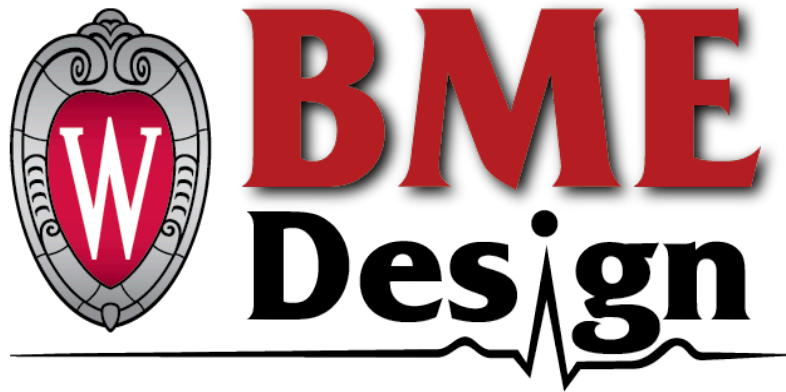




GAIT TRAINER WITH TREADMILL

PRELIMINARY REPORT

Fall 2025 BME 200/300 Lab 302

Team Name:

Step Masters

Team Members:

Grace Neuville (Team Leader)

Sierra Loosen (BSAC)

Julia Shefchik (Communicator)

Katelynn Johnson (BPAG)

Sara Mlodik (BWIG)

Client:

Amanda Pajerski, OTR

Advisor:

Dr. Randolph Ashton

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Abstract

A woman with a significant mobility impairment and seizure disorder relies on a gait trainer to walk during her daily strength and conditioning walks. During the winter months, she requires a safe way to use her gait trainer on her treadmill. Unfortunately, her current gait trainer does not fit onto or around her treadmill, and is unable to be used as-is with her treadmill. Currently available devices that allow a gait trainer to be used with a treadmill are costly and often require replacing existing equipment. To address this, our solution features a low-cost, compactable ramp and track system that allows the gait trainer to be wheeled securely onto the treadmill and remain stable during use. This solution enables continued use of current equipment, reducing financial burden while ensuring accessibility and safety.

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Introduction

More than 25% of adults in the United States have a disability, 35 million of whom are women. According to the CDC [1][2], these 35 million women are three times more likely than their non-disabled counterparts to be diagnosed with conditions like heart disease, stroke, diabetes, or cancer. Even though it has been proven that daily physical activity can help reduce the impact of chronic diseases, improve mobility, reduce muscular atrophy, and increase community involvement [3], less than half of all adults with disabilities report engaging in leisure time aerobic physical activity. For disabled women especially, this is concerning as the lack of musculoskeletal stress puts them at an increased risk for bone conditions such as osteoporosis, which exacerbates the severity of injuries from falls [4]. This discrepancy in physical activity is largely due to limited resources and appropriate access to accessible aerobic exercise. Currently, there are only a few accessible aerobic-equipment options for individuals that use mobility devices, the majority of which are intended for wheelchair users, or to be used in a professional therapy setting and which are unrealistic for everyday use.

Background

Client Information

The client, Amanda Pajerski, is an Occupational Therapist representing her patient who is a woman with a mobility impairment and seizure disorder. This woman cannot ambulate independently and uses a Rifton Pacer Gait Trainer with the assistance of caregiving staff. To maintain her strength and conditioning, she goes on daily walks around her neighborhood with her caregivers. However Wisconsin weather is often unpredictable, and particularly during the

winter months, Mrs. Pajerski's client is unable to get the daily exercise she needs to stay healthy. Therefore, Mrs. Pajerski is looking to have a transfer device fabricated that will allow her patient to use her gait trainer on the 2012 Horizon T101 Treadmill that her clients own. This project is a continuation of a Fall 2024 project, and builds off of the previous team's work, with improvement input from the client, the patient's family, and caregiving staff.

Previous and Competing Designs

When Amanda Pajerski initially recommended her patient use a treadmill for her daily exercise, she intended for her patient to have a Rifton Pacer Gait Trainer with a Treadmill Base that featured a wide base, and was designed to fit around a standard treadmill (similar to the K650 XL model available for Youth sized Gait Trainers) [5]. Unfortunately, soon after the decision was made this base was discontinued. Therefore, the client's patient instead ordered the Rifton Pacer Gait Trainer with the K640 Large Utility Base (featured in Figure 1) [6]. While this base is still wider and more durable than the standard base frame, it is too narrow to fit around the treadmill, and too wide for the wheels to fit on the treadmill track. In Fall 2024, a transfer device (Figure 1) was fabricated for the client by a UW-Madison BME design team. This transfer device, while functional, was heavy and bulky, and not easy for caregiving staff to use as it used hard-to-manipulate C-Clamps to secure the ramp and side tracks. Therefore, this device has not been used by the client's patient.



Figure 1: The Fall 2024 fabricated design features wooden side rails for the gait trainer to rest on top of with a wooden ramp leading up to the treadmill. The images above feature the patient's Rifton Pacer Gait Trainer with the K640 Large Utility Base. The wooden side rails are built to rest above the side of the treadmill and laterally extend the usable area for the Gait Trainer to rest.

There are a few designs available commercially that integrate gait training with a treadmill. Apart from the treadmill-specific base that Rifton previously manufactured, other solutions included gait-training-specific treadmills that have built-in assistive functions for wheelchair transfers and attached postural support [7]. These treadmills are expensive, and are rarely seen outside of professional therapy settings because they are impractical for private use. Another competing design includes a partial weight bearing vertical post, such as the LiteGait models (Figure 2) [8] that have a sling and wide base. Unfortunately, LiteGait's system is not universal to other brands of treadmills.



