X-Chair

Client: Mr. Keith Wanta

Team Members: Marissa Harkness, Ben Lawonn, Jonathon Murphy, Naman Patel, Jenna Warden

Advisor: Mitchell Tyler

Overview of Presentation

- Client Introduction
- Problem Statement
- Background Material
- Project Design Specifications
- Preliminary Designs
- Design Matrix
- Future Work
- References & Acknowledgments

Client Introduction

- Mr. Keith Wanta
  - Works as a Senior Programmer Analyst in the Biostatistics and Medical Informatics Department at the UW-Madison School of Medicine and Public Health
  - Diagnosed with Spinal Muscular Atrophy (SMA) Type 2

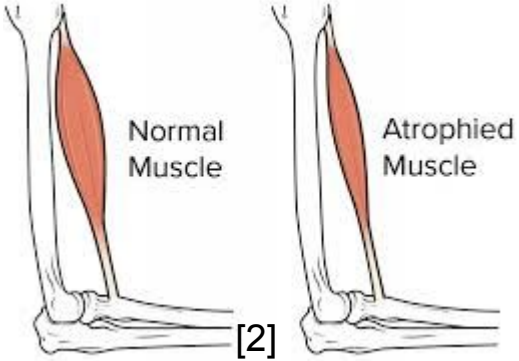
[3]

Problem Statement

Many wheelchair users are unable to take advantage of the benefits of movement. Movement is beneficial for a number of bodily functions such as blood flow, digestion, muscle strength, and bone health. Neuromuscular conditions inhibit the straightening of joints, limiting the overall mobility of the patient. The cost of hiring a CNA or licenced physical therapist is quite expensive and usually is not covered by health insurance for those affected by a permanent disability. The goal of this project is to develop a device that enables wheelchair users to move in various positions, allowing them to strengthen muscles, aid in bodily functions, and help reduce their current movement limitations.

What is Spinal Muscular Atrophy?

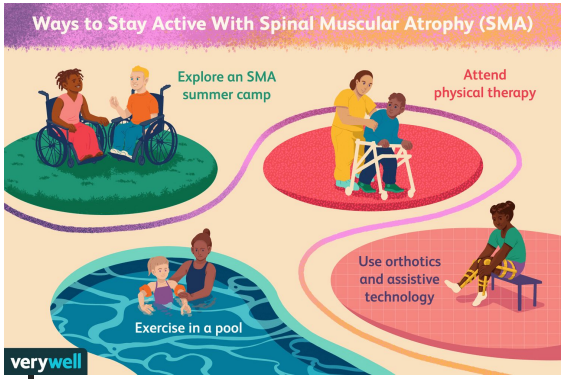
- SMA affects voluntary muscle movement [1]
  - Respiratory
  - Swallowing
  - Back
- Greater impact on proximal muscles before distal [1]
  - Hands remain strongest
- Diagnosing [1]
  - Physical examination
  - Blood work for creatine kinase (CK) enzyme
    - Looks for high levels of CK
  - Genetic testing
  - Muscle biopsy
  - Electromyogram (EMG) to see the speed at which nerves respond to signals



[2]

Improving Conditions

- Medication [3]
- Breathing/swallow aids [3]
- Movement and exercise [1]
  - Exercise without pushing it to the extreme
  - Protect joints from stiffness or injury
  - Preserve range of motion
  - Maintain circulation
  - Exercising in a warm pool can be beneficial



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Competing Designs and Systems

- Inversion Tables
- Blood Pressure Cuff
- Boa Lacing System
- Roller Coaster Harness
- Ratchet Straps

[5]

[6]

[7]

Client Requirements

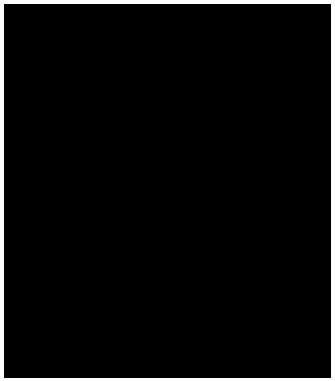
- Independence / autonomous
- Prone position
- Sit and stand positions
- Vibrations
- Stretching of arms and body

[8]

Product Design Specifications Summary

Client requirements:

