CHAPTER 11
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POWER-LIFT TOILET SEAT

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INTRODUCTION

Many of the devices that assist people who are physically challenged in positioning themselves on toilets rely on the available leg and upper body strength of that individual. Usually, one must grasp adjacent side rails mounted near the commode in order to lower and raise himself or herself from the seat. This could be a monumental task for many people who use wheelchairs and those with chronic back pain and/or arthritis. A powered lift seat was designed that enables users to lower and raise themselves to and from a toilet at variable heights with little effort.

An appliance that lowers and raises a person to an existing elongated toilet was developed. The appliance in Fig. 11.1 is the "Power-Lift Toilet Seat." The device fits over the toilet and attaches to the holes where the seat would be fastened. The seat movement patterns the motion of an automatic lift chair. The prototype consists of a stationary lower

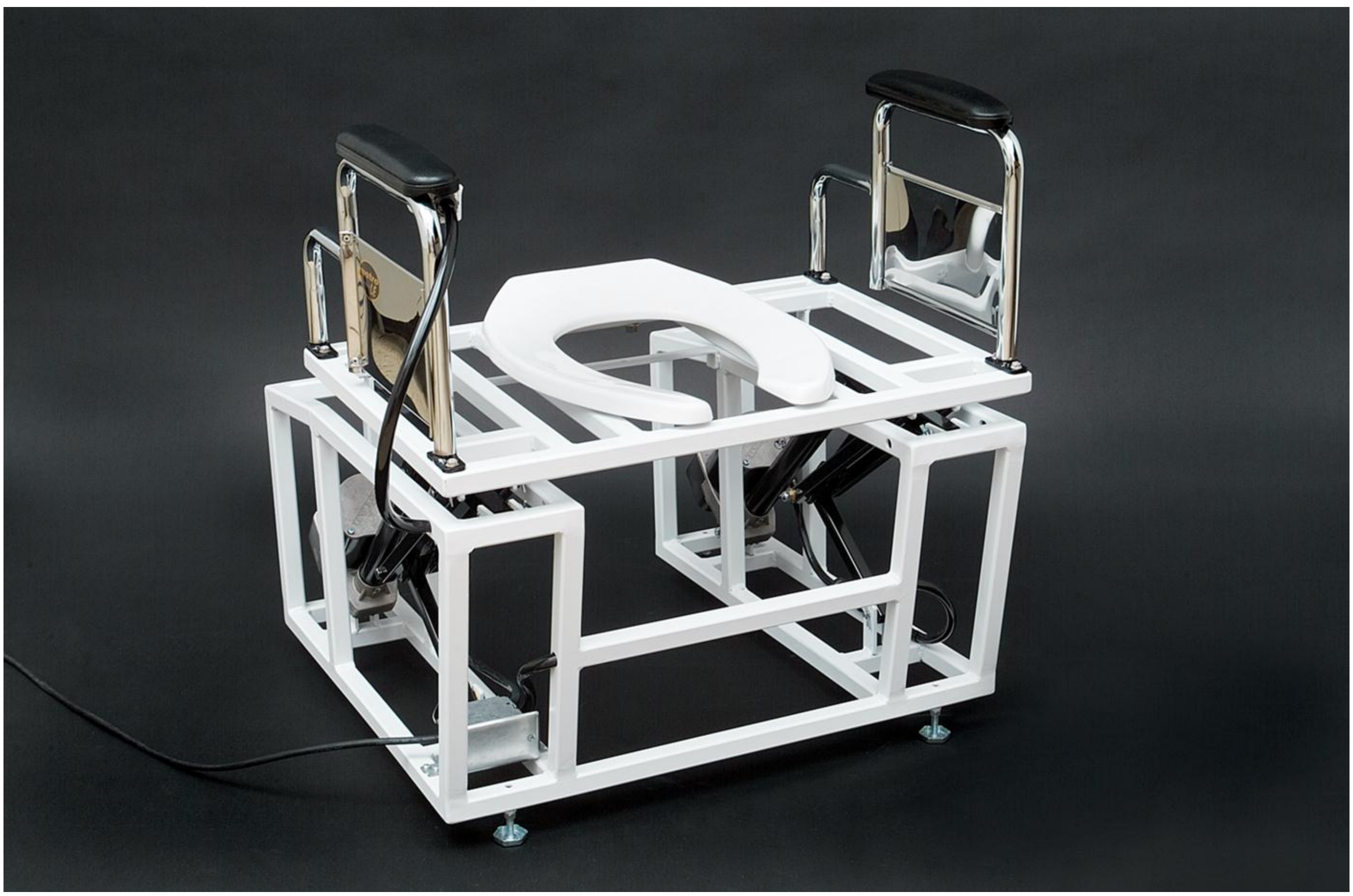

Fig. 11.1. The Power-Lift Toilet Seat.

frame and a mechanically moveable upper frame (where the seat is fastened). These frames are constructed of one-inch by one-inch steel tubing with a one eighth inch wall thickness and welded joints. This device weighs approximately 110-lbs and is capable of safely lifting a person that weighs 300-lbs. The framework of the prototype is exposed but could be protectively covered with a plastic or sheet-metal housing. Moveable parts with the potential of inflicting injury to the user could also be shielded.

SUMMARY OF IMPACT

Devices of this nature are non-existent in hospitals and nursing homes, so the demand for this device is certain. The Power-Lift Toilet Seat allows the client to have privacy and freedom to use a toilet without assistance. The device decreases the physical strain of sitting and standing while using a toilet. With respect to the hospital staff and management, assistive duties could be reduced, thereby reducing a facility's operating costs. Implementation of this device in the private sector would benefit the user as well as reduce the burden of family members serving as caregivers.

TECHNICAL DESCRIPTION

The major goal of the design process was to create a safe device while minimizing complexity of the structure and mechanics. This was important for minimizing production costs for eventual commercialization. A key challenge was to make the device as compact as possible in order to fit into limited surroundings (adjacent to the toilet) and to house the moveable parts. Another challenge was to design a linkage that raised and lowered the seat at a moderate angle comfortable to the user. This obstacle was addressed via re-design procedures (i.e., force diagrams).

The lower frame is 27.5" wide by 25" deep and has four levelers at its base, enabling a height from 15.5" to 17". The height adjustment (see Fig. 11.2) allows the device to be leveled and installed over most existing toilet bowls and compensates for uneven floor surfaces. The lower framework houses most of the mechanical parts that enable the functionality of this device. These parts include two 120-volt AC, 15-amp powered linear actuators, each with a lifting and lowering force of 1100-lb. The linear actuators (see Fig. 11.3) straddle the toilet bowl to evenly distribute the lifting and lowering load of the upper frame. The linear actuators are synchronized to start, lift or lower, and stop at the same rate. They enable a seated person to be lifted from the lowest horizontal position to the maximum vertical seat height of 32" (from the floor) at 35 degrees to the horizontal in about 30 seconds. The same is true for the lowering function. This rate is comparable to that of the lift chair mentioned in the introduction. The upper frame is 27.5" wide by 19" deep and 1" high. Any standard elongated toilet seat can be fastened to the frame. In addition, Fig. 11.3 shows two modified armrests (10" high) from a wheelchair that is fastened to the frame. A momentary up-down switch (see Fig. 11.4) is mounted directly under the armrest to the seated person's right. Thumb pressure to the front of the switch lifts the seat, while pressure to the back lowers the seat. The switch is wired to the linear actuators, which deliver

Fig. 11.2. Device Installed Over Existing Toilet.

Fig. 11.3. Linear Actuators, Linkage Mechanism, and Armrests.

the drive force to identical levering linkage mechanisms straddling each side of the toilet bowl. The linkages are made from 1″ by 1″ steel square tubing (1/8″ thick) for the main linkage and ¾″ by ¾″ steel square tubing (1/8″ thick) for the sub-linkages. The main linkage carries the center of gravity load, while the sub-linkages work off the main linkage to position the front part of the upper frame at an angle comfortable for the person on the seat. This angle changes from zero to 35 degrees to the horizontal as the seat lifts. The 35-degree angle (at the maximum lifting height; see Fig. 11.5) was found to be comfortable and adequate for the project's many test subjects.

The linkages attach to each other and to brackets that are welded to the upper and lower frames. These connections are made with 5/16″-diameter clevis pins, which are held in place by retainer clips. Frictional wear, caused by the contact of moving surfaces, is reduced by the implementation of brass washers placed between them. All connections are tight with the intent of promoting little or no lateral movement of the upper frame while offering little resistance to the force exerted by the linear actuators and the weight of the person on the seat frame.

The device is electrically grounded to the frame and has a ground fault circuit interrupter plug wired to the cord going to the power source. It protects the user from electrical shock from water contact with the electrical components or any short circuit in the system.

The total cost of the design prototype was $393.

Fig. 11.4. Armrest and Switch Location.

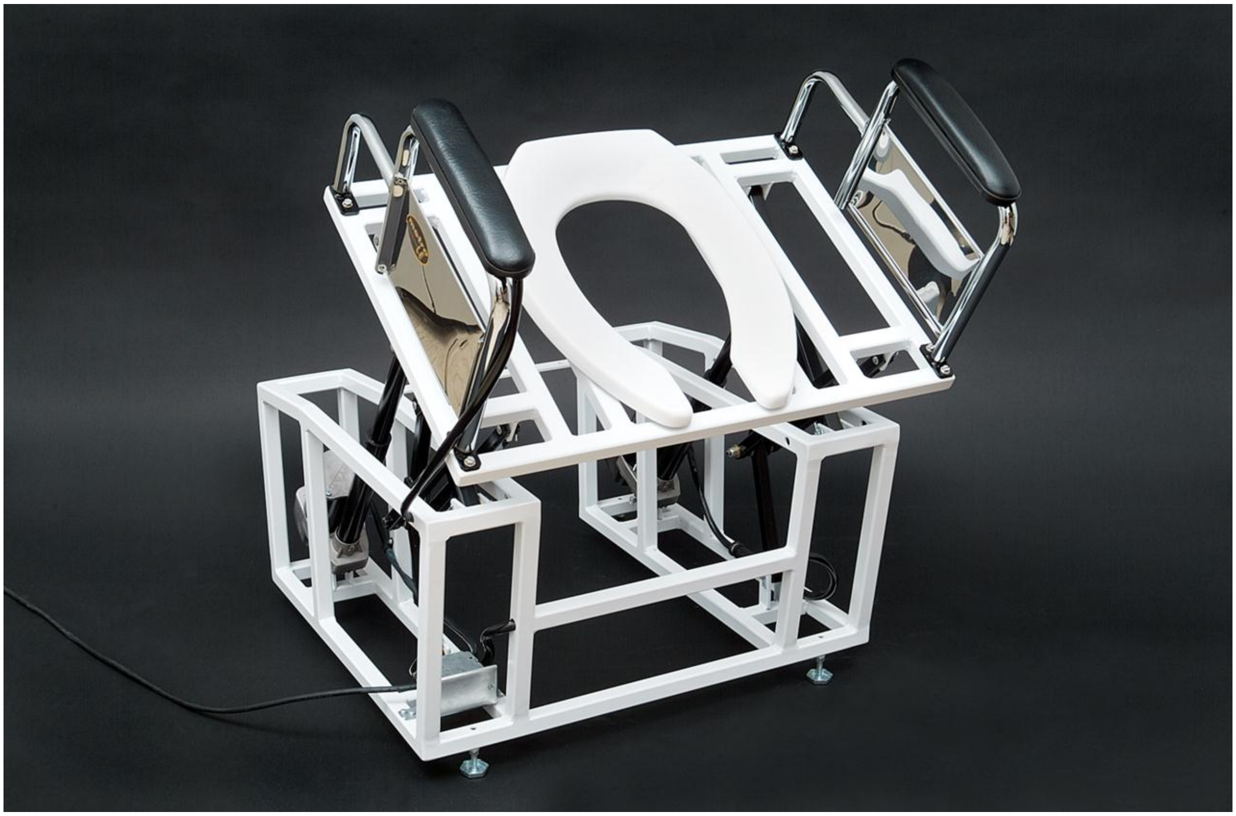

Fig. 11.5. Device at Maximum Height.