Figure 2: The LiteGait 4 Home Adult partial weight-bearing system features a sling, support bars, and a wide base to accommodate treadmill use. This model is compatible with LiteGait manufactured treadmills [8].

Design Specifications

This design is a transfer device that allows the user to utilize her Rifton Pacer Gait Trainer on her treadmill. The transfer device will consist of a ramp system, and over-the-treadmill tracks that support the gait trainer while the woman is on the treadmill. The ramp and track system will be able to bear a combined weight of 173.6 kg during daily use of up to 15 minutes, which includes the weight of the user, one of her caregivers, and the weight of the gait trainer. The device will be easy for users to set up and take down, should take no more than 5 minutes to assemble, and be easy to store. In addition, per NIOSH lifting guidelines [9], the device should require a lifting force of less than or equal to 23kg during the storage process. For safety, the device should feature an anti-slip ramp surface and a track height between 3.8 and 6.3 cm which should work in tandem with a narrow track width to secure the gait trainer to the

treadmill during exercise, and prevent lateral movement. A full description of the product design specifications can be seen in Appendix A.

Preliminary Designs

Design 1: Telescoping Ramp

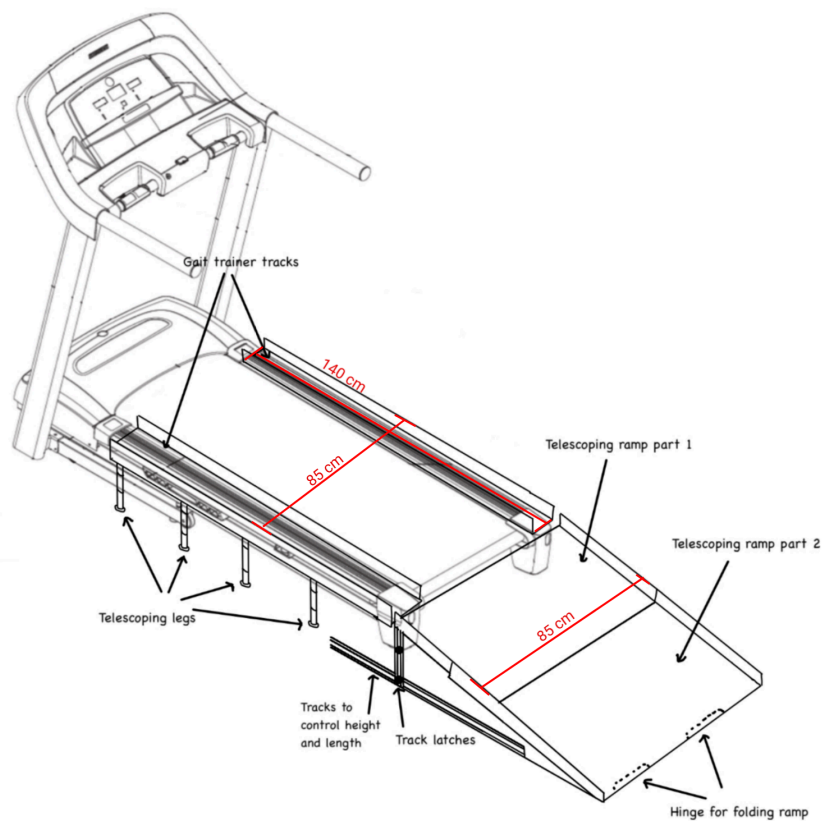


Figure 3: Telescoping Ramp Design Sketch

The telescoping ramp design (Figure 3) has tracks that are able to control the height and length of the ramp to be ADA compliant if the client would need to adjust to another treadmill with different dimensions in the future. The adjustment tracks are held in place by a screw clamp. There is a hinge at the bottom and the tracks are open to allow the ramp to fold fully flat.

The gait trainer tracks are also removable and have telescoping legs that allows the ramp height to be adjusted to other treadmills. The tracks are secured to the treadmill with toggle clamps.

