Assistive Device for Wheelchair Users to Hoist Pants Up

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Problem Statement

Individuals with Becker Muscular Dystrophy, a disease that results in progressive muscular degeneration, often face physical limitations that can pose challenges in performing everyday tasks, including the simple task of pulling up pants. Current solutions are not only cost-prohibitive, but also demand a level of upper-body strength that many affected individuals may not possess. This project aims to develop a prototype solution that will enable individuals with limited arm strength to autonomously pull up their pants.

Background and Motivation

Background: Becker Muscular Dystrophy

- Recessive disorder that leads to progressive muscular degeneration and proximal muscle weakness [1]
- Muscle weakness typically begins in the lower body and progresses to the arms, neck, and other areas, with the exact rate of progression being specific to the individual [2]

Motivation

- Currently the client pulls his pants up from a seated position in his wheelchair by leaning back and forth- typically takes over 7 minutes
- Wheelchair dressing aides currently on the market are costly and require high levels of upper body/arm strength [3]
- Client does not wish to replace current wardrobe with adaptive clothing
- Both the act of pulling up pants and incomplete results cause the client daily discomfort

Figure 1: Pants Up Easy Device [3]

Design Criteria

Criteria	Specification
Ergonomics	Lift less than 8.4 lbs to operate, 5ft x 6ft x 4ft space
Effectiveness	Ability of device to decrease hoist time to 3-4 mins
Ease of Use	Client is able to use product without assistance
Ease of Fabrication	Product can be fabricated within one semester
Comfort	Product minimizes discomfort, strain, and fatigue
Cost	Within the client's budget of $300
Safety	Support 6ft 2in, 230 lb person leaning on device

Final Design and Prototype Fabrication

Fabrication of Frame:

- Assemble standing desk
- Adhere foam to cross beam with zip ties and caulk
- Screw in steel bar on bottom

Fabrication of Winches:

- Screw on extending winch steel bars
- Attach RC winches to ends of steel bars facing towards the user with polyurethane adhesive

Figure 2: Final Prototype Front View

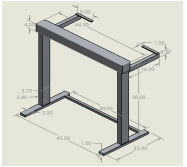


Figure 3: Final Prototype SolidWorks Model

Functionality:

- User can adjust standing desk frame electronically to desired height before leaning over the top
- The wheelchair will act as counterweight so the frame won't tip while in use
- The clips attached to RC winches will attach to pants before user leans over frame
- The RC winches will electronically pull up the pants once the user is in leaned over position

Prototype Testing

RC Winch Path Testing:

- Set RC winches at different distances away from the user and measure angle
- Set all trials at same level (ground) and record speed taken to pull pants up

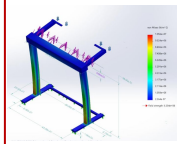
RC Winch Strength Testing:

- Test if RC winch can pull up pants while leaning on the frame
  - 6 trials
  - All success

Frame Strength Testing:

- Place user weight on the top bar and a 350 lb counterweight over the bottom
  - 3 trials, using 230, 240, 250 lbs as the weight
  - 4 minutes each trial
  - No tipping or deformation

Model Testing



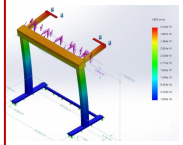


Figure 4 & 5:
4 (top) shows the displacement testing under the load of the forces acting upon the frame.
5 (bottom) shows preliminary model

Stress Testing

- Lowest Factor of Safety is 58.6276
- Minimal stress, max stress is 50x less than yield

Displacement Testing

- Insignificant displacement, less than 1/100 of an inch

Discussion

RC Winch Complications

- Catching of the feed
- Finicky buttons

Design Adjustments

- Location of winches
- Changed material from aluminum to steel
- Purchased and adjusted frame instead of welding

Addressed Design Criteria

- Design not dependent on upper body strength
- Testing validates functionality of product

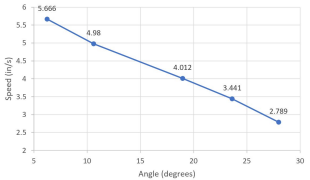


Figure 6: Angle of RC Winch vs. Speed

Future Work

- Replace RC with larger, more durable winch
- Attach winches with bolts to more adjustable arms
- To make more universal, attach winches to free standing 8020 Aluminum frame

Figure 7: 8020 aluminum [4]

Acknowledgements

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References

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