Assisted Rehabilitative Kinematic (ARK)

EML 4501 Spring 2020 – Group 13
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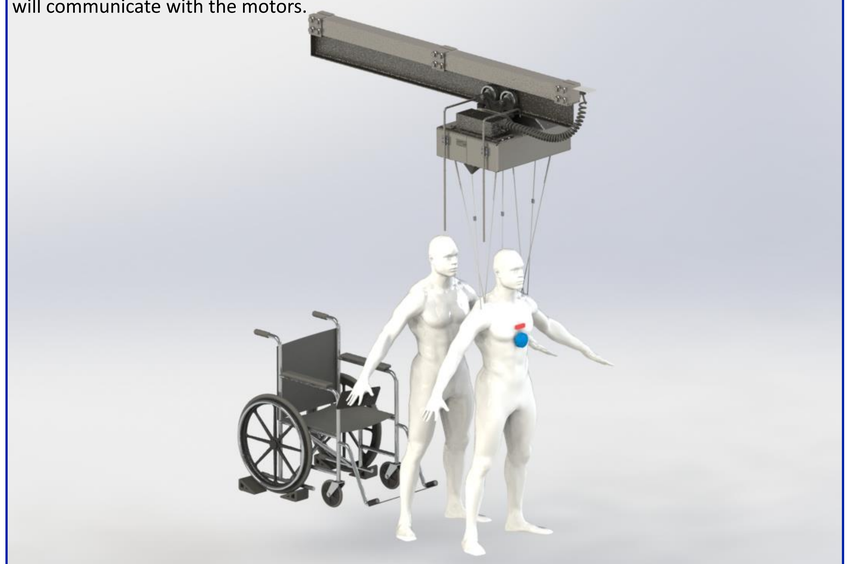
Abstract/Product Overview

The Assisted Rehabilitative Kinematic (ARK) Device is a unique system design to help paraplegics use elliptical machines. The design features a ceiling mounted I-beam assembly, fitted with a trolley, trolley housing, power supply, and harness. The trolley system possesses two motors and a winch designed for supporting the weight of the user and the two motors have the capability of being continuously adjusted with a Raspberry Pi while the user is exercising. This trolley translates one-dimensionally across a specified portion of the I-beam to successfully lift the user from a wheelchair and into position above an elliptical training device. The rehabilitation specialist will be responsible for the movement of the user to the elliptical at a pace comfortable to both.

Figure 1: Full assembly showing the unique I-beam and trolley mechanism as well as the undercarriage and the wheelchair locking mechanism. The patient is wearing the emergency shutoff button and sensor that will attached to the harness and the aid is holding a tablet that will communicate with the motors.



FEA Undercarriage

- Static Test (325 lbf total on winch and 120 lbf total NEMA)
  - Maximum Von Mises Stress: 38.09 MPa
  - Maximum Deformation: 0.2165 mm
- Fatigue Test (10^8 cycles or Infinite Life)

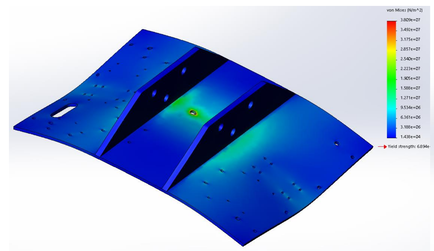


Figure 4: Isometric view of static test with 325 lbf total on winch bolts and 120 lbf total on NEMA bolt holes. Deformation scale 281.

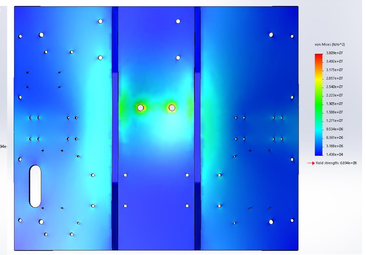


Figure 5: Top view of static test with 325 lbf total on winch bolts and 120 lbf total on NEMA bolt holes. Deformation scale: 281.