Design 2: Suitcase Ramp

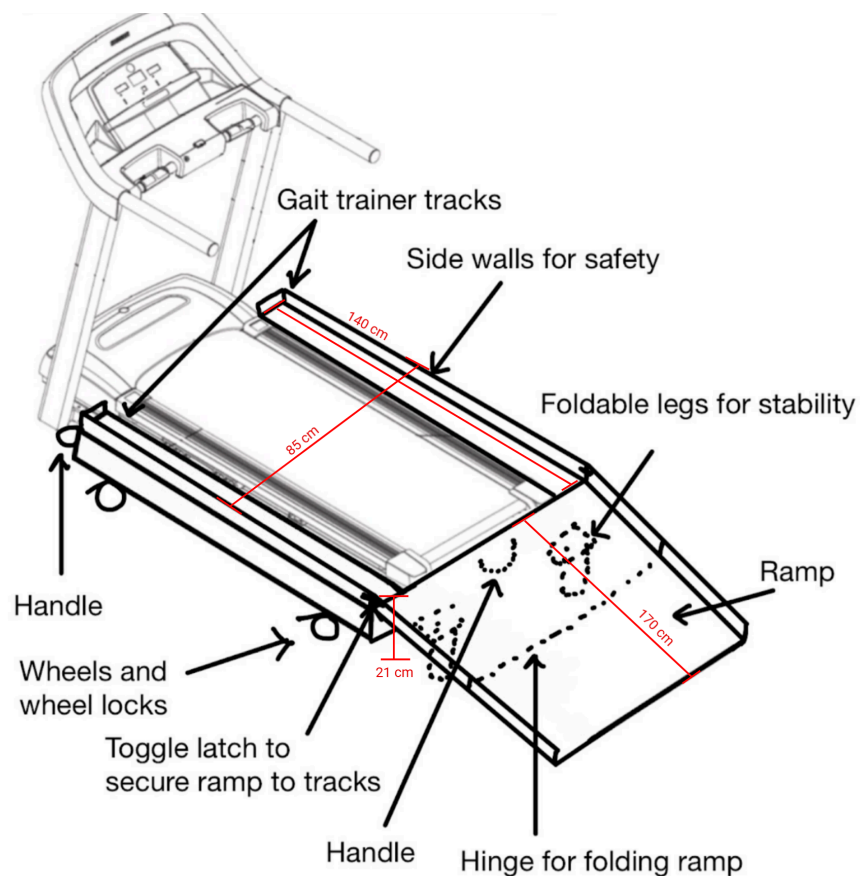


Figure 4: Suitcase Ramp Design Sketch

The suitcase ramp design (Figure 4) has three separate, detachable, components that can all be removed from the treadmill and easily transported to a new location for storage when the treadmill is not in use. The tracks will each be made from a lightweight wood and have wheels that will lock the tracks in place while in use. There will also be handles on the end of the tracks to allow caregiving staff to easily wheel the tracks away like a suitcase. The ramp will be made

from aluminum with supporting legs underneath that can fold for when the ramp is stored and not in use. The ramp will have hinges horizontally along the center of the ramp so that it can be folded in half to take up less space while not in use. There also will be handles for easy transport. Additionally, the side walls on the ramp will attach to the side walls of the tracks via a toggle latch for stability of the entire three part system.

Design 3: Folding Ramp

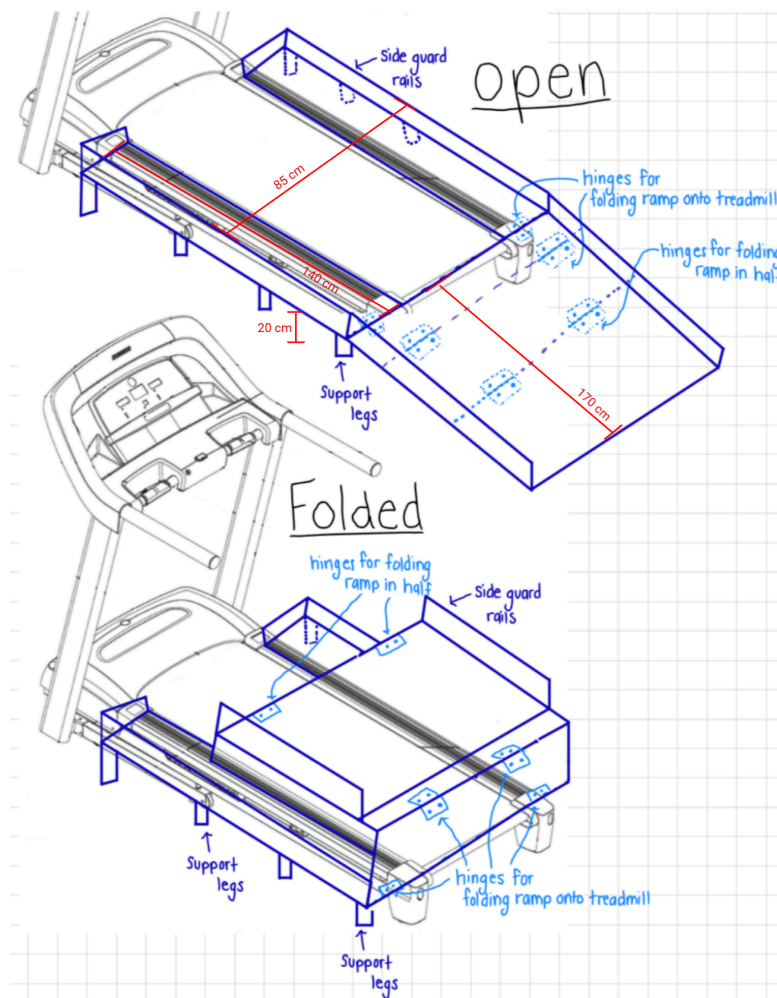


Figure 5: Folding Ramp Design Sketch

The folding ramp design (Figure 5) has tracks along each side of the treadmill that partially rest on the treadmill edge and partially hang over supported by 4 legs. These tracks will be made of wood and permanently attached to the treadmill. Each track has a guard rail on the outer edge and on the front. At the back of the track, there are hinges that connect the tracks to the ramp, allowing the ramp to fold onto the treadmill. There is another hinge on the ramp that allows the ramp to fold back onto itself. The ramp also has a guard rail on each outer edge and will be made of aluminum to ensure it is lightweight for folding.

Preliminary Design Evaluation

Design Matrix

To thoroughly assess each preliminary design, a detailed design matrix was developed (Table 1). This matrix evaluates multiple aspects of the designs based on specific criteria. Each design received a score from 1 to 5, where 1 represents an unsatisfactory rating and 5 represents a very satisfactory one.

