# Chapter 4
# BINGHAMTON UNIVERSITY


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# PORTABLE VESTIBULAR SYSTEM

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## INTRODUCTION

Physical therapists at the Handicapped Children's Association require a portable frame, similar to a swing that can be carried on house calls to clients. This portable vestibular system helps children develop sensory integration. It is light enough (only 22 pounds) to be carried by one person yet supports up to 100 pounds. It is easily folded into a portable size and is compact enough to fit into the back seat of a car. Its easy assembly requires only one person.

## SUMMARY OF IMPACT

Children with sensory integration difficulties have trouble using and integrating two or more senses at the same time. Therapists use input devices and a variety of methods to accustom the child to different multisensory stimuli. This system provides an initial swinging motion that can be incorporated with other stimuli as part of a therapeutic program. Thus, a portable vestibular system makes it easier for therapists to make house calls to provide therapy for children.

## TECHNICAL DESCRIPTION

The swing-like frame of the vestibular system consists of a 48" transverse beam and two sets of removable v-shaped legs. The frame is composed of aluminum tubes, 3/4" I.D. x 1" O.D. The angle separating the legs is 60 degrees. The angle between the transverse beam and legs is 100 degrees.

Three-prong brackets of 3/4" steel rod connect the legs and transverse beam. The brackets are welded in a configuration that holds the transverse beam and legs in the proper orientation. The brackets insert into the leg and beam pipes, and are glued with epoxy cement to the transverse beam. Plastic-coated steel cables, 1/8Ó diameter and fastened with horseshoe cable clamps, are permanently wrapped around each steel bracket to provide an anchor for the swing. An-

Figure 4.1. Photograph of the Portable Vestibular System

other cable, stretched snugly between the anchoring bracket cables, provides a centered attachment point with a hook to connect a swing seat. A cable connects the swing seat to the attachment point.

The v-shaped legs come in two telescoped sections: the section of each leg is 42" long, the lower 45" long. A collar of steel pipe, with an outside diameter of 5/4", covers the middle of each leg. The two steel collars, glued to the lower legs, strengthen the legs, and each leg can be taken apart at this point. Nylon bungee rope, measuring 84", was fastened by pins to the piping to hold the assembly together and simplify setup. The legs extend a maximum 46" when telescoped. When assembled, the legs are 46" apart at the base. A cable between the legs keeps the legs from spreading under load.

Initial testing demonstrates that the frame supports a load up to 160 lbs. However, the system would move left to right horizontally when subjected to a load moving in a circular pattern. This motion was reduced to an acceptable level by attaching straps 2" x 1/8" across the base of the legs.

Safety features include rubber-coated screws to prevent scratching and rubber caps on the feet of each leg to prevent the legs from sliding.

The final cost of the system is approximately $320.

# DUAL-SEATED PHYSICAL STIMULATION SWING

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## INTRODUCTION

A dual-seat swing for physical stimulation was designed for two sisters, ages 21 and 16, who have severe kyphosis, scoliosis, cerebral palsy, and mental retardation. The swing provides the two sisters with enjoyable physical and sensory stimulation, and meets their special requirements: padding to prevent rashes and sores, headrests for head and neck to compensate for lack of muscle control, restraining straps for chest and feet, footrests to keep legs and feet in the proper seated position, and an overall 40- degree backward tilt to support their weight. After several possible solutions were explored, the simplest approach for this unusual dual-seat system was chosen: a lightweight plastic frame that holds two wooden seats. The frame is attached to chains hanging from the ceiling.

## SUMMARY OF IMPACT

Two clients were both in need of a system that provides physical and sensory therapeutic benefits while enhancing their overall quality of life by enabling them to novel movement experience. The swing allows the two young women to rest in a proper seated position while experiencing a sense of suspension in the air and movement back and forth.

## TECHNICAL DESCRIPTION

The swing consists of three major parts: two seats, the plastic seat frame, and the assembly used to suspend the frame from the ceiling. The seats, built from 2 x 8" pinewood and 3/8" plywood, are fully padded and covered with quilted material. Each seat is equipped with fully padded headrests and footrests along with chest and foot straps. PVC plastic tubes beneath the padding serve as leg separators. The frame is built from 1 1/4" furniture-grade plastic tubing. Chains are suspended from hooks driven into the ceiling of the clients' porch. The chains attach to the plastic seat frame by steel straps wrapped around the plastic tubing.

The device is safety tested. All edges are rounded and the pinewood is painted and padded. The safety straps meet testing standards. The seats can support over 100 lb. each, the seat frame 200 lb. The chains can sustain a 500 lb. load.

The approximate total cost for materials is $100.

Figure 4.2. Dual-Seated Physical Stimulation Swing.

# AUTOMATIC SLIDING DOOR OPENER

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## INTRODUCTION

Manual opening and closing of a sliding glass door is impossible for many wheelchair-bound individuals. An automated sliding door opener can compensate for clients' limited mobility. By pressing a button on a personal remote control, the client activates a motor that turns a screw-drive mechanism. The screw-drive then moves a trolley setup that is attached to the frame of the sliding door, pulling the door open or pushing it closed. This design is a modified version of a commercially available garage door opener.

## SUMMARY OF IMPACT

The automatic sliding door opener was built for a wheelchair-bound individual who has only minimal use of his arms and hands. Sliding glass doors require a moderate amount of strength such that the client has required assistance to enter and exit his own home. Assistance is not always available, however, especially in emergency situations. With the push of a button on a remote control, he is now able to go indoors and outdoors as desired, increasing self-sufficiency and fostering a greater sense of freedom and independence.

## TECHNICAL DESCRIPTION

The Automatic Sliding Door Opener is built from a standard garage door opener, and consists of two trolleys mounted on the sliding glass door, a screw-drive mechanism encased in an I-beam, and a compact 1/2 horsepower AC motor housed in an all-weather plastic case. The garage door opener comes with these components, except for the second trolley. Unlike a garage door, which opens vertically, the I-beam section is installed on its side to provide the horizontal sliding motion needed. Additional modifications include seven small mounts holding the screw-drive I-beam in place, and two large mounts holding the motor. Fourteen small "filler" pieces are also added to secure the I-beam and two trolleys, ensuring durability.

Figure 4. 3. Automatic Sliding Door Opener

A custom aluminum bracket is used to attach the trolleys to each other and to the door.

The system includes two safety sensors: an electric eye and a force sensor. The eye's infrared beam causes the door to be pulled open when anything breaks its path. The door will also return to the open position if the force sensor encounters sufficient resistance. These sensors come with the commercial garage door opener system.

This system was first tested on a simulated door and house frame. It was then successfully installed in the client's house. Overall performance is good, and the mounts and brackets are notably sturdy. Trolley length, bracket size and motor power can all be adjusted to various door sizes and forces required to open and close different doors. Manual operation is quick: flip two switches, one on each trolley, and the sliding glass door will operate normally.

The commercial garage door opener costs $180. With additional materials, including the second trolley ($42) and custom bracket ($75), total design cost is a reasonable $429.

Figure 4.4. Detail of Aluminum Bracket.

