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### Wheelchair-Mounted Exercise Equipment for Paraplegics

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# Wheelchair-Mounted Exercise Equipment for Paraplegics

Kamal Aljohani · Tanya Enderli · Shan Guan · Drake Hillman

Faculty Advisor: Dr. Ted Conway, Department of Biomedical Engineering, Florida Institute of Technology

## Motivation

According to the National Spinal Cord Injury Statistical Center (NSCISC) there are over 276,000 people living with a spinal cord injury in the United States, and 41% of these injuries are classified as paraplegia. Since most paraplegics cannot walk, a greater demand is placed on the arms to propel a wheelchair for mobility.

There is a need for lightweight, portable exercise equipment that can be used by paraplegics to maintain range of motion and improve blood flow in the legs as well as build and maintain core and rotator cuff strength to prevent falls and shoulder injuries. Most current exercise equipment designed for paraplegics consumes a large amount of space in the home and is not portable which limits when and where it is used.

## Objectives

The main goal of this project was to design manual exercise equipment that can be used by paraplegics to get a full body workout. By making the equipment portable it will allow the user to exercise more often throughout the day, even when away from home, and thus will promote a greater level of overall health and fitness.

## Acknowledgments

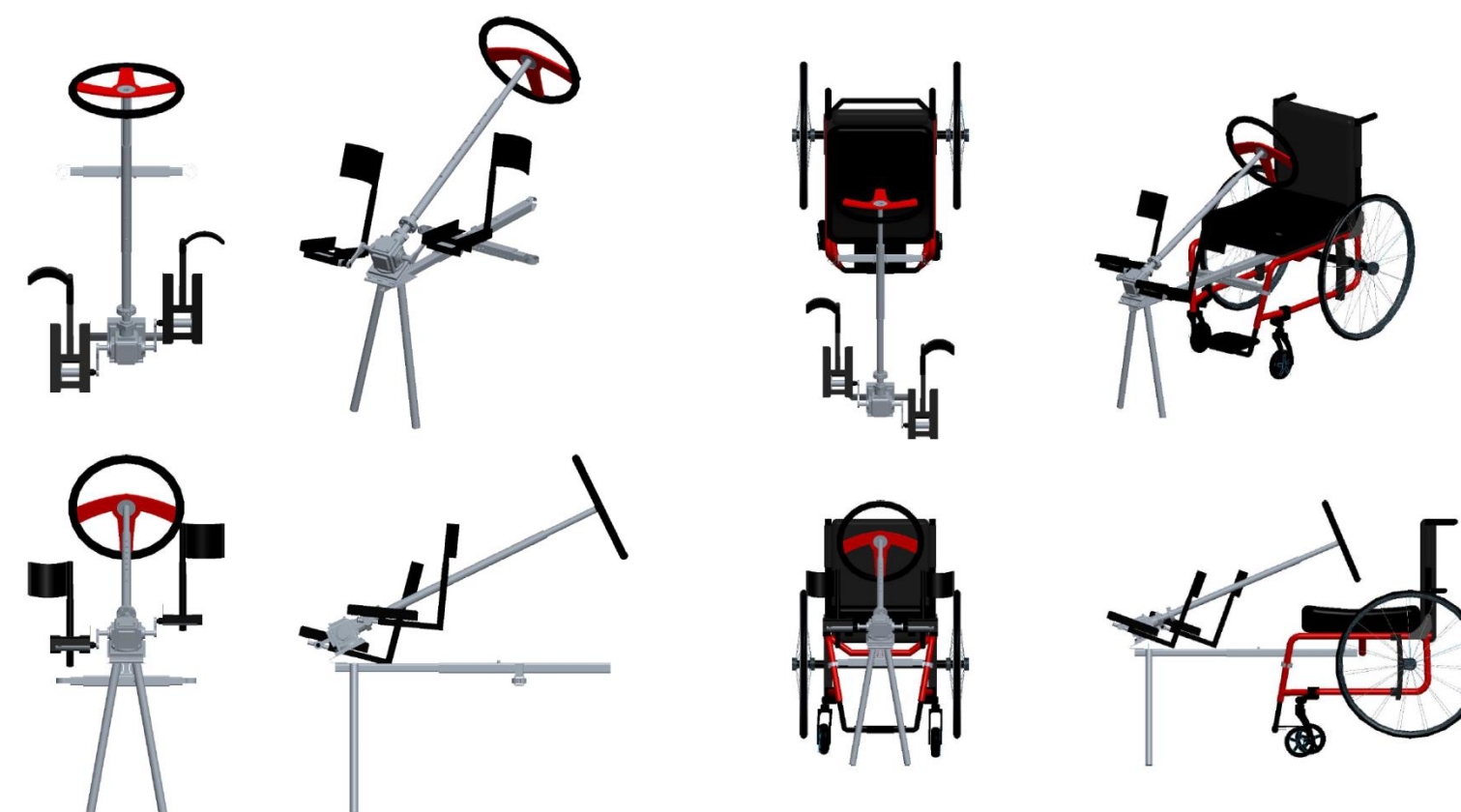
A very special thanks to Laura Leitz and the outpatient physical therapy staff at Sea Pines Rehabilitation Hospital, Heather Anderson, and the Jingzhou Jujing Transmission Machinery Co., LTD.