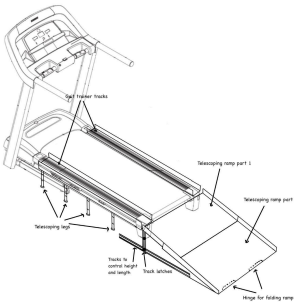
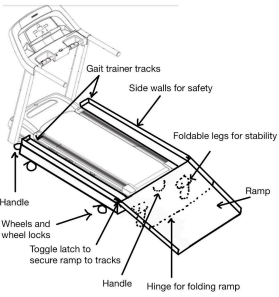
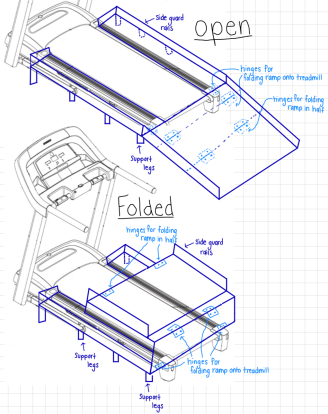
		Design 1: Telescoping Ramp		Design 2: Suitcase Ramp		Design 3: Folding Ramp	
							
Criteria	Weight	Score	Weighted Score	Score	Weighted Score	Score	Weighted Score
Safety	25	3/5	15	4/5	20	4/5	20
Ease of Set Up	25	3/5	15	3/5	15	3/5	15
Weight of Device	15	3/5	9	4/5	12	3/5	9
Compactability	15	4/5	12	4/5	12	4/5	12
Ease of Fabrication	10	3/5	6	4/5	8	3/5	6
Adjustability to Other Treadmills	5	4/5	4	2/5	2	2/5	2
Cost	5	2/5	2	4/5	4	3/5	3
Total	100		63		73		67

Table 1: Design Matrix for Preliminary Designs

Summary of Design Matrix

The evaluation criteria and how each design earned their score are as follows:

Safety (25%) - Safety is the highest priority, as the device must prevent any risk of injury to the user, earning it a 25% weight. The design must support both the user and gait trainer, while keeping the trainer's wheels securely in place, even during a seizure. All three designs provide similar safety mechanisms through track supports and locking attachments. Design 1, however, is slightly lower rated due to a bump in the telescoping ramp that could catch the gait trainer or cause the user to lose balance.

Ease of Set Up (25%) - Ease of setup is critical because the previous prototype was rarely used due to difficulty moving and attaching it with C-clamps, earning it a 25% weight. Each design requires adjusting tracks on and off the treadmill and engaging ramp attachments for each use. While none completely eliminate setup steps, designs that simplify attachment improve usability. All designs perform similarly, with minor differences in attachment mechanisms that could make setup slightly faster.

Weight of Device (15%) - Weight is an important factor because the previous wooden prototype was too heavy to move easily. So, the weight of the device was given a 15% weight in the matrix. The device should ideally weigh under 23 kg. Design 3 ranks highest, as its built-in wheel locking mechanism allows the tracks to be made from lightweight materials while

maintaining stability. Design 1 is heavier due to additional tracks needed to support the ramp, and Design 2 falls in between.

Compactability (15%) - Compactability measures how easily the device can be stored or folded to save space. Compactability is weighted at 15% because the clients also stressed the importance of it being able to fit in their living space. Design 1 ranks highest, as it can fold fully flat and shorten the track legs. Designs 2 and 3 are tied: Design 2's ramp folds but wheel height remains fixed, while Design 3 folds onto the treadmill, reducing footprint but preventing the treadmill itself from folding.

Ease of Fabrication (10%) - Ease of fabrication considers material accessibility and manufacturing complexity. There is considerable access to materials and resources for fabrication plans, so it is only weighted at 10%. Design 2 ranks highest, as it requires fewer custom parts and many components (such as wheels and locks) can be purchased. Designs 1 and 3 are more complex in that Design 1 requires precise fabrication of the telescoping ramp mechanism, and Design 3 needs accurate measurements for compact placement on the treadmill without interfering with the tracks.

Adjustability to Other Treadmills (5%) - Adjustability measures how easily the device can fit other treadmill sizes if a treadmill replacement becomes necessary. Functionality is more important than adjustability, so this category is only weighted at 5%. Design 1 ranks highest, as its adjustable length and height meet ADA guidelines and allow compatibility with multiple

treadmills. Designs 2 and 3 are limited because their ramp heights are fixed, though they still accommodate the client's gait trainer.

Cost (5%) - Cost evaluates material and fabrication expenses, which the client is flexible on so it is ranked at 5%. Design 2 is the most cost-efficient, requiring fewer materials and simpler mechanisms. Design 1 is the most expensive, due to additional ramp materials, while Design 3 is moderately priced because of extra folding hardware.

The winning design was the suitcase ramp. This design scored highest in five of the six scoring criteria categories. The wheels on this design make the set up and take down easier as the device can be wheeled onto the treadmill. The handle also contributes to the ease of set up, making it easier to maneuver. The foldable legs underneath the ramp portion of the device provide added safety and stability to this design. Although the suitcase ramp design is the winner based on the design matrix, the proposed final design combines elements from all three of the preliminary designs.