# ADAPTABLE COMPUTER CHAIR

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## INTRODUCTION

Commercial computer chairs do not provide the needed trunk, head and foot support that some children with disabilities require; nor do they provide an adjustable range of support for varying individual needs and levels of involvement. Similarly, commercially available computer chairs for persons with disabilities are often expensive, lack adjustability and portability, and are too large and cumbersome to be used in standard computer facilities, especially if a therapist or caretaker is also present beside the client. The adaptable chair can be used at desks that accommodate chairs only 24 inches high, 25 inches wide, and 25 inches deep. The chair includes the main adjustability, portability and safety mechanisms clients require: sitting height from 18 to 22 inches above the floor, backward tilt rotation from 0 to 30 degrees, lockable casters, bolsters to push the client forward in the chair, cinch straps for arms and legs, and supports and straps to secure the feet at the correct angle and prevent 'dangling feet.'

## SUMMARY OF IMPACT

An adaptable computer chair was designed and built for a four-year-old client with cerebral palsy and good cognitive abilities. The client's rehabilitation agency required portable chairs that allow room for a therapist to be beside a client in a small room that has insufficient space for large commercially available adaptive chairs. A therapist must be able to set up and secure the chair outside the small room before wheeling the client in. A touch-screen computer is used in the client's speech therapy, so the chair must allow him to sit forward and be highly involved.

Although initially designed for one client, the chair now accommodates several children, ages 4 to 13, with a variety of needs.

Figure 4.5. Adaptable Computer Chair.

## TECHNICAL DESCRIPTION

The chair consists of an inner seat and outer frame, both constructed from birch plywood and held together on either side by two hand screws that are held in place by friction between the two sections.

Two vertical slots in each side of the outer frame allow the inner seat to be moved vertically, and a horizontal slot in the front of the inner seat allows rotation. Casters are attached to the chair by two-by-fours that run along the bottom of the chair frame.

A Velcro cinching strap, threaded through the back of the chair, secures the client's trunk in place. The plywood arm rests, padded with foam liner and attached to the inner chair, move in tandem with seat adjustments. The plywood foot supports can be moved up and down a plywood leg rest to the desired position and then secured with a hand screw. Two Velcro cinching straps secure the feet in place. Aluminum sheeting inlaid around the slots, and foam-pad lining on the back and seat of the chair increase durability and comfort.

The plywood, casters, padding, hand screws, and other hardware and finishing products amount to $175 total. Similar commercial chairs cost $450 to $850.

# MOTORIZED MOBILITY AID

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## INTRODUCTION

The motorized mobility aid was designed and built for a two-year-old child with cerebral palsy. It consists of a plywood platform to stand on, a cushioned steel, plywood and PVC carriage, and a simple drive portable control system. The device, weighing 20 pounds, is designed for both indoor and outdoor use at moderate speeds over uneven terrain, and is configured to fit through standard 32-inch doorways. It has a number of features that encourage development and independence: straps to assist driver balance, dual controls to ensure even use and symmetrical development of hands and arms, and a carriage that feels open and free while maintaining safety standards.

## SUMMARY OF IMPACT

The mobility aid was designed with the two-year-old, 25-pound, 32-inch-tall client's strengths and challenges in mind. Most importantly, her legs do not support her weight. She cannot walk but can support her body weight when appropriate measures are taken to maintain her balance. The mobility aid allows her to stand while moving about, encouraging interaction with her peers while strengthening her legs. She also has limited development of the right side of her body, with best use of her left hand. The dual-control system mandates that she use both hands, and the configuration of the device ensures that she uses both arms and does not rest them on the device's frame. Portability and ruggedness for the outdoors provide the client added flexibility and independence.

## TECHNICAL DESCRIPTION

The motorized mobility aid consists of five main sections: a circular 30" diameter plywood platform, a motorized drive system, a steel and plywood back-support frame, a PVC safety frame on the sides and front, and driving controls mounted on the front.

Figure 4.6. Motorized Mobility Aid.

The device is driven by motors and drive wheels located in the middle of the platform on each side. A cut in the platform on either side of the front dolly wheel allows for flexibility in uneven terrain, and the top of each drive wheel is 3 inches above the surface of the platform. Wheel covers are provided for safety. The motors, attached to the wheels, are mounted through additional cuts in the platform.

The PVC frame extends from the top of the steel backing to the front of the platform, where it detaches at two points. A pin at each point secures the frame while the device is in use. Overall, the frame is bent and configured to keep the driver positioned at the platform's center, to ensure balance, and to keep the driver's arms inside the platform perimeter, at the same time creating a feeling of unconfined openness. When not in use, the PVC frame folds over the foldable steel backing.

The steel backing extends through the platform and is hinged above the platform so it can be folded down. Safety straps extend from a cushioned plywood back support attached to the steel frame.

The two control switches mounted on the PVC frame are activated by gently pushing hinged levers that attach to the switches. The switches are 20 amp, double pole, double throw, momentary switches that move the device only when both levers are pushed. The device stops automatically otherwise. The entire switch mount is angled toward the driver; the angle is adjustable. The switches have been tested for sustained use for 45 minutes.

The cost of this device is $330.