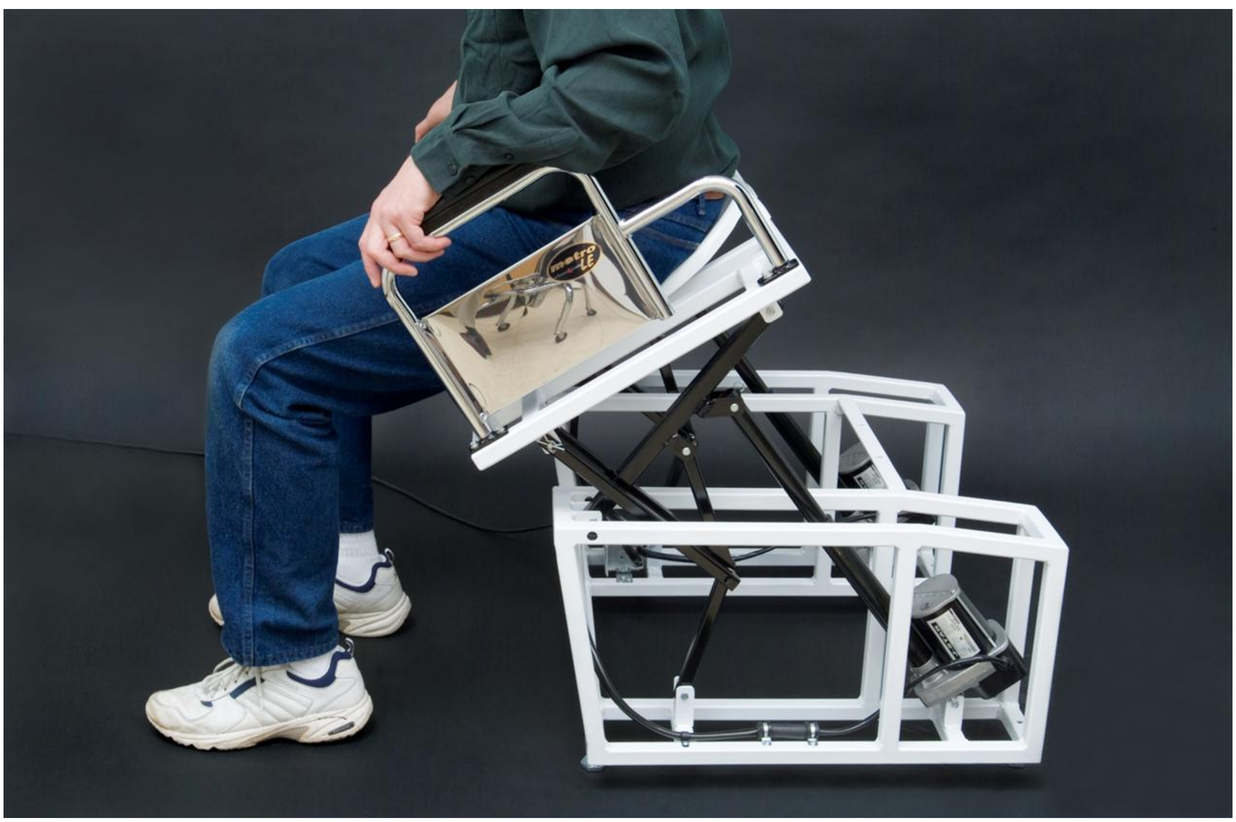

Fig. 11.6. Device in Use at Maximum Height.

REMOTE-CONTROLLED COMPUTER MONITOR STAND

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INTRODUCTION

For some individuals, the process of adjusting the view of a computer monitor in a public computing setting is difficult to perform independently. The objective was to design and build a motorized platform on which a monitor can be supported in order to allow the user to control the position of the monitor screen using a controller and not his or her hands. This device is useful for people with disabilities who are using self-propelled or motorized wheelchairs. In some situations, when a person using a wheelchair wants to use a public computer, the gap between the wheelchair and the desk causes the person to be too far away from the monitor and it leads to lack of hand control. The overall design was meant to ease this problem and help users with disabilities become more self-sufficient.

SUMMARY OF IMPACT

As a result of this device (see Fig. 11.7) a person using a wheelchair is able to adjust his or her view of the monitor without using his or her hands to physically move the monitor.

Fig. 11.7. Remote-Controlled Computer Monitor Stand.

TECHNICAL DESCRIPTION

All the internal components sit within a box constructed of Plexiglass and aluminum plates. A lazy-susan is placed between the base of the aluminum plate and the box to allow for rotation. Two controllers are used to control the tilt angle and the rotation angle. Both of the angles are controlled using two electric car jacks (see Fig. 11.8), one of which has been modified for the rotation angle. The unit is powered using an adapter which converts the 110-volt AC from the wall plug to 12-volt DC 1-amp.

TILT ANGLE

The tilt angle is driven by one electric car jack connected to a controller. A piece of Plexiglass is mounted to the top of this car jack by three hinges, which provide support. The electric car jack height can be adjusted up or down according to the person who is using it. The maximum weight that can be supported by the Plexiglass and the electric car jack is approximately 50 kilograms. The speed rate of the tilt angle is five degrees per second.

ROTATION ANGLE

The rotation angle is driven by the other electric car jack that has been modified to perform this function. The jack has been dissembled from the system, leaving the worm shaft and the motor, which is connected to a controller. A fixed worm gear that is mounted to the base of the aluminum plate engages the worm shaft from the electric car jack (see Fig. 11.9). When the worm shaft rotates, the Plexiglas box casing also rotates. The rotation angle has a rate of approximately five degrees per second. The limiting angles of rotation are 30° in either direction from center (60° total).

ELECTRICAL SYSTEM

An adapter converts the standard 120-volt AC to 12-volt DC for the electric car jacks. A controller is wired and connected between the electric car jacks and the power outlet. The controller wire is about a half meter long and can easily be reached by the user.

SUPPORTING BARS

The supporting bar system is mounted to the top of the Plexiglass case and consists of two aluminum bars that can be adjusted according to the size of the LCD monitor base. These bars ensure that the monitor will not shift or fall during the adjustment of the tilt angle.

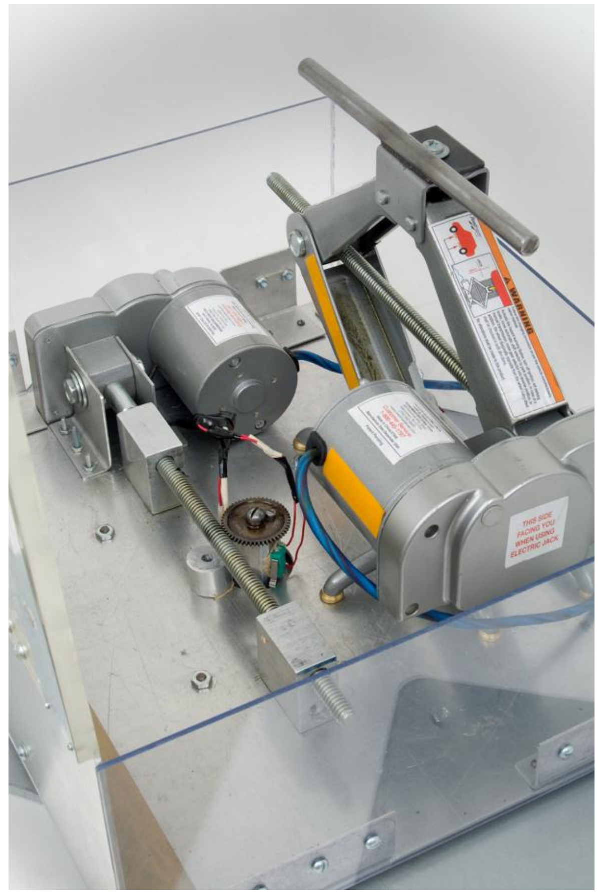

Fig. 11.8. Electric Car Jacks Used for Rotation.

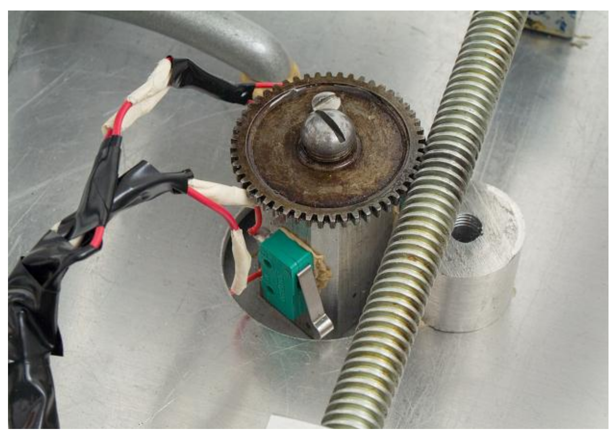

Fig. 11.9. Worm Gear Used to Control Rotation Angle.

The total cost of this project was $113.

ALL-TERRAIN TRACKCHAIR

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INTRODUCTION

This device is a mechanized chair that uses a tank track system in order to easily allow a person to go up and down stairs at a 30-degree angle, with respect to the ground. People who use wheelchairs or do not have the strength to walk up stairs will benefit most from device. The system consists of a four-bar mechanism that keeps the seat of the chair parallel to the ground, preventing the user from falling backward or tipping over (see Fig. 11.10 and 11.11). The complete system is easy to operate and is controlled using manual switches to move the four-bar system. This device can be completely automated by using a potentiometer and an RC servomotor.

SUMMARY OF IMPACT

The device will allow persons with disabilities the ability to travel over rough surfaces that they could not have traversed with a normal wheelchair. It will allow the user to go about his or her daily routine with more maneuverability, a good level of comfort, and confidence by enabling the rider to.

TECHNICAL DESCRIPTION

The four-bar drive system consists of three worm

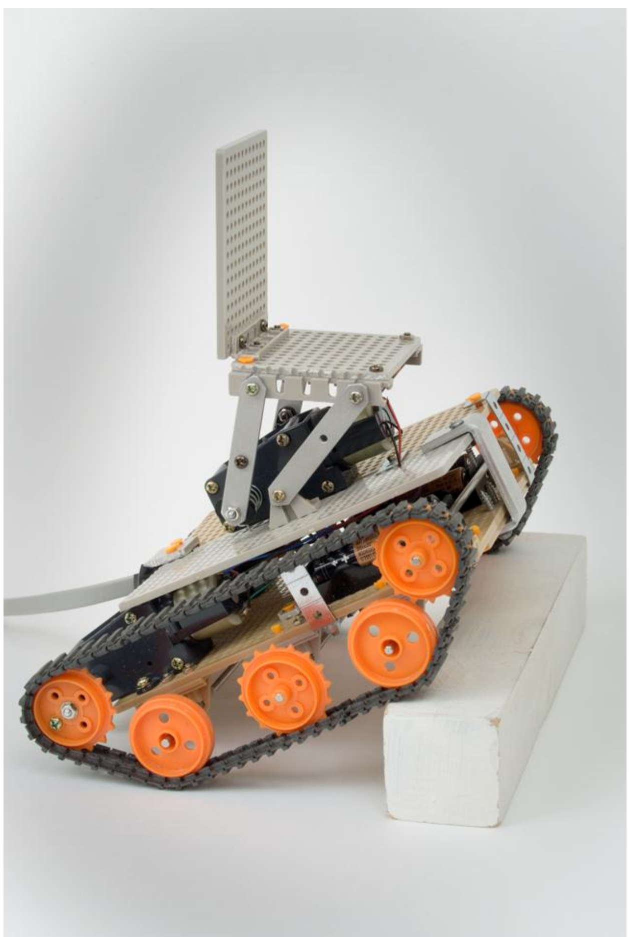

Fig. 11.10. All-Terrain Trackchair on an Incline.

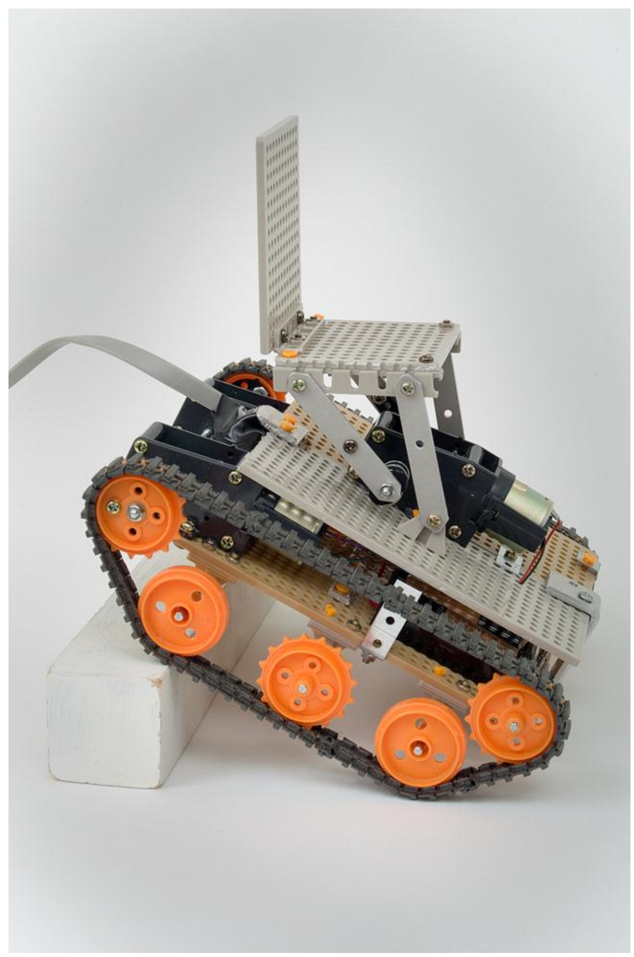

Fig. 11.11. All-Terrain Trackchair on a Decline.

gear electrical motors with 336:1 gear ratios. The system is operated by two manual toggle switches (see Fig. 11.12): one that operates the two drive motors and one for the Grashof double-crank four-bar mechanism, which controls the chair's position. The Grashof double-crank four-bar mechanism aligns the rider's center of mass with the track system's center of mass. This will prevent the device from flipping over when climbing obstacles.

