

Design of a Terrain-Capable Walker-Wheelchair with Torso Support

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James Manzer¹, Gabriel Simon Sosa¹, Brenden Cuddihy¹, Kristen Snarski², and Davide Piovesan¹

¹Biomedical, Industrial, and Systems Engineering Department, Gannon University, Erie, PA, USA

²Physical Therapy Department, Gannon University, Erie, PA, USA

Abstract

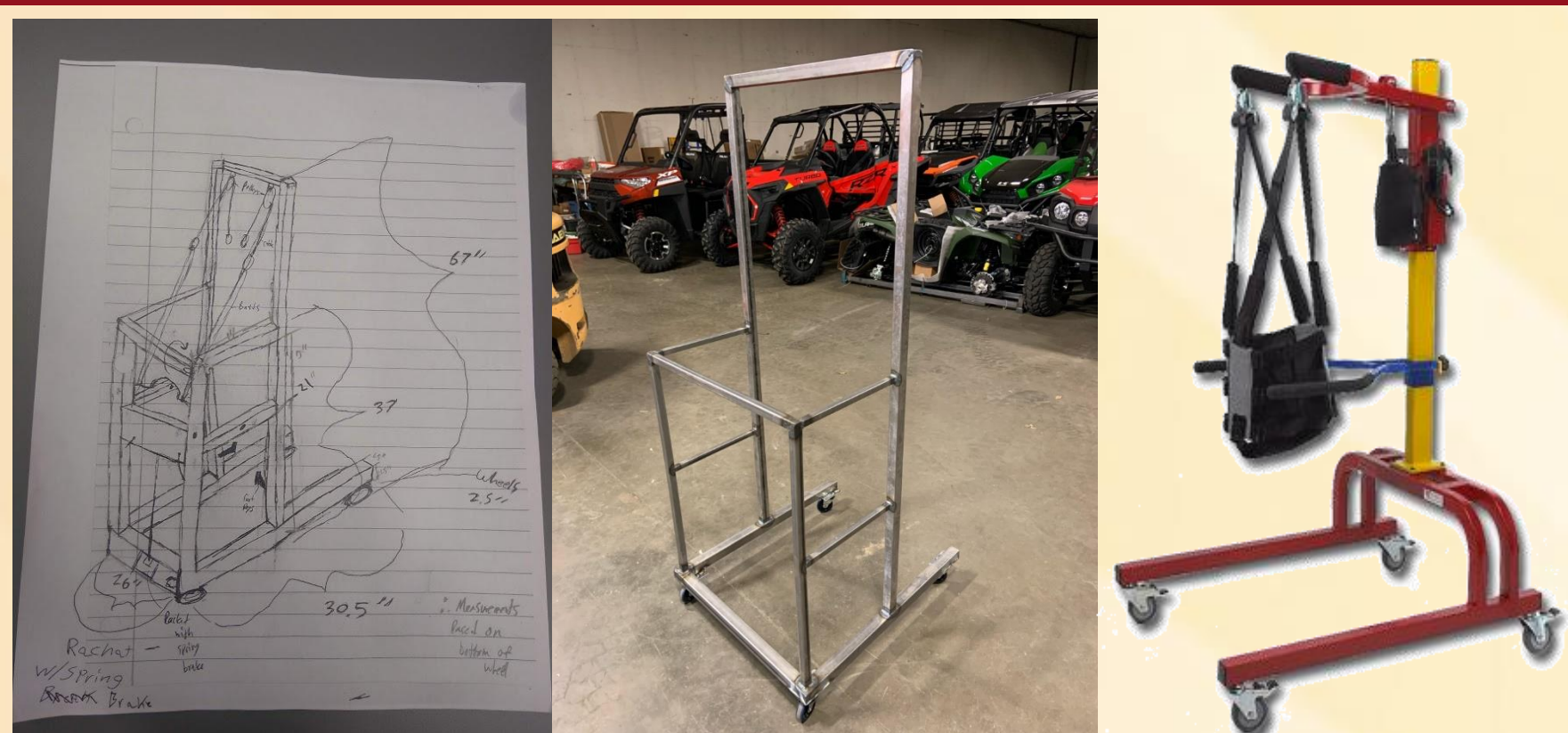
- Globally, nearly 1 in every 10 people are disabled [1].
- There are several desirable characteristics in mobility device design, including wheelchair functionality, walking support, and outdoor terrain abilities.
- An unmet need in the medical industry was found for an ideal mobility device that combines the several highly desirable functions in a single mobility device.
- A solution to much of the lack of good mobility devices is designing for durable, easily maintained functionality at an inexpensive cost.