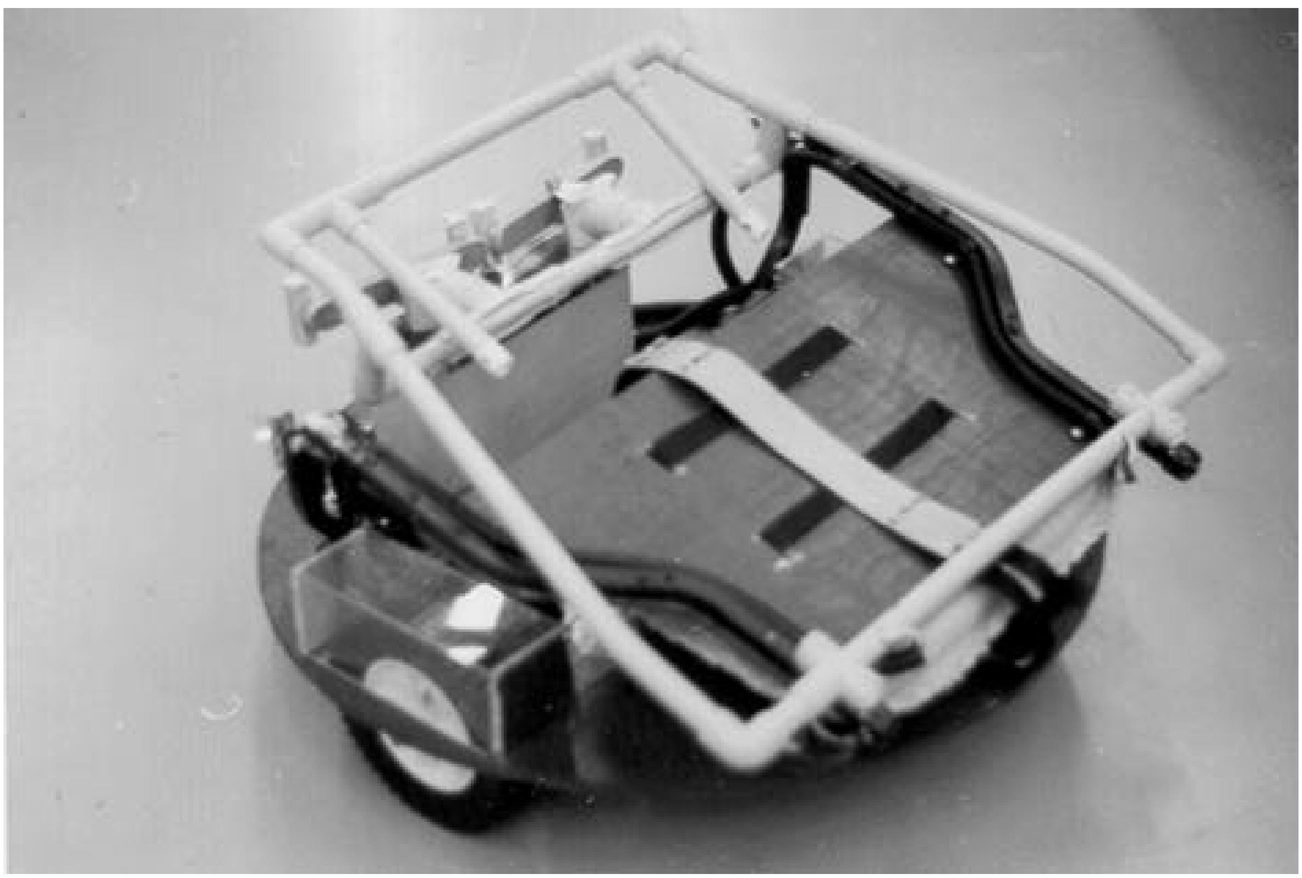

Figure 4.7. Another View of the Motorized Mobility Aid.

# MOTORIZED ACTION / REACTION CART

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## INTRODUCTION

The action/reaction cart is a motorized wheelchair with a simple control system that allows clients to move forward by repeatedly pressing a large button. The control system consists of a switch that requires repeated use to move the cart forward. There are no gears; movement is smooth and unabrupt. The cart is also equipped with standard wheelchair components, including padding, footrests and a battery driven motor. It can be driven on playground blacktop, gym floors, and other areas young clients are likely to go. The cost is significantly less than that for similar commercial systems.

This action/reaction cart helps children with severely limited or slowed movement capabilities move and interact with their peers.

## SUMMARY OF IMPACT

The cart was designed for a nine-year-old girl with Rett's Syndrome. The cart's features are vital to her physical therapy. She cannot walk or talk. Her therapists report the motorized cart allows her to interact with other children on the playground, participate in gym class, and gain a new sense of motivation. Like other children with Rett's syndrome, the client requires frequent encouragement. She has a will to move, and often wants to do something physical, but her slowed movement demands that she exert effort for up to 15 minutes to complete a simple action. To sustain her will and build confidence, the cart's switch functions for a few seconds when hit. The client must remove her hand and hit the switch again to continue movement.

## TECHNICAL DESCRIPTION

The motorized action/reaction cart is built on the frame of a commercial wheelchair. A padded child-sized car seat, motor, battery, electrical circuitry, and a footrest are mounted on a piece of birch plywood, which is bolted to the wheelchair. All the electrical components are located behind the car seat. The car seat provides a soft comfortable ride, and comes with an adjustable harness strap that fits across the chest and holds the client in place.

Figure 4.8. Motorized Action / Reaction Cart

A button switch, four inches in diameter, is used to control the cart. It is attached to a foam-covered aluminum bracket fixed to the car seat. The switch bracket can be rotated out of the way when the client is placed in the seat. A circuit, powered by a motorcycle battery, connects the switch to the motor, and the wheelchair wheel is driven by a small rubber wheel attached to the motor. The circuit is designed to stop the cart if the client's hand is not removed from the circuit after a predetermined length of time. Hand pressure must be completely removed and re-applied to reactivate the circuit. An emergency cut-off switch can be activated any time the cart is in motion. A key lock prevents unauthorized use. As an extra safety precaution, a Tupperware dish catches any possible leakage from the battery. There is no steering control, since steering is beyond the client's abilities.

The birch plywood footrest is mounted on a tubular frame attached to the body of the cart. Adjustable straps on the footrest prevent the client from kicking her legs. An additional PVC tubular frame on either side of the wheelchair prevents the client from touching the wheels.

The final cost of the system is approximately $350. Similar commercial systems cost approximately $3000.

Figure 4.9. Another View of the Motorized Action / Reaction Cart

# TODDLER HAND PROPELLED TRICYCLE

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## INTRODUCTION

A hand-propelled tricycle was built for a two-year old child, whose lower legs have been amputated. Commercial hand-propelled tricycles are typically not designed for children as small as this client. The chain-driven systems used in commercial tricycles are not as safe or easy to use as the friction-drive design presented here. This hand-propelled tricycle is easy to maneuver, and is as stable, durable and comfortable as commercial tricycles.

## SUMMARY OF IMPACT

The tricycle was designed for one child, but is easily adaptable for clients with similar needs. The client has highly developed upper body strength and excellent balance. At 28 pounds, he has age-appropriate weight, reach and proportions. The tricycle's novel design permits less work and greater safety. Use of the tricycle helps develop self-confidence and allows the client to interact more easily with other children.

## TECHNICAL DESCRIPTION

This tricycle is constructed from three children's riding toys: a Tyke's Taxi, a twelve-inch tricycle, and a ten-inch tricycle.

The front assembly wheel mechanism includes a twelve-inch front tricycle wheel, a three-inch idler wheel, and a nine-inch front tricycle wheel.

Commercial hand propelled tricycles are typically chain driven, but this tricycle uses a three-inch idler wheel to drive movement. The lower front wheel rotates forward as the idler wheel rotates forward. Without the idler wheel, the lower front wheel would rotate backwards when the upper front wheel is rotated by the user. The front rotation point occurs near the center of the idler wheel, which is positioned for maximum contact and minimum friction with the other two wheels. This makes it easy to crank the upper wheel and go. These three wheels are attached to 1/4 x 1-1/2 inch stock aluminum bar. The nine and twelve inch wheels run on plastic bearings to reduce friction.

The tricycle's rear assembly is the rear wheel assembly of the Tyke's Taxi. The front wheel assembly is connected to the rear wheel assembly using the Tyke Taxi's neck tube. The angle between the front wheel assembly and the back assembly is 90 degrees

The seat is constructed of wood board, foam rubber padding and vinyl material. Sheet metal is riveted to the lower level of the rear assembly to provide a place for the client to rest his feet while riding the tricycle.

The approximate cost is $100.

Figure 4.10. Toddler Hand Propelled Tricycle.

# MOTORIZED JEEP FOR A TODDLER

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## INTRODUCTION

The motorized jeep is an electric vehicle suitable for a two-year-old toddler with strength and coordination only in the hands and arms. The jeep, based on a four-wheel toy car frame, travels at walking speed or below, is easy to control, and has exceptional maneuverability. It also allows the child to sit or stand with support. In a standing position, body pressures are redistributed and the client is brought to eye level with other children. The jeep is markedly less expensive than commercial options.

