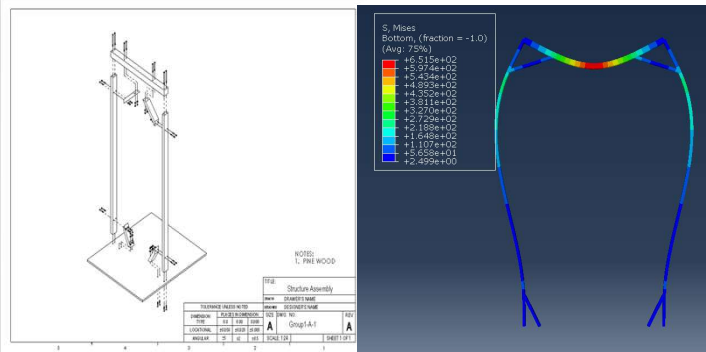
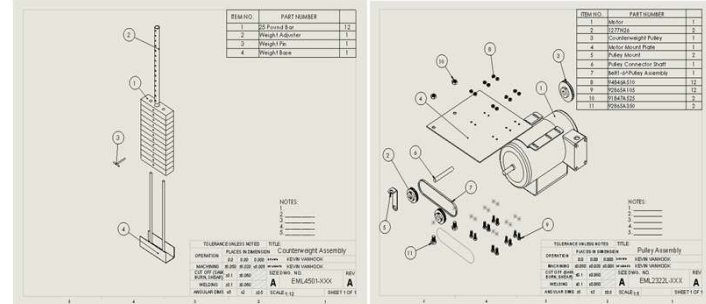


Rehabilitation Assistance Machine Project (R.A.M.P.)

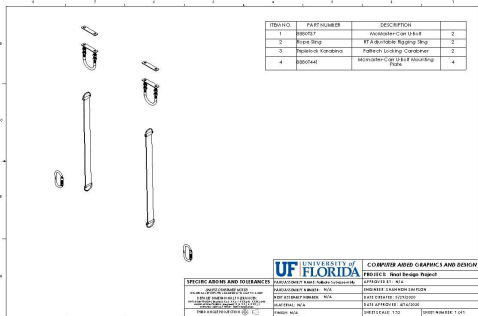
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Pine Wood Structure Subassembly This support structure is unique in its use of pine wood. With support brackets at intersecting points this structure exceeds the requested weight bearing capabilities while maintaining a cheap cost. FEA analysis was performed on the structure to determine bending and buckling factors of safety.

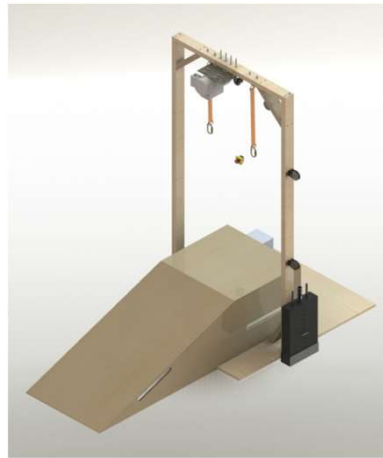


Support Subassembly. The support utilizes a counterweight and rotational motor. The counterweight allows the motor to rotate with less stress as well as supply necessary support.



Failsafe Subassembly This mechanism is used to catch the user in case of a failure of the primary support system. The depicted assembly utilizes two high load capacity adjustable nylon slings that connect to heavy duty carabiners that attach to the harness at the upper shoulder.

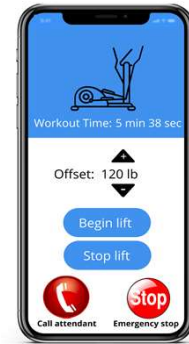
Abstract The R.A.M.P for the aid in walking rehabilitation using an elliptical combines several unique concepts into one machine. The design consists of 7 main mechanisms: The structure, lift, support, failsafe, user interface, foot attachment and harness systems. Unlike similar machines, much of this design is composed of wood, including the structure, the support mechanisms are mounted to, and failsafe. Additionally, a wooden ramp is used for lifting the patient to the height of the elliptical where they then harness into the support mechanism. The wooden design enables us to provide support to the user at a very competitive price. The support mechanism offsets the users weight using a winch, made by an outside contractor, which connects to a pulley system used to guide the winch rope. A transmission was used to account for the necessary changes in support rope speed with the users changing center of mass. The patient will be attached to the structure using a full-body harness. The patient will be attached to the elliptical using a boot foot attachment that the patient would strap into after ascending the ramp. A set of additional rope slings with slack in them connect to the user during operation comprising the failsafe system.



R.A.M.P. Functionality
The purpose of the R.A.M.P. product is to support users while on the elliptical machine. This is done by using a structure, support and lifting mechanism to stabilize the user while exercising. Safety precautions are established through interactive user-interface and failsafe to ensure the user is safe and in control throughout the exercise.