- Autonomy
- Sit/stand position
- Prone position



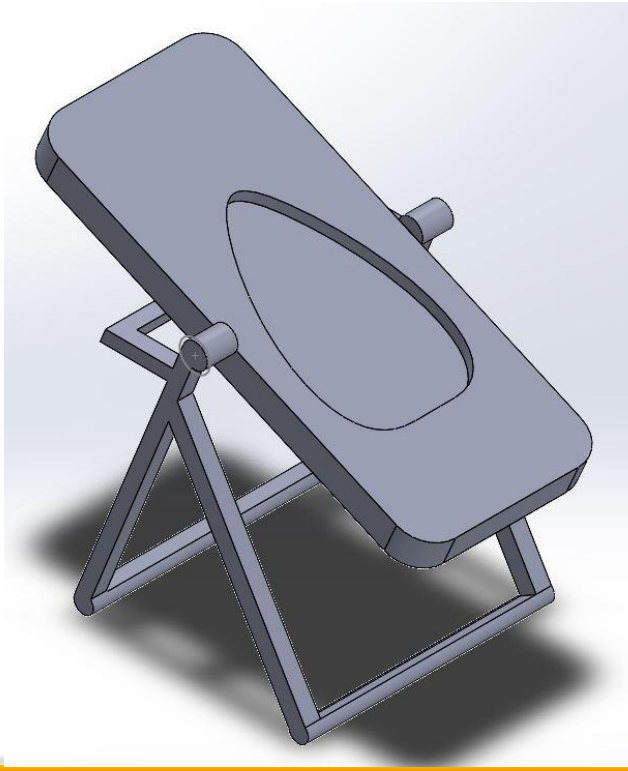
Design requirements:

- Max width of 0.90m +/- 0.01m
- Cost must be under $2000

Preliminary Design 1 - Inversion Table

Description/Features

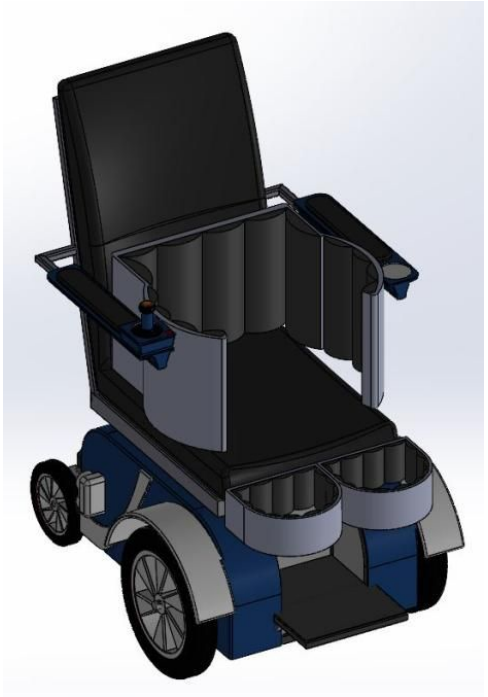
- Standalone device requiring ceiling lift and another person to enter
- Can rotate to vertical and prone positions
- Motorized rotation to ensure safe and controlled operation
- Cost: $720
  - $200 Stainless Steel, $20 Arduino Nano, $400 Servo Motor, $100 Padding & Chair



Preliminary Design 2 - Pressure Cuff

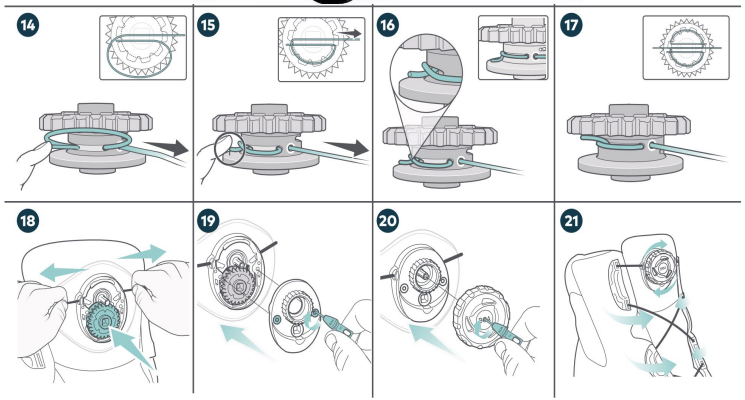
Description/Features

- Pressure cuff secures upper body and each individual leg
- Provides added comfort
- Added variability as the pressure would fill and release over 5 seconds
- Cost: $320
    - $100 air compressor, $100 leg & chest compression cuff, $20 arduino nano, $100 cuff mounts



Preliminary Design 3 - Boa System

- Recommended product platforms
  - H-Series: High power and capacity
    - built for thicker, stiffer applications for large, difficult-to-close equipment
  - M-Series: Durable and powerful
    - workwear and outdoor; withstand force and impact in harsh conditions
- BOA System Video: https://vimeo.com/321387873
- Cost: $132 + wire
  - Boa components $10, nylon webbing $27, padding $10, boot $55