Proposed Final Design

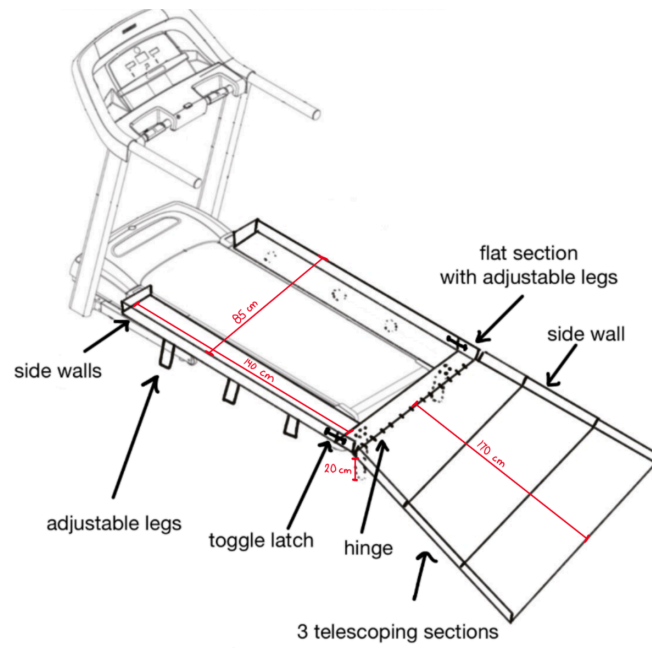


Figure 6: Proposed Final Design Sketch

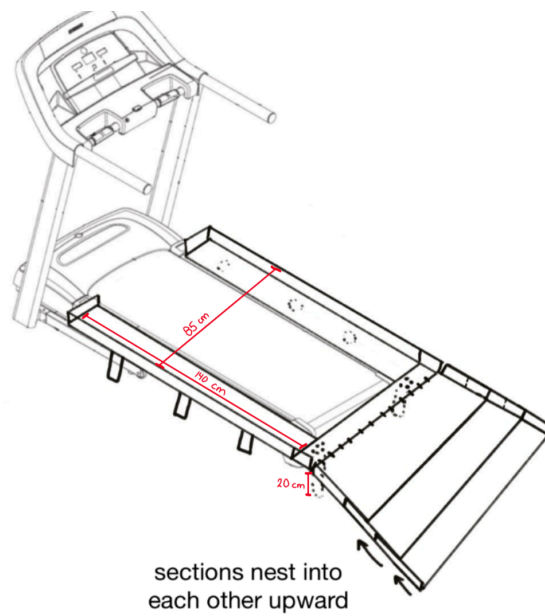


Figure 7: Telescoping ramp nesting into each other

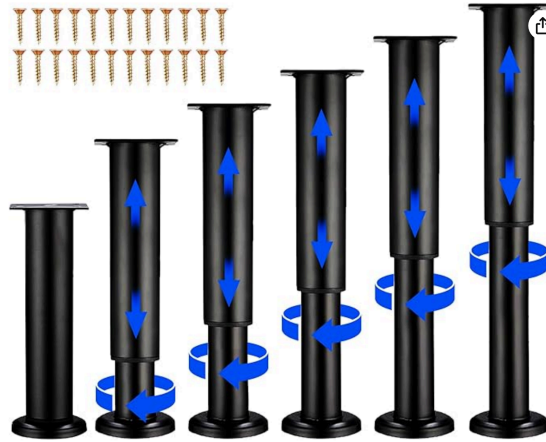


Figure 8: Adjustable legs [10]

After reviewing the three preliminary designs, it was decided to combine aspects from all three designs as well as add on adjustability elements for the proposed final design (Figure 6). This design combines telescoping elements of Design 1 along with folding elements from Design 2 and Design 3. This design has aluminum tracks, supported by adjustable legs (Figure 8). This allows the tracks to change height if a different treadmill was used with the design. At the end of the treadmill before the start of the ramp, there is a flat section also supported by adjustable legs. This section is connected to the tracks by a hinge. The purpose of this flat section is to provide a way for the ramp to be supported by adjustable legs without the legs being impacted by the ramp angle. After the flat section is an aluminum telescoping ramp. The ramp is telescoping, meaning that portions of the ramp can nest inside one another to compact the ramp for folding (Figure 7). It is made of aluminum to keep it lightweight and durable. This ramp is also connected to the flat portion by hinges to allow it to fold onto the treadmill when compacted. Overall, by combining elements of all the designs, the ease of setup, compactability, and adjustability to other treadmills can be maximized.

Fabrication

Materials

The team will use a material that is lightweight and durable to hold the gait trainer, the user, and another caregiver if applicable. Following these guidelines the team will use 1.6 mm thick aluminum sheets for the ramp because its properties fulfill the requirements [11]. The lowest yield strength of available alloys is 5 ksi which is able to hold the combined weight of 173.6 kg [12]. The team selected aluminum channels for the side tracks because their existing U-shaped design simplifies the fabrication process by eliminating the need to weld on side guards. The hinge on the design will also be aluminum for a more cohesive finish of the design. The adjustable legs that will be incorporated into the design are made out of cold rolled steel chosen for their durability [10].

Methods

The team will be using a Grizzly 52" sheet metal shear for cutting all pieces of aluminum. This machine was chosen for its capability of cutting through 1.6 mm thick aluminum sheets and its availability in the ECB lab. For the side rails, the team will use channel aluminum to form sturdy tracks. The team will need to cut a rectangle of aluminum material and then weld it onto the end of the tracks to prevent the gait trainer from rolling forward off the tracks. The adjustable legs will be added by drilling holes through the side tracks and screws will be added so they are flush with the top of the tracks and will not stick out.

For the ramp, the team will weld side guards to the sheet of aluminum to make each individual section. The tracks will be connected and telescoped together by attaching inner tracks on the side, similar to drawer tracks, by drilling holes and screwing the hardware to the pieces of

the ramp. The team will also explore adding non-slip coverings to the top of the ramp and where the bottom of the ramp meets the ground for more stability.

The team will cut the flat portion of the ramp and weld the side guards on. This portion will attach to the telescoping portion of the ramp with a hinge. Connecting the ramp to the side rails will be achieved through toggle latches which will be attached by drilling holes into the side guards and screwed in using appropriate hardware.

Final Prototype

The final prototype will be fabricated using the above methods. The material and connections are subject to change if more suitable materials or methods arise following continued testing and research. After the team's meeting with fabrication staff, a final plan will be made and adjustments to the prototype may be needed. In addition, the team can explore and research materials that are non-slip to incorporate into the device.

Testing and Results

Solidworks FEA Wizard Testing

The team plans to perform finite element analysis (FEA) on various components of the design using SolidWorks SimulationXpress Wizard. These simulations will provide insight into potential critical stress regions and illustrate how each part deforms under applied loads. The analysis will also yield a factor of safety for each component and help evaluate material suitability by comparing stress distributions, deformations, and safety factors across different materials. However, the SimulationXpress tool has certain limitations, as it is restricted to linear static analyses, single-part evaluations, and a single load condition. Despite these constraints,

conducting FEA using the SolidWorks Wizard will offer the team a quick preliminary understanding of how the components are expected to perform under static loading conditions.