Can one device rule them all?



- Using cost-effective materials, a mobility solution was created featuring wheelchair and torso-suspension walking support, outdoor functionality and material selection enabling repairs to be made at the convenience of the local bike shop.

The Creation Process

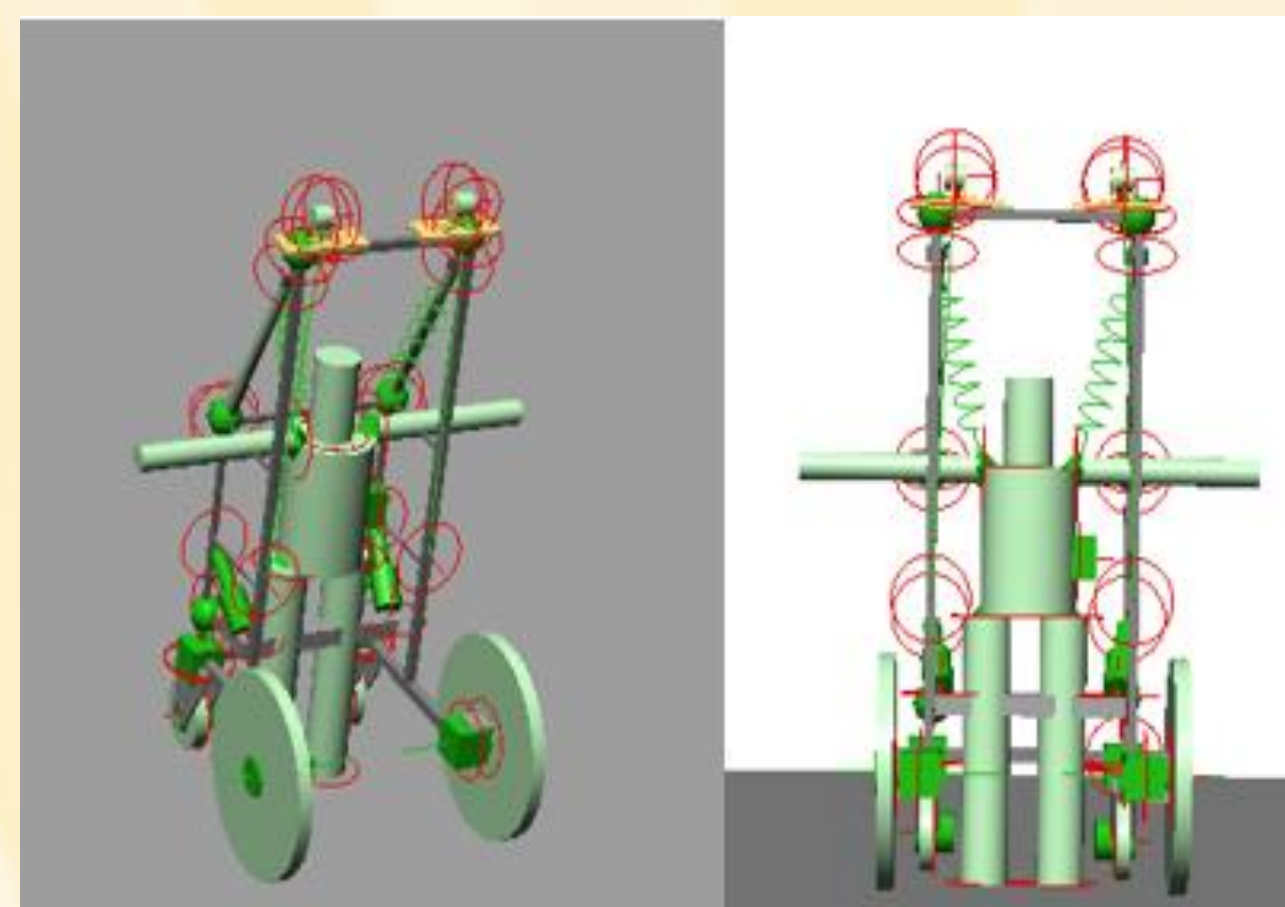


- Several needs of customers and producers were found through brainstorming and research.
- Using an analytical problem-solving process, a quantified prioritization of needs was made.
- Using fundamental physics concepts and market analysis, several design iterations were made
- After a quantified elimination process, a virtual simulation was created to test the best design

