CHAPTER 7
STATE UNIVERSITY OF NEW YORK AT BUFFALO

School of Engineering and Applied Sciences
Department of Mechanical and Aerospace Engineering
335 Jarvis Hall
Buffalo, New York 14260-4400

Principal Investigator:

Joseph C. Mollendorf (716) 645-2593 x2319
molendrf@acsu.buffalo.edu

The Wheelchair Rocker: A Devise that Provides Sensory Stimulation to Children with Multiple Handicaps

Student Designers: Joshua J. LaPenna and Christopher J. Hausler
Supervising Professor: Dr. Joseph C. Mollendorf
Mechanical and Aerospace Engineering Department
State University of New York at Buffalo,
Buffalo, NY 14260-4400

INTRODUCTION

The wheelchair rocker (WR) was designed to provide sensory stimulation for children with multiple handicaps. This device is simply a motorized pivoting platform on which a wheelchair can be mounted. Once the wheelchair has been secured to the platform, it can be set into a rocking motion (see Figure 7.1). Upon completion, the WR was presented to the Center for Handicapped Children in Cheektowaga, New York. The children at this center have extremely poor motor skills. Most are not able to even sit up by themselves. Thus, they live a life of virtually no motion. Multiple handicaps frequently lead children to be bored and depressed, and to suffer from poor circulation. Ultimately, the WR is intended to give the children a sense of interaction with their environment.

SUMMARY OF IMPACT

The design criteria for the WR were defined by the capabilities of the children and the needs of the center. The physical therapists (PT) are often very busy, and are unable to spend long periods of time with any one child. As a result, the PT desired a self-operative, portable device that both the children and PT will feel safe using. Further, it is especially stimulating for the children as well as convenient if the children themselves have some control over the device. This not only allows the PT to leave the WR unattended for short periods of time, but also allows the children to take part in the decision-making process concerning their interactions with the environment.

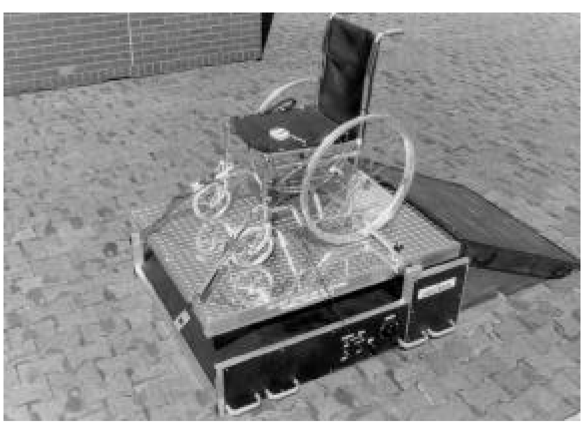

Figure 7.1. The Wheelchair Rocker.

TECHNICAL DESCRIPTION

The overall structure of the WR was made from anodized aluminum tubing (1 by 2 by 1/8-inch). The high strength to weight ratio, which is characteristic of aluminum, provided the necessary structural integrity and low weight requirement needed for a portable device. The frame was designed in such a way that all members come together and are welded at 90 degree angles. All additional components of the WR are fastened to the frame by bolts.

The actual rocking of the platform is accomplished by a Grashof four bar crank-rocker mechanism (see Figure 7.2). The driving link in this mechanism is powered by a 1/2 horsepower DC electric gear motor. The motor was carefully selected to assure that it would not stall under the large loads induced by the rocking of child and wheelchair. As a result of the large torque and low speed requirements, the motor is very quiet. Speed control and cost were the two main reasons a DC motor was chosen over AC. It was decided that the PT should have control of the WR's rocking frequency. This is easily accomplished by varying the voltage across a DC motor. Further, the circuit contains a rectifier that converts the AC power from the wall outlet to the DC power needed by the motor.

Aside from the motor circuit, a switching circuit was also needed. Since it is unsafe to have large amperage going through switches, a steady-state relay was used to separate the two circuits. In this way, the motor circuit could carry five amps of current while the switches draw only a few milliamps. The WR has four switches, a power switch, a start/stop switch, a switch for the child, and a level-stop micro-switch. The power switch simply turns the machine on. This switch is placed in series with the motor. The start/stop switch is intended for the PT to use. This switch will actually set the platform into motion. The child's switch will differ from child to child, depending on the handicaps involved. Each child has a switch he or she can operate best. Thus, the WR is equipped with a universal jack to accommodate all types of switches. This switch operates in the same manner as the PT switch. The micro-switch is attached to the structure in such a way that the platform will only stop in the level position. Since all of these switches are interdependent, a series of mechanical relays were used in the control circuit to implement the logic. The control panel for the WR can be seen in Figure 7.3.

The cost of parts/material was about $1500.

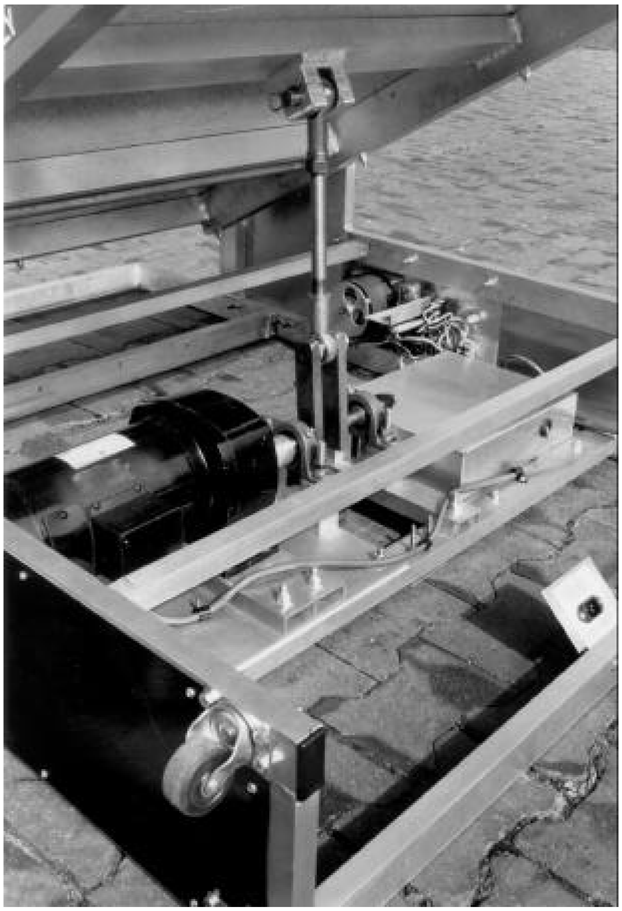

Figure 7.2. Crank-Rocker Mechanism.

Figure 7.3. Control Panel.

Stairclimber/Walker: Apparatus for Amputee

Student Designer: Victor Katilus
Client: Eileen Sette
Supervising Professor: Dr. Joseph C. Mollendorf
Mechanical and Aerospace Engineering Department
State University of New York at Buffalo,
Buffalo, NY 14260-4400

INTRODUCTION

An assistive device was designed for individuals with one amputated leg having some residual component and one leg that is fully functioning. The residual limb must have an inseam of at least seven inches to use this device.

Although prostheses exist for this handicap, the Stair Climber/Walker can be of use for patients who, for some reason, are not wearing a prosthesis. For example, the manufacturing of an artificial leg takes time; therefore, the Stair Climber/Walter is available for interim use.

Before receiving this device, the mobility of the patient for whom this prototype was designed and manufactured was greatly hindered. She lives in a three-story flat with two sets of stairs and does not have a prosthesis. She is confined to a wheelchair and climbs the stairs by sitting on a step and dragging herself along one rise at a time. The Stair Climber/Walker is a device she can use to negotiate the stairs in her home, as well as to traverse on flat ground until she is fitted with an artificial leg.

SUMMARY OF IMPACT

A photograph of the prototype apparatus is shown in Figures 7.4 and 7.5. The patient lost her right leg above the knee and is left with a residual limb having an inseam of 8.5 inches. The device was custom made to fit her physical makeup. Since her weight will be carried by a cushioned ring that wraps around her thigh, a snug fit was essential.

The prototype is a walker that has an easily inserted extension for stair climbing. To use the device, the patient slips her residual limb (right leg) into the cushioned harness and holds on to the handle with her right hand. To walk, she steps forward with her left leg and then lifts the device using the handle and brings her right leg adjacent to the left leg. She must take small steps to traverse, but she has become quite mobile with the apparatus.

In order to climb stairs, the patient slips the stair climbing extension on the device to accommodate the riser height of the airs. She climbs the stairs in a way that is similar to walking. She begins by taking her first step with the fully functioning left leg up to the next riser. Then with her right hand gripping the apparatus handle and her left hand on the stairway railing, she pulls the right side of her body up while straightening her left knee and planting the device on the step.

Figure 7.4. Apparatus.

To go down the stairs, she proceeds backwards. Again, she firmly grips her right hand on the handle while holding the stairway railing with her left hand. She takes a step downward with apparatus first (her right residual limb). With the device on the lower step and flexing her left knee, she brings her left leg down to the same level as the device.

TECHNICAL DESCRIPTION

The device is lightweight (less than four pounds) and strong. The structure is made of tubing and is fastened entirely with welds. There is a lining of foam to cushion the residual limb. To change the device from a walker to a stair climber, an extension is slipped on the bottom of the device to accommodate for the riser height of the stairs. The Stair Climber/Walker Apparatus for Amputee is an inexpensive tool that has greatly expanded this patient's mobility and improved her quality of life.

The cost of the parts and material was about $112.

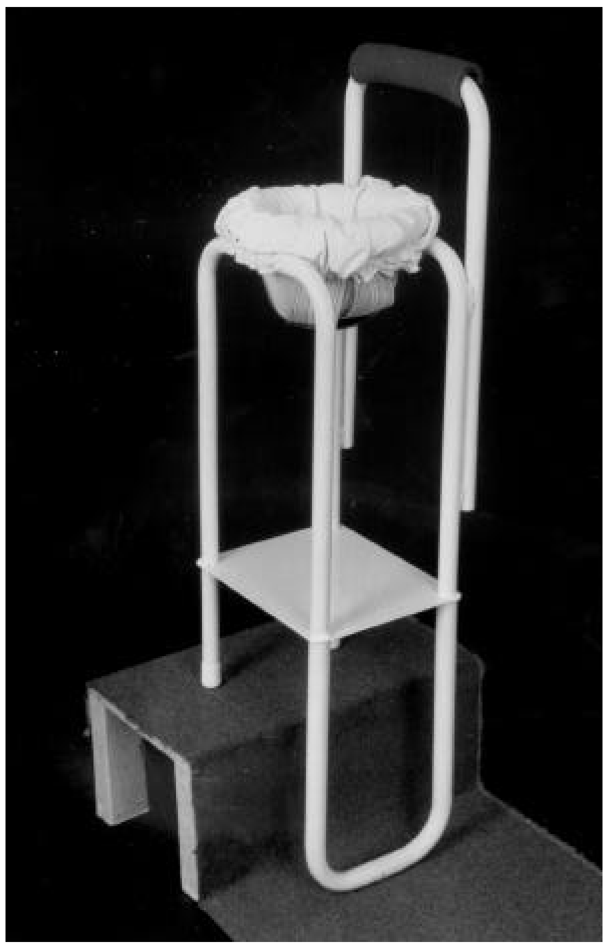

Figure 7.5. Apparatus on Step.

Geared Wheelchair Wheel: Replacement Wheel that Adds a Higher and Lower Gear to Wheelchairs

Student Designers: Brian Bodkin, Kurt Blemel, Matthew Keehan III
Supervising Professor: Dr. Joseph C. Mollendorf
Mechanical and Aerospace Engineering Department
State University of New York at Buffalo,
Buffalo, NY 14260-4400

INTRODUCTION

Wheelchair users are often faced with steep handicap accessible ramps and hills that are difficult to ascend. Some users lack the arm strength to propel a wheelchair effectively even over level surfaces. Some just want to go faster in their wheelchairs. The Geared Wheelchair Wheel fulfills these needs by providing higher and lower gears for increasing speed or ascending inclines.

The design consists of a three-speed gearing system incorporated internally into the wheel hub. The handle normally utilized to propel the wheelchair now acts through the gearing system to drive the wheel at different rates. The user needs only to engage the gear shifter on the wheelchair armrest to change gears. Also, the geared wheel is mounted in place of the normal wheel, with all other aspects of the wheelchair remaining unchanged.

SUMMARY OF IMPACT

The Geared Wheelchair Wheel will increase the mobility of any wheelchair operator. One specific application context is the sport of wheelchair racing. A higher gear would increase the maximum speeds of the wheelchairs, possibly revolutionizing the sport.

Another important application involves climbing ramps and hills. A normal wheelchair can only be propelled at a one-to-one gear ratio, with the handle rigidly attached to the wheel rim. Therefore, the user has no mechanical advantage in ascending steep grades. The Geared Wheel provides a lower gear, enabling the user to conquer these obstacles with less force.

