Neuromuscular Elliptical Rehabilitation Trainer (NERT)

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EML 4501
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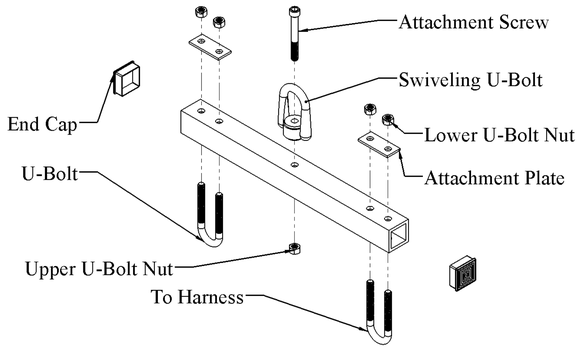
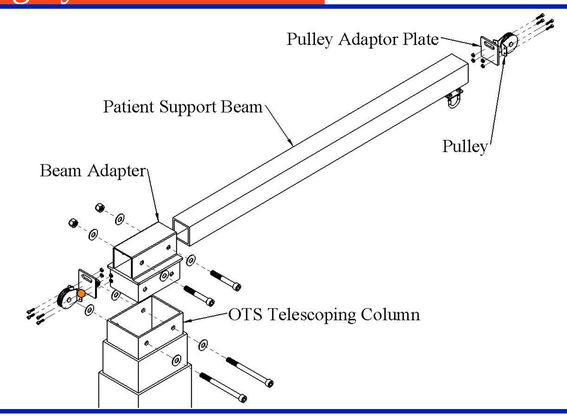
Product Abstract

The Neuromuscular Elliptical Rehabilitation Trainer (NERT) is a lift and harness system that can provide partial or total weight offset as well as gait compensation for patients with neuromuscular disorders. NERT uses two sources of vertical movement actuation to provide both large, less accurate movements using the linear actuator and telescoping columns, as well as smaller, more accurate movements using a cable and winch. The linear actuator is primarily used for lifting the patient to proper position and the winch is used for fine tune adjustment of the force on the patient during movement. To provide an input to these systems an inline tensile force meter will be used in conjunction with closed-loop PID control to minimize the error during tracking of a desired force. NERT incorporates multiple safety features to aid both the patient and trainer. The design contains two emergency stops, one directly adjacent to the operator's laptop stand, and one located on the harness of the patient, so that either can initiate an emergency stop. The design also contains a secondary safety cable attaching the patient to the design's boom to prevent a patient fall in the unlikely case of a main cable failure. NERT also provides lateral stability using handrails which are manually adjusted to aid in patient comfort, confidence, and stability. Overall NERT provides both a safe and practical approach to patient rehabilitation.

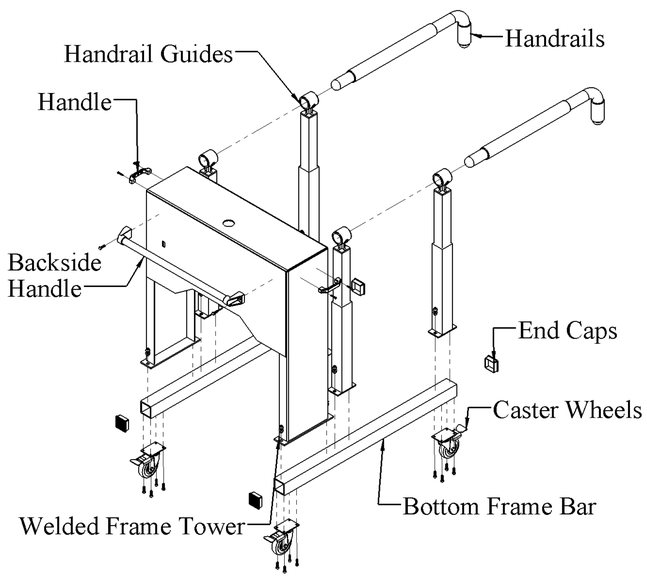
Harness to Frame Interaction



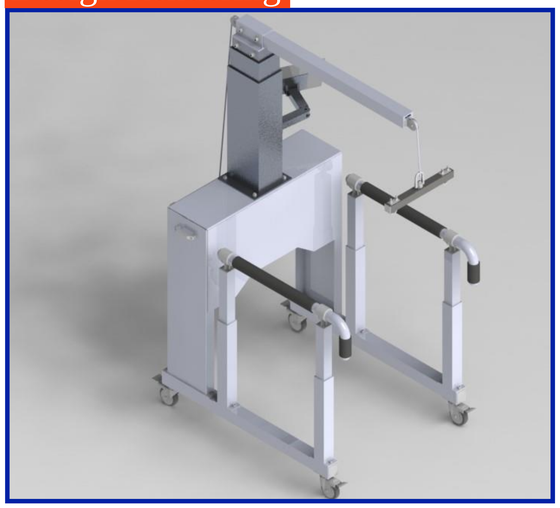
Lifting System and Boom



Frame Subsystem



Design Rendering

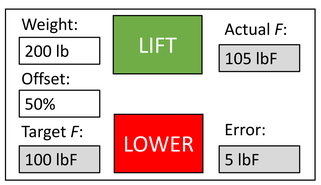


Estimated Cost Summary

- *Off the Shelf Parts:* $2658.85
  - Largest Costs: Duff Norton Telescoping Column ($1200.00), Torbal FB5k Tensiometer ($849.00)
- *Raw Materials:* $710.19
  - Largest Cost: Sheet Steel (36" by 36" 11GA) x2 ($164.40)
- *Manufacturing and MFG Labor:* $2380.57
- *Energy Consumption:* $3.05
  - Largest Cost: MIG Welder Miller Electric ($2.22)
- *Assembly Labor:* $96.00

