Stair Chair Preliminary Presentation

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Overview

Problem Statement

- Patients at Encompass need assistance with stairs
- Crutches not feasible; Step by step not feasible
- Inexpensive, human powered stair lift
    - Not comparable to electrical stair lifts
- 3-5 stairs - outside
- Patients with short disability window

Background

- Client - PT - older patients
- Limited other products
  - Too expensive, not flexible
- Step-by-step [1]

Figure 1: Step by Step Final Design

Product Design Specifications

- Client Requirements
  - Up to 26 weeks of frequent use
  - Withstand up to 140 kg
  - Relative mean 1.72 (load/body mass) [2]
  - Free standing unit
- Safety
  - ISO 13485 [3]
  - Seatbelt
- Shelf Life/Life in Service
  - Protection from temperature, salt, snow
- Size
  - 91.4 cm wide staircase [4]

Design 1: Ratchet

- Continuous track
- Ratchets every 5cm or less
- Handbrake down
- Seat will swivel
- Lap belt

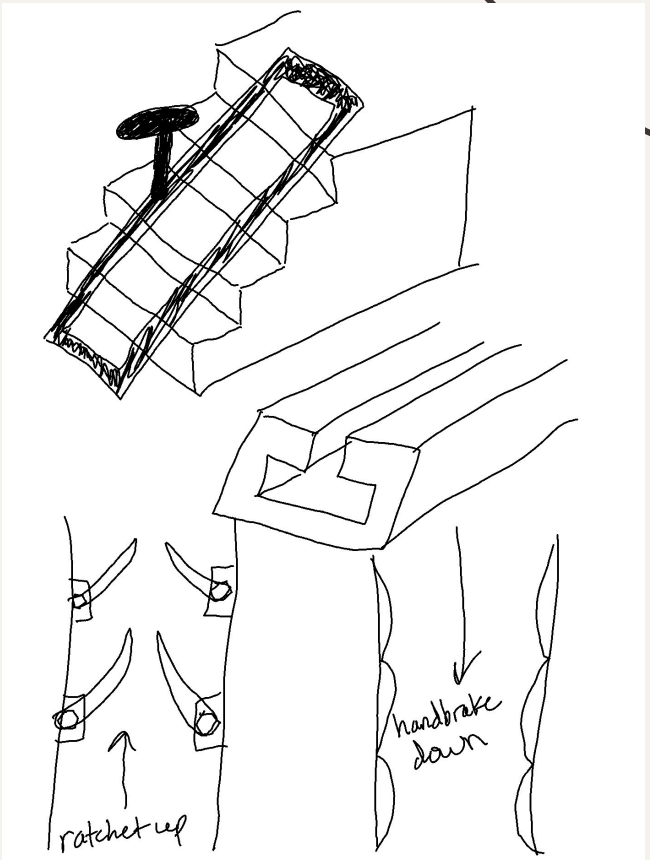


Figure 2: Ratchet Design

Design 2: Counterweight

- Assists in ascent
- Controls descent
- Seat will swivel
- Single track
- Adjust weight for each patient