The prototype is a 1/12 scale model of the actual system. It is powered by four AA batteries. The majority of the materials used for the prototype are plastics including the: 1) tracks; 2) chair; 3) gears for the motors; 4) base and chair platform; 5) driving sprockets and idler wheels for the track system; and 6) motor housings. Aluminum was used for the links of the four-bar mechanism, driving and idling axles, and support brackets. Steel springs were used to increase the tension on the four-bar mechanism links to reduce the mechanical slop created by the four-bar mechanism's driving motor gear train.

To automate the chair's four-bar system, a potentiometer would be mounted on the chair with a mass attached to its shaft to act as a pendulum. When the system ascends or descends an incline, the mass would turn the potentiometer, creating an output voltage. The potentiometer output voltage would be read by an RC servomotor and output a step input voltage to the four-bar motor. The RC servomotor would be programmed to give voltage outputs based on the potentiometer voltage to prevent the chair from oscillating.

The total cost of this project was $251.

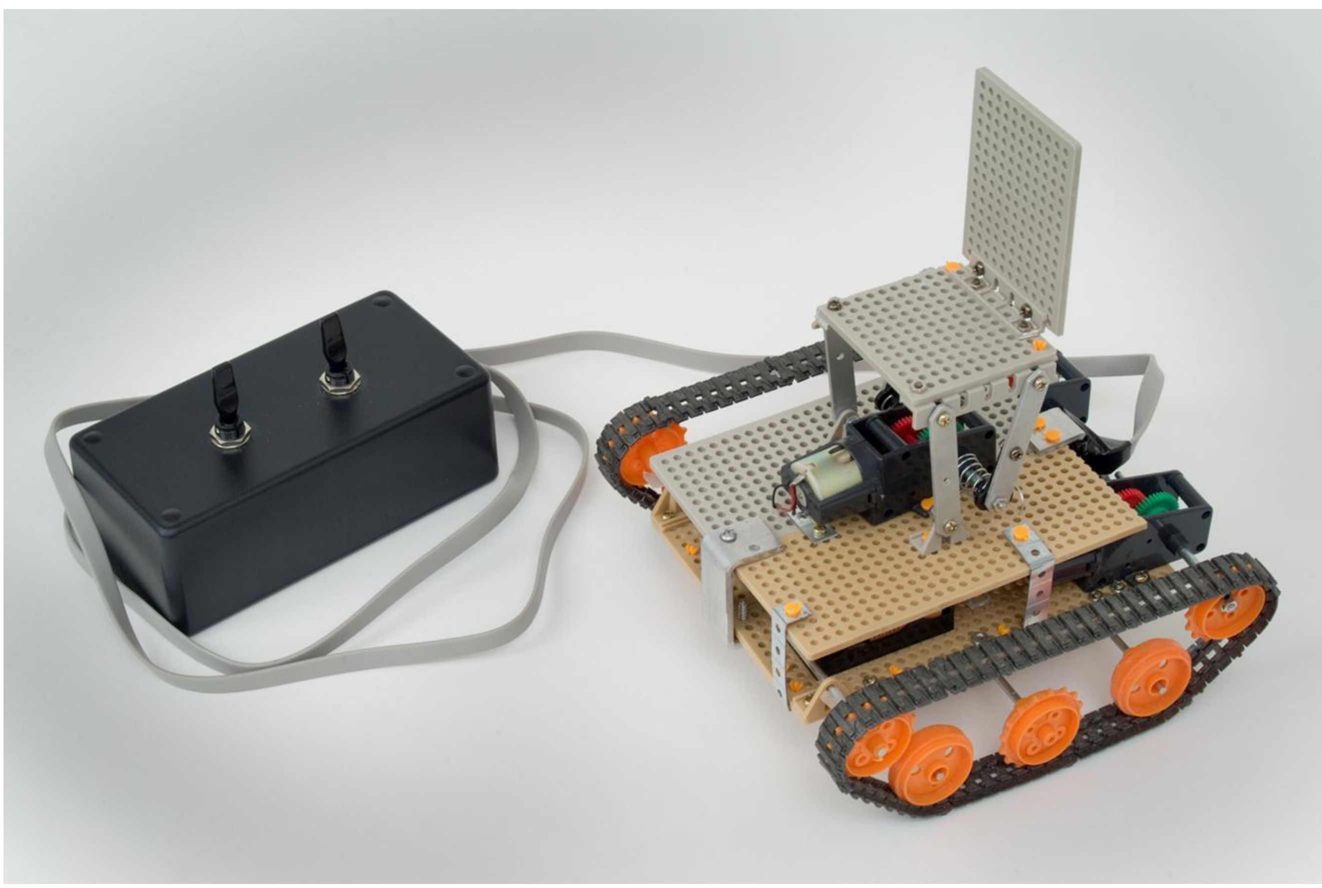

Fig. 11.12. All-Terrain Trackchair with Controller.

WHEELCHAIR/WALKER HYBRID

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INTRODUCTION

The task of walking in a mall can often be strenuous even with the aid of a walker. A device was designed to help people with disabilities to travel short distances without assistance. This device can transform from a wheelchair to a walker and vice versa with minimal effort.

SUMMARY OF IMPACT

The wheelchair/walker hybrid will help people with disabilities become more mobile and independent. It is important that people stay active and get exercise, but it is also important they not overexert themselves. The user can operate the device as a walker (see Fig. 11.13) to exercise his or her legs until he or she gets tired and then he or she can sit down and operate the wheelchair using his or her arms (see Fig. 11.14).

TECHNICAL DESCRIPTION

This device was constructed by making several modifications to an existing Rollator (a walker with a seat). The first modification was to replace the small rear casters with two 20-inch wheelchair wheels. Each wheelchair wheel was mounted onto the Rollator frame using an aluminum block clamp (see Fig. 11.15). These clamps were manufactured by machining a block of aluminum so that it would fit the contour of the frame after being cut into two separate pieces. Five holes were drilled into each block for five separate bolts. One hole was drilled for the wheelchair wheel axle and another four holes were drilled and tapped so that the block could be drawn together and tightened onto the frame.

Once the wheelchair wheels were mounted, the original brakes were removed from the front casters and fastened onto the wheelchair wheels. These brakes were securely attached by the use of two U-bolts for each of the two brakes. Two U-bolts were used to ensure no unintended alignment of the brakes after repeated use.

Fig. 11.13. Wheelchair/Walker Hybrid Being Used as a Walker.

Fig. 11.14. Wheelchair/Walker Hybrid Being Used as a Wheelchair.

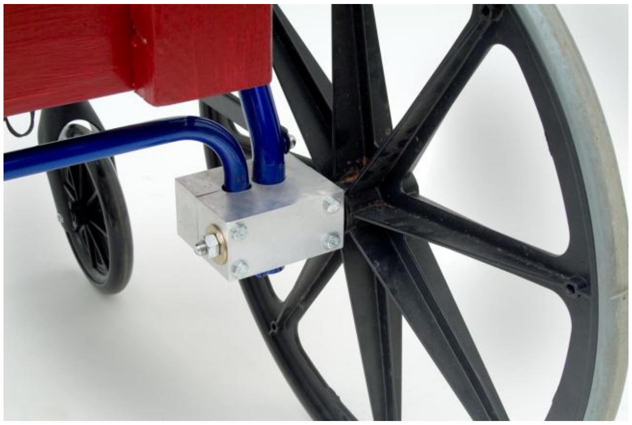

Fig. 11.15. Wheelchair Wheels and Mounting System.

Fig. 11.16. Caster Wheels and Mounting System.

The original rear caster wheels were then mounted on the front of the Rollator through the use of an adapter piece (see Fig. 11.16). Each adapter piece

Fig. 11.17. Wheelchair/Walker Hybrid.

consists of a small rectangular aluminum block with a hole through it, fitting the tube portion of the caster. A tension pin was then used to fasten the caster to the adapter piece. To attach the adapter piece to the Rollator frame, a solid aluminum round bar was welded to the adapter piece at a 60-degree angle, which fits properly into the frame. The existing split clamp on the Rollator was then used to securely tighten the round bar portion of the adapter to the frame.

To make the final product more comfortable, the original seat on the Rollator was replaced because it was too small and had no back support. The replacement seat is an actual wheelchair seat and backing donated by a surgical supply company. It was mounted on a wooden frame and attached to the Rollator through the use of wood screws. A coating of red paint was applied to the wooden frame to make it more cosmetically pleasing.

The final cost of this project was $174.

CONTACT LENS STORAGE CASE AND INSERTER

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INTRODUCTION

A prerequisite to wearing contact lenses is that the user possess the ability to perform the daily tasks necessary to wear and care for the lenses. The objective of this project was to provide individuals with a device that allows them to use contact lenses despite limited functionality of one hand.

SUMMARY OF IMPACT

The device provides people with the ability to clean, store, insert, and wear contact lenses independently using only one hand. It acts as an easy-to-use staging area for performing all daily tasks required by contact lens use.

TECHNICAL DESCRIPTION

Primary design considerations were ergonomics, comfort, simplicity, and ease of use. The device is comprised of four major components (see Fig. 11.18): 1) base; 2) center rod; 3) outer cylindrical shell; and 4) piston. Attached to the top of the center rod is a small plastic piece on which a contact lens may rest. This contact holder is a small ring that is approximately 7/16″ in diameter. A ring was chosen as opposed to a solid concave piece to minimize the surface area between the holder and a wet contact, thus minimizing the adhesive forces between contact and holder. The device stands approximately 6″ high in the piston-down position and 8″ high in the piston-up position. The base measures 6″ in diameter.

Hovering around the center rod is the main piston, the diametrical position of which is restricted by the outer cylindrical shell. Near the top of the piston, a chamber was machined so that its height coincides with that of the contact holder. This feature, in addition to the installation of an O-ring into the piston, allows for the chamber to be filled with saline solution and doubles in function as a storage case. The piston is held in place vertically by friction with the O-ring and the close tolerances of the piston, shell, and rod.

Mounted on the base of the device is a small holding cell on which a contact may be set temporarily and cleaned with saline solution. The contact is then

Fig. 11.18. Contact Lens Aid's Components.

placed on the contact holder on the top of the rod and the chamber filled with saline solution. Fig. 11.19 shows the piston in its up position, where it is possible to fill the bottom of the piston with saline solution, immerse a contact lens, and store it overnight.

When a user wishes to insert a contact, he or she simply pushes down on the piston, revealing the top of the rod and the contact resting on it. The saline solution level lowers with the piston. Holding his or her eyelids open with one hand, and supporting his or her elbow on a table top, the user slowly moves his or her eye to meet the contact. As with initially learning how to insert contacts, this procedure takes practice to become efficient.

An additional feature of the device is the application of "soft-touch" gel to the top perimeter of the piston and an optional spring that fits around the center rod below the piston. Using this configuration, it is possible to install a contact with or without using hands. The high friction of the gel restrains a user's eyelids as he or she pushes down with his or her head on the spring-supported piston, raising the contact into his or her eye.

This "no-hands" configuration was initially the intended design of the project. However, testing the device showed that for the same amount of practice, the repeatability of success was much lower than for usage with one hand. In addition, if success could not be attained nearly 100% of the time with this configuration, then its use by someone requiring its aid would be impractical. Replacing a contact lens on the holder from a failed attempt cannot be done by someone without use of at least one hand.

Polycarbonate was selected for the center rod and the piston for its strength, machinability, and light weight. The use of polycarbonate for the piston was also needed for its transparency; it allows light into the chamber so the user can see the contact. The base and outer cylindrical shell were both machined from acrylic because of its lower cost and machinability.

The total cost of the project was $48.

Fig. 11.19. Contact Lens Aid with Piston in up Position.

Fig. 11.20. Contact Lens Aid in Use.

MOBILE LAPTOP WORKSTATION FOR PATIENTS IN BEDS

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INTRODUCTION

Patients who lie in a bed have a difficult time using a laptop due to the inconvenience of overheating and the risk of damage if the laptop should fall. This device addresses the problem that patients lying in bed face when attempting to use a laptop by keeping the laptop elevated above the user. The mobile laptop workstation has an adjustable-height horizontal boom arm that extends across the bed to the user (see Fig. 11.21). The device can also be used in a household environment.