Coefficient of Friction Testing

The team plans to conduct coefficient of friction testing to ensure that the ramp meets American Society of Safety Engineers (ASSE) guidelines. The ANSI/ASC A1264 standard suggests a coefficient of friction of 0.5 [13]. Ideally, testing would be conducted using a tribometer; however, with the limited scope of the project, simple coefficient of friction testing will be conducted. The team will determine the COF by first measuring the angle of inclination at which the gait trainer begins to slide on the ramp by using Phyphox inclination data. Then, the team will use equation 1 and the previously determined angle to find the COF. The coefficient of friction should be greater than 0.5 per the ASSE guidelines.

$$\text{Equation 1: } \mu_{static} = \tan(\theta)$$

Side Walls Testing

The team plans to determine the force needed for the gait trainer wheels to climb over the 2.54 cm side walls. Using Phyphox accelerometer with g data collection, the team will push the gait trainer until the gait trainer climbs over the side walls. The smartphone with Phyphox accelerometer with g, will be strapped to the gait trainer near its center of mass to ensure accurate results. Using Equation 2, the force generated by the push can be calculated. This force should be greater than the force due to the weight of the gait trainer's user, 667 N, so that if they were to fall the gait trainer would not be able to wheel over the edge.

$$\text{Equation 2: } F_{t, climb} = m_{sys} \cdot a_{sys}$$

Stability Testing

The team will assess the overall stability of the device by evaluating its movement during three time trials. Each trial will consist of operating the device on the treadmill for five minutes. Prior to testing, the team will mark the initial position of the device on the floor and measure any displacement that occurs during the testing period. The device will be considered stable if the displacement is less than 1 cm and if there is no observable rocking, tipping, or progressive drift.

Ease of Use Testing

The team will evaluate the device's ease of use by measuring the time required for setup and takedown of the device across three trials. To meet product design specifications, the setup and takedown time must not exceed five minutes. Prior to data collection, the test subject will complete three practice trials to become familiar with the procedure to accurately reflect the performance of care-givers who will be accustomed to operating the device.

Discussion

Following testing, the team will make any necessary adjustments to maximize user safety during use of the device, while also emphasizing ease of device setup. The materials should be strong enough to support the weight of the user and gait trainer; in case of emergency, the device must additionally be able to support the weight of a caregiver which, in total, is approximately 173.6 kg. Although the materials must be strong and durable, they should also remain lightweight and easy to move to increase ease of setup. The SolidWorks FEA testing will provide the team with feedback about the materials ability to support the necessary amount of weight, and help the team visualize where failure of the device might occur. The other testing procedures

outlined above will further provide feedback on the device design, and allow the team to improve the final product.

Although the testing procedures will be beneficial to the improvement of the design, there are some testing limitations. The SolidWorks FEA testing does not take into account the natural degradation of the materials used in the design. The testing will show where the stress concentrations are on the design using an ideal version of the material. However, it is possible that the materials of the final design will naturally degrade over time and create new areas of stress which could potentially make the device unsafe. Another limitation of the testing is that the team does not have constant access to the specific treadmill that the final device will be used with. The treadmill resides at the user's home, which is located off campus. This limits the team's ability to easily test and fit the device to the treadmill, which means the team is relying heavily on the measurements of the treadmill that were taken during a visit to the user's home. These measurements could also contain errors as they were taken manually with a tape measure.

One ethical consideration is the interaction of the user with the device. The ramp must be easy for the user to navigate and not jeopardize their safety. This means that the ramp should not be too steep for the user to walk up, and the side rails should remain stable while the treadmill is on. The ramp and side rails should also remain in place and not shift positions while the user is wheeling the gait trainer onto them. The device should not place any additional stresses on the user or negatively impact their gait.

Sustainability of the design should also be considered. The materials used in this design should make the product reusable, ideally making the operating life and shelf life of the design approximately 15 years, which is comparable to ramp devices commercially available [14].

Making the device out of durable materials ensures that the device can continue to be used without having to frequently replace it, therefore decreasing the overall quantity of materials used and increasing the sustainability of the device.

Conclusions

Gait trainers are used to help those with limited mobility ambulate. Physical activity is important for maintaining muscle strength and improving one's mood, but unpredictable winter weather can limit the ability to use a gait trainer outdoors. This device will allow a gait trainer to be used in tandem with a treadmill, allowing for ample physical activity throughout poor weather conditions. The device will include a ramp to allow the gait trainer to wheel onto the treadmill, as well as two side rails that support the gait trainer while the user walks on the treadmill belt. The final design must emphasize user safety as well as have compatibility with other treadmills with varying dimensions in case a new treadmill must be purchased. The final design should also prioritize easy set up; previous prototypes have not succeeded in this, leading to a lack of use of the gait trainer on the treadmill. The proposed final design features side rails that can vary in height via adjustable legs, as well as a telescoping ramp that nests into itself for compact storage. The design also has raised side walls to ensure the gait trainer cannot accidentally roll off the side of the device. In the future, the team will conduct various modes of testing to ensure the prototype meets both the client and user needs. After testing, the results will be evaluated and any necessary changes will be made to finalize the design.