## SUMMARY OF IMPACT

The two-year-old client has cerebral palsy with spastic quadriplegia. She is unable to walk, stands only with assistance, and is unable to hold herself upright in a sitting position. However, moderate hand grasp strength and moderate flexion and extension of the lower arms provides her with the control needed to operate a vehicle on her own. The jeep allows her to stand, relieving the pressure she experiences in the abdominal cavity due to slouching when she sits.

Figure 4.11. Toddler Motorized Jeep.

## TECHNICAL DESCRIPTION

The toddler jeep is based on a Power Wheels toy car frame with two centrally located drive wheels and a single wheel in the front and back. The drive train, drive wheels and axle are bolted with brackets to the underside of the jeep frame. The seat is mounted with PVC flanges inside the upper side of frame, and includes seat padding, seat supports and other final touches. Two momentary reversible toggle switches control the jeep when two levers are depressed forward or backward, singularly or simultaneously. The control panel with the control levers is attached to the seating system.

Altogether, the motorized jeep comes to $350, well below the $6000 to $7000 for commercially available electric wheelchairs.

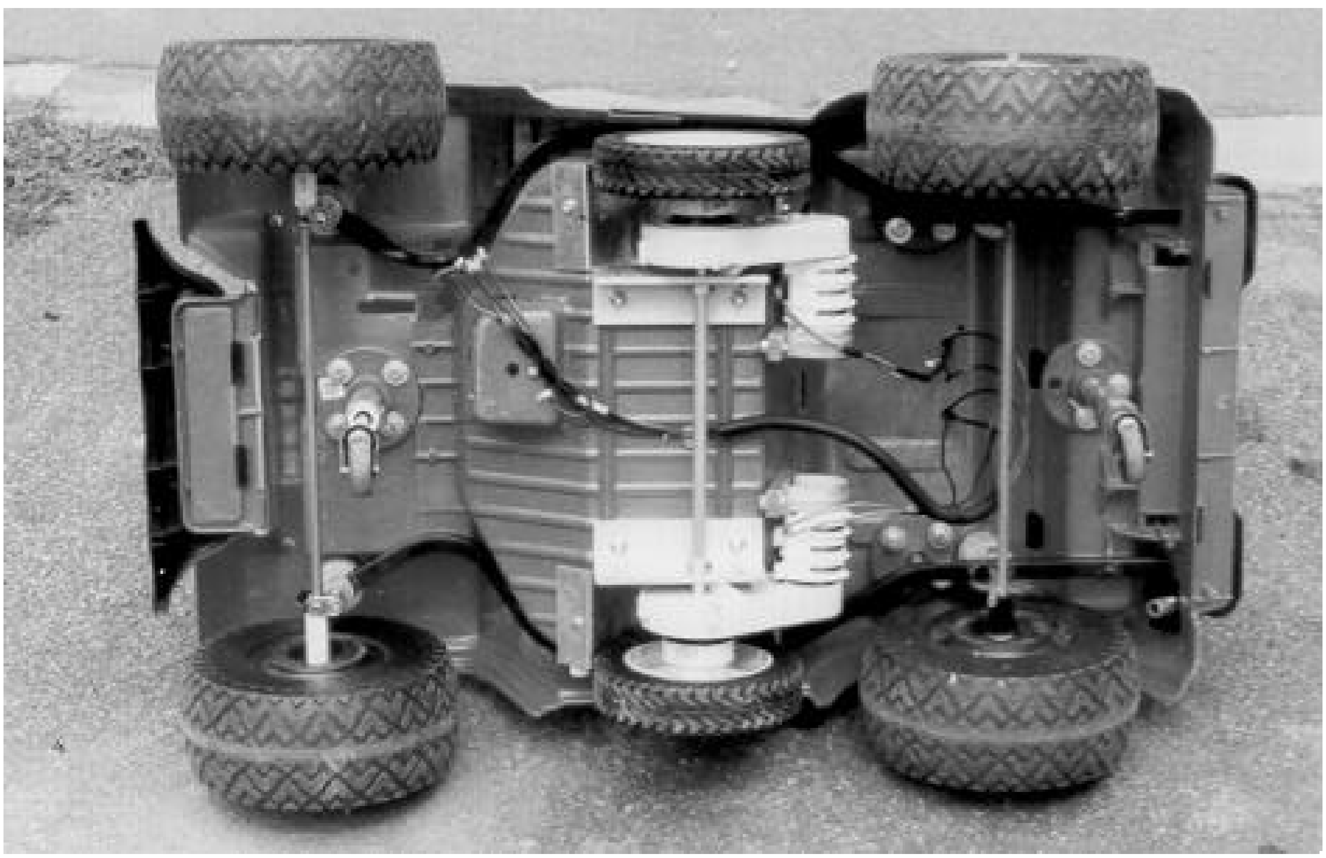

Figure 4.12. Bottom view of the Toddler Motorized Jeep.

# MODIFIED ROWING MACHINE

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## INTRODUCTION

The modified rowing machine is designed for those who want to exercise the entire range of motion in their legs without relying on the legs for strength, and for those who want upper body strengthening without strain to the back or spine. Users rely on their arms instead of their legs to push their seat back and forth. Based on a commercial lifting rower, the machine includes foot rests and foot straps to hold feet and legs in place, a seat belt to prevent falls while in motion, a tapered seat back for back support, and additional safety features to stabilize the machine while the client mounts it.

## SUMMARY OF IMPACT

The modified rowing machine was custom designed and built as an exercise device for a thirteen-year-old client with spina bifida. He is paralyzed from the waist down but has full range of involuntary motion and flexibility in his lower body. His feet are angled at 45 and 50 degrees, and one leg is approximately one inch shorter than the other. He also has full upper body movement and strength, even with his limited spinal flexibility. The design is easily transferable for clients with similar needs.

## TECHNICAL DESCRIPTION

A commercially available lifting rower with a minimal number of moving parts was modified to meet the client's requirements. The redesigned parts include the arm bars, the seat and the foot rests.

The arm bars are made immobile so the seat may slide back and forth when a force is applied to them. To accomplish this, the arm bars are moved from their standard position on a joint in the center of the machine, to a new location at the base of the machine. The bars were detached from the center joint by removing the bottom lip of the bar. They were then reinstalled at the base, in which two holes had been drilled.

The commercial rower comes without a seat back. A steel bar and a piece of wood were used to create a tapered back that does not interfere with the client's rowing motion. The sheet metal fits between the wheels in the track and the bottom of the seat. To prevent the seat from moving while the client is getting on, the sliding track and base are connected to each other using two brackets. A seat belt is added for safety.

To accommodate the client's angled feet, holes were drilled on the back of the existing footrests, and the footrests may be slid back onto the bar at the appropriate angle. This is a quick approach easily adaptable to other clients' needs. To account for difference in leg length, the center of the footrest was cut out and filled with wood of sufficient thickness.