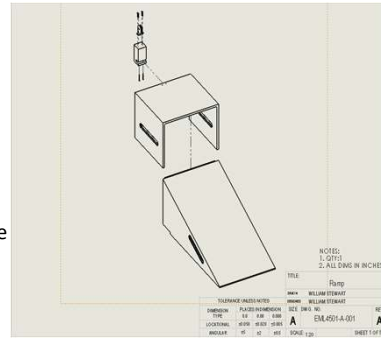
Product Cost Overview

	OTS Part	Raw Materials	Manufacturing/ MFG Labor	Energy Consumption	Assembly Labor	Total
Structure	52.08	206.86	7.68	5.49	171.36	443.47
Support	645.88	233.50	79.10	0.25	19.37	978.10
Failsafe	229.92	-	-	-	1.04	230.96
User Interface	50.00	-	-	-	-	50.00
Lift Mechanism	-23.40	392.99	197.12	8.23	33.47	655.21
Harness	121.26	-	-	-	-	121.26
Foot Mount	96.52	-	0.022	0.01	33.33	129.88



User Interface The interface is a phone app, designed to be simple and user friendly. With its simplistic design, the user can learn how to properly use the app in a short time. In this application, the user can choose their offset weight, start and stop lift, call attendant, and stop machine in case of any emergency. The buttons are big and easily accessible with one hand to help the user while on the elliptical.

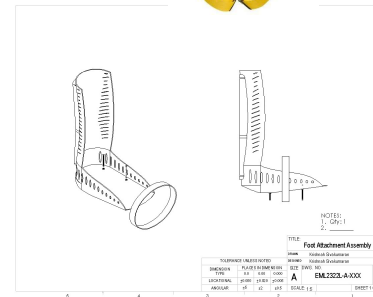
Lifting Mechanism The pine wood ramp employed allows the patient to be pushed up the incline onto the platform to be harnessed in. To reduce the load necessary for the patient to be pushed by an attendant, additional supporting rope is temporarily routed through a pulley on the platform and attached to fixed points on the wheel chair so that it may exert an assisting force on the user.



Harness The harness is produced by Fall Protection Depot. There are large back and shoulder pads for user comfort and 5-points of adjustments for optimal fit. D-Rings on the shoulder ensure the user remains vertical during elliptical training.



Foot attachment subassembly This mechanism is used as an anchor the because it is attached directly to the elliptical. The foot attachments are modeled after a walking boot, the supporting structure is made of polyurethane, with nylon straps that are adjustable to accommodate all users.



