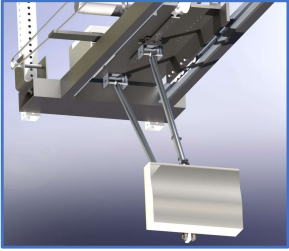


# WOMBAT

## Weight Offset and Mechanical Balance Trainer

### Balance Sub-Assembly:



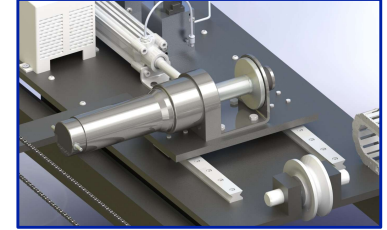
#### Key Features:

- Mechanical fall prevention
- Ball joints allow natural movement
- Slider allows vertical adjustment

### Abstract:

The use of Functional Electrical Stimulation (FES) to aid in the rehabilitation of individuals with neuromuscular disorders is an increasingly common practice. Unfortunately, the use of FES is limited by the current patient rehabilitation machines available on the market that allow an individual to simulate common exercises. The WOMBAT is an all in one product designed for hospital or home use that turns an elliptical or treadmill into a state-of-the-art walking/running rehabilitation machine. The cart-based lifting, balance and weight control system attaches to a reinforced ceiling above the elliptical/treadmill. The product utilizes Proportional Integral Derivative (PID) feedback control to maintain a calibrated and continuously adjustable pneumatic weight offset control during exercise. The tethered harness weight offset control in combination with its mechanical linkage balancing system safely prevents individuals from falling outside the bounds of proper gait to prevent injury. The product contains an intuitive user interface for the individual, as well as the trainer to allow for independent user control and trainer assistive control. The user/trainer assistive control allows for full motorized control of the system, eliminating the need for trainer physical exertion at any point in the use of the system. The WOMBAT system provides an affordable, reliable and innovative alternative to the common pully and harness systems used today.

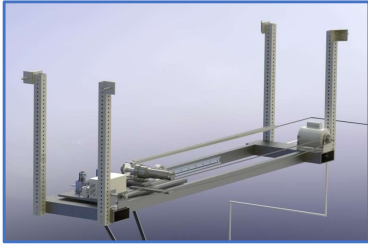
### Lifting Mechanism:



#### Key Features:

- Electric winch and pulley system
- Winch locks the user in place at the desired height
- Works in series with the pneumatic cylinder

### Structural Sub-Assembly:



#### Key Features:

- 72" guide rail to smoothly transport the patient to the elliptical
- Adjustable supports to accommodate various ceiling heights

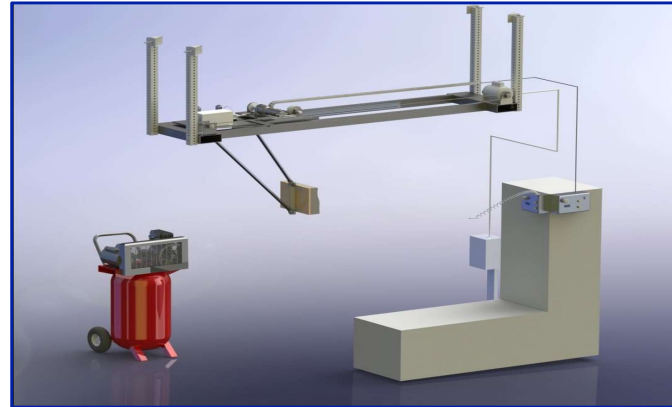
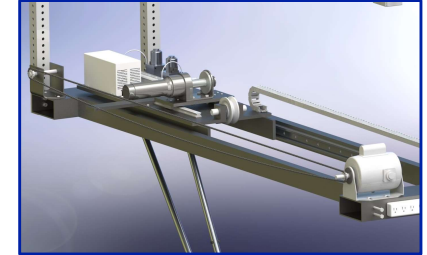


Figure 1: Full Assembly

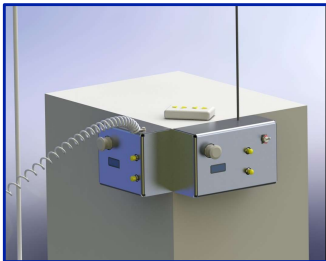
### Translational Movement:



#### Key Features:

- A chain welded to the cart pulls the cart assembly
- Takes advantage of roller bearings to translate cart under load.

### User Interface:



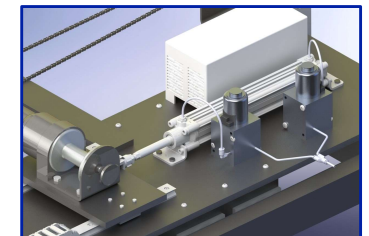
#### Key Features:

- Control for both User and Trainer
- Weight offset control and LCD
- Emergency Shutoff buttons and Tether

### Summary:

The WOMBAT is a cart-based lifting, balance and weight control system that attaches to a reinforced ceiling above the elliptical. The cart incorporates all the sub-systems needed to aid in the rehabilitation of individuals with neuromuscular disorders. An electric winch is used along with a pulley system to lift the user from the wheelchair to a desired height. The rope that hangs from the pulley system will be attached to the user through a harness that the user wears. Once the user is lifted, they will be translated over to the elliptical machine using a cable and gear system. Once positioned over the elliptical, the balancing mechanism attaches to the users back. The user is suspended by linkage with a bar that attaches to the users back, the bar has pin joints that allow for vertical motion, but also have limited rotation, which helps prevent out of bounds motion. The weight offset mechanism uses a pneumatic cylinder in order to maintain a calibrated and continuously adjustable weight offset control during exercise. The balancing and weight offset systems prevent individuals from falling in any direction. The WOMBAT contains an intuitive user interface for both the user and the trainer to allow for independent user control and trainer assistive control. For additional safety precautions there is also a tether that attaches the user to the elliptical in case of an emergency.