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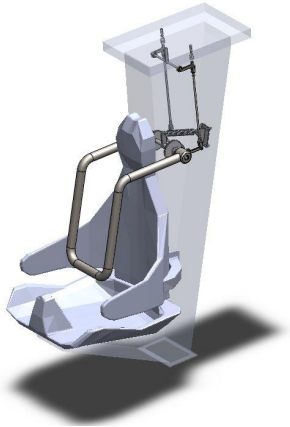
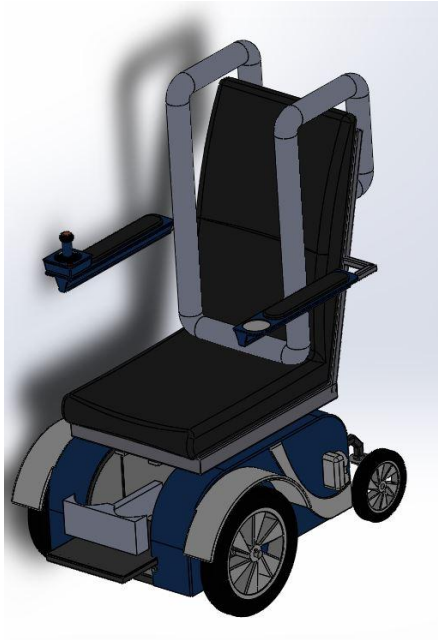
Preliminary Design 4 - Roller Coaster Harness

Description/Features

- Chest and leg restraints can be controlled simultaneously
- Ratchet locking system
- Added safety
- Commonly known mechanism
- Cost: $450
  - Gear/Ratchet system ~ $150, U-Shaped Restraint and padding ~ $300





Design Matrix - Adaptation or Standalone Device

Testing	Standing Wheelchair Adaptation	Inversion Table [redacted]
Safety (25)	20	15
Independence/ Autonomy (20)	20	4
Ease of use (15)	12	6
Cost (15)	12	3
Comfort (15)	12	9
Stability(10)	8	6
Total (100)	84	43

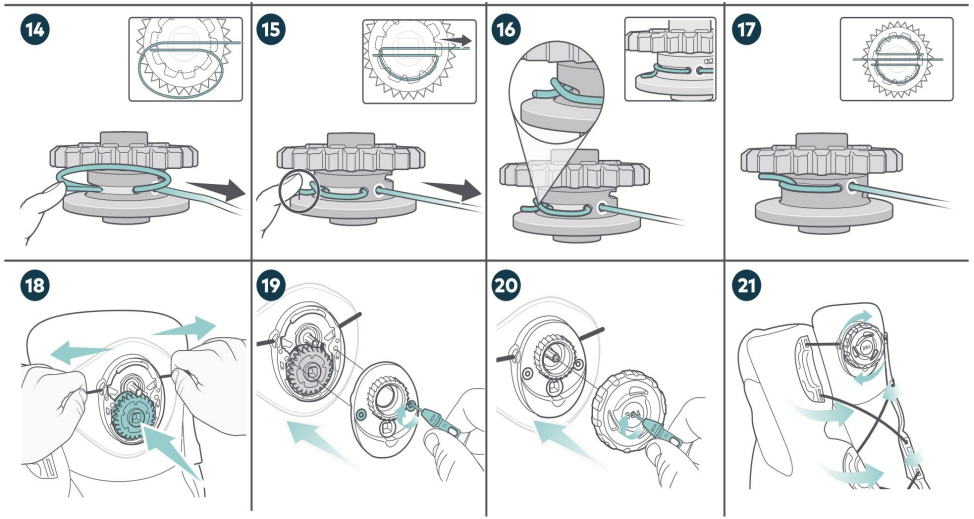
Design Matrix - Chest Area

Testing [redacted]	Boa System	Pressure Cuff	Roller Coaster Harness
Safety (25)	25	20	25
Ease of Implementation (20)	20	16	12
Ease of use (15)	15	12	15
Cost (15)	15	12	6
Comfort (15)	12	15	9
Stability(10)	10	10	10
Total (100)	97	85	77

Design Matrix - Leg Area

Testing	Boa System	Pressure Cuff	Roller Coaster Harness
Safety (25)	25	20	25
Ease of Implementation (20)	20	16	12
Ease of use (15)	9	9	12
Cost (15)	15	15	6
Comfort (15)	12	15	12
Stability (10)	10	8	10
Total (100)	91	83	77

Proposed Final Design



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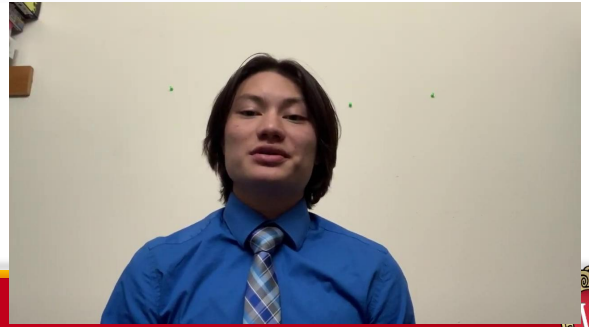

Future Work

- Integrating multiple systems
- Automating mechanical aspects
- Bluetooth compatibility
- Researching ratchet systems

[11]

[10]

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Acknowledgements

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Questions?

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