The lower gear also allows people with limited arm strength to drive the wheelchair by themselves.

Additionally, the Geared Wheel retains the one-to-one gear ratio for standard wheelchair operation.

Figure 7.6. Mounted Wheel.

TECHNICAL DESCRIPTION

The Geared wheel functions in essentially the same manner as a three-speed bicycle. In fact, the prototype pictured in Figures 7.6, 7.7 and 7.8 used the rear hub from such a bicycle. Modifications to the hub were made in order to fit the needs of the wheelchair user. These alterations included:

- Adjusting the coaster brake mechanism to allow movement in reverse. Otherwise, the wheel would lock when the user tried to propel themselves backward.

- Moving the gear shifting device (which was initially located on the handle side of the wheel) to beneath the wheelchair. This allowed the wheelchair with the Geared Wheel to retain approximately the same width as the original wheelchair. The hub axle had to be drilled and fitted with a specially machined steel cylinder to accomplish this task. The cylinder, threaded onto the protruding end of the axle, holds the shifting mechanism in place with a second set of threads.

The steel cylinder also acts as the mounting post for the Geared Wheel. The outer surface of the cylinder was threaded to allow quick bolted attachment to the wheelchair mounting bracket. Since a bike hub is held fixed at both ends of its axle, the Geared Wheel's single connection presented the risk of having the axle bend or break. The cylinder effectively increased the strength of the axle. A needle bearing was also placed between the hub and cylinder to reduce resistance.

Moving the handle connection from the wheel rim to the hub was necessary to drive the three-speed transmission. A steel circular plate was machined and welded to the hub where the normal bike sprocket would be located. A ½-inch galvanized steel conduit was bolted in three places on the plate and then attached to the handle ring. Three additional sections of conduit added strength to the handle geometry.

The Geared Wheelchair Wheel is an effective and relatively inexpensive assistive device with numerous applications.

The cost of the parts/materials was about $160.

Figure 7.7. Close-up of Geared Wheel Mounting.

Figure 7.8. Close-up of Geared Wheel Hub.

Remote Door Opener: A Device that will Unlock and Open a Door for a Disabled Person with Limited Motor Skills

Student Designers: Keith Schroder, Michael Jansen and Neal Ginsberg
Supervising Professor: Dr. Joseph C. Mollendorf
Mechanical and Aerospace Engineering Department
State University of New York at Buffalo,
Buffalo, NY 14260-4400

INTRODUCTION

For many people with disabilities, conventional doors can be a problem. Keys can be hard to handle when a person's hand-eye coordination is diminished. An automatic door opener was designed for a specific door on the campus of the State University of New York at Buffalo. The device allows its user to gain entrance to his work area without the assistance of co-workers. A remote controlled device will enable him to unlock and open the door at the push of a button.

SUMMARY OF IMPACT

A device was built to allow remote controlled access to a room. The device causes no interference with the existing locking mechanism or doorknob. The device could be manipulated slightly to fit on most doors.

TECHNICAL DESCRIPTION

Industrial strength door openers currently exist but are not inexpensive. The remote device presented here is inexpensive, small, and allows regular-keyed access by other occupants. The door opener components are shown in Figure 7.9.

Figure 7.9. Door Opener Components.

The door originally had a top mounted pressured hinge that normally kept the door in a closed position. The hinge was replaced by a pressured hinge that acts to keep the door open. This means the door must be manually shut. When unlocked, the hinge forces the door to the open position, allowing access to the room.

The locking mechanism on the door is always locked from the outside and always unlocked from the inside. The door originally could be unlocked from the outside with the use of a key. The installation of the remote opener now allows entrance by using the remote switch. The unlocking mechanism is installed on the inside of the door (Figure 7.9). A wooden clamp-like handle is secured to the door handle so as to not interfere with manually turning the actual doorknob. The wooden handle is connected to fishing line running horizontally across the door. Midway across the fishing line a motor is mounted to the door. Attached to the motor is an arm that rotates clockwise when the motor is activated. The arm pushes the string, pulling the wooden handle, causing the doorknob to turn. The door is then opened and the remote user has access to the room.

The cost of parts/materials was about $70.

Figure 7.10. Door Opener Mounted.

Modified Ambulator: A Walker that Allows for One-Handed Collapsibility and Incremental Weight Adjustment

Student Designers: David Eyngorn, Nathan Kyser, Thomas Sass
Client Coordinators: Robin Tirado, M.S., Ed.; Center of Assistive Technology (CAT)
Supervising Professor: Dr. Joseph C. Mollendorf
Mechanical and Aerospace Engineering Department
State University of New York at Buffalo,
Buffalo, NY 14260-4400

INTRODUCTION

This project addresses two main issues: 1) the need of a disabled person to collapse a walker without removing his or her hands from the handles and 2) the need for a lower center of gravity for a walker to provide a greater sense of stability. Improvements over existing walkers were necessary as no commercially available walker provided one-touch collapsibility with a convenient location for activation. In addition, such walkers are generally made to be as light as possible, which conflicts with many persons' psychological need to “feel” stable. The additional weight should satisfy this need while allowing for adjustments to suit each individual.

SUMMARY OF IMPACT

The modifications were made with a particular user in mind. The client has limited mobility of the right side of her body, while the left side of her body is fully functional. Her attempts at using a quad-cane have been unsuccessful due to her loss of balance on several occasions. Also, using a conventional walker did not provide this client an adequate sense of stability. The client is presently going through rehabilitation in an effort to re-enter the workplace. Mobility (getting around the office and to and from the car) plays a key role in reaching her objective of employment. The modifications should assist her with her goals. A photograph of the modified ambulator is shown as Figure 7.11.

TECHNICAL DESCRIPTION

The project consists of two components:

- actuation mechanism (with safety device), Figure 7.12;
- incremental weights, Figure 7.13.

Figure 7.11. Modified Ambulator.

The actuation mechanism modification entailed use of the existing single-button mechanism along with a device that activates it. The mechanism consists of a brake handle, cable, and lever/bracket. As a precautionary measure, a safety device was also incorporated into the brake handle to prevent accidental collapse of the walker. The safety device

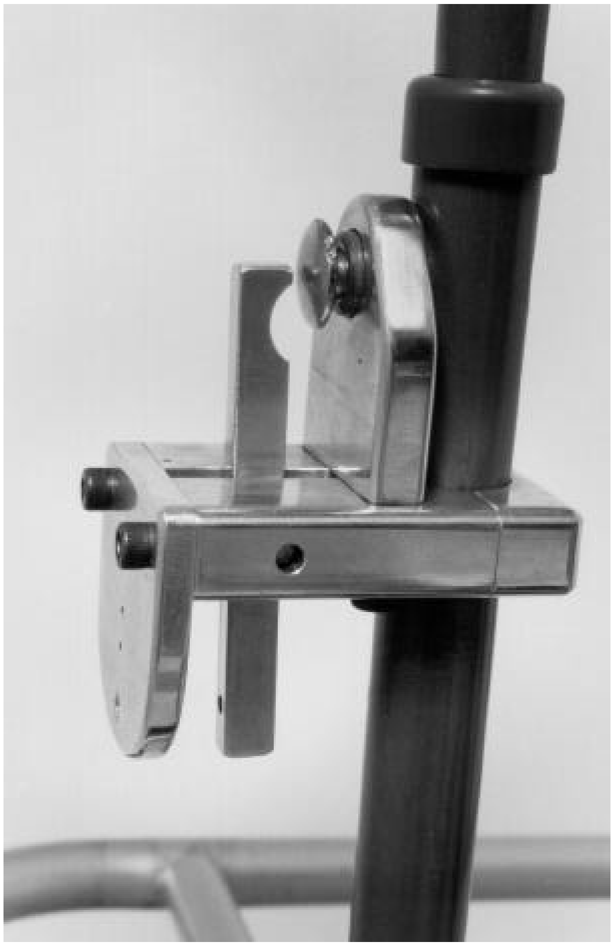

Figure 7.12. Actuation Mechanism.

requires the user to depress a safety button while pulling on the brake handle. Once the handle is released, the safety mechanism locks the brake handle in place. The motion of the handle is translated through the brake cable to the lever/bracket. The lever/bracket depresses the existing button (which allows for collapsing of the walker) through a simple lever action. The lever and bracket are both made of aluminum that provides corrosion resistance and an aesthetically pleasing appearance

Figure 7.13. Incremental Weights.

The incremental weight is made of stainless steel bar stock machined to fit the legs of the walker. Stainless steel was chosen because of its high density and corrosion resistance. The weight sizes are one pound, half pound, and quarter pound. The added weight can be adjusted from zero to ten pounds. The weights are clamped in place with a tightening bolt. The tightening bolt will also deter the user from unnecessary and unsupervised removal of the weights. By nature of the adjustable height of the walker the legs are easily removed, therefore, allowing easy removal of the weights.

The cost of the parts/materials was about $130.

The Versi-Grabber: A More Versatile Assistive Reaching Device

Student Designers: Richard Donegan, Christine Stokolka and Steven Ward
Supervising Professor: Dr. Joseph C. Mollendorf
Mechanical and Aerospace Engineering Department
State University of New York at Buffalo,
Buffalo, NY 14260-4400

INTRODUCTION

There are many assistive reachers on the market today. None, however, offers more than a straight member with a gripping device on the end. With current reachers, if an elderly person who has had hip surgery wishes to retrieve a can of soup from a high cupboard, he or she can only reach straight up. In order to pick up the can a 90-degree bend in the reacher is required. Also, current reachers tend to serve only one function. Often a patient must purchase several reachers for various needs.

The Versi-Grabber is a much more versatile device that allows 180-degree rotation of the gripping end with respect to the straight member. The Versi-Grabber is also designed to have interchangeable heads so that only one reacher needs be purchased (See Figure 7.14).

SUMMARY OF IMPACT

The Versi-Grabber will allow disabled people to easily reach places and objects that other reachers cannot. The simple act of getting a can of soup from a shelf is important to a disabled person who wishes to be an independent as possible.

The device will also eliminate the need for several reachers. Several attachments can be designed to be compatible with the trigger end such as back and leg scratchers, a flexible or straight gripping mechanism, a shoe horn, a bath sponge, and so on.

TECHNICAL DESCRIPTION

The device was constructed from a current reacher used for picking up objects. A flexible steel tube similar to that of a goose neck lamp was used to provide the desired flexibility for the gripping attachment as seen in Figure 7.15. The reacher has a non-standard rectangular cross section so a special coupling end was designed from standard size cylindrical tubing. The rest of the couplers could then be easily made from standard size aluminum tubing.

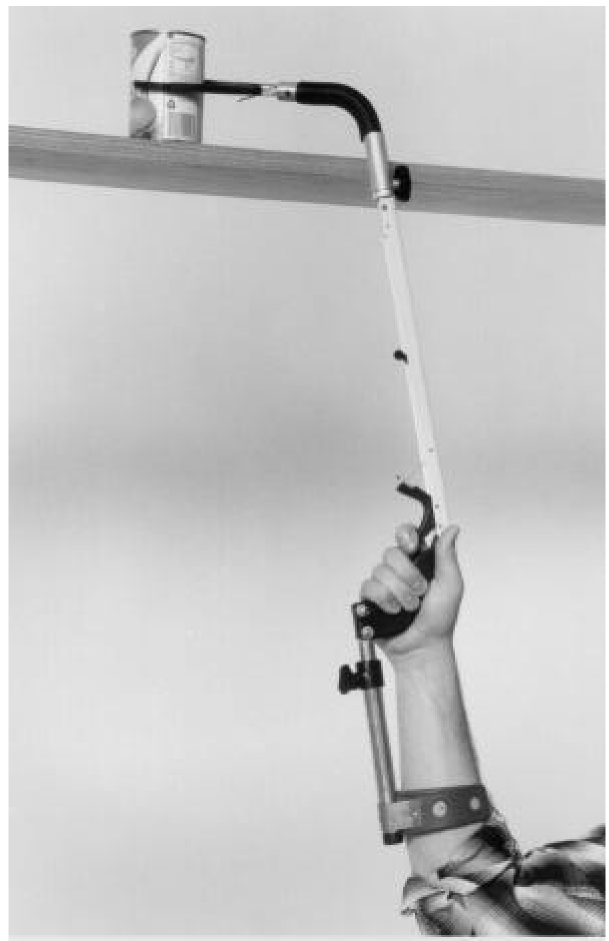

Figure 7.14. The Versi-Grabber.

The quick disconnect coupler was designed so that a person with arthritic hands can operate it. As shown in Figure 7.16 a large knobbed screw and slot arrangement is used to provide easy detachability. The large knobbed screw is threaded into the male side of the coupler. Each attachment has a female end like that in Figure 7.16. The components slide together and the screw is tightened preventing rotation or axial separation between them.

Figure 7.15. Flexibility of Design.