SUMMARY OF IMPACT

This device provides more freedom of movement for the user while reducing the risk of the laptop being damaged by falling. It provides added safety for patients in bed by keeping the laptop away from flammable objects, such as the sheets, should overheating occur.

TECHNICAL DESCRIPTION

The device is designed to have the free end of the U-base slide under the bed. The actuator (see Fig. 11.22) sits on the closed end of the U-base next to the bed. The boom arm extends from the top of the actuator over the bed. At the end of the boom arm is a tray that holds the laptop in place while in use (see Fig. 11.23).

To operate this device, the user places the laptop securely onto the laptop tray and uses the necessary controls to adjust the actuator. The switch (see Fig. 11.22) controls the up-down motion of the actuator. The clamps have adjusters that permit changing of the boom arm angle and the orientation of the laptop tray.

The base is constructed from aluminum 6063-T5 tubing with cross-sectional dimensions of one inch by two inches and a wall thickness of one eighth inch. Aluminum was chosen due to its light weight and high strength. The four caster wheels have locking mechanisms that keep the device stationary when required.

Fig. 11.21. Mobile Laptop Workstation.

The actuator used is a 12" Stroke Square Tubular Actuator that supplies 40 lbs of force at a rate of one and three quarters of an inch per second. The actuator has limit switches at the beginning and end of its stroke. It is powered by a 12-volt DC adaptor that is plugged into a three-pronged electrical outlet.

A manual momentary double-pole double-throw switch allows the actuator to move for as long as the user's finger is held on the up or down position of the switch.

Initially, the actuator had clevises at the bottom of its base. It was removed and replaced with a flat base to allow for easy attachment to the U-base. For added support, triangular braces were added to the base in order to counteract the movement and torque produced by the force at the end of the boom arm. The bar that extends out from the actuator was extended four inches to make room for the clamp when the actuator is at its lowest height.

The boom arm clamp allows for the mounting of the aluminum boom arm to the actuator beam. It allows the user to pivot the boom arm if necessary. This boom arm has an outer diameter of one inch, a wall thickness of one eighth inch and a length of 30 inches. The laptop tray is attached to a ball and arm system which has a U-bolt mount on one end. The U-bolt mount is connected directly to the boom arm while the ball and arm system permits orientation adjustments of the laptop tray.

The total cost of this project was approximately $400.

Fig. 11.22. Actuator and Switch Assembly.

Fig. 11.23. Mobile Laptop Workstation with Laptop Tray Shown.

RESTROOM LIFT-ASSIST DEVICE

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INTRODUCTION

The purpose of this project was to create a device that helps people with disabilities stand up from a wheelchair and transfer to a toilet seat. This device is easy to use, since it is simply operated by a remote control that moves the crutch up and down (see Fig. 11.24). The crutch functions as a support for the user and can be adjusted to different heights. This device was designed to be used in conjunction with the support bar that is already installed in many restrooms.

SUMMARY OF IMPACT

The use of this device helps the user transfer to a toilet seat without assistance. A device of this type provides the user enhanced independence and privacy.

TECHNICAL DESCRIPTION

The crutch, which has an adjustable pin, is shortened so that it can be used by a person when he or she is sitting in a wheelchair. The crutch also has a handle so that when it is used, the user will be able to stabilize himself or herself. The bottom of the crutch is connected to an electronic jack (see Fig. 11.25) that is powered by a 12-volt, 10-amp motor using a solid aluminum cylinder. The jack provides a force that is capable of lifting the person's weight; it provides enough power to lift up to 2000 pounds. A rechargeable 12-volt 10-amp battery, as seen in Fig. 11.26, is used to power the electronic jack; this will enable the jack to operate for maximum of 10 hours before it has to be recharged. A cover for the battery was built from acrylic clear glass and connected to a hinge, which provides easy access. This cover has the purpose of protecting the battery from possible water splash.

Fig. 11.24. Restroom Lift-Assist Device.

A switch and fuse are also used in the device. The switch was installed to maximize the life of the battery to at least 10 hours a day. The user may easily turn it on and off by using this switch. The function of the fuse is to protect the battery whenever the motor gets stuck or jammed, therefore preventing battery burnout. As for the base, ¼" thick aluminum was used to provide stability when weight is applied to the top of the crutch. A wider base would give more stability to the device; however, a larger base would increase the overall weight of the device. Therefore, a 20" by 11" aluminum plate is used.

The final cost of this project was $105.

Fig. 11.25. Electric Jack Assembly.

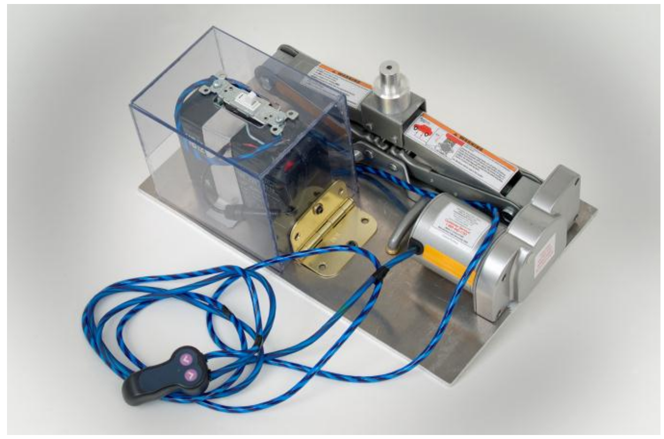

Fig. 11.26. Battery Box and Switch Assembly.

Fig. 11.27. Restroom Lift-Assist Device in Down Position.

IN-SHOWER BACK CLEANING AID

Designers: JiTai Chen, and Tin Ng Chin
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INTRODUCTION

This shower chair is designed to provide back cleaning assistance for people with limited flexibility using rotating loofah rollers and a simple hand-powered crank system. Power from this rotating crank is transmitted to the loofahs by sprockets and a chain system; a series of gears transmit power to all five loofah rollers.

SUMMARY OF IMPACT

This device helps an individual with limited flexibility to clean his or her back in the shower.

TECHNICAL DESCRIPTION

The shower chair consists of a main supporting structure: the rolling loofahs and the power system. This device was designed to accommodate people of different heights, from five feet four inches to six feet four inches. The design incorporated as many non-corrosive (plastic) parts as possible, suitable for prolonged exposure to water in the shower. For some parts, this specification was compromised due to budget and manufacturing capabilities.

The main structure is made of one-and-a-half-inch diameter PVC pipes; the joints supporting the greatest amount of weight are cemented to achieve maximum load capacity. The maximum load has not been tested nor calculated, but it can be assumed to safely carry most people due to the high strength properties of PVC piping (Tensile Strength: 50-80 MPa). The back structure was not cemented together to allow for future replacements of the loofahs, and to provide access for repairs.

The rollers are constructed from short PVC pipes wrapped with loofah material that entails a sheet of sponge with a coarse texture. Each loofah has a three- eighth-inch aluminum rod fixed in the center that mounts to the back frame. Power is transferred to all of the rollers by the use of plastic gears secured to the aluminum rod in each roller. The gears of each roller engage one, then the other, which rotate in the opposite direction as the adjacent roller. The gears used were actually K'NEX toy gears; these were used due to the low cost compared to custom gears. They also have a relatively high strength that proved to be adequate for this application.

Fig. 11.28. Crank and Roller System.

Sprockets and a chain (see Fig. 11.28) were installed to transfer power from a rotating hand crank to the gears. The sprockets are constructed from a nylon material and the chain is steel. This system is mounted to the support bars attached to the seat; both the support bars and seat were made of wood. The user sits on the chair and moves the rotating hand crank that operates the entire device (see Fig. 11.29). The maximum speed of rotation is 80-RPM.

The total cost of the project was $169.

Fig. 11.29. In-Shower Back Cleaning Aid in Use.

FOOT-FREE DRIVE ASSIST DEVICE (FDAD)

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INTRODUCTION

The Foot-Free Drive Assist Device (FDAD) assists people with a leg disability while driving (see Fig. 11.30). It was specifically designed to be used with an automatic-transmission automobile and can be used by people of all ages with a large range of leg disabilities. The FDAD allows people with limited mobility to enjoy traveling without depending on others. The FDAD can be installed on basically every passenger car, and was designed to support the majority of arm lengths. The mechanics of the FDAD are rather simple; when the lever is pulled up the automobile will accelerate, and when it is pushed down the automobile will decelerate and eventually come to a stop. In order to comply with driving safety requirements, the FDAD was designed to be handled by the driver's left hand and it will reset to its steady state position (no-throttle and no-brake) when the lever is released. The driver handles the steering wheel using his or her right hand while controlling the velocity of the vehicle with his or her left hand.

Fig. 11.30. Foot-Free Drive Assist Device.

SUMMARY OF IMPACT

The revolutionary design behind the FDAD not only makes driving possible for people with leg disabilities, but it is also: 1) lightweight; 2) easy to install; 3) easy to maintain; and 4) affordable.

TECHINICAL DESCRIPTION

The Foot-Free Drive Assist Device is made from round aluminum tubes with: 1) one-inch diameter, one-eighth-inch thick aluminum plates; 2) plastic buckles; and 3) nylon straps. Two adjustable telescoping tubes are fitted with two different-sized aluminum clamps, which are used to grip the acceleration and brake pedals. The two ends of the aluminum tube are attached to a control bar, to be grasped by the driver's left hand. A tension spring was added to prevent unnecessary braking when left idling. The driver is required to pull the control bar towards himself or herself to accelerate and press it straight down to stop. Webbing assemblies, made of nylon straps and plastic cam buckles, are used to secure the structure. This is done by wrapping the webbing around the steering shaft housing protruding from the dash board. The control bar should be horizontal to the ground and there should be no difference between the brake arm height and the throttle arm height, regardless of differences in height between brake and throttle pedals. When properly installed, there should not be any binding or hesitations of any of the movements and the device should be able to apply full throttle and brake.

The final cost of this project was $91.

Fig. 11.31. Foot-Free Drive Assist Device Installed in an Automobile.

CONVERTIBLE AWNING FOR WHEELCHAIRS

Designer: Robert Collins
Supervising Professor: Dr. Joseph C. Mollendorf
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INTRODUCTION

A device (see Fig. 11.32) was designed to protect wheelchair users from sun, rain, wind, and snow. The Convertible Awning for Wheelchairs allows wheelchair passengers to choose when to protect themselves from the elements of nature.

SUMMARY OF IMPACT

The rigid lightweight frame is easily converted from its closed position to a position that protects the wheelchair passenger without changing how the wheelchair is used. The Convertible Awning for Wheelchairs minimizes the weight load by eliminating power sources, motors, and mechanical linkage systems.

TECHNICAL DESCRIPTION

The U-shape uprights of the awning are made from galvanized steel electrical metal tubing (EMT). Steel EMT is an ideal material choice it can easily bend into a U-shape. Once bent, the steel EMT remains rigid due to the cold working properties inherent in steel. The galvanized surface treatment ensures that the steel will not rust. At each end of the U-shape tubes there is a three-inch-long piece of solid steel which is riveted into place. When the awning is mounted, these four pieces of steel fit into where the wheelchair arm rests once mounted. When the awning is in its closed position, the front upright is secured by two torsion spring-loaded steel clamps.

The cover of the awning is made of synthetic leather. It is sewn with heavy nylon thread around the front upright and is attached with Velcro around the vertical part of the rear upright.

The armrests are mounted on top of one-quarter-inch thick aluminum cross-members. When the awning is in the open position, the aluminum cross-members provide stability for the awning structure. The bars are joined in a manner that does not allow the awning to collapse accidentally.

Fig. 11.32. Convertible Awning for Wheelchairs.

The total cost of this project was $70.

Fig. 11.33. Wheelchair with Awning Retracted.

INSTRUMENTED SHOE FOR INDIVIDUALS WITH LOWER EXTREMITY WEIGHT-BEARING LIMITATIONS

Designer: Daniel R. Cumm
Supervising Professor: Dr. Joseph C. Mollendorf
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INTRODUCTION

Individuals who have had orthopedic surgery are commonly prescribed partial weight-bearing limitations on the lower extremity. The Instrumented Shoe for Individuals with Lower Extremity Weight-Bearing Limitations helps in the treatment of patients after orthopedic surgery.

SUMMARY OF IMPACT

The patient wears the shoe during treatments to help the therapist monitor how much weight is being applied throughout the shoe and how it is distributed. The Post-Orthopedic Surgery Shoe can either be placed over a shoe that is on the patient's foot or worn by itself as a shoe.