The final cost was approximately $185.

Figure 4.13. Photograph of the Modified Rowing Machine.

# VACUUM PAGE TURNER

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## INTRODUCTION

This vacuum assisted page turning device requires only slight movement over a sensor to automatically turn pages forward or backward. An infrared photocell detects the reader's movement, and a suction-cupped arm attached to a vacuum pump system pivots, grabs onto a page, and turns it. The page-turner accommodates a wide variety of reading materials of different sizes, including books, magazines, and binders with normal and laminated pages. The angle at which the reading material faces the user is also adjustable.

## SUMMARY OF IMPACT

The vacuum page-turner was originally designed and built for a client with muscular dystrophy. It is appropriate for a wide range of individuals. Whether on the job or in the privacy of one's home, the page turner works with the simplest hand movement, making the world of printed material available to those who might otherwise be limited.

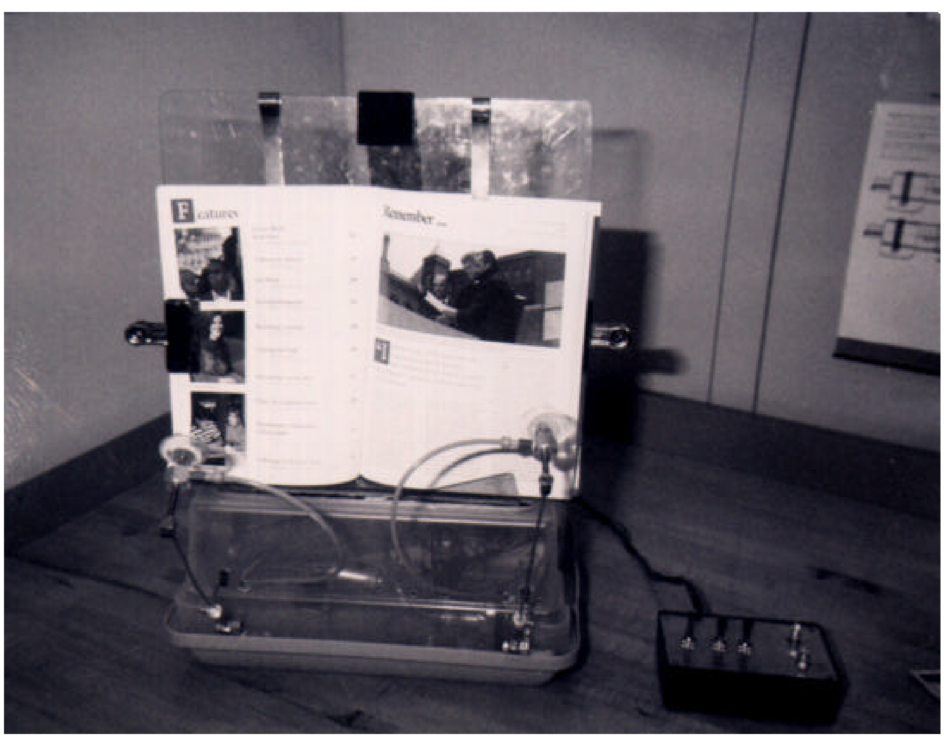

Figure 4-14. Vacuum Pager Turner.

## TECHNICAL DESCRIPTION

The vacuum page turner consists of a sensor package, a sloped box-like housing to support a book, pivot arms to turn pages, a suction cup on the end of each arm to grab pages, a worm gear box to move the arms, a vacuum pump with solenoid valves, and a vacuum regulator switch to drive the suction cups.

The page-turner is controlled by two infrared photocell emitter-detector packages, one for each page-turning direction. When the reader's finger is placed over an emitter-detector package, the emitter beam is refracted, the detector senses the refracted light, and an electric pulse activates the mechanical system.

When the system is activated, the vacuum pump depressurizes the air tank to a pre-set vacuum level. Next, the worm gear box activates one of the arms and pivots it forward. The right arm is activated to page forward, while the left arm is activated to page backwards. Once the activated arm comes in contact with the page, a solenoid is switched to the open position, allowing atmospheric air to pressurize the air tank. This causes the page to be drawn to the suction cup. Then the arm pivots downward, drawing the suctioned page away from the others. A planetary motor rotates a large arm from underneath, swiping the page to the opposite side of the binding. When the swiping arm is counter-rotated, it pushes the page backwards.

The two pivot arms consist of long, slender steel hollow rods mounted opposite one another along the sides of the housing. One end of a pivot arm is screwed to a pivot point on either the right or the left side of the housing. The arms are attached well below the bottom edge of a book so as not to obstruct a reader's view regardless of the viewing angle chosen. The other end of each arm attaches to a treated aluminum cylindrical sleeve. A spring between the arm and sleeve permits the arm to travel as needed according to the reading material being turned.

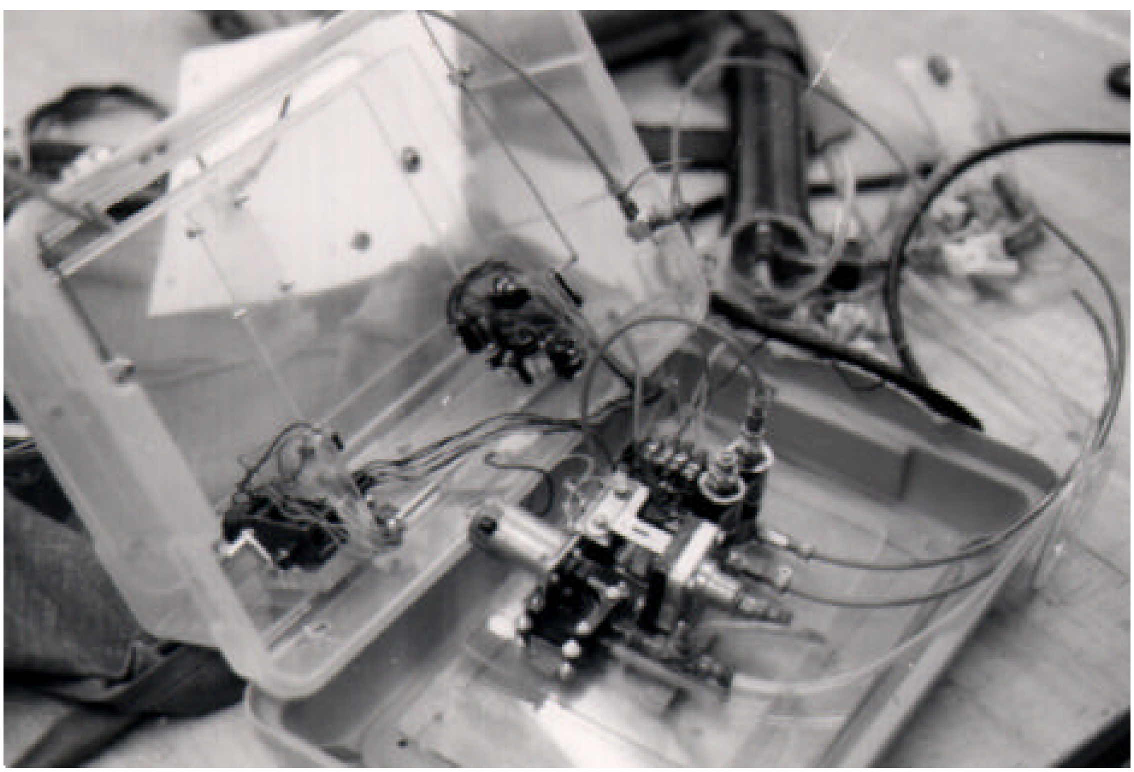

Figure 4-15. Internal View of the Vacuum Pager Turner.