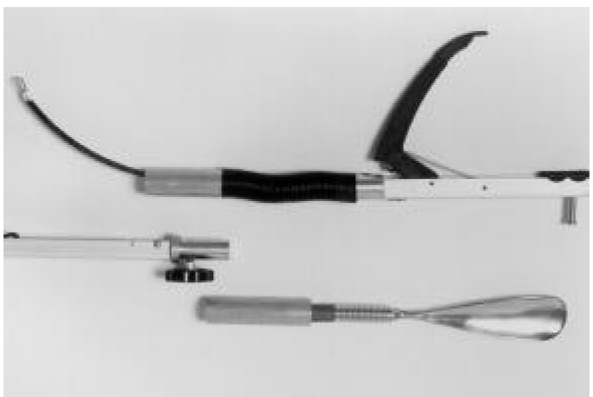

Figure 7.16. Quick-Connect Coupler.

To operate the grabbing attachment a control string is needed. When the trigger is pulled, the string is also pulled and activates the gripper. A piece of stiff plastic tubing through which the string passes was fixed into the attachment end. The stiff tubing allows for easy insertion of the thread through the hole in the quick connector on the trigger side. To facilitate the quick detachment design, a hook and loop arrangement on the string allows it to be easily disengaged.

The following are the simple steps required to change attachments on the Versi-Grabber. First, tension in the string is released by closing the gripping mechanism. Second, the string is disengaged by simply unhooking it from the loop. Third, the large knobbed screw is loosened and the attachment is pulled off. To put another attachment on, the procedure is reversed. The entire process takes only a few seconds and can be done by someone with little manual dexterity.

Another handy feature is a telescoping arm brace. By loosening the knob on the bottom, the pole can be adjusted for any arm length.

The cost of parts/material was about $30.

Variable Height Computer Table: Allows Computer Height to be Easily Adjusted to Accommodate Children with Different Disabilities

Student Designers: Steven B. Everett and George C. Michalko
Client Coordinator: Mary Ann Saloman, Center for Handicapped Children
Supervising Professor: Dr. Joseph C. Mollendorf
Mechanical and Aerospace Engineering Department
State University of New York at Buffalo,
Buffalo, NY 14260-4400

INTRODUCTION

At the Center for Handicapped Children, there are children with varying degrees of disability. Some of these children are confined to wheelchairs, while others are lying down. Some use standers that allow them to stand in a somewhat erect position. A computer table was designed so that it could be easily adjusted in height to accommodate each of these children. Since the device is being used in a classroom setting, it must be reliable, durable, and extremely safe. The unit must be portable, with wheels and a depth small enough to allow it to fit easily through doorways. To ensure the acceptability of the device, it should also be aesthetically pleasing.

This device consists of a three walled study carrel, in which the tabletop can be moved up and down using a motor driven rack and pinion system.

SUMMARY OF IMPACT

Using the Variable Height Computer Table, the staff at the Center will be able to easily adjust the height of the table by simply pushing a switch. This will save time and effort, and reduce the risk of damage to the computer.

TECHNICAL DESCRIPTION

The three main components of the table are the three sided study carrel frame, rack and pinion drive unit, and electrical system.

The study carrel frame was built using a laminated particleboard. This particleboard met the strength

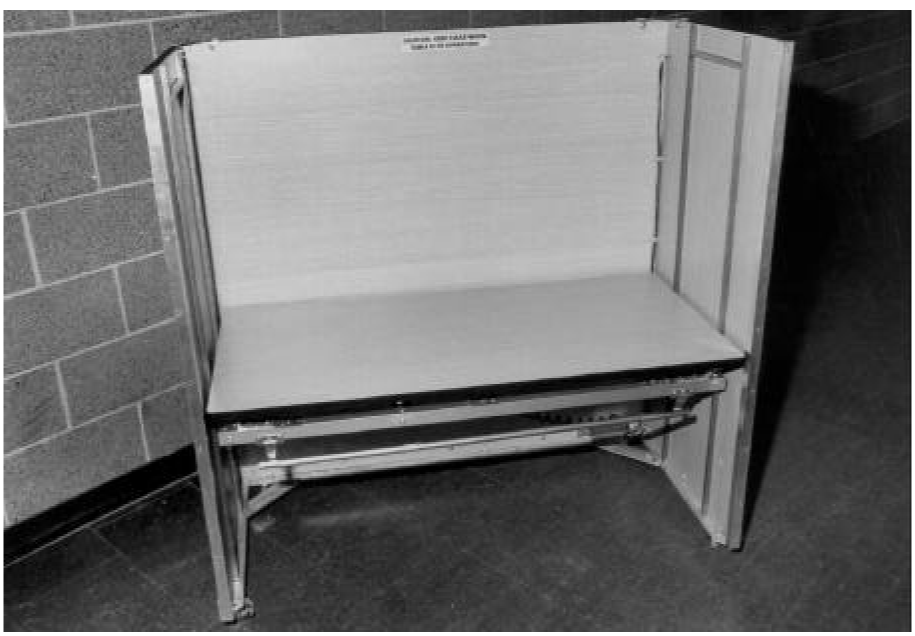

Figure 7.17. Varible Height Computer Table.

requirements and the laminated surface made it pleasing to the eye. An aluminum frame was built around the base of the wooden frame for additional strength. Castor wheels for the unit were mounted onto the aluminum frame.

The drive unit consists of a motor, a worm and worm gear, steel shafts, two pair of miter gears, and four racks with pinion gears. The motor drives a short shaft with the worm and worm gear. Using miter gears, the short shaft drives the other shafts, which run the full length of the table top. At each end of these long shafts is a pinion gear. When the motor is engaged, these four pinion gears crawl along the four racks, raising or lowering the table top. Because these pinion gears are connected by solid shafts, and powered by the same motor, they provide safe, stable support for the table top (Figure 7.18).

In the electrical system, a momentary up-down switch was used to activate the motor. A 90 V DC permanent magnet motor was used because it is small, has reversible operation, and met the calculated torque and speed requirements. Power for the motor is provided by passing AC current through an AC-DC rectifier.

Because the racks were mounted to the side walls of the study carrel, there was a possibility that if the side walls were to separate, the pinions could come out of the racks and the table top could drop. A guide system was added to eliminate this risk.

The variable height computer table provides safe, stable support of the table top and computer system, and makes height adjustment very easy. The table meets the needs of the Center for Handicapped Children, and will ultimately save a great deal of time and effort.

The cost of parts and materials was about $790.

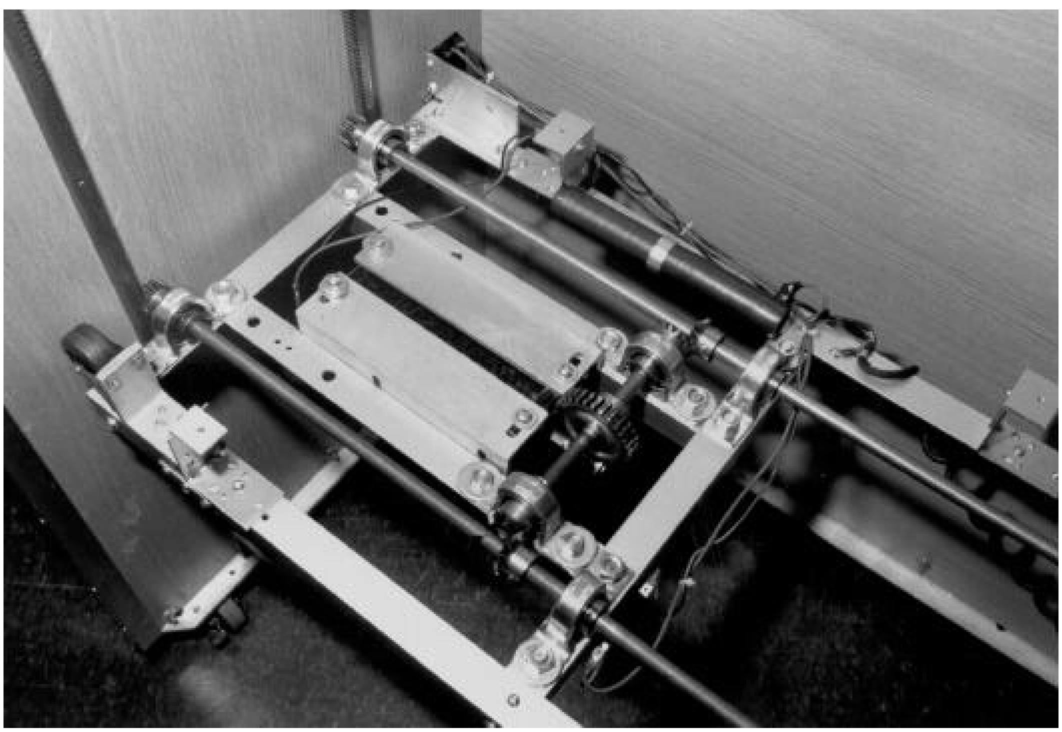

Figure 7.18. Motor Drive System.

Anti Collision System

Student Designers: Timothy S. Lane and Martyn J.C. Berry
Supervising Professor: Dr. Joseph C. Mollendorf
Mechanical and Aerospace Engineering Department
State University of New York at Buffalo,
Buffalo, NY 14260-4400

INTRODUCTION

The inspiration for this project came from observing a blind youngster who, particularly in unfamiliar environments, needed to be warned as he strayed near obstacles (such as furniture). Upon hearing a warning, a call of "hands [-up]" or "careful," he raises his hands to investigate the hazard. The basic intent was to construct a device that would remove the need for the presence of a sighted supervisor, thus providing greater independence to both the youngster and his parents. It seems obvious that a device of this sort could be of use to blind people of all ages, possibly as a substitute for the traditional white cane.

The design utilizes an ultrasonic transducer similar to those found in the auto focus mechanism of a Polaroid camera. The transducer is mounted remotely from a processing unit that, through an earphone, generates an audible indication of a hazard. In the prototype, the transducer is mounted on the head. The processor is contained in a sturdy box enclosed in a pack. This gives hands-free operation in the same manner as a miner's head lamp. Other configurations, such as hand held type (flashlight style), a button type, or a hat type may be more desirable.

Figure 7.19. System Components.

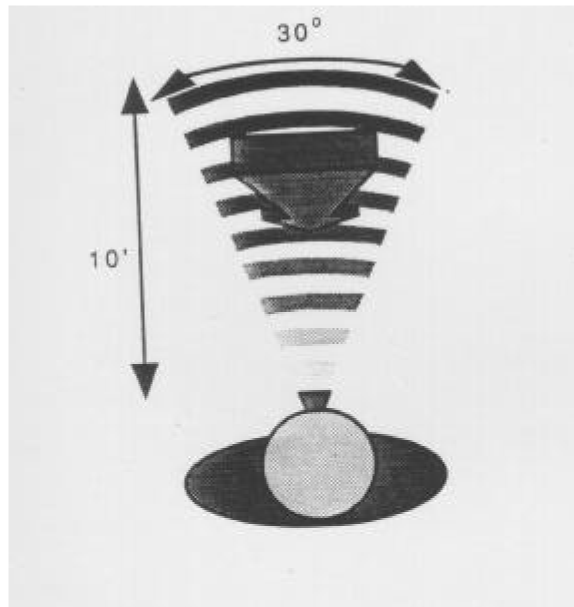

Figure 7.20. Cone of Detection.

SUMMARY OF IMPACT

It is hoped that the anticollision system will enable blind persons to enjoy a safer, more independent, and more confident interaction with their surroundings.

The prototype had two modes of operation. By momentarily depressing a button on the unit the user may elect either to hear a tone with a pitch that is proportional to the distance of the transducer from an obstacle, or just to hear the tone as an obstacle is approached; these modes of operation enable the user to use the device to sense their surroundings or simply as an alarm of an oncoming hazard.

It was felt the device could be introduced to blind children as a toy.

TECHNICAL DESCRIPTION

The device was physically divided into two discrete units, the ultra-sonic transducer and the processor. In operation, a pulse is transmitted toward a target and the resulting echo is detected. Using the processing unit the time elapsed between the initial transmission and the echo detection can be converted to distance, based on the speed of sound. In this arrangement the transducer works both as a loudspeaker to transmit the outgoing signal and as an electrostatic microphone to receive the echo. The outgoing signal takes the form of a high frequency inaudible "chirp", lasting for about half a millisecond. A 400-volt signal is applied across the transducer each time a chirp is transmitted. Thus, the transmitter had to be carefully packaged in a robust and non-conductive high density polyethylene casing. This casing measures approximately 2-1/8 inches in diameter by 1.0 inch and was attached to the elastic headband. The ranging circuit was mounted separately with the processor.

In order to install this onto the EEPROM on the computer board, algorithms were designed and arranged in an HC11 assembly code using a PC text editor. Following completion of the basic program, a button was added to allow the user to toggle between the two modes of operation.

The transducer and processing unit was connected using a heavy-duty 0.25-inch phono cable. A standard earphone jack was used so that any style of earphone can be used. The earphone volume was set using various resistors. A 0.25-inch jack for a battery charger socket and on/off switch was also used.