TECHNICAL DESCRIPTION

There are two main components to the assembly: a shoe and a microcontroller (see Fig. 11.34). The shoe contains strain gauges (CEA-06-240UZ-120) that are bonded together by epoxy to sheet metal plates and then wired in a Wheatstone bridge configuration to measure bending moments (see Fig. 11.35). When the shoe is twisted or bent, it has a positive or negative moment, depending on how it is bent. This is reflected in the signal output.

The microcontroller (CME-11e9-EVBU MC68HC11E9) contains the machine language logic that controls the system. The output from the strain gauges is fed through the strain gauge conditioner (6202-2965 / BRIDGE AMP) and read as an input to the microcontroller. The microcontroller has a portable power source consisting of two dual AA battery holders. The liquid crystal display (16x2 LUMEX LCD) displays a real-time reading of the force being applied to the shoe. The logic of the machine language is developed so that if the applied force exceeds the prescribed force, a Piezo electric buzzer goes off until the force drops below the prescribed force. The logic is a continuous loop so the prescribed force can be changed during treatment. The shoe is wired in such a way that if the logic is developed, the shoe can be used to inform the therapist about the patient's step characteristics.

The total cost of this project was $255.

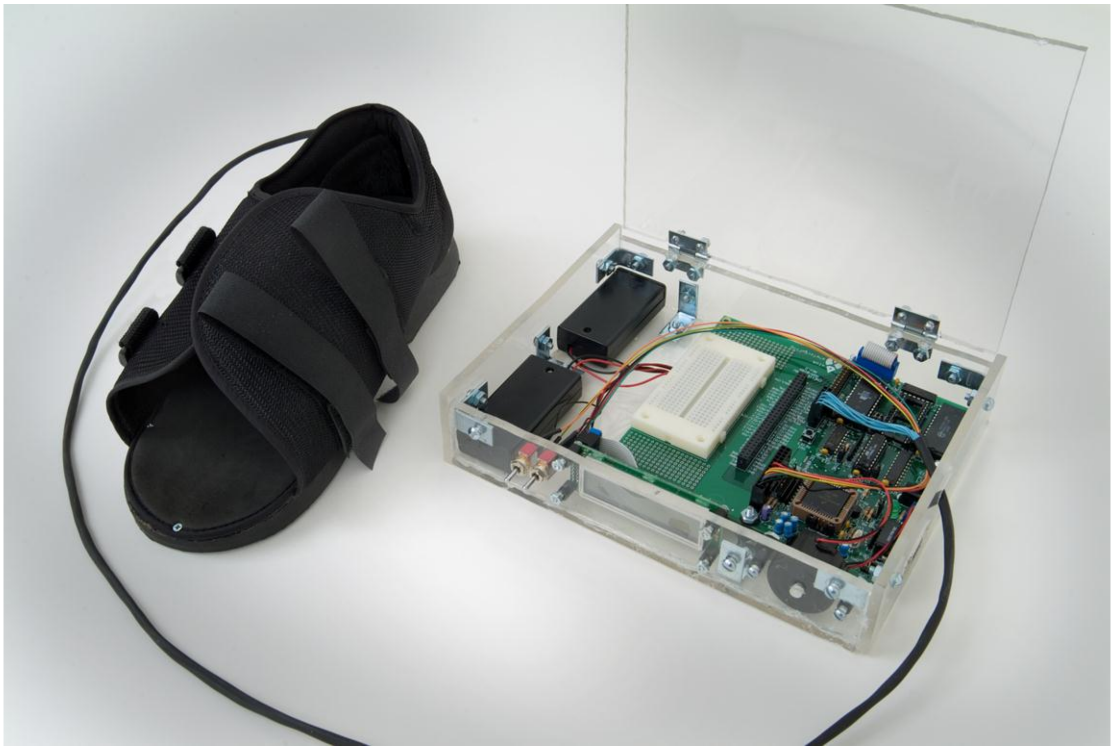

Fig. 11.34. Instrumented Shoe for Individuals with Lower Extremity Weight-Bearing Limitations.

Fig. 11.35. Shoe and Strain Gauges.

AUTOMATIC MILK AND CEREAL DISPENSER

Designers: Nandan C. Dabhade and Thomas C. Law
Supervising Professor: Dr. Joseph C Mollendorf
Department of Mechanical and Aerospace Engineering
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INTRODUCTION

Certain people cannot necessarily lift a heavy jug of milk or hold it steady for the extended period of time required to pour the desired amount on breakfast cereal. This device allows the user to simply press a button (see Fig. 11.36) and automatically receive his or her breakfast in a quick, coordinated, and regulated manner. This product is also extremely versatile in that the cereal or milk containers may be used to fill and dispense almost anything that is snack-sized, (e.g., peanuts, popcorn) and almost any liquid, such as water or juice. This product also has a built-in cooler attached at the top, which eliminates the need for refrigeration. It features a door that can be opened and closed above the cereal container, which allows for quick and easy refilling of the dry food of choice.

Fig. 11.36. Automatic Milk and Cereal Dispenser.

SUMMARY OF IMPACT

This product allows people with disabilities the ability to make themselves a quick and healthy breakfast, which aids in improving their day-to-day health. It will also enhance independence. Furthermore, this product's customer base is expandable to those that are simply pressed for time, such as busy parents and school children who do not necessarily have the time to cook breakfast.

Fig. 11.37. Milk and Cereal Storage Containers.

TECHNICAL DESCRIPTION

The main engineering features utilized in the Automatic Milk and Cereal Dispenser (Fig. 11.37 and 11.38) include: 1) a modified shaft and gearbox; 2) a fluid pump; 3) a power converter; and 4) a cooling unit. An existing hand-powered cereal dispenser was purchased and the shaft was removed and modified by grinding down half of it to a flat edge. This was then replaced in its original location, which was in between a hand-powered set of spinning paddles that allow the cereal to drop into the bowl. The part of the shaft that was extruding from the paddle mechanism was then connected to two sets of gears and secured with set screws. These gears are in turn driven by an electric motor. Initially, the motor did not provide enough torque to allow for smooth flow of cereal. Therefore, an external torque multiplier was purchased. This multiplier provided a gear ratio of four to one. This unit was mounted onto the existing motor and allowed the paddles to spin at a rate of approximately one revolution per second.

The fluid pump used was purchased from a hobby store and was originally designed to regulate the flow of fuel into model airplanes. This pump was attached to the existing fluid-containing column through a one-quarter-inch copper pipe and composite tubing. The fluid pump exit pipe was placed next to the cereal dispensing tube, allowing it to be poured into the bowl at the same time. The pump used provides the ability to dispense fluid at approximately one ounce per second. The power converter was homemade and reduced the voltage from 12-volt to 6-volt. It is important to note that the power converter is restricted to DC through the use of diodes. This is due to the fact that the cooling unit can only receive a lower voltage of DC current (as opposed to most household outlets) since it was designed to be incorporated into a car cooler. It then required a converter that would make it safe to use for this application. Lastly, this cooling unit was placed at the top of the chassis and allows for it to be a self-refrigerating device. While it takes approximately one full night after initially plugging in to actually cool the fluid, it is an extremely consistent temperature regulator and can hold a temperature of approximately 40 degrees Fahrenheit.

Total cost of the prototype was $180.

Fig. 11.38. Automatic Milk and Cereal Dispenser Being Filled.

BED-MAKING DEVICE

Designer: David J. Dedo
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INTRODUCTION

The bed-making assistive device (see Fig. 11.39 and 11.40) can help anyone with a disability perform the daily task of making a bed. This device was built on a half scale but is capable of fitting any size bed. Although this device does not fully pull off or help replace the bottom sheets, it is capable of moving top sheets and comforters up and down the length of the bed. The device is installed under a bed and, once installed, the sheets are clipped to the device and the operator can control the sheet location by flicking a switch. It takes about five seconds to move the sheets fully up or down the length of the bed.

Fig. 11.39. Bed-Making Device.

Fig. 11.40. Bed-Making Device with Sheets Retracted.

SUMMARY OF IMPACT

This device helps people with disabilities make a bed. It may reduce pain and enhance independence.

TECHNICAL DESCRIPTION

The system is powered electrically by a DC gear motor that is plugged into a common wall outlet. A bridge rectifier is needed to convert the AC current from the wall outlet to a DC current, which is required by the motor. A double-pole double-throw switch is used to control the direction of the motor. As for the safety mechanism, there are limit switches at each end of the bed to prevent the device from destroying itself. There are pulleys on the dual output shaft of the motor and V-belts used to translate the rotational motion to linear motion (Fig. 11.41). In this prototype, the V-belts are approximately 100” long. There is a wooden cross-member fixed to the pulleys via two U-bolts. The wooden cross-member comes from under the bed to the side of the bed at a height level equal to the top of the mattress. Most of the structural parts and the bed frame were constructed from wood because it was easy to manipulate and it was readily available.

The total cost of this device, with a donated motor, was approximately $160.

Fig. 11.41. Electric Motor and Pulley Assembly.

GEARED MANUAL WHEELCHAIR WITH VARIABLE SPEEDS

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INTRODUCTION

A modified wheelchair (see Fig. 11.42) with high and low gears was designed to allow the user to control his or her speed while traveling on inclined and declined surfaces. It will also allow the user to turn the handrail used to drive the wheels with less force and make it easier for one to move while going uphill or downhill.

SUMMARY OF IMPACT

This device addresses the challenge faced by persons with disabilities in wheelchairs while they are traveling up a hill or an inclined ramp. Many find it hard to turn the handrails and drive the wheels since it requires more force to push themselves up the incline. It also addresses the problems that wheelchair users have of controlling their speeds while traveling down hills or declined ramps. This is done by allowing them to slow down the wheelchair by using the different speed gears.

TECHNICAL DESCRIPTION

The modified wheelchair with high and low gears uses a driving system similar to a bicycle on each

Fig. 11.42. Geared Manual Wheelchair with Variable Speeds.

wheel. There are two separate driving systems, one for each wheel with three different speed ratios (high speed, normal speed, and low speed). For each drive system on the wheelchair, there is a drive shaft, transfer shaft, derailleur wheel hub, and handrail (see Fig. 11.43). All of these components were assembled together inside the gear box housing, which connects to the wheelchair by three bolts on each side.

On the drive shaft, there is one 19-tooth sprocket aligned with the middle gear on the spline from the transfer shaft, which is connected with a chain. This sprocket is mounted to the shaft by a needle bearing that allows it to spin freely in one direction and lock in the other.

On the transfer shaft (rear shaft) there is a spline that is welded in place. The spline has three sprockets with different tooth counts (14-tooth, 19-tooth, and 25-tooth). Also on the transfer shaft there is another sprocket with 20 teeth that is aligned with the 20-tooth sprocket ,which is on the wheel hub in the front of the gear box. These two sprockets are also attached by a separate chain.

On the wheel hub, there is a 20-tooth sprocket attached to the inside end that attaches the wheel hub to the transfer shaft. On the inside of the wheel hub, there are two ball bearings pressed into place that allow the drive shaft (handrail shaft) to spin freely. A bracket that holds another needle bearing was attached to the outside of the wheel hub.

The gear box is split into two different sections: the left side and the right side. Down the center of the gear box, about seven inches from the bottom, there is a support beam that runs down the length of the box. Both the transfer shafts and the drive shafts are supported by this beam, which allows them to turn freely. On the back of the gear box, a bracket that holds the derailleur in place was mounted and aligned with the smallest sprocket on the spline from the transfer shaft. The chain that connects the spline to the sprocket on the drive shaft also runs through this derailleur, which allows the wheelchair to have variable speeds.

The derailleur on each side and the tension in the cables are controlled by a friction shifter connected to each cable. This allows the tension to change in

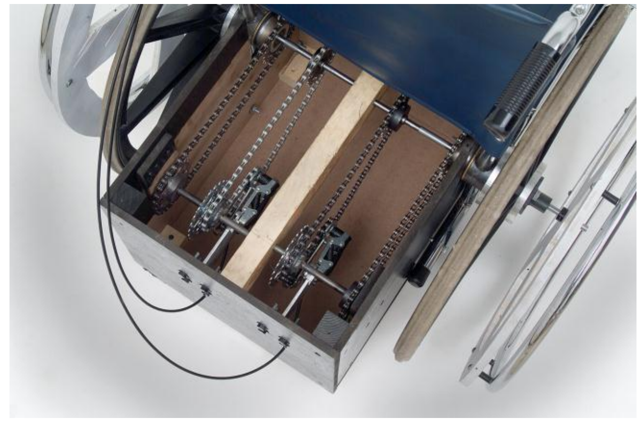

Fig. 11.43. Wheelchair Gear System.

both cables with just one shifter. A custom part was machined to connect the two cables into one.