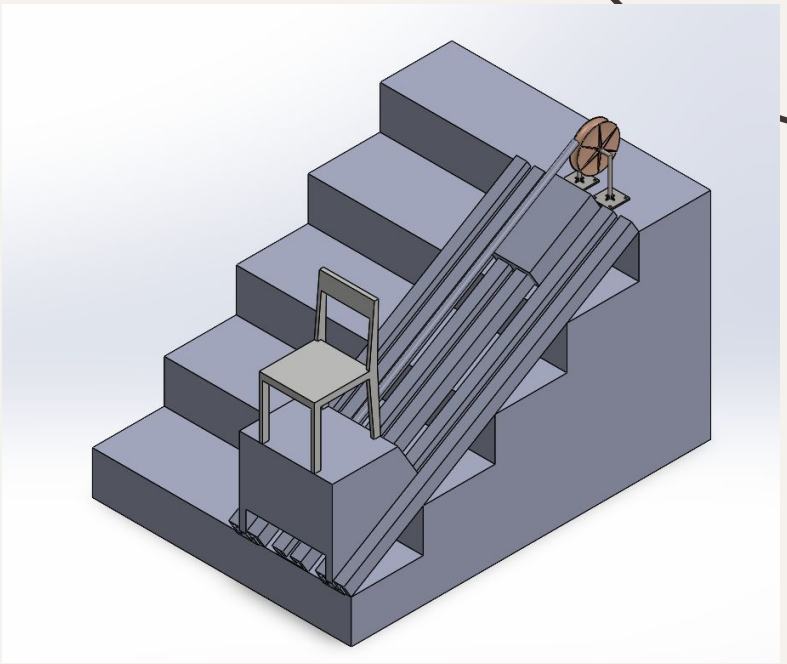


Figure 3: Counterweight Design

Design 3: Hydraulic Pump

- Barbershop chair
- Pump on bar
- Hydraulic provides assistance
- Track system

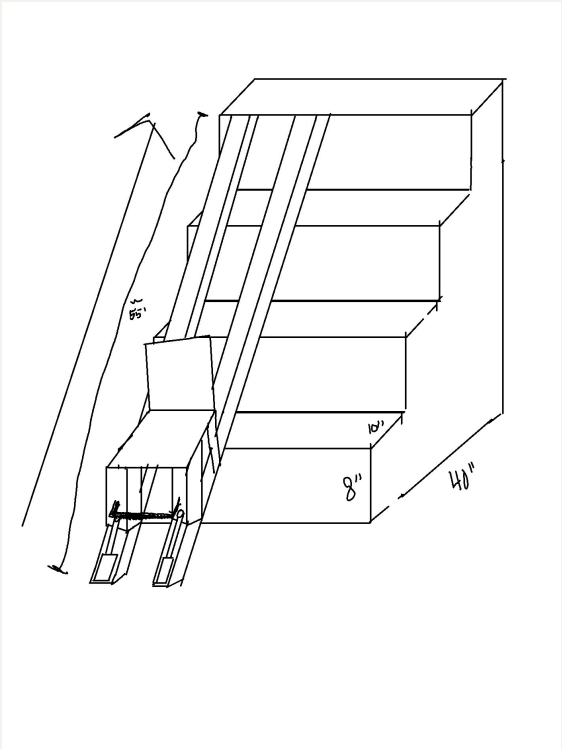


Figure 4: Hydraulic Pump Design

Design 4: Vertical Lift

- Lift straight up with winch
    - Leverage
- Platform
- Ramp hinges until flat
- Wheelchair accessible

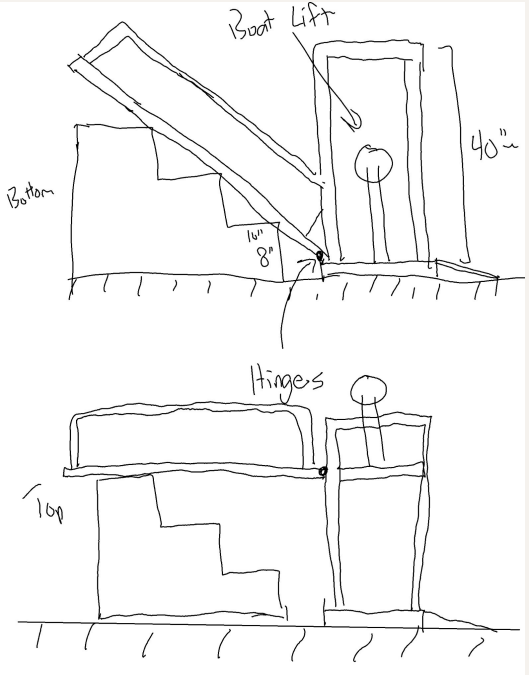
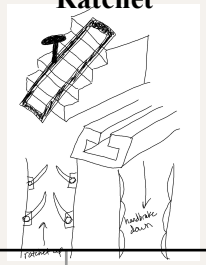
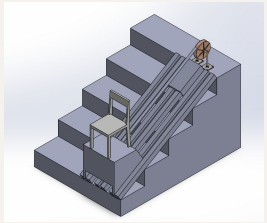
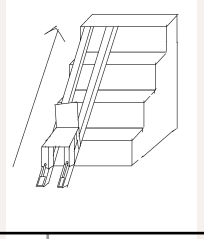
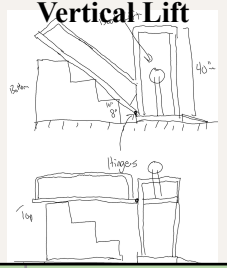


Figure 5: Vertical Lift Design

Design Matrix & Final Design

Design Criteria (Weight)	Design 1: Ratchet 		Design 2: Counterweight 		Design 3: Hydraulic Pump 		Design 4: Vertical Lift 	
Safety (25)	2/5	10	4/5	20	4/5	20	5/5	25
Efficiency/Ease of Use (25)	4/5	20	5/5	25	3/5	15	3/5	15
Adaptability (15)	3/5	12	2/5	6	2/5	6	5/5	15
Ease of Fabrication (10)	2/5	4	4/5	8	3/5	6	4/5	8
Weather (10)	3/5	6	4/5	8	3/5	6	4/5	8
Cost (10)	4/5	8	3/5	6	3/5	6	2/5	4
Weight (5)	5/5	5	1/5	1	5/5	5	1/5	1
Total Score (100)	**65**		**74**		**64**		**76**	

Testing

- Hinge maneuver
- Force required to lift - N
    - Test ratio of input and output
- Weight limit- kg
    - Failure Test - Factor of Safety
- Stability of structure

Future Work

- Decide mechanism
- Proof of concept
- Scale model

- Full size model
- Adjustable to any set of stairs
- Adjusting to weather conditions

References

[1]“Step by Step: A comprehensive approach to stair climbing assistance,” *Wisc.edu*, 2023. https://bmedesign.engr.wisc.edu/projects/f23/stair_assist_bench

[2]R. L. Parrino, K. L. Strand, A. C. Hockman, and J. F. Signorile, “Leg press and chest press strength normative values by half-decades in older persons,” *Experimental Gerontology*, vol. 150, p. 111401, Jul. 2021, doi: https://doi.org/10.1016/j.exger.2021.111401.

[3]ISO, “ISO 13485 Medical devices,” *ISO*, 2016. https://www.iso.org/iso-13485-medical-devices.html

[4]“Wisconsin Legislature: SPS 321.04(2)(d),” *docs.legis.wisconsin.gov*. https://docs.legis.wisconsin.gov/code/admin_code/sps/safety_and_buildings_and_environment/320_325/321/ii/04/2/d