Cost Overview

- Off-the-self (OTS) Parts Cost: $2,300.80
- Raw Material Cost: $492.00
- Manufacturing and Labor Cost: $1,345.62
- Energy Cost: $0.17
- Assembly Labor Cost: $53.31
- Total Cost: $4,191.73

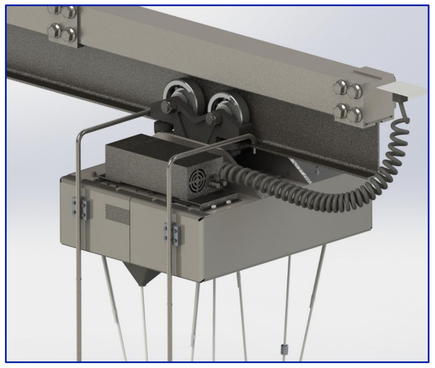


Figure 2: Undercarriage, trolley, and power supply.

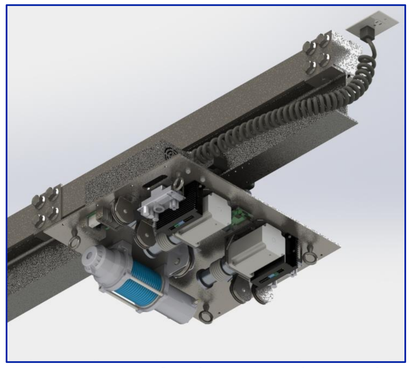


Figure 3: Interior of undercarriage showing the motors, driver, pullies, voltage booster, and Raspberry Pi.

FEA I-Beam Analysis

- Static Test (360 lbf load)
- Maximum Von Mises Stress: 485.5 MPa
- Maximum Deformation: 0.2488 mm

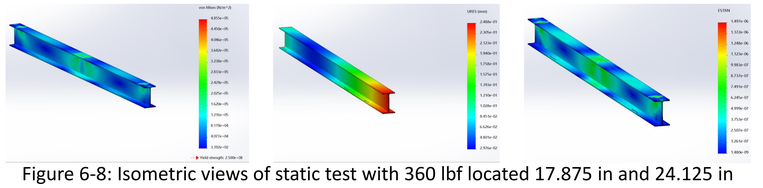


Figure 6-8: Isometric views of static test with 360 lbf located 17.875 in and 24.125 in from image nearside. From left to right: stress, displacement, and strain. Deformation scale 871.028.

Customer Needs	1, 30	2	3, 9, 29	4, 10, 11, 15, 16, 17, 19, 20, 21	5, 6, 8, 25, 28	7, 12, 13, 14	22, 23, 26, 27	18	24
Requirement	Size (2'10" × 8')	Power (120 VAC and 15-amp)	Interference	Weight offset, support 100% weight (297 lb), maintain balance and offset during exercise, comfortable, variable (ability to adjust from 0 – 100% weight) and continuous offset weight (use of program to continuous adjust)	Safety, FOS of 2, fail-safe catch (withstand impact force of 528 lbf), prevent hitting, emergency shutoff (operable by user or specialist) , lifetime (45 years)	Transition User (1-2 ft/s)	Programmable with GUI and Features (single click with ¾ inch icons), automatic shutdown (upon load of 700 lbs or vertical drop of 6 inches by 95% male), visual indications (LED indicator)	Mounting (mount into structural support in walls or ceiling or sit on floor)	Cost (materials and OTS parts cost less than $4,000)
Subsystem	Frame	Power	Whole system	Interior Undercarriage	Whole system, Cables, and Harness	Whole system	Interior Undercarriage, Motor Housing, and tablet.	Ceiling Mount	Whole system
Feature	I-Beam and Trolley Floor Area (1'5" × 2'2")	Power Supply (12 DC, 110/220 ACV, and 80 Amps)	Whole System does not have interference with the system, person, or ETS.	Winch, NEMAs, Cables, and Drivers/Controllers can adjust the variable weight offset, continuously, comfortably, left and right, vertically, and accommodate the full weight.	Safety cables, and harness emergency stop button.	Frame and trolley, winch, user aided, and trolley locking mechanism.	Motor drivers and controllers, Raspberry Pi, LED signals, and a programmable tablet.	Ceiling Mount that attaches to structural support beam to hold the I-beam and trolley.	Material and OTS Part Cost: $2,792.80