# PORTABLE POOL LIFT

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## INTRODUCTION

A school district requires a portable lift to raise and lower high school students into a swimming pool. Commercial pool lifts require permanent alteration of the pool facility in order to anchor a lifting frame to the pool deck. The Portable Pool Lift uses flotation as the lifting force, so that a rigid, load-bearing mounting system is not required. An inverted rectangular plastic tank, attached to pivoting PVC plastic arms, provides a flat lifting surface, which raises and lowers the student into the water. The rotating arms are attached to a plastic frame, which is anchored to the pool by a post. The post fits into an existing hole in the poolside. Clips are used to engage a lip on the pool surround.

Attached to the top of the flotation tank is a hardwood board, which extends toward the pool edge. In the raised position, this board rests on the side of the pool. This serves as a seat and slide board for moving the student from poolside onto the lift. In operation, the student moves onto the board and holds onto the plastic frame attached to the flotation tank, as shown in Figure 4.16. Air is pumped into the tank via the frame, which is attached to an air source, a converted shop vacuum cleaner. As water is displaced from the tank, it rises off the poolside until the rotating arms are vertical, at which time the air supply is removed and the flotation tank is allowed to settle slowly into the water, expelling air back through the vented frame. When the tank reaches its bottom position, the seat board butts up against the side of the pool, holding the tank away from the side and keeping the rotating arms at an angle so that a vertical lifting force will cause them to rotate, as shown in Figure 4.17. At this point the student is submerged and can move around in the water, supported by his buoyancy. Figure 4.18 shows the frame and air pump sitting on the pool deck.

Figure 4-16. Portable Pool Lift in Raised Position.

Figure 4.17. Portable Pool Lift in Lowered Position.

## SUMMARY OF IMPACT

A school district is required by the Americans with Disability Act to provide access to its pool for two entering students. District authorities did not want to make permanent modifications to the pool. A commercial pool lift is very expensive. The Portable Pool Lift can be installed in about five minutes and allows assistive aides to move the students into and out of the water with minimum effort. The Portable Pool Lift weighs about 30 pounds, so it can easily be lifted out of the water and stored in an adjacent storeroom.

Figure 4-18. Portable Pool Lift and Air Pump on Poolside.

## TECHNICAL DESCRIPTION.

The swinging arms and flotation tank are made of PVC plastic to avoid rust. It is lightweight and easy to fabricate. The furniture-grade PVC tubing is supplied with slip joints, which are used as hinges for the rotating arms. The rigid support frame, which supports the rotating arms and flotation tank, serves as a piping system for conveying air from the blower to the flotation tank. PVC ball valves are mounted in the arms of the support frame to control the airflow for inflation and evacuation. However, it is easier to control the flow by simply pushing the nozzle on the supply hose into its connecting hole in the frame with the air pump running. When sufficient air has been injected into the flotation tank, the supply hose is removed and the connecting hole serves as a vent.

Although reversible shop vacuums exist, an old vacuum was modified in this case to provide a positive pressure air source. The air source has to provide a static air pressure of at least 24 inches of water in order to operate the Portable Pool Lift.

As shown in Figure 4.18, a vertical post is used to anchor the top portion of the frame to the pool. This post uses a wedging action to hold it in the hole in the pool deck, although it is not necessary to hold it that tight. The lower anchor clips are made of modified slip joints with wing nut tightening screws. These are pulled tightly against the protruding lip to hold the Portable Pool Lift tightly in place. In addition to these anchoring points, a rubber-coated steel wedge is forced under the edge of the base to keep it from rotating out from the wall under the flotation tank’s lifting force. The base support frame and side support frame are designed to fit the clients’ pool. Additional anchoring systems could accommodate the particular geometry of a given swimming pool edge.

# HINGED DOOR OPENER

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*Supervising Professor: Richard Culver, Ph.D.*
*Department of Mechanical Engineering*
*Binghamton University*
*Binghamton, NY 13902-6000*

## INTRODUCTION

A door opening device was designed for an adult man with paraplegia. The client desired a device that would allow him to open his front door without the aid of another person. The device was to allow for either manual or automatic opening while ensuring safety for anyone who would come in contact with it. Some existing solutions appeared useful but were expensive, ranging in price from $1200 to $1500.


Figure 4.19. Hinged Door Opener

## SUMMARY OF IMPACT

As a result of the door opener the client has become more independent in his daily life. Now that he can open his door, he is able to go outside independently, or to open the door to allow someone into his home.

## TECHNICAL DESCRIPTION

The hinged door opener was made by purchasing a garage door opener and modifying its internal machinery. A lever arm was devised and mounted on the gear drive sprocket on top of the opener. The arm, made mostly of aluminum, consists of a shaft that connected to the sprocket at the base, with two arms extending off the top of the shaft. A wheel was attached between the ends of the two arms so that no mark would be made on the client's wall where the arms would push the door open.

After the construction of the arm, a new motor was put into the opener to slow the speed at which the sprocket would rotate. The original speed was around 1500 RPM. The new speed was approximately 6 RPM, requiring around 5 seconds for the door to be opened. Installing this new motor required some modifications to the internal setup of the garage door opener. A new motor mount had to be constructed for the modified due to its different shape. A three-inch adapter was added to the end of the motor shaft

The front end of the casing was cut out slightly so that the motor could fit into the device properly. The original shield for the light was left installed to cover areas where wires might otherwise be exposed.

The total cost of the hinged door opener and accessories required for the project came to $308. The garage door opener cost $150 and the aluminum bar cost $25. The new motor and capacitor cost a total of $99. The remaining costs were made up from some minor modifications that were made to the door itself. Two spring hinges ($22) and two L braces ($9) were purchased to help support the door opener on the door. The total cost was from $900 to $1200 lower than the price of a commercial door opener.