Design Concept

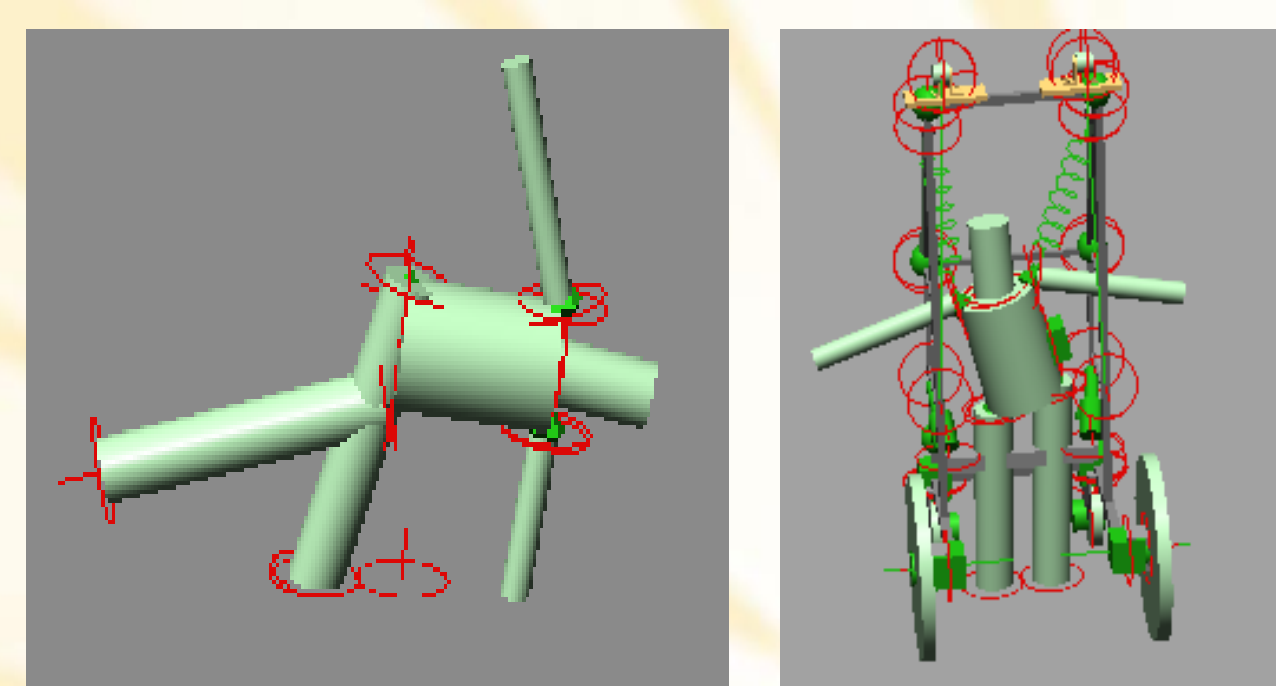
- Use suspension-overhead concept for walker to offer easy torso support and balance.
- Include wheelchair and a sit-to-stand lever aid so that the user only needs one device.
- Design for outdoor as well as indoor use though large, inflatable tires with the largest in front [2].
 - Absorbs vibration
 - Overcomes obstacles without leverage of forward pushing with the arms
- Make practical on a global scale to include rural, low-resource countries through choice of bike parts in material selection.
- Offer size adjustability to reach large audience through adjustable cables and seat height.

Step One: The Virtual Model



- A virtual model of the walker wheelchair was built in Creo 6.0, then tested in SimWise 4D.
- A human dummy was built to scale using literature values.
- Constraints chosen by research to emulate bike parts