The cost of parts/material was about $226.

ACKNOWLEDGEMENTS
Roger Krupski provided guidance and assistance with computer programming and electronics. Kenneth Peebles and the workshop team provided help in the manufacture of the sensor casing.

Figure 7.21. Headband Embodiment.

Collapsible Chair for a Walker

Student Designers: Todd Chalmers, Mark Messinger and Timothy Speyer
Client Coordinator: Linda Chalmers, Hospice Buffalo, Inc.
Supervising Professor: Dr. Joseph C. Mollendorf
Mechanical and Aerospace Engineering Department
State University of New York at Buffalo,
Buffalo, NY 14260-4400

INTRODUCTION

A client of Hospice Buffalo requested that a seat be installed on his walker. In addition, he wanted to have wheels added to the front legs. These modifications were necessary because he frequently became exhausted when walking considerable distances. The addition of a collapsible seat on the right side of his walker will allow the client to sit whenever he desires. The addition of front wheels will aid in mobility and reduce the effect of the added weight of the collapsible seat. Hospice nurses stated that safety and weight were critical design parameters. It was important to ensure that the seat be very easy to set up and use, as the client has limited physical ability. Furthermore, the design was not to interfere with the primary function of the walker, to help users walk more efficiently. In summary, a seat attachment was designed such that it did not impede the client's walking but when needed could easily be used. These design criteria had to be met while collapsibility was still preserved.

SUMMARY OF IMPACT

The basic idea of incorporating a seat onto a walker offers the client a greater degree of independence and eliminates the worry of fatigue. This project will have a significant impact for physically challenged people. As before, the client will be able to collapse his walker for easy storage. But now, instead of walking to a bench, he can merely position the attached seat with one hand. The attachment fulfills the needs of the client and satisfies the design criteria. Because the seat height was designed to be adjustable, this design can be equally appreciated by people of various sizes who share this client's limitations.

Figure 7.22. Walking Configuration.

The seat attachment was designed for use on walkers of a similar type, with minimal additional machining, thus making it a viable option to consider for an assembly line process. While maintaining safety, the additional weight gain is less than five pounds.

Figure 7.23. Sitting Configuration.

TECHNICAL DESCRIPTION

The attachment is made of standard one-inch aluminum tubing. It connects to the walker using an aluminum pivot mount and collar. The seat frame will then pivot out from the side of the walker on the aluminum collar. The seat platform is constructed of two triangular pieces of plywood that connect to the frame with U-clamps. Modified hinges connect the two pieces along the fold. The seat cushion is composed of vinyl-covered rubber foam. In case of maintenance or long-term storage, the entire attachment frame can be fully disassembled.

The attachment has the following advantages:

- It is convenient and easy to install.

- It can be positioned with one hand. Also, it can be installed and removed with the use of a screwdriver.

- It is not obtrusive. The attachment adds eight inches to the total width of the walker, preserving its ability to pass through doorways. Additionally, the position of the attachment allows the walker to remain collapsible.

- It is aesthetically pleasing. The frame is composed of tubing similar to that of existing walkers. The seat covering is also color-coordinated to match the walker.

The cost of parts/materials was about $75.

ACKNOWLEDGEMENT
Kenneth Pebbles and the other technicians at the University of Buffalo Machine Shop provided input and assistance in machining. Bernie Fix and Gerry Mertzlufft at Apple Rubber Products provided help in the machining of various parts. Hospice Buffalo Inc. generously donated a walker identical to that of the client.

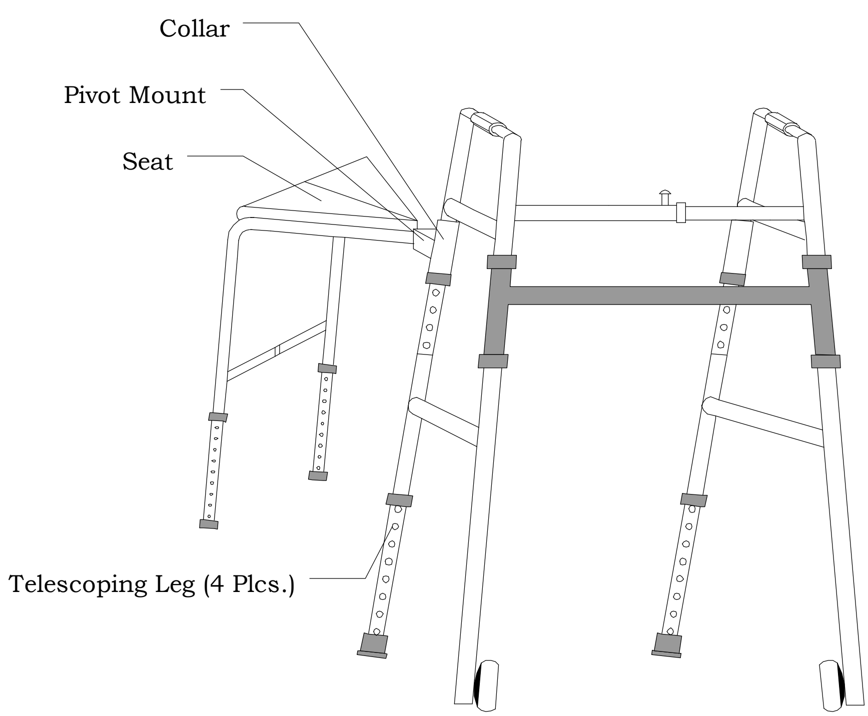

Figure 7.24. Fully Assembled Seat on Walker.

Easy-Access Cause-Effect Toy

Student Designers: Bjorn DeBear, Manish Patel and Sarfraz Naina
Client Coordinator: Dr. Shelly Lane, University of Buffalo Occupational Therapy Dept.
Supervising Professor: Dr. Joseph C. Mollendorf
Mechanical and Aerospace Engineering Department
State University of New York at Buffalo,
Buffalo, NY 14260-4400

INTRODUCTION

Many children with multiple disabilities have poor motor skills. This makes it hard for them to learn cause-effect relationships and slows their cognitive development.

Dr. Shelly Lane, at the University at Buffalo Occupational Therapy Department, understands the needs of such special children. Dr. Lane feels that the toys possessed by her department offer very few sensory stimuli. The stimuli the toys do provide generally cannot be turned off selectively by the therapist if they overwhelm a client. Furthermore, the children treated by the department have a great deal of difficulty using many toys because of their poor motor skills.

This project was undertaken to address this problem by constructing a cause-effect toy. The challenge was to modify an existing toy to create desirable sensory stimulation, a toy that could be activated by switches and deactivated selectively by a therapist.

Figure 7.25. Front View of Toy.

SUMMARY OF IMPACT

The toy used was an improvement upon an existing Fisher-Price play set called the "Roll-Around Playground." This improvement allows occupational therapists to teach young children with multiple disabilities cause-effect relationships. The improvement makes this possible through easy-access plate switches connected to electrically-powered play features.

The easy-access switches allow children with multiple disabilities to turn on the following effects: 1) a swing that swings back and forth; 2) a merry-go-round which spins; 3) a door that swings open and stays open as long as its switch is depressed; 4) a bell tower that lowers, rings a bell, and causes a toy person to drop through a chute; 5) a wading pool that lights up; and 6) a speaker that plays a short melody.

The swing, merry-go-round, door, and bell tower components existed before the improvement, but could only be manipulated by children possessing good motor skills. The improved version causes these components to move automatically through the use of electric motors and solenoids.

TECHNICAL DESCRIPTION

The "Roll-Around Playground," contained the following moving components: swing, merry-go-round, door and bell tower. The improvement on this product allows these components to move by electric power, and adds a light component and a sound component to the toy.

All components are activated through the depression of easy-access plate switches. The swing is caused to move by a crank in a gearbox linked to a three-volt motor. The merry-go-round is caused to move by a shaft running from a gearbox linked to another three-volt motor. The door is caused to move up a rocker-rocker mechanism linked to a six-volt solenoid. The bell-tower is caused to move by a cable linked to a cable linked to a 120V AC solenoid. The wading pool light is a bank of nine 3V LED pairs. The LEDs comprising the pairs are connected in series, so the overall voltage drop across the component is six volts. The speaker and the circuitry producing the music are from a "Micro-Jammer"® keychain toy. The 120-volt bell tower solenoid is connected in parallel with a three-volt adapter and a six-volt adapter. This circuit receives current directly from a wall outlet plug. The three-volt adapter in turn provides power to the two motors and the music circuit, which are all connected in parallel. The six-volt adapter provides power to the door solenoid and the wading pool light which are also connected in parallel. The easy-access plate switches shorting the circuits are plugged into the jacks located in the front of the toy.

The modified toy will help occupational therapists empower young children with multiple disabilities by demonstrating that they can have an effect on their environment. The plate switches are operable by children with very poor motor skills, and the play features are activated the moment corresponding switches are depressed, clearly displaying tangible cause-effect relationships

The cost of parts and materials was about $320.

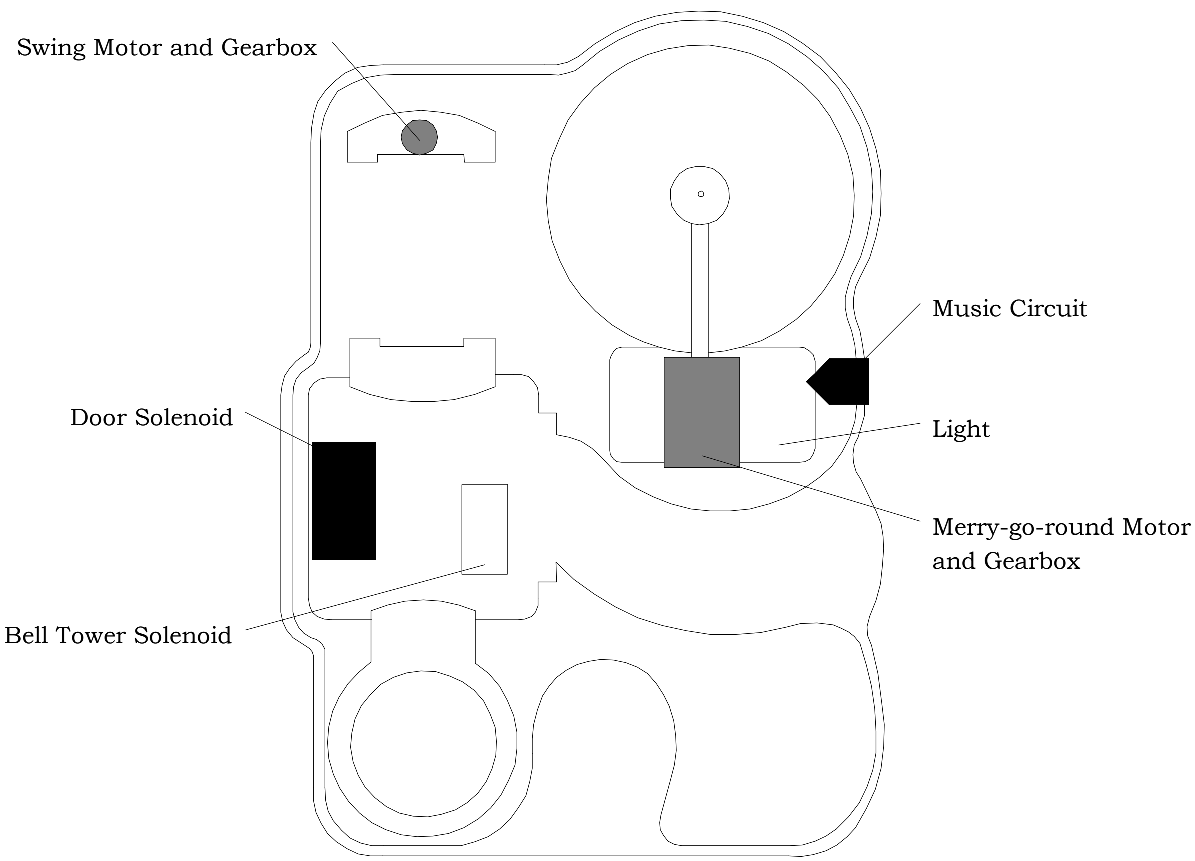

Figure 7.26. Internal Components of Toy.

Paper Money Identifier for Persons who are Blind

Student Designers: Eric Lieberman, Nick Nikolaidis, Ka Wai Hung, and Pok Chong
Supervising Professor: Dr. Joseph C. Mollendorf
Mechanical and Aerospace Engineering Department
State University of New York at Buffalo,
Buffalo, NY 14260-4400

INTRODUCTION

In order for blind people to gain independence they must overcome many barriers. One of these barriers is identifying paper money. When making purchases, blind people have no way of ascertaining whether or not they receive the correct change. This device will not only assist them in receiving proper change, but also with any other type of monetary transactions.