Customer need	Quantitative Metric	Subsystem(s) used to fulfill the Customer need	Detail
1. Must fit inside a medical or rehabilitation facility, taking into consideration a. Ceiling height (when assembled) b. Clearance through doors (when assembled) c. Loadbearing capacity of floors d. Floor footprint (during assembly and when assembled)	Size	Structure Lifting Mechanism	Structure and Lifting mechanism are the largest items in the model and have been reduced to satisfy this requirement.
2. If powered, runs from 120 VAC electricity from a standard wall outlet with 15-amp breaker capacity	Support Power Consumption	Support Mechanism	An OTS motor was found to satisfy this requirement.
3. Allows the user to stand and exercise on a standard elliptical machine without interfering with the elliptical machine's operation	Harness Lateral Balance	All	Foot attachment is bolted on to the pedals and does not interfere with the natural motion of the elliptical.
4. Supports the full weight of the user up to the full capacity of the elliptical machine	Support Full User Suspension Harness Factor of Safety	Support Mechanism Harness	The counterweight is capable of supporting the full weight of the maximum end of the patient by itself. The motor is powerful enough to move the patient similarly. The chosen harness has the capability to support the full weight of the user.
5. All design margins have an acceptable factor of safety	Failsafe Factor of Safety Support Factor of Safety Structure Factor of Safety Harness Factor of Safety	All	All OTS parts are rated for equal to or greater than acceptable FoS and designed component analyses completed show that the designed components adhere to our FoS requirements as well.
6. Includes a fail-safe system to catch the user, preventing a fall should the primary system fail	Failsafe full user suspension	Failsafe	The failsafe subsystem is comprised of three distinct components, a rope, sling, and carabiner that connects to the harness.
7. The user is lifted from the wheelchair and placed on the elliptical trainer at safe and comfortable speeds.	Support Comfort Harness Comfort	Harness Support Mechanism	The harness is simple to put onto the user with Quick Connect and 5 points of adjustments for optimal fits while being lifted.
8. The system will prevent the suspended user from swinging and/or hitting the elliptical trainer or the wheelchair during transfers to/from the wheelchair or elliptical.	Harness comfort	Support Mechanism Harness Foot attachment	The strap boots foot attachments serve as anchors, where the user will be strapped in to the Elliptical. The harness has D-Ring attachment at the top of the shoulders to prevent the user from swaying during transfers.
9. Allows the user to translate unencumbered in the vertical direction during exercise	Support speed	All	Motor follows changes in center of mass.
10. Prevents the user from losing balance in a sagittal (backward or forward) fall	Foot attachment stiffness Failsafe, Support, and harness pitch balance	Foot attachment Failsafe Support mechanism Harness	Motor is strong enough to support full weight if necessary. The harness has D-Ring attachment at the top of the shoulders to prevent the user from losing balance.
11. Prevents the user from losing balance in a transverse (left or right) fall	Failsafe, Support, and harness yaw & roll balance	Foot attachment Failsafe Support mechanism Harness	Motor is strong enough to support full weight if necessary. The harness has D-Ring attachment at the top of the shoulders to prevent the user from losing balance in a transverse fall.
12. Lifts the user from a seated position (e.g., a wheelchair) to fully suspended	Harness Safety, Support Balance, Support Safety	Support mechanism Harness	Motor is strong enough to support full weight if necessary. With the Quick Connect feature, the harness can be attached while the user the in a seated position.
13. Moves the fully suspended user from their original location over a standard elliptical trainer	Lift Mechanism Weight Support	Lifting Mechanism Support mechanism Harness	Motor is strong enough to support full weight if necessary. Harness is able to support the full weight.
14. Holds the user suspended over the elliptical trainer while they are being strapped into the trainer	Harness Lateral Balance	Harness Support mechanism	There is a pulley directly above the elliptical to suspend patient. The harness has D-Ring attachment at the top of the shoulders to allow the user to be suspended vertically over the elliptical.
15. Accommodates user body sizes ranging from a 5% female to a 95% male	Harness Comfort	All	The harness comes in various sizes that allow to be adjusted and accommodates all user body sizes.
16. Once user is attached to the elliptical trainer slowly transitions to preset offset weight	Harness Support Offset Weight	Support Mechanism User interface	The counterweight is constructed using 25lbs weight bars. The total weight of the bars reaches as much as 300lbs.
17. Allows user to select offset weight to any value between 0% and 100% of their body weight	Offset Weight	User Interface Support Mechanism	The counterweight is constructed using 25lbs weight bars. The total weight of the bars reaches as much as 300lbs.
18. Can be mounted from structural members in walls or ceilings or can sit on the floor.	Structure Attachment	Structure Lifting mechanism	By utilizing a baseplate, the structure may rest on the floor with no outside structural members supported. This baseplate also allows for the ramp to connect and sit atop the ground as well.
19. Provides continuous user-defined offset weight support for the user while the user is exercising	Support Counterweight Interval	Support mechanism	The counterweight system allows offset intervals of 25lbs from zero to 300lbs.
20. Offset weight support feels continuous to the user despite the repeating periodic motion of their exercise	Support Sensor Efficiency	Support Mechanism	The motor is fast enough to follow the change of center of mass of the patient.
21. Must provide pre-set weight offset over the full vertical, horizontal, and transverse range of the user's motion during exercise	Support Sensor Functionality	Support Mechanism	The cable supporting the patient has enough length to allow user to move as necessary.
22. Is programmable (i.e., control parameters can be changed, or a more complex control routine added in software)	Developing Time	User Interface	The app is to be coded so that it connects with the assembly via Bluetooth. It will allow user to change the settings depending on their needs.
23. Has an intuitive user interface	App Functionality	User Interface	The design is simple and user friendly with big and easy to access buttons.
24. Prototype cost for materials cannot exceed \$4,000	Cost	All	Total cost: \$ 2465.91
25. Includes an emergency shut-off that can be actuated by the user or a nearby trainer that safely stops all motion while fully supporting the user's weight	App Functionality	Failsafe User Interface	2 E-stop buttons are wired into the support motor power and can be pressed to cut power to support mechanism at any time during operation.
26. Includes an automatic force-based safety limit shutoff that shuts down the device if either 1) a maximum force on the lift is exceeded or 2) the lift experiences an unexpected rise in force magnitude or direction [e.g., it gets caught on something during motion].	Support overshoot	Support Mechanism	Support mechanism will include a tension force sensor to monitor force and shutoff in the case of exceeded or unexpected force changes
27. Has a visual indicator easily seen by the user and a nearby trainer that shows when the system is on, what mode it is functioning in, and how much user weight is being offset	App Functionality	User interface	When the system is on, the background color of the app will change from blue to red. The app will clearly display the functioning mode and the user's offset weight.
28. Has an operational lifetime that exceeds by three times the operational lifetime of a standard elliptical trainer	Lifetime	All	Components in each subsystem were designed to maximize lifetime.
29. FES stimulation pad electrical connections must be accessible	Size Range	Foot mount	The foot attachment is designed with straps to be easily adjusted allowing more access to the foot and therefore the FES.
30. Overall footprint of lift system plus elliptical trainer cannot exceed 2.43 m X 3.05 m (8' X 10')	Lift Mechanism Size Structure Size	Lift Mechanism Structure	The added longest and widest dimensions on the combined lift mechanism and structure configuration do not exceed allotted footprint.