The wheelchair is operated by turning the handrail, which is attached to the drive shaft. When the drive shaft is turned, it turns the 19-tooth sprocket, which has a chain that runs to the three sprockets and through the derailleur. This chain drives the spline, which is connected to the transfer shaft. When the transfer shaft is being turned, it turns the 20-tooth sprocket as well. This sprocket is connected to the 20-tooth sprocket on the wheel hub by another bike chain. When the 20-tooth sprocket on the transfer shaft in the back is turned, it moves the 20-tooth sprocket, which is connected to the wheel hub. When the wheel hub turns, the wheel will also end up turning in the given direction. When one wants to shift gears and make the wheelchair go faster or slower, all he or she has to do is turn the shifter knob to a higher or lower setting while in motion. When this is done, the tension in the cable will either tighten or loosen and change the gearing accordingly.

To travel in reverse, all one needs to do is start turning the handrail backwards and the needle bearings that are positioned in the system either lock or spin freely. This allows the tension in the chains to remain constant, which will drive the wheelchair smoothly.

The total cost of this project was $186.

WHEELCHAIR PROPULSION ASSIST LEVER

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INTRODUCTION

Many wheelchair users have difficulty independently operating their wheelchairs. A reduced range of joint articulation makes it difficult to grab the rear wheel as intended and to propel oneself. This project was intended to allow people using wheelchairs to mobilize themselves with greater capability and independence.

SUMMARY OF IMPACT

This design ideally enhances independence, self-confidence, and privacy of people using wheelchairs.

TECHNICAL DESCRIPTION

The Wheelchair Propulsion Assist Lever (see Fig. 11.44) has a simple design with a few moving parts that imitate a ratcheting mechanism. The design uses a spoke brace to apply the driving torque to the wheel instead of using a bearing to transfer the torque.

This device consists of a two-foot shaft that has a hand grip on its top end to allow the user to apply a forward push and initiate operation. The shaft connects to the wheelchair with a bearing fitted around the axle screw already connecting the rear wheel of the chair (see Fig. 11.45). The bearing is attached mid-shaft to allow for some shaft to extend beyond the bearing. The piece of the shaft beyond the bearing is where a counterweight is attached. A counterweight is necessary to provide a restoring moment about the bearing. This restoring moment ensures that the counterweight is directly below the bearing and the other end of the shaft with the grip is above the wheel in a region reachable by the user.

To transfer the torque there is a brace hinging on the shaft, which transfers the rotational motion of the lever in only one direction. The hinge allows for the spoke brace to interfere with the spokes on a forward stroke of the lever, transferring the lever's rotational motion to a driving torque. On the return stroke, the hinge allows for the spoke brace to sweep out and over the spokes, transferring no torque to the wheel on a return stroke. This provides for a design restriction of no propulsion assist in the rear direction. This could possibly affect the practicality of the device, but it was assumed that the majority of wheelchair traveling is in the forward direction.

Fig. 11.44. Wheelchair Propulsion Assist Lever.

In order to function properly, the spoke brace must extend laterally from the wheel shaft and be perpendicular to the plane of the rear wheel. To ensure that this spoke brace returns to this perpendicular orientation after each time it sweeps over the spokes on a return stroke, a tension spring was connected to the shaft and the side of the spoke brace. The spring returns the spoke brace to its operating orientation during use to ensure that it can interact with the spokes in a forward stroke at all times. It is in this way that the Wheelchair Propulsion Assist Lever provides a driving torque to the rear wheel by means of a limited forward rotation. The final cost of this project was $60.

Fig. 11.45: Installed Assist Lever.

Fig. 11.46: Wheelchair Propulsion Assist Lever in Use.

REMOTE-CONTROLLED AUTOMATIC DOORKNOB OPENER

Designers: Michael Harlach and Joshua Morss
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INTRODUCTION

A remote-control device was designed for people who cannot turn a doorknob. The Remote-Controlled Automatic Doorknob (see Fig. 11.47), allows the user to simply press a button on a remote control, sized to fit on a keychain, and have the door latch release. The device also functions as a regular doorknob with full locking functionality.

SUMMARY OF IMPACT

This device addresses the challenge any person with limited hand use may face. This could include, but is not limited to, people with arthritis or missing fingers. It has been designed to fit on the common household door.

TECHNICAL DESCRIPTION

There were three goals that this project was intended to accomplish. The first was to create a doorknob which would retract the door latch with a remote control. Second, this doorknob had to function as a regular doorknob for users without a remote. Finally, it had to fit on any standard household door. These predetermined goals gave rise to several design constraints. Power had to be supplied to the device since it was intended to be attached to a door and be remote-operated. It was determined that a power cord would be impractical in most cases; therefore, a battery was chosen. Also, the door latch mechanics proved to be a major challenge during the design process. Physically turning the knob would have required a motor with considerable torque; therefore, it was decided that door latch itself would simply be pulled back.

The device opens the latch by converting rotational motion into a linear translation of the door latch. This is achieved by having a motor turn a threaded rod on which a bar is mounted. The bar goes forward and backward as the rod spins to pull the latch open and closed. A small piece of aluminum was attached to the latch mechanism for the bar to grab onto and pull the latch back. The threaded rod is linked to the bar through gears in a one to one ratio. At each end of the threaded rod is a bearing mounted to the case to allow for smooth rotational motion. The motor is rated for 20-volts although only 12-volts are supplied to the motor due to the size of the battery.

A circuit was then designed to accomplish the desired rotation of the motor. The circuit includes a 12-volt battery, the remote control receiver, two relays, two limit switches, and the motor. The purpose of the circuit is to start the motor rotating when the remote button is pressed. As the bar goes along the threaded rod, it hits a limit switch when the latch is fully open. This then triggers a relay to switch the direction of the motor and close the latch. When the bar reaches its home position, another limit switch is pushed, causing the other relay to turn off the circuit.

The parts are all encased in a 15- by 7-inch wood case, which protrudes 2 3/4 inches from the door. The top of the case is made of Lucite and is cut into two sections. One section gives access to the battery, while the other is for the mechanical components of the device. Both sections are hinged to allow for access to the parts, though the component section is only accessible with the doorknob off. The battery compartment of the case includes two Velcro straps to secure the battery. The case is attached to the door by five wood screws.

Due to the extended distance, the unit protruding from the door, the main arm, the locking mechanism, and the screw holes had to be extended. This was done by fabricating an extension for the main arm that slid over the original arm and by welding an extension to the locking mechanism. Extenders were fabricated for the screw holes that screwed into the original holes, which had a threaded opening on the other end.

The total cost of this project was $232.

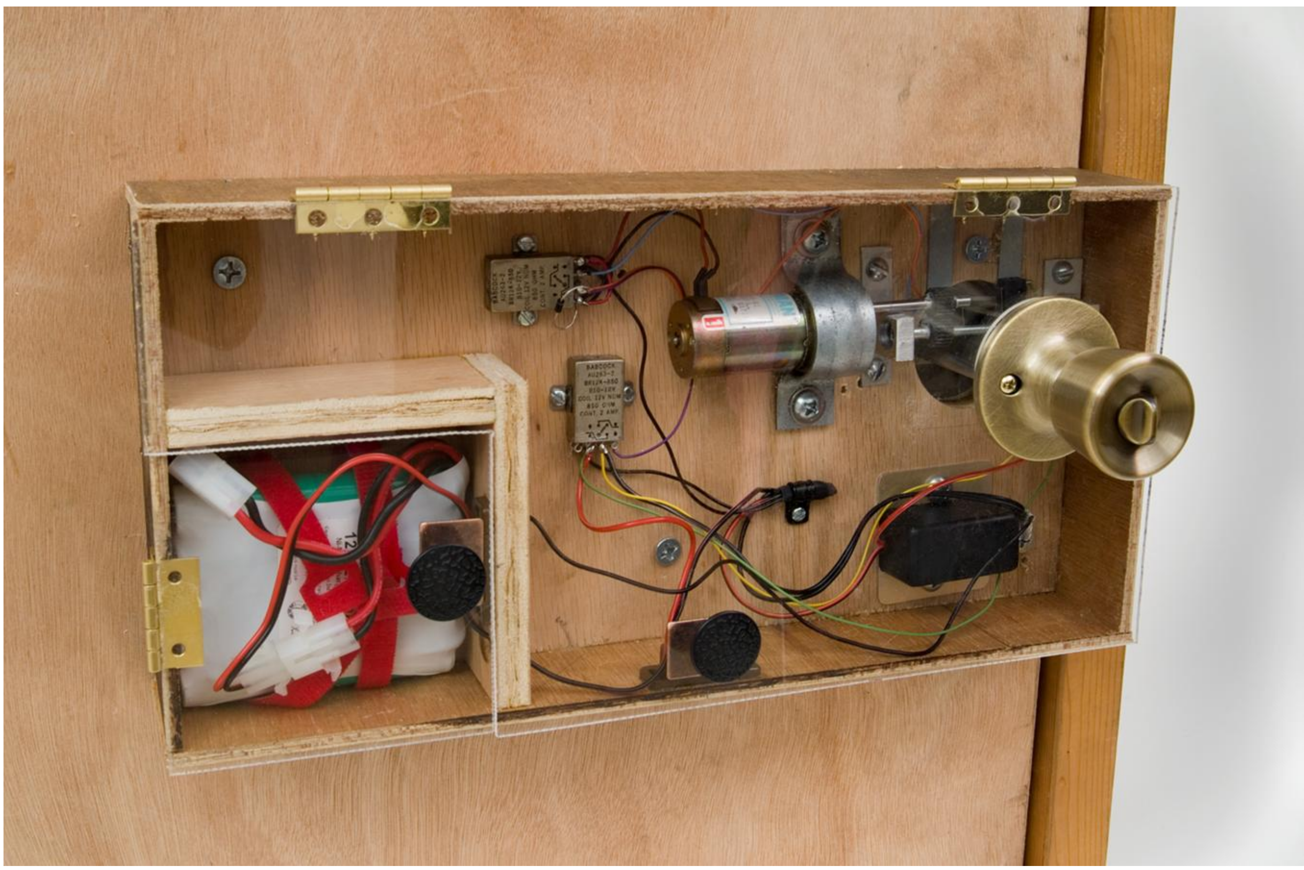

Fig. 11.47. Remote-Controlled Automatic Doorknob Opener.

ROLLABLE CHAIR BASE ATTACHMENT TO AID IN SITTING AT A TABLE

Designers: Thomas Heneghan and Patrick Pettengill
Supervising Professor: Dr. Joseph C. Mollendorf
Mechanical and Aerospace Engineering Department
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INTRODUCTION

When using a traditional four-legged chair, it can be difficult to pull or slide oneself toward a desk or table. Rather than sliding across the floor on the legs of the chair, the adjustable chair base attachment allows the user to roll on four caster wheels, making forward and backward movement much easier. By use of a mounted brake lever, keeping the chair where it is placed is also easily accomplished. The brake lever location on the chair's frame allows easy use of this device (see Fig. 11.48).

SUMMARY OF IMPACT

With the simple adjustment of the base, the frame can be mounted to just about any traditional four-legged chair to aid in mobility of those who are unable to pull themselves toward a table or desk using their own strength. This can also be used by people with a broken bone or those in a cast; they would not have to take all the weight off the chair's legs to move it, which can be especially difficult on rough surfaces and carpeting.

TECHNICAL DESCRIPTION

The adjustable chair base can be used with or without the use of the braking system, depending on the ground pitch and the user's preference. The brake lever is used to operate the brakes, which are standard on the caster wheels used. These brakes are designed to keep the chair stationary or free-rolling when needed. When used on level surfaces, the brakes can be used as needed by preference of user. The design of the braking mechanism on the wheel side gives the user the option of installing different wheels onto the frame for use on different surfaces, like hardwood floors. In the case that the wheels were changed, the braking system would remain in operation as long as the new wheels possess pre-installed brakes from the manufacturer.

Fig. 11.48. Brake Lever Location on Chair.

Fig. 11.50 shows a detailed view of the brakes located on the wheel side; as shown, this system utilizes the original brake lever.

The chair base is adjustable to fit chairs ranging from 16" to 20" deep and ranging up to a maximum width of 20". The main frame is made from one eighth inch thick angle iron for strength and rigidity. The frame is capable of handling up to 500 lbs and could be capable of handling more weight with the use of stronger caster wheels.

The brake lever assembly can be mounted easily with a few screws onto the underside of the chair seat itself. The brakes are operated by a standard bicycle brake cable for ease of use and possible replacement. When the chair is set on top of the frame, it is held down by tightening a tie-down strap over the leg supports and to both sides of the frame. The strap is used to add additional safety by securing the chair to the base without installing more screws into the chair.

The total cost for this project was about $81.

Fig. 11.49. Rollable Chair Base Attachment.