The device entails a laser scanner that scans a section of a bill into a microcomputer. The microcomputer then compares this scan to prescanned bills. When it finds a match within a certain confidence limit, it outputs the value of that bill in a series of beeps. For instance, a twenty dollar bill would make the device give two low pitch beeps and one high pitch beep. The low pitch beeps correspond to the first digit, two and the high pitch beep corresponds to the second digit, zero. Similar logic is used for ones, fives, and tens.

This device is only a prototype. In order to make the device practical it must be condensed to pocket size. However, this will require the production of customized parts that are expensive and are time-consuming to produce.

SUMMARY OF IMPACT

It is expected that the Paper Money Identifier for the Blind (PMIFB1) will increase the confidence of blind people in making monetary transactions and promote independence. To use this device, a blind person will turn it on, place the bill in the device, and pull the bill out slowly. Once a match is found the device will output the bill denomination.

Figure 7.27. Sealed Unit

TECHNICAL DESCRIPTION

The device consists of a laser module, a photodetector array, a microcomputer, a motor, a mirror, and its outer casing. The outer casing includes a track where the money is to be inserted by the user.

This laser module includes a laser with a lens on the end, which permits the laser to be focused. It also contains the laser circuitry, which regulates the voltage going to the laser. The laser is a visible light five-milliwatt laser. It is positioned at a fifteen degree angle in the mirror with respect to the track.

The mirror is 10 mm diameter circular front surface mirror. It is mounted on the motor so it can guide the laser over the paper money.

The photodetector array is composed of eight detectors angled downward at the money and one detector angled upward facing the mirror. The detectors are used to transmit data to the computer based on light and dark spots on the money as either high or low value bits.

The microcomputer is the Motorola M68HC11. Its purpose is to use the laser, detectors, and the motor to scan in data from a bill. The microcomputer will then compare it to prescanned data and output a value using an IC controlled piezoelectric buzzer when a match is found. The microcomputer uses a sophisticated program to perform this process.

The cost of parts/materials was about $508.

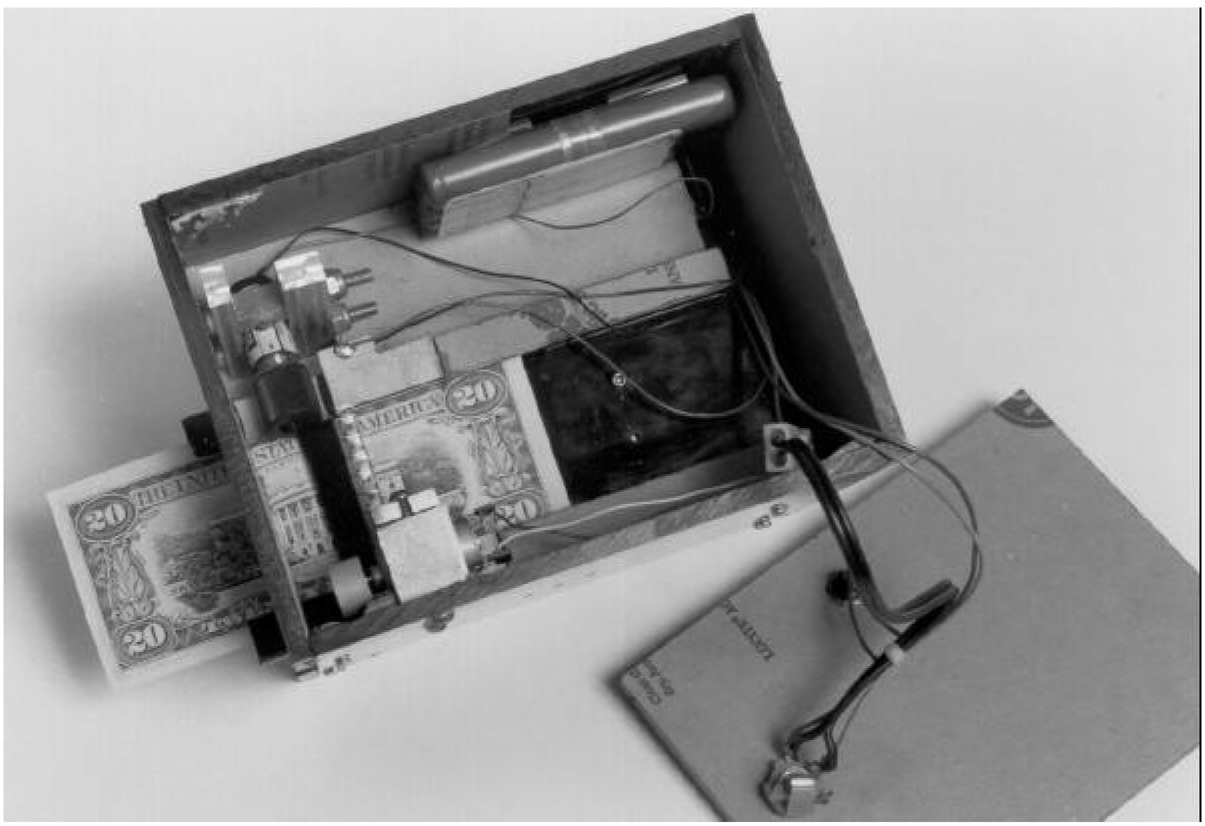

Figure 7.28. Exposed Unit.

Single Hand Gear and Braking Mechanism For One Handed Bicycle Operation

Student Designers: Jason Vaughan, Mark Dunmire, David Bongiovanni and Scott Homac
Supervising Professor: Dr. Joseph C. Mollendorf
Mechanical and Aerospace Engineering Department
State University of New York at Buffalo,
Buffalo, NY 14260-4400

INTRODUCTION

This project affects people with limited use of one hand. A person with such limitations may find it hard to ride a standard bicycle safely because brake and shifting levers are located on both sides of the handle bars. In such cases, it is safer to have all controls located on the side of the usable hand. The current design is to be used with the right hand on a 21-speed mountain bike. The design was built for high performance capabilities, but is versatile enough to be used by a rider of any level.

SUMMARY OF IMPACT

Current market products of this nature do not exist, making this a one of a kind unit. The hope is for this device to increase the rider's potential through decreasing limitations of impaired riders. The prototype may also inspire others to pursue improvements with similar designs.

The applications of this device could evolve beyond an assistive device for impaired persons. It may be that control of all shifting and braking functions from one hand is beneficial for all who like to ride bicycles. For now, the design and ease of use is more practical for persons with unilateral impairments.

TECHNICAL DESCRIPTION

The design integrated currently available standard brake and shifting levers. Two sets of levers were combined into one unit. The top set of levers control the front sprocket derailer, moving the chain through three gears and the front brake. One top gear lever moves the chain up the sprocket sizes and the other

Figure 7.29. Front View.

down. The same occurs for the back derailer, where one lever moves the chain up the gear cog and the other down. In this case the far bottom lever moves the chain up through seven different gears.

The unit was made by pressure-fitting available brake and shifting levers together with metal pins. First, the two pieces were cut and shaped by removing excess metal. This was done so that the front brake and derailer levers could be laid into a position on top of the back levers. Holes were then drilled into each piece where pins were used to pressure-fit the other together. A spacer was used to provide the correct clearance between the pieces. Once together, a metal epoxy was used to fill the void and provide strength. After hardening, the part was shaped to be contoured and physically appealing.

All levers have cable adjusters at the lever base. This eliminates the need for minor adjustments accomplished by resetting the cable in the derailer or brake clamp. Both brake levers also have adjusting screws where the position of the levers can be manipulated. This was incorporated so that the levers may be offset from each other, making them more accessible. The need for adjustability was such that the unit could be more versatile for each individual rider.

The cost of parts/materials was about $109.

Figure 7.30. Back View.

Wheelchair-Height Adjuster To Raise A Handicapped Individual to Another Plane

Student Designer: Clifford J. Solowiej
Supervising Professor: Dr. Joseph C. Mollendorf
Mechanical and Aerospace Engineering Department
State University of New York at Buffalo,
Buffalo, NY 14260-4400

INTRODUCTION

This project addresses a serious problem faced by nurses and nursing assistants. After an individual is confined to a wheelchair, other people must assist in the vertical transport of the handicapped individual. Incorrect lifting may lead to painful back injuries.

Figure 7.31. Close-Up Of Cylinder, Connector, and Rear Wheel.

SUMMARY OF IMPACT

There are no known existing devices that perform the same functions that the Wheelchair-Height Adjuster does. Hopefully, hospitals will find this type of invention to be a beneficial tool.

Figure 7.32. Wheelchair Up-Position.

The Wheelchair-Height Adjuster allows an individual to be easily transported in the vertical direction. The operation of the device is simple. By pumping the pump, the wheelchair rises, and by twisting the release valve, the wheelchair lowers.

TECHNICAL DESCRIPTION

The device is composed of an assembly of four hydraulic cylinders with a twelve-inch stroke. The front two cylinders have round, half-inch diameter rods and the rear two hydraulic cylinders have hex, half-inch diameter rods. The hex rod keeps them from rotating. Other parts include a hand pump with a stroke-volume of two cubic inches, a relief valve, two flow divider valves, an oil reservoir, four mounting braces, and two rearwheel connectors. The four mounting braces mount directly to the wheelchair in the respective places of the wheels. The cylinders are end mounting and screw into the mounting braces. Lock nuts are then screwed on to make sure the cylinders do not come unscrewed. The respective wheel connectors are screwed onto the ends of the rods of the cylinders and then the wheels are attached. The pump is mounted on the right side so that the handicapped individual can pump up the wheel chair or else the nurse can pump it up. The reservoir is mounted on the left side. Hydraulic hoses connect the pump, the cylinders, the relief valve, and the flow divider valves. The purpose of the relief valve is to set a maximum pressure inside the hydraulic assembly. Finally, the flow divider valves ensure that the wheelchair will rise evenly.

The cost of parts/materials was about $1336.

Figure 7.33. Wheelchair Raised Position.

Passage Detection System that Alerts Staff when Patient Leaves Care Unit

Student Designers: Kurt Hacker, Jarred Osborne, Henry Zhao and Yuan Lai
Client coordinator: Carol Hacker, Erie County Home and Infirmary
Supervising Professor: Dr. Joseph C. Mollendorf
Mechanical and Aerospace Engineering Department
State University of New York at Buffalo,
Buffalo, NY 14260-4400

INTRODUCTION

In busy nursing homes, such as the Erie County Home and Infirmary, the staff is limited and therefore unable to supervise patients at all times. Patients with dementing illnesses such as Alzheimer's disease are especially problematic as they tend to wander and get lost within the hospital complex with no way of telling someone they are lost. A simple solution would be to lock the exit doors to the unit. Due to state laws this is not possible. The current device will give nurses the warning they require to retrieve patients before they leave the unit, reducing the need for constant supervision.

SUMMARY OF IMPACT

The main goal of this device is to retain the patients within a residential unit, where they will remain safe. The staff will also spend less time searching for missing patients.

Figure 7.34. Finished Unit In Case.

TECHNICAL DESCRIPTION

The device is comprised of three main components: the transmitter, the receiver, and the wireless microphone. The transmitter and receiver are from a commercially available "invisible fence" animal containment system. The transmitter consists of a control box that sends a low frequency radio signal through a closed wire loop attached to the box. This loop is mounted around the exit doors of the nursing unit. The control box is plugged into a standard 110-volt, wall outlet.

The receiver, which picks up the radio signal sent through the wire, has two exposed metal posts on its surface. When the receiver unit, worn by the patient, passes through the doorway and crosses the wire, the receiver is activated. When this occurs, a small electrical current is sent to the metal posts. This current sounds a small beeper placed in series between the posts. The beeper continues to sound until the receiver leaves the transmitter's range, which is approximately six feet on either side of the wire.

The wireless FM microphone is packaged together with the receiver. When the beeper is activated, the microphone broadcasts the sound to a FM radio located at the nurse's station or carried by a nurse. The microphone is easily tunable to frequencies between 88 and 108 MHz and has a range of over 400 feet.

The receiver and microphone are packaged together in a lightweight, shock-resistant leather case that can be clipped to a patient's pants or looped through a belt.

The user was quite satisfied with the design as it provided a less expensive alternative to commercially available systems, while at the same time effectively controlling the problem of patient wandering.

The cost of the parts/materials was about $200.

Figure 7.35. Receiver, Microphone and Carrying Case.

Computer Monitor Shelf with an Electronically Adjustable Height and Depth For Use By Handicapped Children

Student Designers: Jir-Shyr Chen, Jeffrey S. Parker and Shu-Sheng Yu
Client Coordinator: Barbara Kopko, Cattaragaus BOCES, Olean, NY
Supervising Professor: Dr. Joseph C. Mollendorf
Mechanical and Aerospace Engineering Department
State University of New York at Buffalo,
Buffalo, NY 14260-4400

INTRODUCTION

When using computers, handicapped children are often hindered by the constraints imposed upon them. Some children find it difficult to view the monitor at a fixed position, especially those in wheelchairs. Those who are taller require the monitor to be elevated. Wheelchairs also prevent the people from moving close to the monitor. Consequently, wheelchair users require the monitor to be adjusted forward.