Total Est. Cost: $5848.66

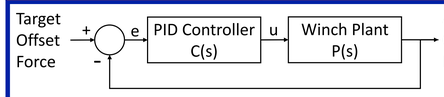
User Interface Mockup



Trainer functions through laptop interface:

- Raising/Lowering the Patient
- Input: Patient Weight and Offset
- Output: Target and Actual Offset Weight
- Offset Error

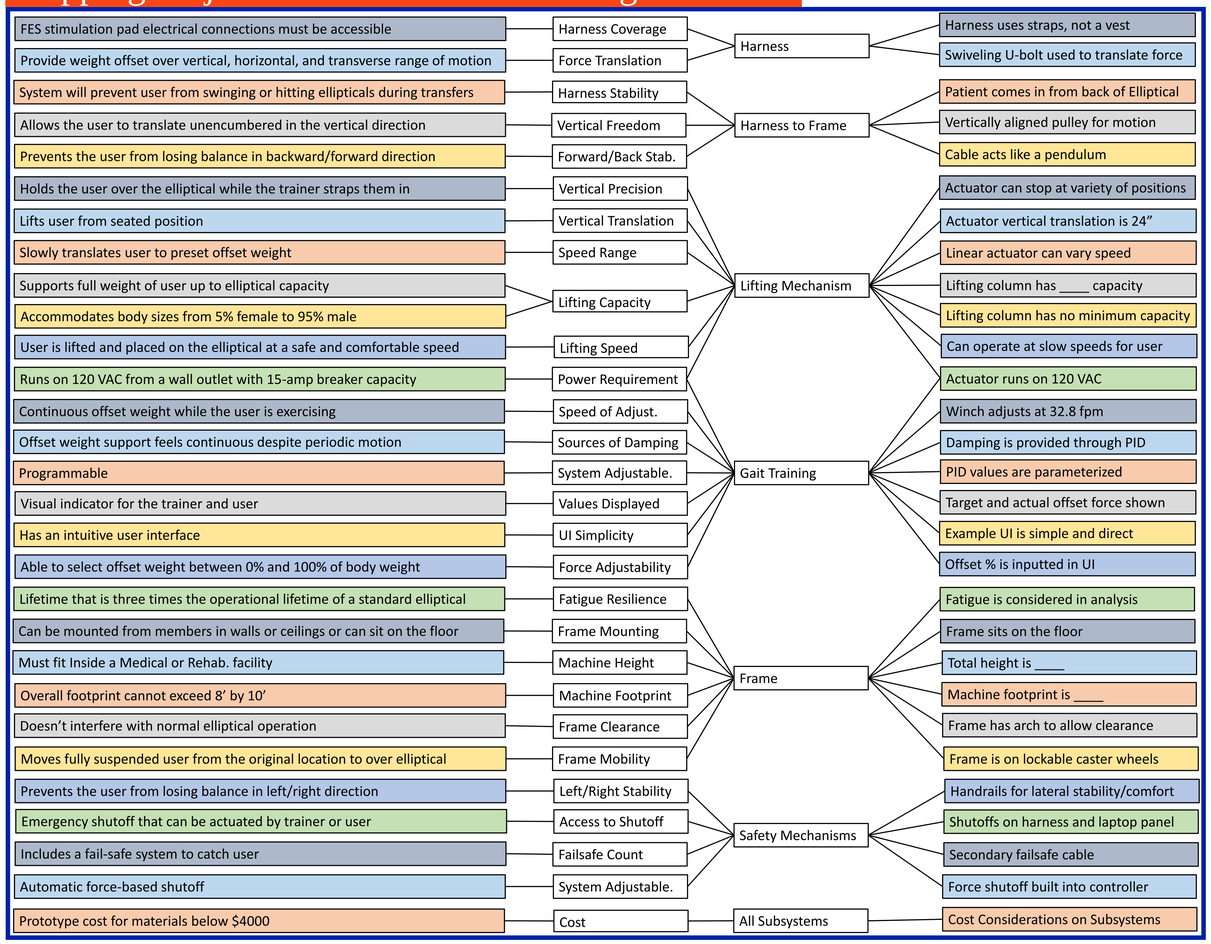
Gait Closed-Loop Control Scheme



$$F_{Target\ Offset} = Patient\ Wt. \times Offset\ \%$$

- Target offset force is a function of the patient's body weight inputted by the trainer.
- Offset force is measured using the Torbal FB5k tensiometer

Mapping Major Customer Needs to Design Features



Product Functionality and Features

Vertical Movement Actuation

- A winch is used to fine tune the force applied to the patient and account for the gait movement
- Same force applied to the patient throughout vertical movement.
- Linear Actuator and Telescoping Column to lift patient to desired position

Safety Features

- A secondary cable attaches the patient to the boom to prevent the patient from falling
- Hand railings that aid the patient with lateral movement were also added to aid with lateral stability
- Sudden Jump in Force Failsafe (S-JIFF) shutoff, which would activate in the case that the measured force changed significantly indicating the patient was falling off the elliptical

Movement

- Wheels are provided on the frame to move the frame into position for the patient.
- Linear actuator can be lowered to allow the machine to fit under doorways

Harness

- The harness provided for the patient attaches to the winch cable and includes straps that go over the shoulders of the patient as well as around the waist of the patient