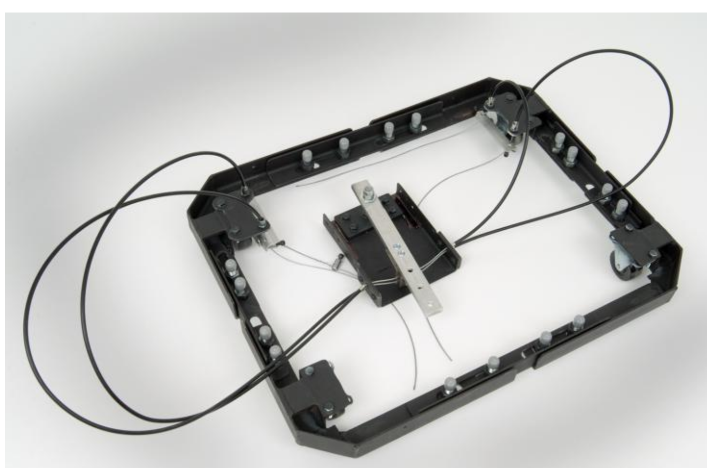

Fig. 11.50. Rollable Chair Base with Braking System.

SPACE-SAVING ADJUSTABLE CRUTCHES

Designer: Josh Hollenbeck
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INTRODUCTION

When someone injures a leg, he or she will often require a crutch to aid his or her mobility. Most crutches have limited adjustability, making one set usable by a small range of people. Also, many users complain about how uncomfortable their crutches are. This crutch addresses both of these problems since it is highly adjustable and has comfort gel on the underarm rest.

SUMMARY OF IMPACT

This device functions like any basic crutch and provides mobility for someone with an injured leg. The key difference between this crutch and any other one is its adjustability (see Fig. 11.51). The crutch works for anyone ranging from a height of about four feet to about six feet. This adjustability will allow hospitals and home medical suppliers to stock one size of crutch for almost any user instead of many different sizes, thus saving space in storage. The adjustability also allows for easy storage when not in use. This crutch is beneficial to a family as well. If one person in the family injures his or her leg, they can simply purchase this crutch and retain it in case another family member, regardless of his or her height, requires the aid of a crutch at a later time.

TECHNICAL DESCRIPTION

The adjustable crutch combines the technology of a standard aluminum crutch with that of an adjustable cane. The majority of the construction is very similar to a standard crutch; the difference lies above the handle, where the adjustable cane technology is implemented. The sliding adjustable tubes are attached, using rivets, to the existing tubing of the crutch, making the crutch highly adjustable. Holes are drilled along the crutch to allow for adjustment of the handle height. A small piece of angled metal is attached at the bottom of the crutch to act as a foot pedal for easy adjusting (see Fig. 11.52).

Fig. 11.51. Full Range of Adjustable Crutches.

Comfort gel is added to the underarm rest (see Fig. 11.53) for user convenience. This crutch will fit users in the height range of 51.2” to 73.3”.

The total cost of this product was about $63.

Fig. 11.52. Foot Pedal for Adjustments.

Fig. 11.53. Comfort Gel for Underarm Support.

ADJUSTABLE AND PORTABLE WHEELCHAIR SCISSOR LIFT

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INTRODUCTION

This device was designed to help people who use wheelchairs get into places that may not have been accessible in the past.

SUMMARY OF IMPACT

This device helps people using wheelchairs get into buildings or up large ledges that do not have the necessary features to allow for easy access.

TECHNICAL DESCRIPTION

The scissor lift is made to be portable and as light as possible for a quick and easy fix in order to get someone up or over an obstacle. The lift is operated by a half-inch drill, which enables this device to be used anywhere as long as a drill of this size is on hand. The lift has a square shaped frame with sides measuring roughly four feet long and only four inches high when the ramp is off to one side. There are scissor supports on both sides of the top platform and the bottom platform, where the same ends are fixed. The other ends are on rails that allow the scissor lift to slide around the base, pushing the platform up. The platform is propelled upwards with a scissor-car jack that is placed in the center of the unit. When the hooked bar is placed, this jack can be attached to the half inch drill.

The final cost of this project was $30.

Fig. 11.54. Adjustable and Portable Wheelchair Scissor Lift.

Fig. 11.55. Wheelchair Lift with Elevated Platform.

AUTOMATIC LOWERING AND RAISING CAR ROOF RACK SYSTEM

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INTRODUCTION

The Automatic Lowering and Raising Car Roof Rack System allows people who are short or people with upper body injuries to access a roof rack on a large vehicle. A motor connected to the roof rack is easily turned on with a push of a button, which can be placed anywhere inside of the vehicle. The rack is then lowered to the side of the vehicle for easy access (see Fig. 11.57).

SUMMARY OF IMPACT

Vehicles only have a certain capacity; many times luggage or other large items need to be placed on the top of the vehicle. People who are short or people with upper body injuries may not be able to access this luggage space. With the automatic lowering and raising ability, this space is easily accessible by almost anyone, even children.

TECHNICAL DESCRIPTION

The automatic rack began with a critique of a standard ski rack on a large SUV. The only way to reach the rack was by standing on the rear tire; this was not safe or even possible for many people.

Fig. 11.56. Automatic Lowering and Raising Car Roof Rack System.

The whole system is based around a garage door opener. This is the muscle of the system. The motor is a 1/2 horsepower, chain-driven system. The chain can be lengthened and shortened to fit any size vehicle. It has plenty of power to lift any amount of luggage that would typically be put on the top of a vehicle. A smaller, more condense motor could be used in place of this motor.

The chain is connected to the rack system, which is constructed of half-inch and three-quarter-inch steel tubing. Four horizontal sections are connected with two vertical sections each. These vertical sections are cut in half and connected with cotter pins to allow a bending motion as the system is lowered down the side of the vehicle. On the end of each horizontal piece are garage door wheels. These allow the rack system to easily roll up and down the top and side of the vehicle. These wheels can be padded to protect against vehicle damage during use.

The final part is the track system. The track system is very similar to that used with a garage door. These tracks are used to allow proper movement. They are just large enough for the wheels to fit in. They have three walls, a top, bottom, and side, to make sure that the rack system does not fall off the vehicle. The curved part of the track system uses only a one-wall design because this part would only be necessary when the vehicle is not moving. For this reason, it is unnecessary to add additional weight and wind resistance to the design.

With all three sections connected to the vehicle's roof, the motor can be attached to the battery of the car and the remote button can be placed anywhere in the inside of the vehicle.

The total cost of the automatic roof rack was approximately $200.

Fig. 11.57. Device Configuration While Loading.

SELF-PROPELLED TRAVEL LUGGAGE

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INTRODUCTION

The purpose of this project was to create a self-powered luggage device that makes traveling easier. This device is ideal in an airport where long, open, flat hallways require people to physically move their luggage relatively long distances. This device is intended for people who have disabilities who travel on a regular basis, and would like an easy way to transport their checked luggage. It can also be scaled down to accommodate carry-on luggage, although that was not the goal for this prototype.

SUMMARY OF IMPACT

The device proved to be a very effective. The speed can be adjusted from very slow to a fast-paced jog by twisting the throttle. It takes very little practice to become proficient at using the throttle mechanism.

TECHNICAL DESCRIPTION

The heart of the Self-Propelled Travel Luggage (see Fig. 11.58) is the electrical system, which consists of a 24-volt DC motor, 24-volt speed control, battery power supply, and twist throttle (see Fig. 11.59). This system was obtained by using parts from an electric scooter.

The system operates at 24 volts and uses two 12-volt batteries wired in series to produce the required voltage. When installation is completed, the throttle can be twisted to deliver variable power to the motor. The amount of power transmitted is dependent upon the throttle rotation angle.

The reason for the twist throttle being located on the right side is due to the angular velocity created as the cart moves forward. By changing the mounting from the left to right side, the throttle does not continue to twist as the luggage cart moves forward. If the throttle was kept on the left side of the cart, it would continue to gain speed and quickly get out of control.

Fig. 11.58. Frame and Electrical Components.

Fig. 11.59. Twist Throttle.

The device is rear-wheel drive and the motor delivers power to the driveshaft through a #25-chain and sprocket. The gear ratio (one to four) greatly reduces the amount of top speed the cart can accomplish. This makes carrying large loads easier since there is stronger low velocity acceleration.

There are several improvements that would need to be made in order to commercialize this device. These include modifications to the electrical system and overall setup that would make use easier and more practical. An improvement to the electrical system would be the introduction of a speed control, which has the capability to reverse. This could be used as a brake and also to navigate in tight corners and elevators.

A simple battery charger could be added for a small price. This would consist of a charger to be permanently connected to the battery packs. It could then plug into an outlet through a retractable cord. This part was not added in order to keep the cost of the project to a minimum.

To make the luggage practical for travel, the handle would also need to collapse upon itself. There are many systems available on the market to accomplish this task; the best solution would be a twist-locking mechanism. This feature would also make the product more versatile.

Another improvement would be wagon-style turning, which is when the front axle turns on a pivot at its center. Wagon-style turning would be a great way to navigate this cart in tight corridors or elevators. This would allow the front end to be turned more readily. In this case, the front wheels could be motorized. This would greatly enhance the maneuverability of the luggage when combined with a speed control which is capable of traveling in reverse.

Safety concerns are numerous for a product of this nature. If this is put in unfamiliar hands, it could quickly become a fast moving projectile. It does not take long to learn the standard operating procedures of this cart. If it were to be used as intended, it would remain safe.

The total cost was approximately $200.

Fig. 11.60. Self-Propelled Travel Luggage in Use.

FLYWHEEL ENERGY STORAGE ATTACHMENT FOR MANUAL WHEELCHAIRS

Designers: Jarrett Kaczmarski and Jeremy Kruger
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INTRODUCTION

The operation of a manually powered wheelchair is inefficient in nature. Nearly constant energy input is required to keep the wheelchair in constant motion. The addition of the flywheel to the wheelchair's drive wheels acts as an energy storage device, being charged while the operator is manually spinning the wheelchair and discharged when the energy input is discontinued. The flywheel design has two gears, one connected directly to the flywheel and the other to a free-spinning gear with an internal bearing. This feature allows the operator to switch between the flywheel mode and the free gear side depending on his or her preference, which allows this device to function as a conventional wheelchair.

SUMMARY OF IMPACT

The attachment of a flywheel to a manually powered wheelchair reduces long-term fatigue of the operator. Once the flywheel is charged and engaged, all the operator has to do is sit back and enjoy the ride. It is useful for assisting wheelchair users climbing ramps and going down long hallways. The addition of the free-spinning gear allows the wheelchair to act in its conventional manner. The free gear setting might be used in a crowded situation, or where long straight paths are not possible.

TECHNICAL DESCRIPTION

The flywheel attachment device consists of two main axles (see Fig. 11.61). The first is the drive axle, which is connected to the large rear wheels of the wheelchair; the second is the flywheel axle, which sits in the enclosure mounted on bearings. The wheelchair wheels are connected to the drive axle by a connector plate with a welded internal thread collar for mating to the drive axle. Each connector plate is pre-drilled for the different spoke arrangements of various style wheels. The drive axle is a three-piece system, with two pieces connecting to the wheelchair wheels and then threading into the drive gear axle. Connecting the drive gear to the drive axle is a machined hub, which fits inside the gear and allows for the drive axle to pass the center with a keyway for proper positioning and torque transfer. An eight-inch 52-tooth gear was used to provide a sufficient gear ratio.

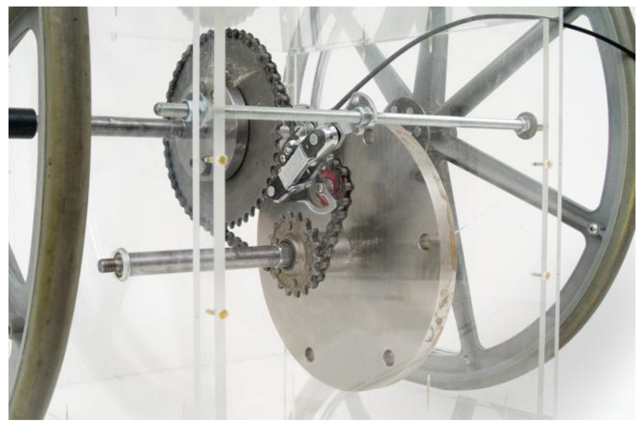

Fig. 11.61. Gear and Flywheel Assembly.

Fig. 11.62. Derailleur and Chain System.

The flywheel axle is a two-piece construction with each outer side of the shaft resting in bearings mounted in the enclosure. The flywheel sits on the left shaft with the use of a keyway. Attached to the flywheel is a two and a half-inch extension that the flywheel gear mounts to, its position being fixed with the use of a machined step on one side and a collar on the other side. The flywheel gear is a two inch 14-tooth bicycle gear, providing a four to one gear ratio from the drive gear to the flywheel. The free gear is mounted on the smaller portion of the left shaft. The free gear slides over the threads with a locking nut to fix its axial position. The shaft can be adjusted axially by threading the right shaft further on or off the left shaft. The free gear is a three inch 18-tooth gear with an internal bearing. This provides a two and a half to one gear advantage from the drive gear; this is unnecessary since it is not spinning against any resistance. Instead, this gear size was chosen to mate well with the flywheel gear.