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Appendix

Appendix A: Product Design Specifications

Problem Statement:

A woman with a significant mobility impairment due to a seizure disorder requires support while walking because of seizure risks and poor postural strength. She has a Rifton Pacer Gait Trainer which has allowed her to resume walking outdoors; however, it is unsafe to use in winter. It is crucial for her to be able to use the gait trainer for daily walks in order to maintain her muscular strength and mental health. The solution is to design a transfer device that will allow her to use her gait trainer on a Horizon T101 treadmill to give her the opportunity to maintain her muscle conditioning when weather conditions are not favorable. The transfer device will need to allow the gait trainer to be wheeled onto the treadmill and secure the wheels in position so it cannot fall off the side while she's walking. It will need to hold the weight of the gait trainer, the user, and one caregiver, totaling to 173.6 kg. It will need to be easy for caregiving staff to use, taking no more than 5 minutes to assemble, under 23 kg, and have the ability to fold in order to maintain the functionality of her living environment.

Client requirements:

- One transfer device that can repeatedly attach or permanently attach to the client's treadmill
- Easily fold for transfer with a handle or fold with the treadmill
- Withstand the weight of the gait trainer, user, and staff

- Be durable to withstand the usage needs of the client
- Have a smooth finish with no sharp edges
- Be slip-resistant to prevent falls
- Have safety guards to prevent the wheels from sliding off of the device while in use

Design requirements:

1. Physical and Operational Characteristics

a. Performance requirements

- i. The device must be able to transfer the client and her gait trainer from the ground to her treadmill platform. The device should be able to sustain the weight of both the client and her gait trainer, as well as the weight of an additional caregiver (approximately 173.6 kg). The device should be able to withstand daily use of about 10-15 minutes, and have the ability to easily fold into a compact shape. For storage, the device must follow NIOSH lifting equation guidelines in order to allow caregivers and family members to move it independently without strain [1]. For ease of use, the device will allow the gaitwalker to work seamlessly with the treadmill, and not hinder the user's movement.

b. Safety

- i. Due to the nature of the client's seizure disorder, the device should secure the gait trainer to the treadmill during exercise, to reduce the chance of the client falling off the treadmill. In addition, the locks securing the gait trainer should be easy for caregiving staff to remove and engage, to ensure that they have quick access to the client in the case of a medical episode. In the case of a medical episode, the

device must be stable enough to bear 173.6 kg. That being said, the device must be less than 23 kg in order for caregiving staff to reasonably move without fearing strain and possible back injury per NIOSH guidelines. For transfers, the surface of the device should be even, smooth to the touch, and slip-resistant. Furthermore, the device should be flush with the treadmill belt so that the wheels and client's clothing do not get caught during the transfer process.

c. Accuracy and Reliability

- i. The client should be able to use this device up to seven days per week, at intervals of 10-15 minutes without device failure. With the help of two caregiving staff, the client should be able to complete her transfer onto the treadmill and secure her gaitwalker in five minutes or less. Similarly, when disembarking from the treadmill, the client and two caregiving staff members should be able to unlock the device and transfer back to the floor in five minutes or less. When the device is no longer needed, its storage process should take no longer than five minutes for a single user. Correspondingly, when needed, the device set up process should take no longer than five minutes for a single user to complete.

d. Life in Service

- i. The device must remain functional for the entire lifespan of the client's current treadmill as it will be fitted to the treadmill's specific dimensions. It should be able to withstand regular usage by the client, including sessions of 10-15 minutes multiple times a week, with the possibility of increased use during the winter months. Both the weight of the client and the weight of the gait trainer must be supported by the device for the duration of use, meaning the device must be

extremely durable. The shelf life of the device should be approximately 15 years [2].

e. Shelf Life

- i. The device should be stored inside when not in use. To ensure a maximum life in service, the device should be stored at temperatures of less than 55°C and in an area with less than 70% humidity to maintain structural integrity and ensure client safety [2] [3]. With proper storage conditions, the shelf life should match the life in service of approximately 15 years.

f. Operating Environment

- i. The device should properly function while attached to the treadmill within the client's home, where it will be positioned on top of hardwood flooring. Ideally, the device should fold to be less than 85 cm wide and 170 cm long to minimize the space needed for storage within the home. The device also needs to be compatible with the client's gait trainer which will simultaneously be used with the treadmill.

g. Ergonomics

- i. The device should be easily moved by the client's staff, and by their family. In addition, the clamping mechanism used to secure the device to the treadmill should be operable with little to no exertion, either through a one-time attachment for permanent attachment, or a method that is easily repeatable.

h. Size

- i. The device should have a width of at least 86.5 cm which is the width of the Horizon T101 treadmill to prevent the Rifton Pacer Gait Trainer from falling off the treadmill [4]. The length will depend on the height of the treadmill for the client's set up to be compliant with ADA guidelines for ramps [5]. Guardrails should be added on the side of the ramp and should be at least 2.54 cm above the surface of the ramp.

i. Weight

- i. The device should be able to support the weight of the client which is around 79.4 kg and in some instances, a caregiver which is also around 79.4 kg. The device also needs to support the client's Rifton Pacer Gait Trainer which has a total weight of 14.8 kg which includes the K640 model with the utility base [6]. In total, the device needs to support 173.6 kg. The device itself should weigh under 23 kg, the typical weightlifting job requirement following NIOSH lifting model [7].

j. Materials

- i. The materials used for the device should be lightweight, yet durable enough to withstand the weight of the pacer, the client, and another caregiver if necessary. Aluminum is a good option for this device due to its rigidity and the weight of the material itself in comparison to other similar materials [8]. In addition, considering the available alloys and tempers of aluminum, the lowest yield strength is 5 ksi which would support the aforementioned expected load [9].

k. Aesthetics, Appearance, and Finish

- i. The Gait Trainer with treadmill device should be lightweight, durable, and easy for caregiver staff to use. The device will consist of a ramp, two tracks for the gait trainer wheels, and four wheel locks to hold the wheels in place. The device will be easily compatible with the Horizon T101 treadmill and Rifton Pacer Gait Trainer. The ramp will be slip-resistant by having a coating such as the ResuGrip Non-Slip Floor Coating by Sherwin Williams which is designed to follow ADA guidelines [10]. The ramp should have a shallow incline following ADA guidelines, and lead onto tracks that start out wider and lead to a narrower fit. The tracks should have a smooth finish to let the wheels easily get to and from the locking device. All of the components should be black to blend in with the treadmill, with the exception of the start of the tracks, which should be yellow for an easy guide onto the tracks.

