Gait Trainer With Treadmill

Preliminary Product Design Specifications

Fall 2025 BME 200/300 Lab 302

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Step Masters

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18 September 2025

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 light enough 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℃ and in an area with less than 70% humidity to maintain structural integrity and ensure client safety [3] [4]. 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 into smaller dimensions 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 34" which is the width of the Horizon T101 treadmill to prevent the Rifton Pacer Gait Trainer from falling off the treadmill [5]. The length will depend on the height of the treadmill for the client's set up to be compliant with ADA guidelines for ramps [6]. Guardrails should be added on the side of the ramp and should be at least 1" 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 [7]. 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 [8].

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 [9]. In addition, considering the available alloys and tempers of aluminum, the lowest yield strength is 5ksi which would support the aforementioned expected load [10].

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 [11]. 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 [12].

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 [13].

b. *Customer [14]*

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 [15].

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 [16]
   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 [17]
   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 [18]
   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 [19]

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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