### Weight Offset:



#### Key Features:

- Electro-pneumatic positioning system (EPPS) precisely controls the vertical position of the patient
- Capable of up to 581 lbf output

OTS Parts: \$4,309.39	Energy Consumption: \$0.04
Raw Materials: \$1,149.23	Manual Labor: \$40.65
MFG and MFG: Labor: \$315.84	Total Cost: \$5,815.14

# WOMBAT

## Weight Offset and Mechanical Balance Trainer

Customer Need	1: Overall Size & Weight	2: Power Requirements	3: User-Elliptical Interference	4: User's Max Weight	5: Factor of Safety	6: Fall Fail Safe	7: Safe Comfortable Speed Movement	8: User does not Hit Elliptical in Translation
Metric Basis	(The weight of the machine being less than 1000 lb.) (Size was estimated to be the sum of lengths in both the x and y direction.)	Runs from 120 VAC electricity from a standard wall outlet with 15 amp breaker capacity.	Preferred system allows user to utilize elliptical as normal.	The design must support up to 350 lbs.	Factor of safety of 1.5 on all analysis	Correcting Sagittal and Transverse forces must be greater than 27.7 lbf.	Concept which operates at a speed closest to 1.04 ft/sec (0.317 m/s)	Prevent the user from swinging more than 4 inches.
Subsystem	Lifting, Structural	All Subsystems	Translational	Lifting, Structural, Weight offset, Balance	All Subsystems	Balance	Lifting, Translational	Translational
Feature	Minimum Mass Material Selection	Power Supply	Cart System			Mechanical Linkage	Mechanical Linkage	Cart System
Customer Need	9: User Exercise Vertical Translation	10: Fall Prevention Forward/Back	11: Fall Prevention Lateral	12: Lifting from Wheelchair	13: Translation Over Elliptical	14: Suspend User for Strapping In	15: Accommodates All Users	16: Slow Weight Offset Transition
Metric Basis	Design with greatest vertical translation capability.	Correcting sagittal forces must be greater than 27.7 lbf.	Correcting transverse forces must be greater than 27.7 lbf.	Ability to pick up user from wheelchair.	Maximize distance of translational capability.	Ability to lift user to desired height.	Design for body sizes ranging from a 5% female to a 95% male.	Smooth, continuous weight offset settings.
Subsystem	Weight Offset	Balance	Balance	Lifting	Translation	Lifting	All Subsystems	Weight Offset
Feature	Pneumatic Cylinder	Mechanical linkage	Mechanical linkage	Electric locking Winch	Cart Guide System	Electric Locking Winch		Electro Pneumatic Positioning System
Customer Need	17: Weight Offset 0-100%	18: Versatile Mounting	19: Continuous Weight Offset During Exercise	20: Continuous Weight Offset Perception	21: Universal Position Weight Offset	22: Programmable	23: Intuitive User Interface	24: Cost
Metric Basis	Intuitive and accurate weight offset selection control.	Mountable to ceiling.	Smooth, continuous weight offset settings.	Smooth, continuous weight offset settings.	Weight offset over the full range of the user's motion during exercise.	Customer would like to be able to program product.	Physical movements to complete a given goal should be less than 5.	The cost for the design cannot exceed \$4,000.
Subsystem	User Interface	Structural	Weight Offset	Weight Offset	Weight Offset	User Interface	User Interface	All Subsystems
Feature	Control Buttons for user/Trainer	Ceiling mount Connection	Electro Pneumatic Positioning System	Electro Pneumatic Positioning System	Pneumatic Cylinder	Open Source Programming	Simplified User controls/ Large text	
Customer Need	25: Emergency Shut off	26: Force Based Shutoff	27: Visual Indicator	28: Operational Lifetime	29: FES Pad Accessibility	30: Product Footprint		
Metric Basis	Based off distance relative to the user's reach.	System reaction time to acceleration limit of 0.5g or 4.90 m/s <sup>2</sup> .	Text and Icons must be large enough to discern while exercising.	Operational lifetime is three times lifetime of a standard elliptical.	Do not Block Access to user FES Pad locations.	Overall footprint of system cannot exceed 2.43 m X 3.05 m (8' X 10').		
Subsystem	User Interface	User Interface	User Interface	Structural	All Subsystems	All Subsystems		
Feature	E-stops, E-Tether	Force Sensor	LCD Interface	Metal Material Selection	User Harness and Pully System	Cart System		

### Balance Sub-Assembly:

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