## Future Design

There are many enhancements that could be made to this device in the future, including:

- Creating a universal design for attaching the pedaling device to folding wheelchair frames
- Simplifying the assembly of the components
- Modifying the equipment for use by quadriplegics

## Passive Pedaling Device



The legs will be passively pedaled by the user putting his or her feet in pedals attached to the outputs of a bevel gearbox and then rotating a steering wheel connected to the input of the gearbox.

## Shoulder and Core Device



Clamps fixed to the wheelchair frame will allow for the attachment of resistance tubing of different lengths to accommodate a large range of core and shoulder exercises. Six levels of resistance tubing will be included with the device so the end user can select the strength of tubing that corresponds to his or her own upper body strength.

## Design Criteria

Input from the test end user and project guidelines set by the faculty advisor led to the development of the following criteria:

- Device must be lightweight and portable
- Manually exercise legs, shoulders, and core
- Promote overall well-being
- Universal design for fixed-front wheelchairs
- Should be easy to assemble, disassemble, and use
- Proven safe by hand calculations and ANSYS Workbench analysis prior to testing

## Results

Pedaling Device Equipment Specifications:

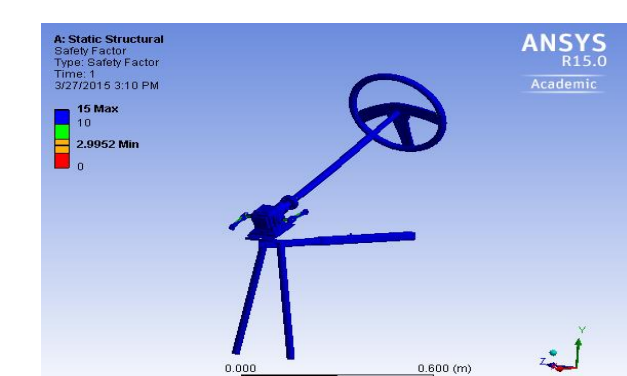
- Gearbox Speed Ratio, Input to Output - 2:1
- Radius of Steering Wheel - 7 in.
- Radius of Pedal Crank Arm - 3-5 in.
- Input to Output Force Ratio: 10.0:46.7 lbf

Budget:

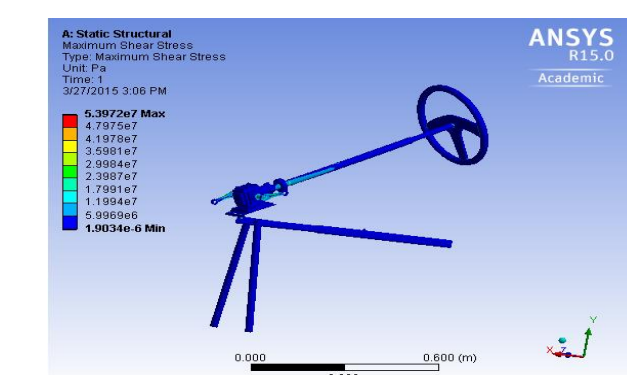
Pedaling Device total cost - \$ 998.00

Resistance Tubing Device total cost - \$ 250.00

ANSYS Analysis:



Minimum Safety Factor: 2.995



Maximum Shear Stress: 7828 psi

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