A motorized adjustable shelf was created to allow the user to adjust the computer monitor's position (see Figures 7.36 and 7.37). To effect the vertical motion, a simple scissors jack is employed and a rack and pinion is used to produce the in/out motion. Sliding tracks are used to stabilize the shelf and to guide the movement. To adjust the monitor, the user need only press any one of four large push-buttons. Because the users are mainly handicapped children, several safety precautions are added. A protective covering surrounds all moving components, and a master switch allows teachers to prevent misuse of the shelf.

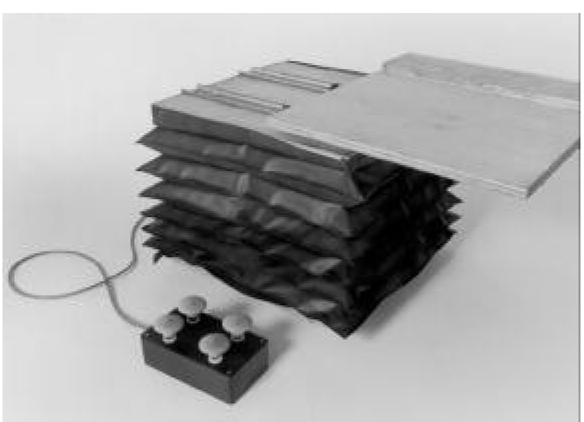

Figure 7.36. Finished Unit In Up and Down Position.

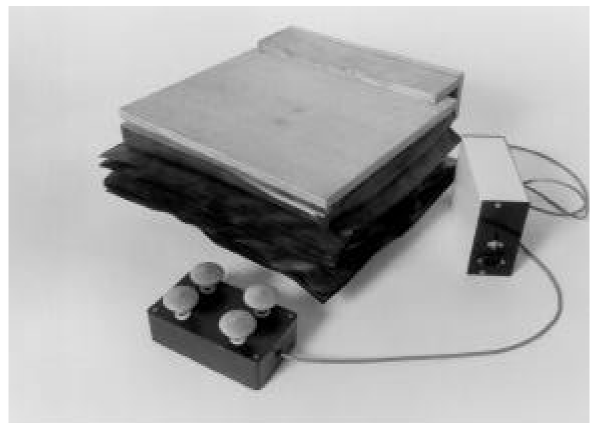

Figure 7.37. Finished Unit In Down and In Position.

SUMMARY OF IMPACT

The shelf should allow a wider range of people better access to the computer. This also reduces the need for buying several computer workstations to accommodate each student.

An alternate use of the adjustable shelf should be as a cause-effect device. The movements actuated by the push-buttons are noticeable enough for the child to learn the cause-effect relationships

TECHNICAL DESCRIPTION

Because no existing device could be found to satisfy the client's needs, a new design was created. The design consists of a mechanical component and an electrical component.

The compressing/depressing of a pair of scissors jacks actuates the up/down motion. A large flange attached to a drive screw and motor will power the motion. As the motor turns, the flange will either compress or decompress the scissors jacks, thereby raising or lowering the platform, respectively.

A rack and pinion attached to a second motor will move the upper shelf in and out. The movement of the upper shelf is constrained by the sliding tracks. Also, the tracks provide support for the upper shelf.

To limit the range of motion of the shelf, mini-limit switches are used. The limit switches will stop power to the motors when triggered. From the fully compacted position, the shelf can raise 10 inches and extend outward 10 inches.

All of the components are enclosed within a neoprene bellows. The bellows is custom-made to fit the design.

For the electrical component, the main concern was safety. A simplified schematic showing only the up/down portion can be seen in Figure 7.38. K1a and K1b are relays powered by the "up" switch and K2a and K2b are relays powered by the "down" switch. The schematic for the in/out motion is the same. Basically, when a push-button is pressed, one of two relays is triggered. This will cause the motor to turn in the appropriate direction. Should two conflicting push buttons be pushed (i.e., up and down, or in and out), the system will not operate.

All of the electrical components are housed in a box located at the back of the shelf. A master switch located on the box allows the supervisor to stop the movement of the shelf at any time. Also, the limit switches open the circuit when triggered, thereby stopping motion.

The cost of the parts and materials was about $200.

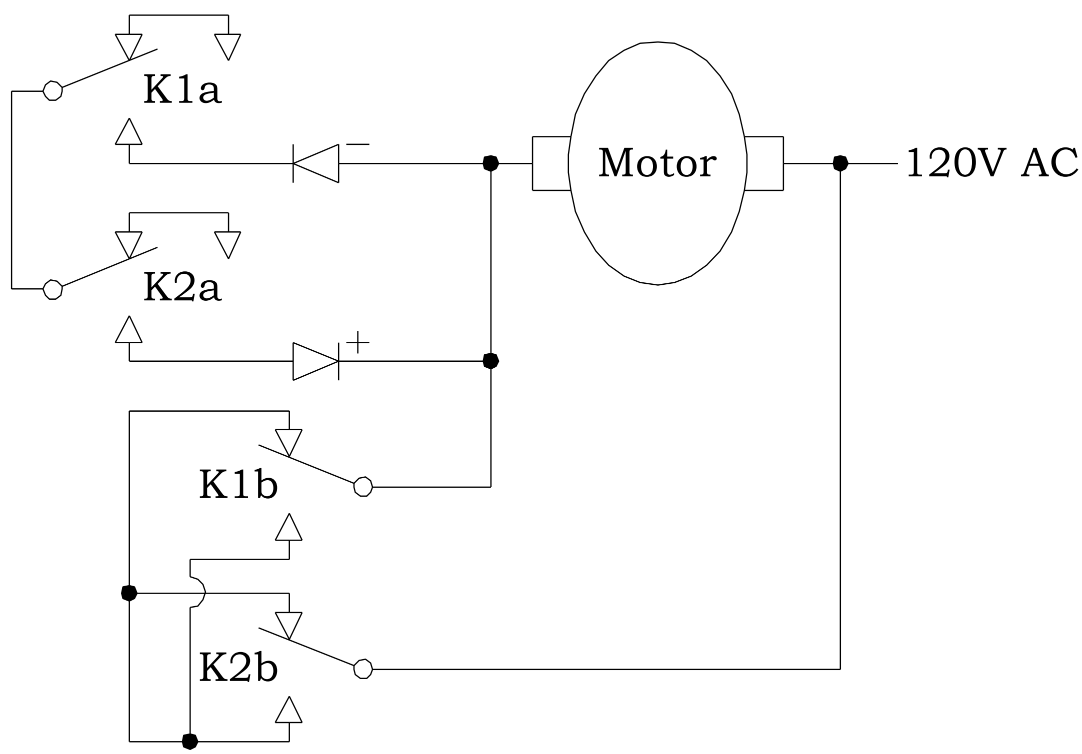

Figure 7.38. Simplified Schematics.

Light Sensor for Blind People: A Device to Enable Blind People to be more Aware of their Surroundings

Student Designers: Mitch H. Lee and Meng Ung
Supervising Professor: Dr. Joseph C. Mollendorf
Mechanical and Aerospace Engineering Department
State University of New York at Buffalo,
Buffalo, NY 14260-4400

INTRODUCTION

The objective of this project was to design and build an assistive device to enable blind people to "sense" the brightness of their surroundings, so that they will be safer in dark places.

Several aspects were considered to ensure that the design was practical and reliable. The device had to be lightweight, small and rugged, so that a blind person could carry it all the time. It was important that it be affordable as well as easy to operate.

Figure 7.39. The Light Sensor.

SUMMARY OF IMPACT

The Light Sensor was successfully built. It weights about 1 ounce. It is packaged in a plastic cylinder (with a height of 1 inch and radius of 1/2 inch). The plastic case makes the device hard to break. The device is small, lightweight and rugged. The device is operated by an on/off switch that makes it very easy to use.

The Light Sensor enables a blind person to "sense" the brightness of his or her surrounding by emitting different sound pitches corresponding to the intensity of the light. The brighter the surrounding, the higher

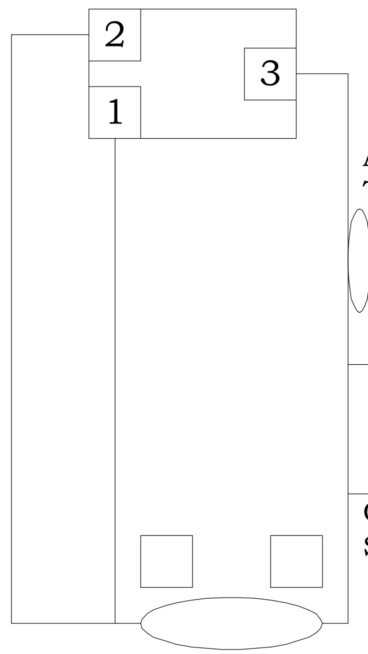

Figure 7.40. Circuit Diagram Of The Light Sensor.

sound pitch the device produces. Through the sound pitch, a blind person can tell how bright the surroundings are and thus how well other people could see him or her. He or she may take extra safety precautions when the sound pitch from the device is low, so that possible danger can be avoided.

TECHNICAL DESCRIPTION

The Light Sensor mainly constructed in two parts, the circuit design and the package case design. For the circuit, a TSL235 Light to Frequency Converter was used to convert light frequency to audio frequency. An AT17 Audio Transducer receives the audio signal and generates sound. A 3V Lithium watch battery powered the device and an on/off switch regulated the electrical current.

In normal daylight, the circuitry produces ultrasonic sound, which is inaudible. To detect normal daylight, the light surrounding the device had to be dimmed to produce sound within an audible range. This was done by concealing it in the package case. The case had three chambers, the top one holding the Light to Frequency Converter. The chamber was sealed from light by a removable cap.

The only light source was from the center hole in the cap. The hole diameter was chosen to allow the correct amount of light to enter, so that the audible audio range matched the light intensity range of daylight. The hole could be made smaller to accommodate brighter daylight or larger for indoor use. Two top chamber caps were made to be used for typical outdoor and indoor light conditions, respectively. The second chamber held the Audio Transducer and the on/off switch. The third chamber held the battery. It was covered by a cap at the bottom. The cap was removable to allow for changing of the battery.

The cost of parts and materials was about $15.

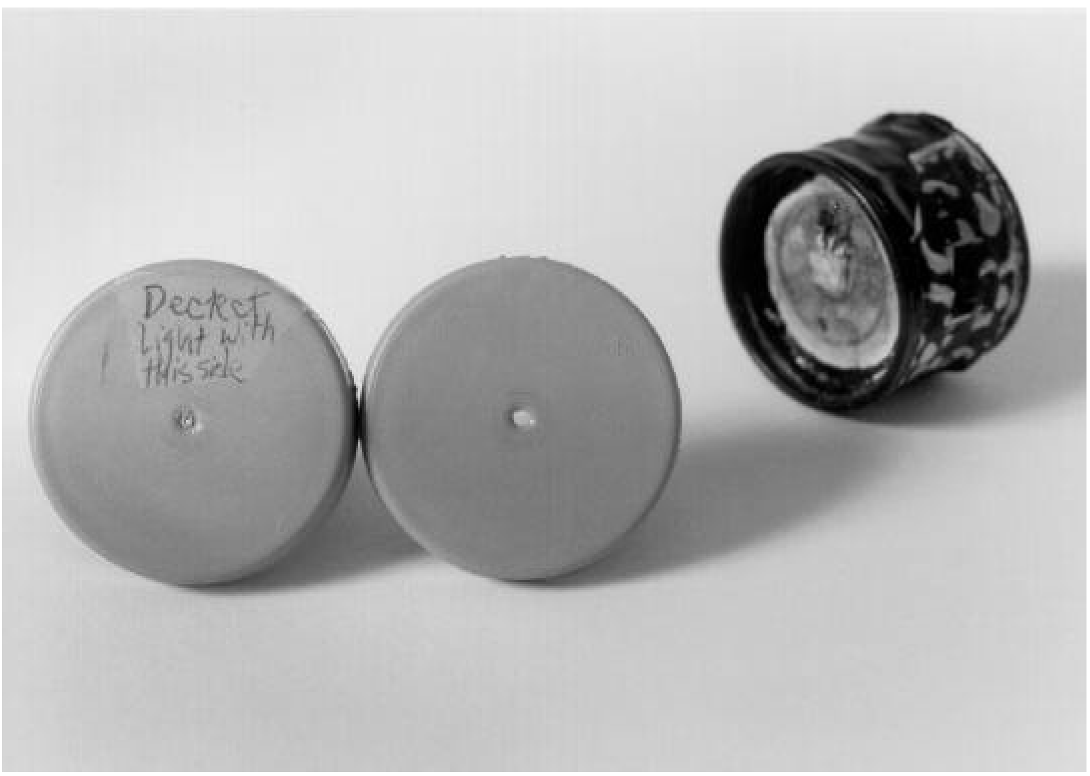

Figure 7.41. Light Sensor With Indoor and Outdoor Caps.