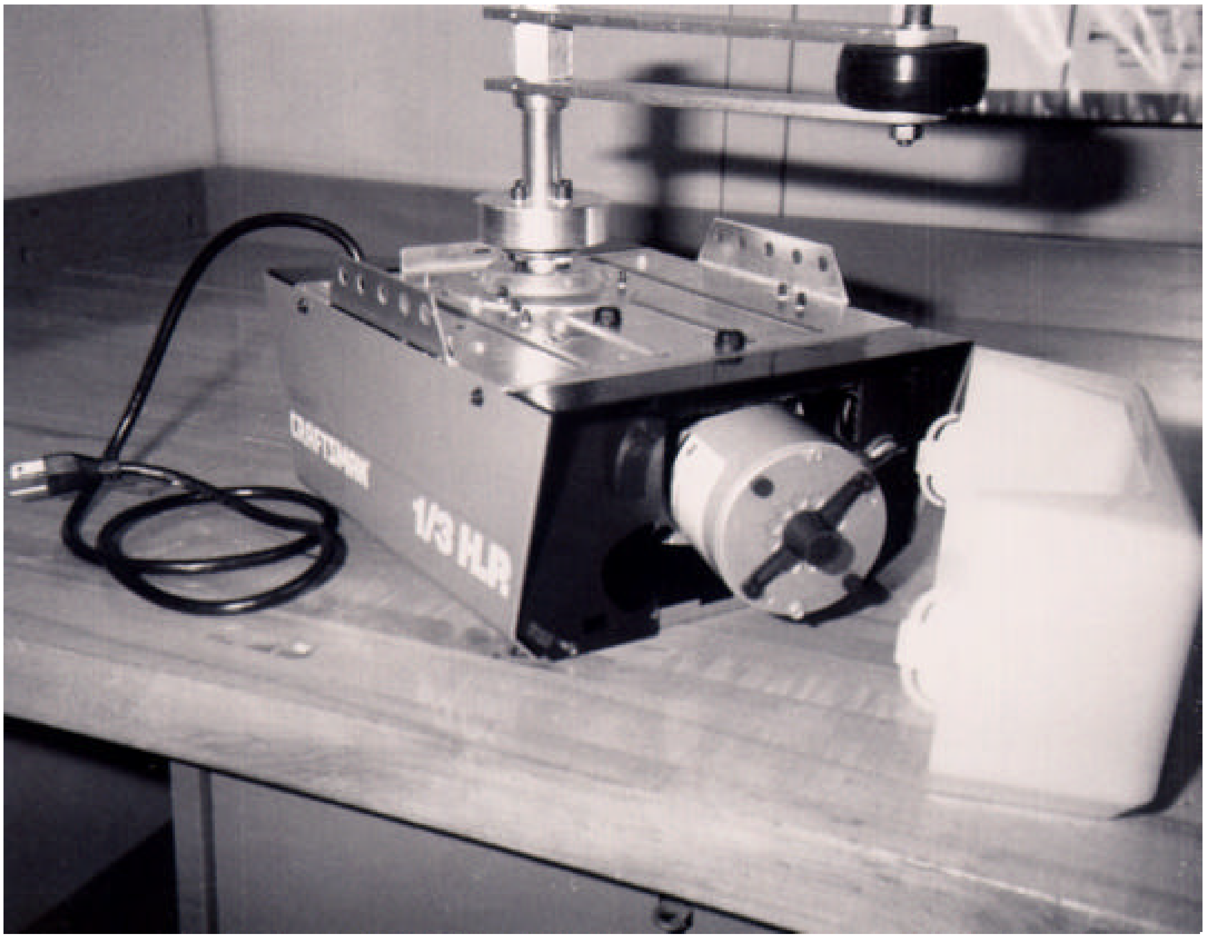


Figure 4.20. Low Speed Motor in Door Opener.

# WHEELCHAIR LIFT

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*Client Coordinator: Valdo Rogers*
*Broome Developmental Center*
*Supervising Professor: Richard S. Culver, Ph.D.*
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## INTRODUCTION

A wheelchair lift was designed and built to facilitate wheelchair repair and servicing for a developmental center. The pivoting legs of the lift and table consist of two rotating rectangular frames placed at a slight angle to each other. When the table is lowered, the angle between the legs makes the table tilt so that one edge is lower than the other as it reaches the floor. The wheelchair can be rolled onto the tilted tabletop, where a spring-loaded rotating flange is used to secure it. When the lifting arm is lifted, it rotates the legs, raising the table and wheelchair to normal table height. In the vertical position, the legs can be locked against a wooden frame that supports them. When not in use, the handle is stored in the reversed position in the legs. The flange can be held flat against the tabletop by a clip when it is not needed. The wheelchair is held in place on the tabletop with Velcro straps while it is being serviced.

Figure 4.21. Wheelchair Lift in Raised Position

Figure 4.22. Wheelchair lift Lowered for Loading.

## SUMMARY OF IMPACT

The client, a developmental center, has a large number of wheelchairs that require regular servicing and repair. Normally, technicians service them on the floor since, at 100 pounds or more, they are too heavy to lift to table height. The limited space in the workshop prevents using a ramp for raising the wheelchairs and precludes a space dedicated solely to lifting wheelchairs. The wheelchair lift described here requires minimal space, and can be used as a regular working surface when not needed for wheelchair repair.

## TECHNICAL DESCRIPTION

The wheelchair lift is constructed of common building materials. The lower frame is made of 2x6, 2x4 and 1x6 lumber. The table top is 3/4 in plywood. The legs are Type-L, 3/4 in. copper tubing. The lifting handle is a special, 5/8 in. copper tubing with 1/2 in. steel rod glued inside to increase bending resistance.

The legs are set at a 5? angle, such that, when lowered to the floor, the high end is approximately 10 inches off the floor. The copper tube runs in bearings made by holes through the fir lumber. When raised to a vertical position, regular 4-inch bolt latches lock each of the four legs rigidly against the wooden frame. The two legs that hold the lifting handle are topped with T connections, providing the lifting handle access to the legs.

The pivoting flange is made from 20-gage sheet steel, which is bent over the edge of the plywood. It is attached to the tabletop with a piano hinge. Leaf springs, bent from piano wire, push the flange up from the tabletop to an angle. When a large wheelchair wheel rolls against it, it locks in place, keeping the wheelchair from rolling backward. When removing the wheelchair, rotating clips on each side of the table allow the flange to be held flat against the tabletop.

The approximate cost of materials for the wheelchair lift is $50. To our knowledge, there is no comparable device on the commercial market.

Figure 4.23. Detail of Flange.

# GAIT EXERCISER

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*Client Coordinator: Colleen Griffith*
*Johnson City School District*
*Supervising Professor: Richard S. Culver, Ph.D.*
*Department of Mechanical Engineering*
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## INTRODUCTION

An instrumented frame has been built to stimulate gait dexterity in young children. The frame consists of three parts: an adjustable support frame, instrumented walking beams, and a control console that provides visual feedback when the walking beams are depressed (Figures 4.24 and 4.25). The load level at which a red light for each beam turns on can be adjusted to encourage the child to place full weight on each leg.