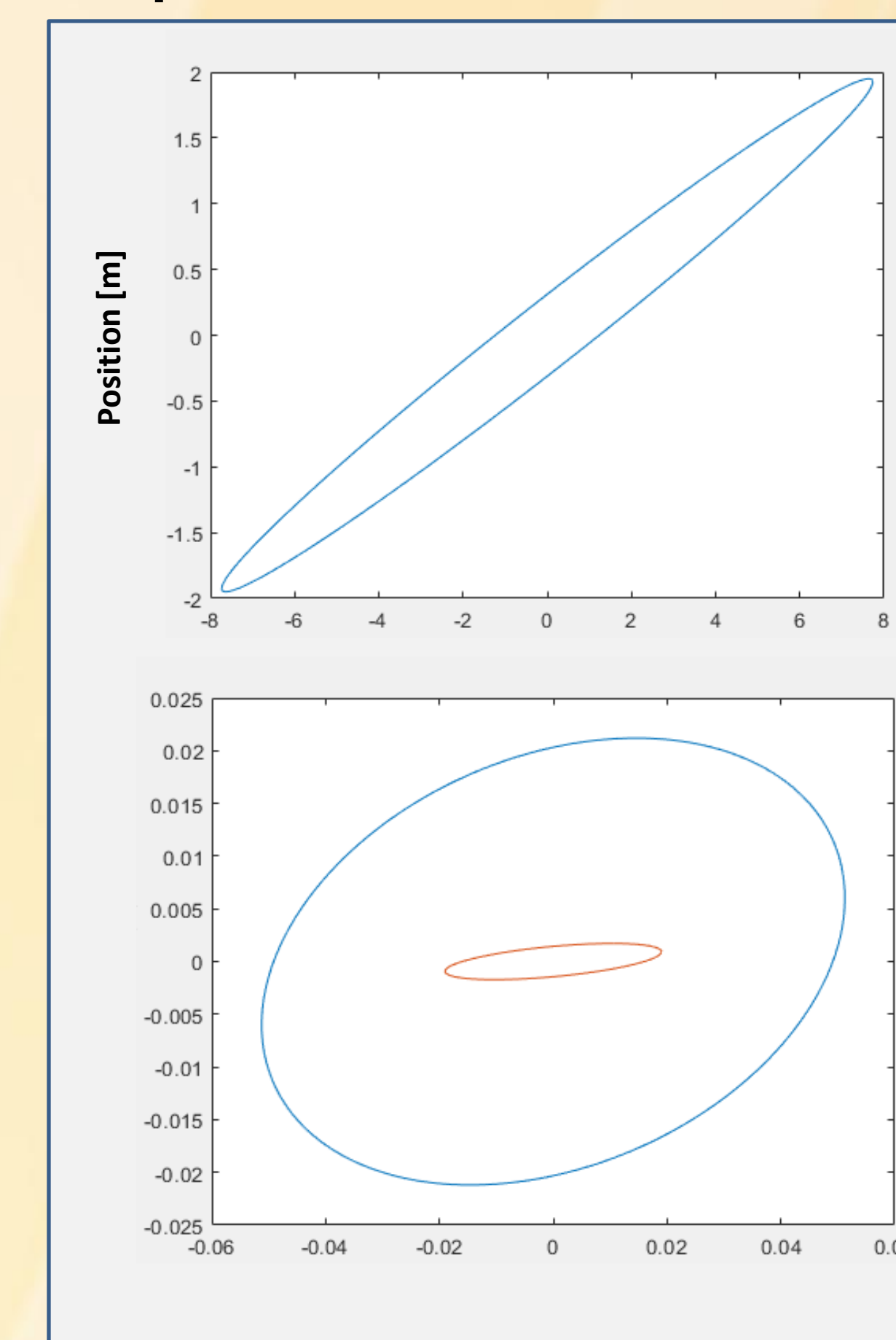
Step Two: Test for Failure



- One of the greatest concerns for the disabled is falling over.
- A test an analysis were performed of a person falling over to see how much of a difference the device made on the person's stability.

Performance Test: How much does it do for a person falling over?

In two tests, a dummy was allowed to fall from a tilted position, once with no device, once with the device.



A 95% covariance ellipse of the center of masses was developed in MATLAB to measure the stability of the dummy.

- Free Fall:
Falls to ground
Dummy center of mass moves 2 meters
Hits ground in under 2 seconds.
- Walker-wheelchair:
Dummy moves a maximum 5 cm from start position
Dummy returns to stability

A Successful Optimal Device?

- The tests showed that this design is safe from risk of falling
- As research is progressing, a prototype has been developed after several other virtual simulation tests for axle strength and stability when hitting a bump
- Next steps include verification testing to meet standards and then introducing it to user groups to iterate design based on user's needs and wants.



References

- [1] World Health Organization. (2011). World report on disability 2011. World Health Organization.
- [2] Pearlman, J., et al., Design Considerations for Wheelchairs Used in Adverse Conditions. 2018.