Anti-Slip Tread with Engaging Cleat for Use with Assistive Walking Devices in Inclement Weather and Variable Terrain

Student Designers: James Militello, Matthew Sass, and Michael Zampogna
Supervising Professor: Dr. Joseph C. Mollendorf
Mechanical and Aerospace Engineering Department
State University of New York at Buffalo,
Buffalo, NY 14260-4400

INTRODUCTION

The objective of this project was to design and build a cleat to minimize the amount of slip regularly experienced with assistive walking devices in inclement weather and variable terrain. Existing assistive walking devices serve the user well on a multitude of indoor surfaces but are less effective outdoors, often slipping, thus increasing the chances of falling. With this in mind, a new design was focused on two main aspects: optimum traction on outdoor surfaces such as loose gravel or ice, and the versatility to be used indoors without damaging existing surfaces such as wood or tile floors. Ergonomics, ease of use, and aesthetic characteristics were also taken into consideration to produce a mechanism that was as user friendly as possible.

SUMMARY OF IMPACT

The anti-slip tread with engaging cleat was successfully built to reduce slippage in inclement weather and variable terrain. It was equally reliable and stable for indoor use. The unit combines a movable stainless steel cleat with a rubber anti-slip tread to enhance traction. For indoor use, the cleat can be retracted allowing only the anti-slip tread to contact the floor, eliminating damage to floor surfaces. The cleat is easily retracted using a lightweight hand control lever.

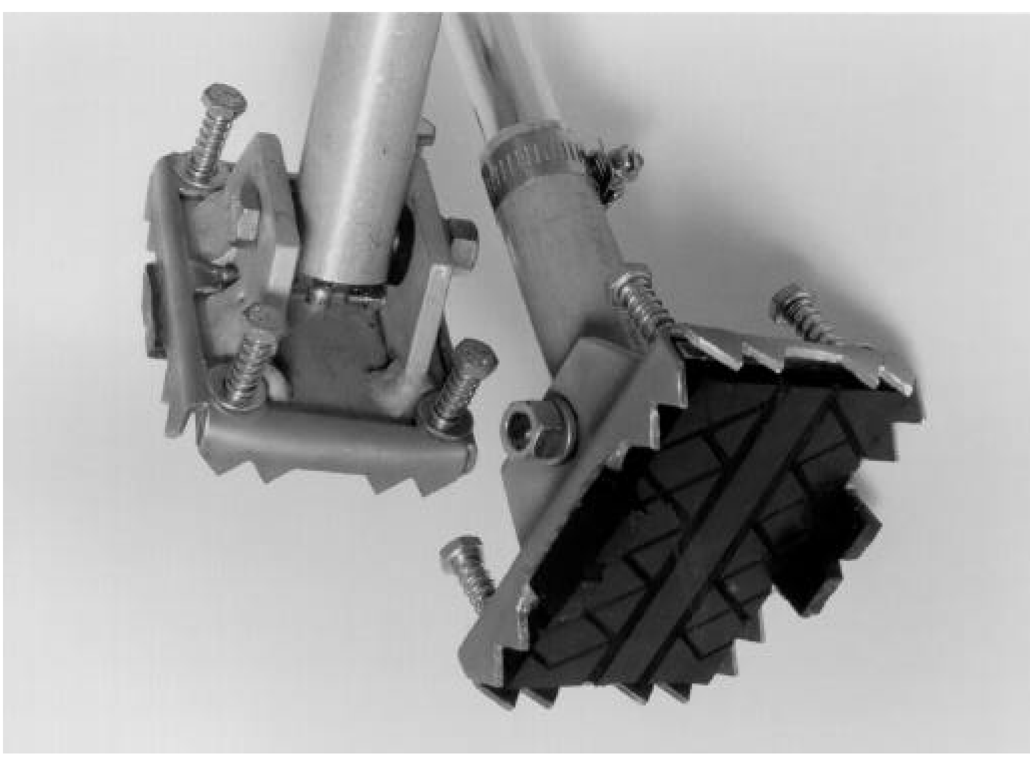

Figure 7.42 Anti-Slip Tread With Engaging Cleat

TECHNICAL DESCRIPTION

The primary component to this design is a base plate that supports both the cleat and attachment tube. The spring-loaded cleat travels on four bolts that are mounted into the base plate. This allows for smooth, even vertical movement of the cleat when being engaged or disengaged. The cleat is locked into the engaged or disengaged position by two ball plungers. The ball plungers are connected to a cable that is controlled via bicycle brake handles attached to the walking device.

The attachment tube is designed to rotate 120 degrees about the pivot joint hole and approximately 10 degrees laterally about the center of the base plate. This enabled the anti-slip device to adjust for uneven terrain by implementing dual axes of rotation. The attachment tube is also designed to be compatible with a variety of assistive walking devices.

The anti-slip tread with engaging cleat offers many advantages over current traction enhancements for assistive walking devices.

- Increased traction. The mechanism allows for major improvement in outdoor traction with increased floor contact in indoor areas.
- Dual axis of rotation. Contact surface with ground is maintained at all times for any walking motion.
- User friendly. Simple control requiring little effort to manipulate.
- Ergonomic. The addition of components alters the basic design of existing walking devices very little.
- Adaptability. A variety of devices can accommodate the mechanism.

PROCEDURE FOR MECHANISM USE:

Engaging cleat

- Pull lever, cleat travels to lower position.

- Release lever, plungers lock cleat into place.

Disengaging cleat

- Pull lever, retracting plungers.

- Press assembly against floor, raising cleat to upper position.

Figure 7.43. Anti-Slip Tread With Engaging Cleat Mounted On Crutches.

- Release lever, plungers lock cleat in upper position.

Testing procedures yielded favorable results. In comparison to conventional assistive walking devices, the most marked improvement with the cleat engaged is on ice in wintry conditions. With the cleat raised, the rubber pad provides excellent traction on all indoor surfaces, wet or dry. The tread pattern employed channels water away from underneath the unit, maximizing contact with floor surfaces at all time. The mechanism is also stable, durable, and light.

The cost of parts/materials was about $100.

Ergonomic Ratchet Propulsion Device to Ease Stress on Wrists while Using Wheelchairs

Student Designers: Dong Won Kim, Kim Ming Chow, Sun Hum Choi and Jung Soe
Supervising Professor: Dr. Joseph C. Mollendorf
Mechanical and Aerospace Engineering Department
State University of New York at Buffalo,
Buffalo, NY 14260-4400

INTRODUCTION

The common commercially-available wheelchair design is not ergonomically optimal. Round handlebars attached to the wheels are particularly problematic. They force the user to use hand movements that might injure the wrists. The wrists must flex in such a way that they are strained. Skin can be damaged from rubbing against the handlebars. Also, the user hunches forward to propel the wheelchair, an impossibility for many people. These repetitive movements are especially difficult for elderly or weak users.

The racket propulsion device solves these problems by offering an alternative to the round handlebars, namely, levers to drive the wheels.

Figure 7.44. Close-Up Of Components Attached.

SUMMARY OF IMPACT

In order to allow the greatest number of people to use this device, it is designed to be: 1) simple, thus inexpensive; 2) easily attachable and detachable without tools; 3) collapsible; 4) maneuverable; and 5) adjustable (to fit a range of wheelchair sizes and styles). Additionally, it requires no permanent alteration to the wheelchair, thus preserving any warranty. The arm levers use a pair of Sears Craftsman ratchets and bicycle brake levers.

It is hoped that this device will add comfort and convenience to the riding experience of its users.

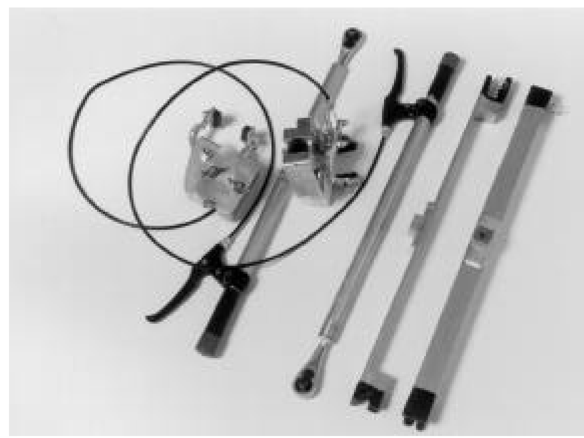

Figure 7.45. Dismounted Components Displayed.

TECHNICAL DESCRIPTION

The main idea of this propulsion device is that the user turns the wheels the way he or she would turn a nut with a ratchet. That is, in forward drive, the ratchets exerts a torque on the wheels on the forward stroke, and none on the backward stroke.

The user pushes and pulls the arm levers, which pivot around the hubs of the crossbars. The crossbars rotate the wheels. At the hub end of each arm lever is a ratchet, which is reversible with a switch. At the arm lever's other end is a brake lever. The brake lever, via a cable, operates the brake mounted on the wheelchair frame.

The two crossbars are constructed of aluminum plates with clamps welded to the ends. The clamps go behind the wheels' round handlebars and are locked into place with pins. One clamp on each crossbar to maneuver into place over a wheel. The ends are also plastic-coated to avoid marring the wheelchair.

The hub is an aluminum block machined to receive a ratchet. A hub is welded to the center of each crossbar.

Each brake is bolted onto two aluminum blocks, which are mounted onto the wheelchair frame. Two hand-operated wing nuts hold the two blocks together, sandwiching a rubber-padded bar between them.

The cost of parts/materials was about $145.

Figure 7.46. Components Attached.

A Temperature Sensing Cup that Alerts the User of Extremely Hot or Cold Liquids

Student Designer: Won Ki Park
Supervising Professor: Dr. Joseph C. Mollendorf
Mechanical and Aerospace Engineering Department
State University of New York at Buffalo,
Buffalo, NY 14260-4400

INTRODUCTION

This project addresses the needs of persons affected with reduced sensory perceptions of taste and temperature in the mouth. There are medical conditions in which persons lose the ability to sense varying temperatures of solid or liquid intake. Elderly individuals may be particularly vulnerable to this type of condition, as sensory acuity often declines with age. Young children may also be at risk for intake of dangerous temperatures. There is a need for a device that alerts the user to extremes in liquid temperature.

SUMMARY OF IMPACT

The temperature sensing cup entails a temperature sensing device integrated with a cup. The temperature sensing device was chosen primarily for its effectiveness in detecting extremely hot temperatures, which tend to be most harmful. Various kitchen utensils (e.g., a soup ladle) could also be modified to include the temperature sensing device.

TECHNICAL DESCRIPTION

The device uses a quick temperature sensing instrument. The speed of temperature detection is an important factor since most users will not wait long before consuming a hot cup of coffee or soup. A digital thermometer that incorporated a thermistor was chosen. The thermistor uses a ceramic device in which resistance drops dramatically upon exposure to high temperatures, thereby permitting a current to complete a circuit that will alert the user of sudden temperature changes. Tests of the thermistor device (U.S. Patent 5,165,798) in hot liquids gave good results.

The thermistor can be connected to visual or audio devices that will readily alert the user. Visual warnings may include a liquid crystal display, colored lights (for the color blind), etc. The audible alarm may include a buzzer, digital voice warning, etc.

The digital thermometer device is attached to a flexible plastic holder, and the ensemble can be mounted onto the upper wall of a coffee cup.

The cost of parts and materials was about $20.

Figure 7.47. Digital Thermometer Inside the Modified Case Mounted on a Coffee Mug.

Motorized Exercise Bicycle Designed to Redevelop the Range of Motion in the Legs after Injury

Student Designers: Pamela Lyons, Mark Graham, Erik Tomer and David Spink
Supervising Professor: Dr. Joseph C. Mollendorf
Mechanical and Aerospace Engineering Department
State University of New York at Buffalo,
Buffalo, NY 14260-4400

INTRODUCTION

This project is designed to aid in rehabilitating the knees and surrounding tissues after reconstructive surgery. Following surgery many patients experience difficulty using exercise equipment such as stationary exercise bicycles. Many patients experience pain as their muscles are exerted in pushing the pedals. The large circular motion of the pedals can also be damaging and painful following surgery. Patients often need to start with small easy movement of their limbs.

The present design consists of a normal exercise bicycle that has been fitted with a motor to provide assistance in moving the pedals. The design also allows for different ranges of motion in the pedal stoke by providing adjustable crank arms for the pedals.

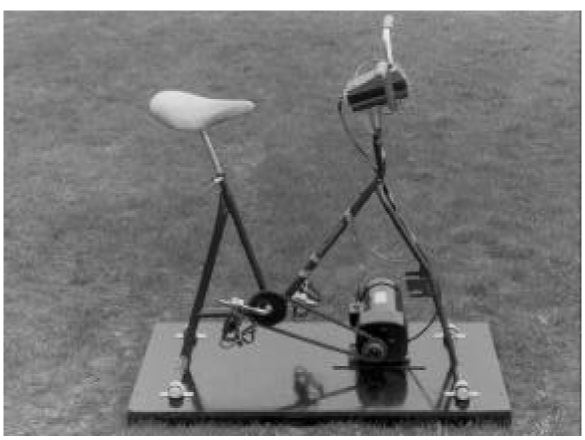

Figure 7.48. Motorized Exercise Bicycle.