2. Production Characteristics

a. Quantity

- i. This project consists of making one device compatible with the client's T101 Horizon treadmill including a ramp, two wheel tracks, and four wheel locking mechanisms. Considering mass production, the quantity would need to meet market demands among the population of people who would benefit from using a gait trainer with a treadmill. The gait trainer market is expected to grow significantly in the next 10 years due to an increasing elderly population, prevalence of mobility disorders, and need for rehabilitation devices [11].

b. Target Product Cost

- i. The initial budget for this project is \$500; however, the budget is flexible. The client is willing to increase the budget if the device is functional and meets all specifications. The budget will need to cover all material costs for prototyping, testing, and final fabrication.

3. Miscellaneous

a. Standards and Specifications

- i. The ramp will need to follow ADA Guidelines 405.2 and 405.4 for Ramps and Curb Ramps. The slope ratio of the ramp must not exceed 1:12, 1 unit of height per 12 units of length. The run and landing surfaces must be firm, stable, and slip-resistant [6].

b. Customer [12]

- i. This ramp and platform device's target audience is for individuals who require a gait trainer to walk and benefit from treadmill walking, but do not have a compatible gait trainer and treadmill system that allows the patient to be supported at the height of the treadmill. This particular product is specified to the patient's gait trainer and foldable treadmill style.
- ii. The ramp must be either permanent and foldable with the treadmill or detachable but lightweight to save space.
- iii. The device must be easy to maneuver in small spaces, lightweight, and user friendly for the caregivers or nurses to set up.

- iv. The platform must have a locking and securing mechanism for the wheels so they cannot fall off the side while walking, but also have the ability to unlock seamlessly in the case of an emergency.
- v. The device must abide by ADA safety guidelines (see section 3a. *Standards and Specifications*).

c. Patient-related concerns

- i. The ramp and platform system must be designed for the customer's specific gait trainer model by accommodating 20.32 centimeter front casters and 29.21 centimeter back wheels [13].
- ii. The device must abide by the customer's safety needs.
 - 1. The ramp and platform must have a minimum of 2.54 centimeter guard rails (preferably 2.54-5.08 centimeters).
 - 2. The device must be able to stay secure on the platform in the case of a patient seizure.
 - 3. The device must be capable of supporting at least 173.6 kg: the weight of the individual using the gait trainer (79.4 kg), the gait trainer base (8.8 kg), the dynamic upper support (6.1 kg) and one caregiver/nursing staff who may need to step on (upwards of 79.4 kg), in the case of a seizure.

d. Additional optional patient requests

- i. The device should have the option to allow use with a new treadmill in the case that the current treadmill stops working.

e. Competition

i. Rifton Gait Trainer Treadmill Base [14]

1. Rifton offers a treadmill base for their gait trainers that is wide enough to fit around the width of a treadmill.
2. The gait trainer has a lever to raise and lower the harness to adjust the harness height with the treadmill height which allows the system to work across different treadmill models.
3. This system allows the use of a gait trainer with a treadmill at home.
4. Drawbacks: This system requires the purchase of a new gait trainer base. The base is wider and the lever system makes the gait trainer bulkier. For practical use, this gait trainer base may be too large, meaning that a person may need two gait trainer bases: one for everyday use and one for the treadmill. This is not cost effective and would require switching from one gait trainer base to another.

ii. LiteGait for Adults [15]

1. LiteGait has an overhead harness system that supports the user while on the treadmill.
2. There is a base of 2 beams that span the length of the treadmill, allowing for stabilization and a bar in the front that connects the stabilization beams. The front bar has a large vertical beam attached. This beam has arm supports in front of the user and holds up the harness.

3. Drawbacks:

- a. The device is meant for clinical usage and therapeutic exercise, not for at home.
- b. The device contains many electronic features beyond what our client needs, making this option not cost effective.
- c. The device would only be used for treadmill walking, meaning that the patient would need to transition from their current gait trainer to the LiteGait for each treadmill usage.

iii. Body-Weight Support Treadmill Gait Training System [16]

- 1. Sunshine Medical has an overhead harness system designed for treadmill walking, similar to the LiteGait.
- 2. The device has a base constructed with two beams that span the length of the treadmill, two front cross bars connecting the base beams, and a vertical column that has two hooks at the top holding up the harness.
- 3. This device provides significant body-weight support, which would help Nadine's caregivers in assisting her walking .

4. Drawbacks:

- a. This device is made for Sunshine Medical Treadmills, which are not foldable.

- b. The device would require the user to transfer from their current gait trainer to the gait trainer treadmill system for every treadmill session.

iv. HCI Fitness Wheelchair Ramps [17]

1. The HCI wheelchair ramp utilizes a 2 part ramp and platform system that allows wheelchair users to safely roll up and enter certain HCI equipment such as rehabilitation devices and medical exercise machines.
2. Drawbacks:
 - a. There are no guard rails on the sides of the ramp and platform.
 - b. Since this device is specialized for wheelchair users, the ramp does not extend the full width of the product. When using a gait trainer, the middle of the ramp height needs to be the same as the sides to keep the user's feet and gait trainer at the same level.
 - c. The product is designed for use with HCI equipment and may not be compatible with a treadmill.
 - d. The product's ramps and platforms are not foldable, meaning they would take up a large amount of space in a home.

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