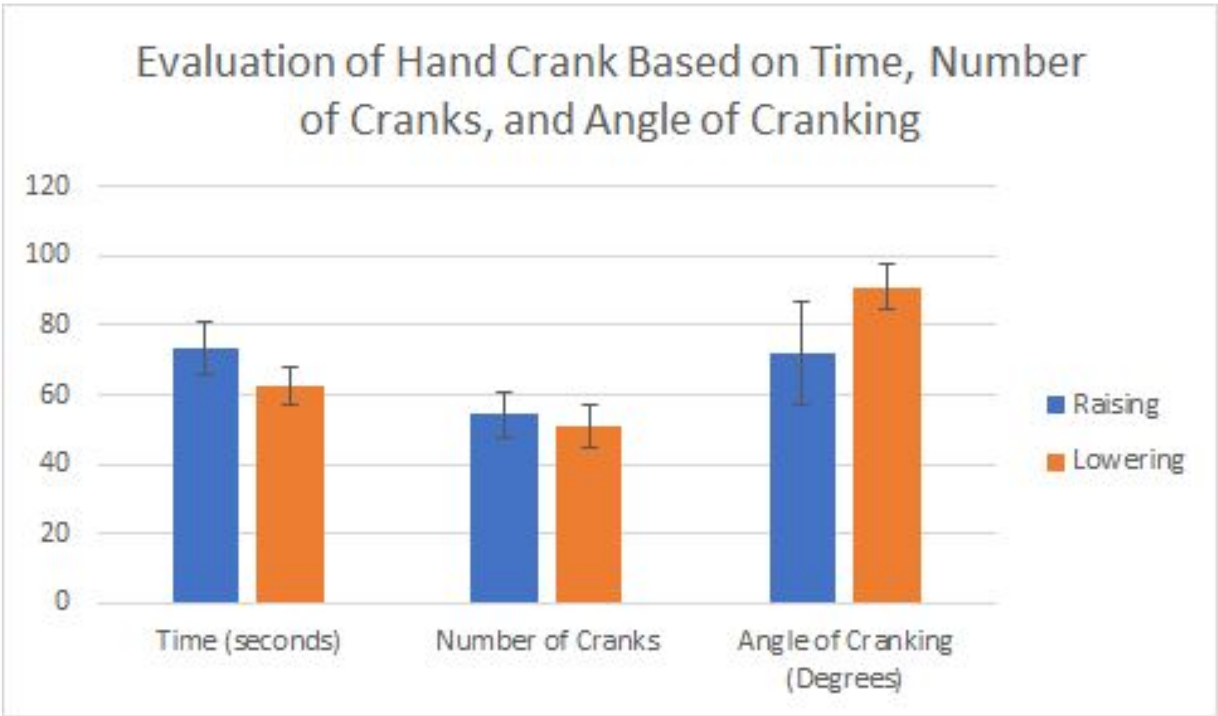


Figure 5: Both pictures show the movement of the ratchet

Figure 2: Graph showing the relationship between force required to move the seat laterally and the weight on top of the platform. The R^2 value is close to 1 showing the strong relationship between the data and the line of best fit. The line of best fit is the linear equation y=0.294x*+2.55

Figure 3: This graph shows the results of the test used to evaluate the hand crank function. The recorded data was number of cranks needed to reach the maximum and minimum heights, angle used to crank the ratchet up and down, and the time needed to reach the maximum and minimum heights.



Directions for Operation

- Attach the ⅜ inch drive by ⅞ inch deep socket to the ratchet
- Attach the ratchet to the right side of the scissors lift
- Switch the ratchet direction of rotation as seen fit
- Begin cranking the ratchet until desired height is reached
- Move laterally by applying force to side of chair

Future Work

Securement

- Find alternative mechanism to attach device
- Locking mechanism for transfer

Further Testing

- MTS testing
  - Find maximum loads with before failure
  - Find maximum deflection before failure
- Repeat tests with users having limited leg strength.

Automation

- Create method to lift user automatically
  - Scissor lift with actuators included
  - Motorized transfer assistance

Acknowledgements

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- Mr. Dan Dorszynski

References

[1] A. Koontz, M. Toro, P. Kankipati, M. Naber, and R. Cooper, "An expert review of the scientific literature on independent wheelchair transfers," Disability and Rehabilitation: Assistive Technology, vol. 7, no. 1, pp. 20–29, 2011.

[2] S. L. Groah, I. Ljungberg, A. Lichy, M. Oyster, and M. L. Boninger, "Disparities in Wheelchair Procurement by Payer Among People With Spinal Cord Injury," Pm&r, vol. 6, no. 5, pp. 412−417, 2014.