SUMMARY OF IMPACT

It is anticipated that this device will speed up the patient's recovery as well as make it less painful. This design is also intended to make the rehabilitation process safer. Patients will be able to use the bike immediately following surgery instead of waiting until their muscles are strong enough to use a normal

Figure 7.49. Permanent Magnet Gear Motor.

bicycle. In addition, by using the crank arms, patients will be able to work their muscles at several ranges of motion. This will enable patients to use the bicycle at various stages of rehabilitation.

TECHNICAL DESCRIPTION

An existing exercise bike was modified to provide assistance during the entire pedal stroke. A motor was used to move the pedals, a DC controller to control the speed of the pedals, and adjustable crank arms to vary the range of motion at which the pedals rotate.

A 0.75 horsepower 90-volt permanent magnet DC gear motor with a parallel shaft was used. A torque limiter was attached, as a safety precaution, to the shaft of the motor. It will disengage if the patient's legs get caught or go in the opposite direction. The torque limiter sprocket was linked by a chain to a sprocket that controls the pedal movement.

The motor is bolted to a 1 inch board to provide support. The motor will supply .75 horsepower with a maximum speed of 40 rpms and torque of 705 in-pounds. This is more than enough torque for a patient from 100-300 pounds. The motor is wired into a DC controller that enables the patient to control the speed at which the pedals rotate. This DC controller can also be set to control the deceleration, acceleration, maximum current and maximum speeds of the motor.

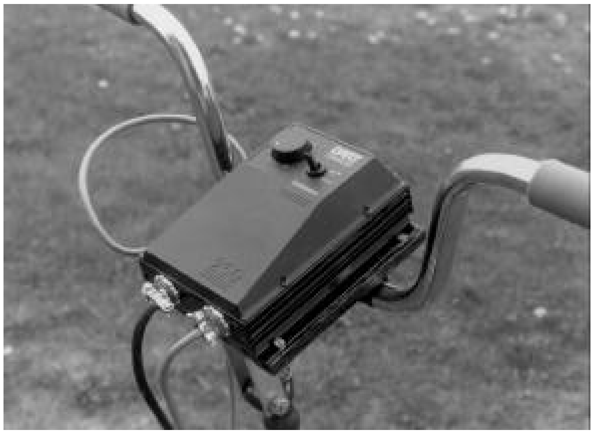

Figure 7.50. DC Controller.

This controller is mounted in between the handlebars so it is accessible to the patient, see Figure 7.50.

The original crank arms were cut off and new crank arms were welded on. To increase the strength of the weld, a dowel pin was inserted between the crank arm and the shaft. The adjustable crank arms have eight holes in them. The pedals can be removed and a pin can be set for smaller or larger ranges of motion (see Figure 7.51).

ACKNOWLEDGEMENTS
Willie Willerth provided assistance in choosing the proper motor and controller. Kenneth Peebles and Roger Teagarden provided assistance in the machining and welding of the crank arms.

The cost of the parts/materials was about $900.

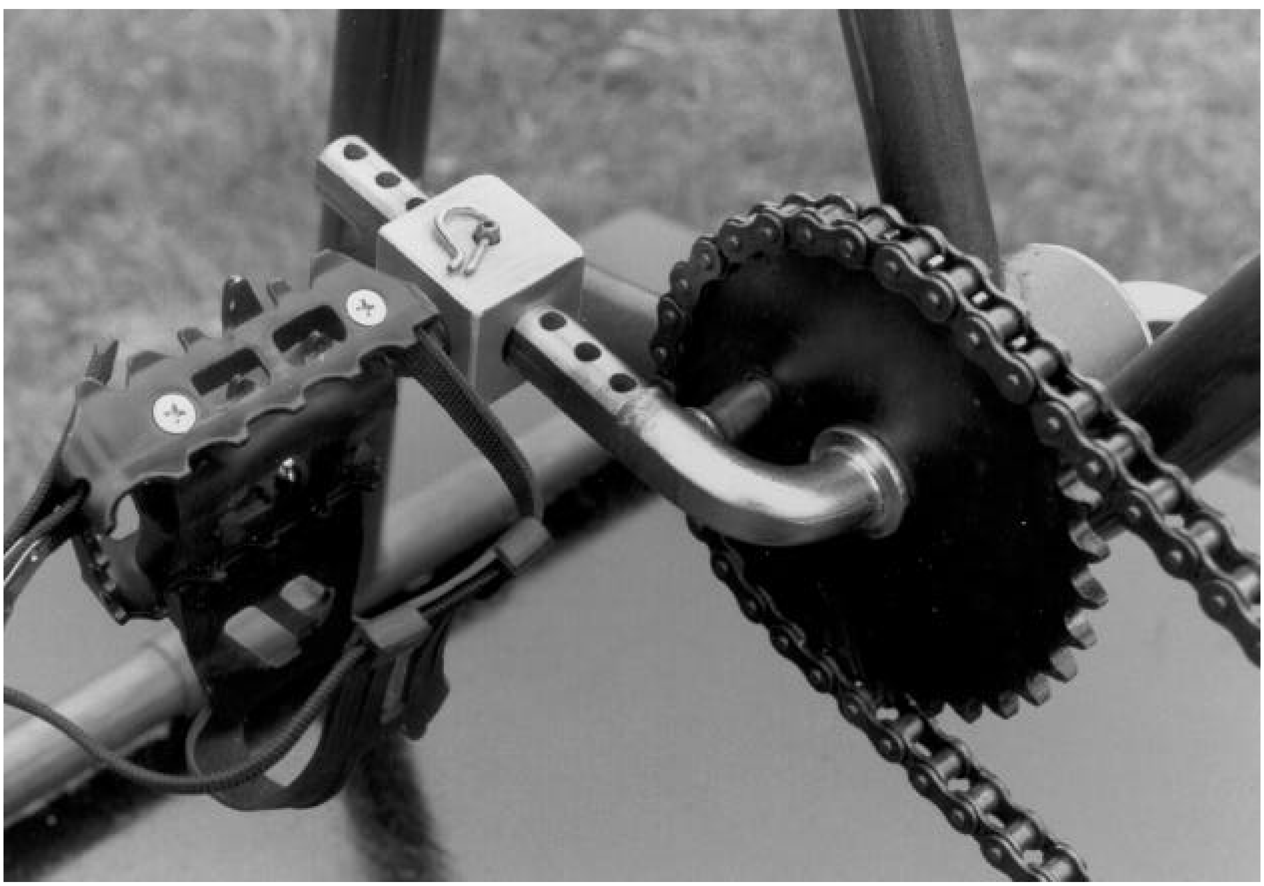

Figure 7.51. Adjustable Crank Arms.

The Countertop Jar Opening Device for People who Do Not Possess the Strength to Open Common Jars

Student Designers: Neil T. Gillott, Glenn D. Mohr
Supervising Professor: Dr. Joseph C. Mollendorf
Mechanical and Aerospace Engineering Department
State University of New York at Buffalo,
Buffalo, NY 14260-4400

INTRODUCTION

The motion of squeezing and twisting is problematic for people with arthritis, and for people with a lack of hand strength or motor control. One task that requires this squeezing and twisting motion is the opening of common household jars.

This device is designed to open a wide range of jars and bottle types and sizes, eliminating the twisting and squeezing movement. The lower mechanism secures the jar so that it will not spin while the jar is being opened. The upper mechanism is used to grab the lid and twist it. The upper mechanism is controlled through a simple toggle switch, and the lower mechanism is controlled through a push button. Neither control mechanism requires significant strength or advanced motor skills for operation.

SUMMARY OF IMPACT

When this jar opener is used as an assistive device in the home, the need for others' help will be eliminated. Large amounts of foods today are packaged in jars. Hopefully, having access to these foods at all times, without the help of others, will increase the quality of life of challenged people. Another benefit of this device is that its use is not limited to the elderly or disabled. Many people experience problems opening very tightly sealed jars. This device can help all people in these situations.

TECHNICAL DESCRIPTION

The range of the opener was made for jars as small as baby food containers and as large as a two-liter soda bottle. The height differential is made possible through a linear bearing that may be adjusted to fit any height jar.

The lower unit, which is used as the jar locking mechanism, is a center closing vise. This type of vise was used because the center of the jar has to remain in

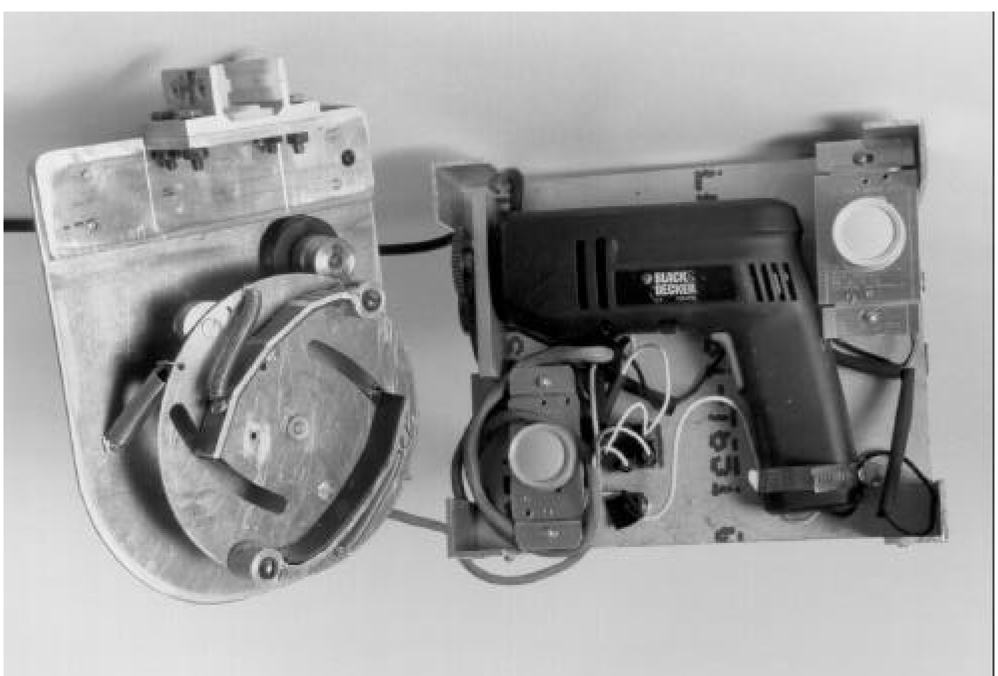

Figure 7.52. Upper and Lower Mechanisms.

a constant position regardless of the diameter of the jar. This is important for the function of the upper unit. For the prototype, aluminum was the material of choice. The unit has rubber padded V-type jaws to help eliminate slippage. The vise is center closing due to left and right handed threaded rods welded together at the center. Guide rods were added to give the vise jaws added strength and increased stability. The unit is powered through a mechanically reversible three-amp hand drill motor. A hand drill was used because of its ease of adaptability, and because it was substantially cheaper than a bulk motor. The motor is operated by the push button switch. A jar is placed in the vise and the button is pressed. The motor rotates the threaded rod and the vise is closed on the jar. Pressure on the jar is limited by the press fitted gear attached to the main shaft. The gear spins freely after a certain amount of force is applied. This force is suitable enough to hold the jar without spinning or crushing it.

The upper mechanism is designed to grab the lid and rotate it, releasing the lid from the jar. The design is similar to a drum brake on a car. This grabbing mechanism rotates, creating the twisting motion necessary to remove the lid. The arms are designed to work for any jar style. The arms have a height of 3/4 inch. This height allows the greatest range of jars to be opened. The arms are attached to the drive motor by a high strength fishing wire. The resistance springs do not allow the mechanism to rotate until the arms are right on the jar lid. When the arms are tight on the lid, the force of the resistance springs is overcome, thus allowing the mechanism to turn. When the mechanism turns, the jar lid is removed. The motor is then reversed by switching the toggle switch in the opposite direction. When the motor starts to back off, it releases the pressure on the lid and returns to the beginning position.

The circuitry involved in the jar opener is different for the two motors. The drill used for the upper mechanism has an electrically reversed motor. A momentary double through double pole switch was used. This switch is used to replace the trigger switch that comes with the drill. Reversing the action of the motor is as simple as switching the toggle switch in the other direction. A dimmer switch is used to control

Figure 7.53. Jar Opener With Jar.

the current and is used as a speed control for the mechanism. The drill used for the vise mechanism is a mechanically reversible motor. It is controlled by a momentary single pole single through switch. To reverse the motor, a switch on the drill housing must be used. A dimmer switch was also incorporated into the circuit for use as speed control.

The cost of the parts/materials was about $226.