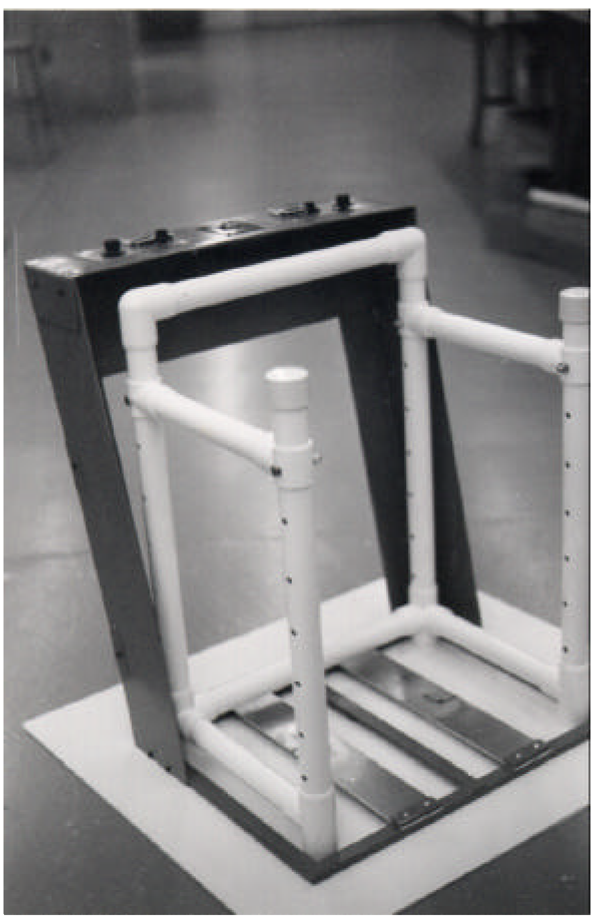

Figure 4.24. Gait Exerciser - Rear View

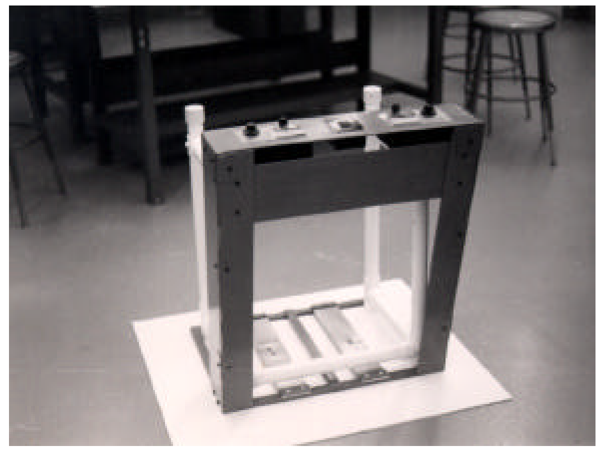

Figure 4.25 Gait Exerciser - Front View.

## SUMMARY OF IMPACT

The Gait Exerciser was developed for children with limited walking ability in a school setting. A device that gives them feedback when they are walking properly was requested. Feedback is provided via red lights that turn on when the user applies sufficient load on the walking beam to reach a preset level. Audio signals can also be attached to the system to make a sound when the desired load is reached. The independent adjustment for the preset load on each walking beam allows the system to accommodate children with special disabilities. It will also accommodate children with weights ranging from 30 to 60 pounds. Comparable commercial systems are very expensive and do not provide the desired adjustability.

## TECHNICAL DESCRIPTION

The Gait Exerciser walking beams are made of 3x1/4 inch aluminum plates, to which strain gages have been mounted on top and bottom. When a child steps on the beam, the beam deflects, activating the strain gages, which register pressure electrically. Wires from the gages travel through the frame to the console where the electronic controls are mounted.

The circuit functions by measuring the difference in voltage between the two strain gages on the walking beam. This voltage difference is acquired by passing the two voltage signals, one from each strain gage, through a differential amplifier. Next, the signal is next filtered to remove high frequency and 60 Hz noise. A non-inverting amplifier is used to amplify the signal so that it is of the same magnitude as the power supplies (? 9V). The resulting output signal is input to a voltage comparator in which the user has set a reference voltage. When the reference voltage is reached, a visual output is generated. A diagram of the circuit is given in Figure 4.26.

In operation, the sensitivity and the base weight of the user can be adjusted by the therapist through dial controls so that the walking load is indicated on a meter. This can be set to turn on a red light when the desired load above the base weight load has been applied. The child supports him/herself with the plastic beams on the support frame.

The support frame is made from 1 1/4 inch furniture grade PVC plastic. The horizontal arms can be adjusted vertically. The support frame for the walking beams is 1/2x1 inch steel bar. The control console is made from 1/8 inch 6061-T6 aluminum. When in use, the walking beams are covered with sheet rubber, with feet painted on the surface to indicate where the child should step. The cost of the gait exerciser materials is $120.

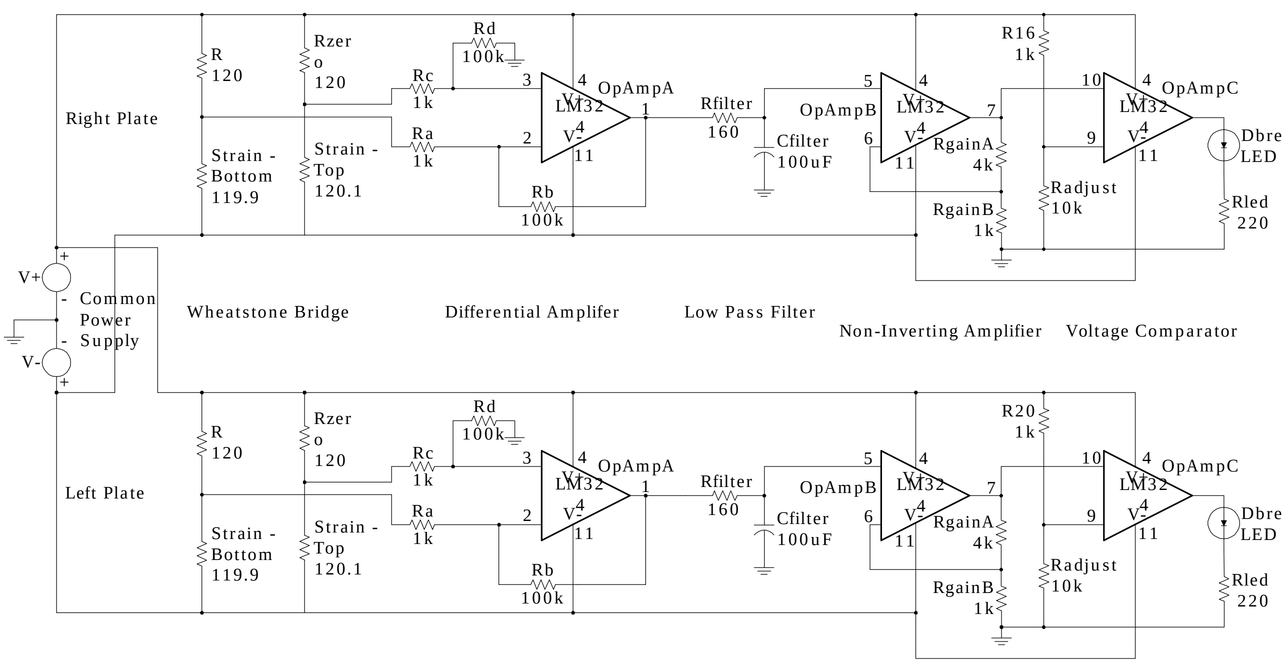


Figure 4.26. Circuit Diagram for Gait Exerciser.