A basic spring-loaded derailleur by XUNDAH (see Fig. 11.62) was used for the gear changing. This was mounted on a third shaft running across the entire enclosure. The derailleur is mounted so its gears are aligned with the flywheel gear. A #41 chain was used to connect the entire system. The derailleur was operated by a six-speed bicycle shifter, connected by a tension cable between both components.

The final cost of this project was $197.

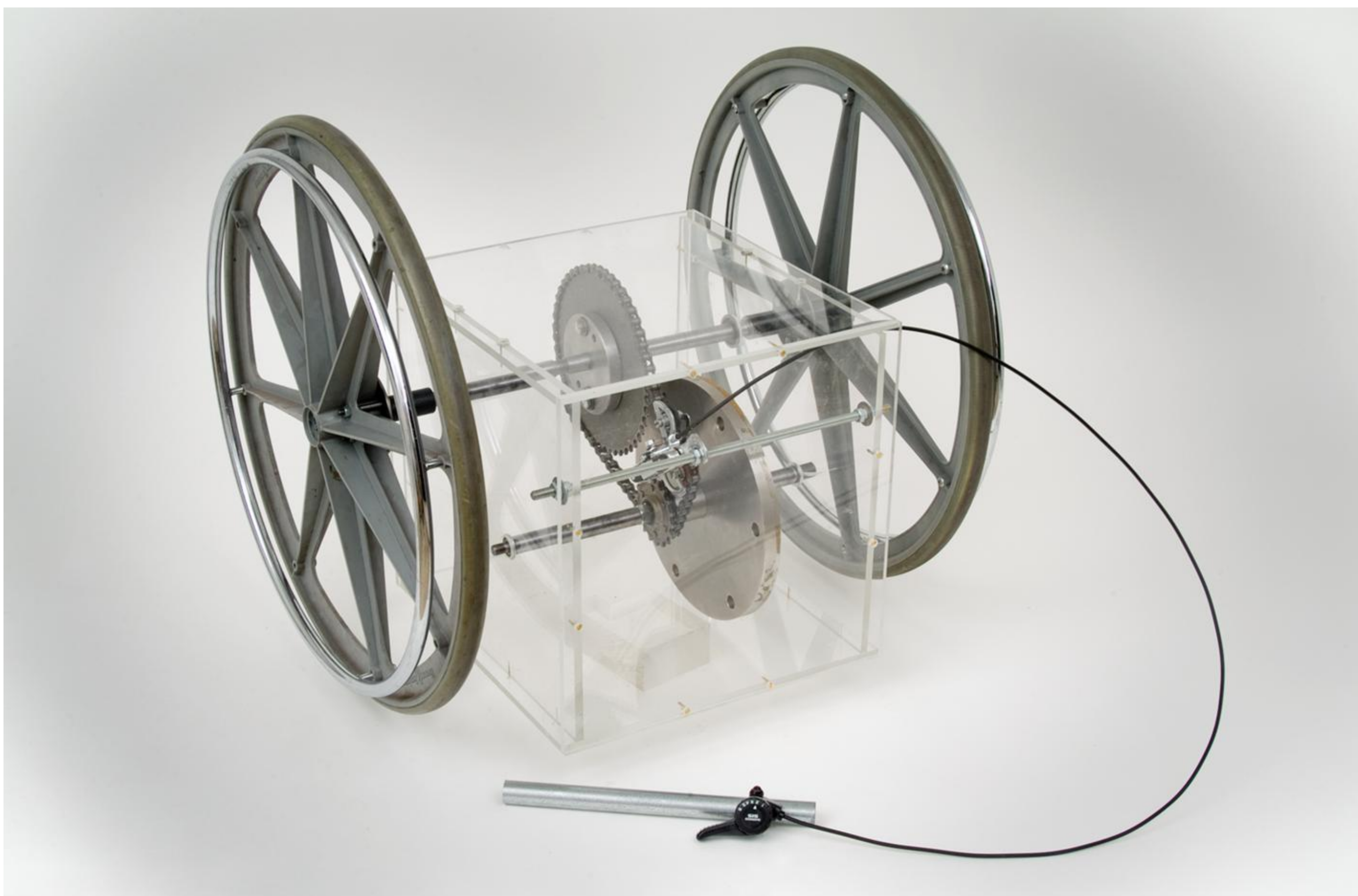

Fig. 11.63. Flywheel Energy Storage Attachment for Manual Wheelchairs.

RETRACTABLE STABILITY MECHANISM CRUTCH WITH LED NAVIGATION

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Client: Scott Goheen
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INTRODUCTION

People who use forearm crutches find that these types of crutches are not very stable. Due to the fact that they need to use both hands to work the crutches, it is difficult for them to hold a flashlight if they need to move around at night.

SUMMARY OF IMPACT

With the addition of the four extra leg supports, the crutches become very stable and can stand by themselves (see Fig. 11.64). LED lights were added to each crutch to allow the user to see at night and move around without any assistance from another person (see Fig. 11.65).

TECHNICAL DESCRIPTION

A pair of height-adjustable crutches was used to attach the LED light navigation system and extra leg supports. The LED lights were attached to the crutch with a screw and bolt. The lights were located just below the handle so that the user can turn them on and off by using his or her pinky finger.

The two circular parts for each leg support system were made from a three inch diameter piece of aluminum stock. It was milled on a lathe to have the bottom portion be 2 9/16″ in diameter and 11/16″ thick. The top portion was milled to be 3 5/16″ thick and have a diameter of 1 3/8″. The piece was then bored out to a diameter of 7/8″, leaving a wall thickness of one quarter inch. A 3/16″ groove was then milled into the circular part. The groove is cut by starting at one inch down from the top of the part and cutting a vertical groove 5/16″ toward the top of the part. A slot was then cut to allow the square bracket and leg supports to be moved into position for use and moved out of position when not in use.

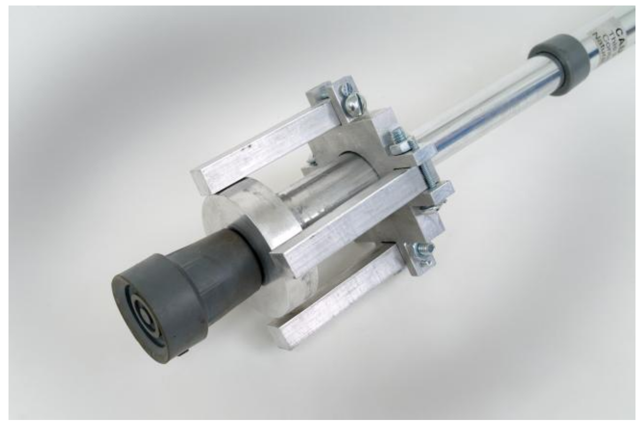

Fig. 11.64. Additional Leg Supports.

Fig. 11.65. LED Light Attached to Crutch.

The two square brackets needed to hold the supports and mount to the circular parts were machined from a four inch by half inch by 12″ flat bar. Each bracket was made 4″ x 4″ square, and has a hole bored through the middle with a 1 3/8″ diameter. The four sides each have a slot cut into them that holds the support legs. Each slot is located ¾″ from either corner and has a wall thickness of a ¼″; the width of the gap is ½″. For each slot, two holes were bored to hold the leg supports. One hole is a ¼″ diameter located ½″from the end, and the other hole is a 1/8″ diameter located 3/16″ from the end. The 3/16″ hole holds a screw that keeps the leg supports from fanning out away from the crutch leg. A 3/16 hole is then counter-bored into the bracket and a 10-32 threaded screw is inserted. This screw sits in the slot that is cut into the circular part and holds the square bracket and legs onto the circular part.

The eight leg supports were cut from half inch by 4′ long square bar stock. Each leg was cut to 3 7/16″ and has a ¼″ diameter hole located ¼″ down from the top edge of the leg. These legs are then attached to the square brackets using ¼″ bolts.

The entire unit is then assembled and bolted to the crutches. The rubber end cap is removed, and the unit is placed on the shaft of the crutch. The end cap is then replaced, and the unit rests on the top of the end cap and is bolted into place.

The cost of this project was $69.

Fig. 11.66. Retractable Stability Mechanism Crutch with LED Navigation.

RANGE FINDER FOR PEOPLE WITH VISUAL IMPAIRMENTS

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Co-designer: Roger Krupski
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INTRODUCTION

Navigation and obstacle avoidance can be difficult for people with visual impairments. The goal of this project was to allow the user to identify obstacles and paths in the surrounding environment with a simple, easy-to-use device. A handheld system was chosen for two reasons: to reduce the amount of stress on the person's body when using it for long periods of time, and because it is likely that people who have been visually impaired for a long time will be comfortable using a handheld device for detecting the environment, similar to a cane. This handheld component (see Fig. 11.67) uses a flashlight casing as the enclosure for comfort and for reduced weight.

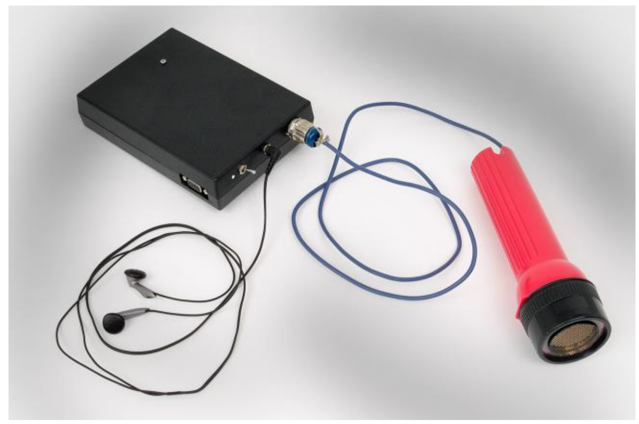

Fig. 11.67. Range Finder for People with Visual Impairments.

SUMMARY OF IMPACT

By using a flashlight casing, and keeping only the needed components inside, the part of this device that is handheld can be used for long periods of time without straining the user's hand. It also provides the advantage of being able to quickly scan multiple directions with little effort and can easily be stowed inside a coat pocket when not in use. The belt-mounted enclosure safely contains all other components and allows the user to easily switch the device on and off. Finally, the transducer used provides a narrow enough beam that information regarding the environment can be obtained quickly and reliably.

TECHNICAL DESCRIPTION

The Polaroid Electrostatic transducer is mounted by fitting it into a hole through the flashlight's plastic lens. The diameter of the hole is slightly larger than the diameter of the front of the transducer (1.513"). A small amount of glue was used on the lip of the transducer, which has a diameter of 1.69" and is 0.159" behind the front of the transducer. This allows the front portion of the transducer to protrude from the lens while holding it in place. Once the transducer was secured to the lens, it was placed inside the cap, which was fitted to hold the lens.

The Polaroid 6500 series sonar ranging module is secured in the front part of the flashlight case using the tapering of the flashlight's front and a slot, which held the actual parts of the flashlight. Additionally, the module is surrounded by non-conductive foam for protection. The module had its edges, not containing circuitry, trimmed to fit the slot and had a 500uF capacitor attached to account for the power drain each time it pings. The wires in the cable that carry power to the module and a signal from the module to the controller, were then attached and run out the back of the case. Once the transducer was connected to the module, the cap was filled with the non-conductive foam and placed onto the flashlight; this applies pressure to the back of the transducer to help secure it in the cap and prevents contact with the module. At the end of the cable, a plug was attached so that the handheld component can be disconnected.

The controller is the CME-11E9-EVBU board made by Axiom Manufacturing. This board was mounted within a purchased 4.88" x 6.88" x 1.5" enclosure that had been slightly modified. Once the board was secured, a volume control, a toggle switch, a connection to the module, and a connection to the power source were attached. The power source for the prototype is four AAA lithium batteries, which allow the system to run for 19 hours before they have to be replaced. A potential way to improve the system would be to use either AA batteries or use rechargeable batteries and have a plug setup so they can be charged without removing them from the enclosure.

The code for the range finder is programmed into the controller and adjusted to give the desired range and ping rate. This gives it a minimum range of about 1 1/2 feet; under this range, the tone will not change. The maximum range is set at 13 feet; the device will generate no tones at distances longer than this. The code can be adjusted to increase or decrease these ranges. A lower range will make the tones more sensitive to change; however, it will also decrease the area that can be sensed. The present settings were determined by repeated testing of the device to obtain enough sensitivity to identify significant changes in the distance while giving a reasonable amount of range. The final component is the headphones, which emit a tone based on distance. The pitch of the tone is determined by the controller board, and any stereo headphones can be used with this device.

The total cost of this device was approximately $195.

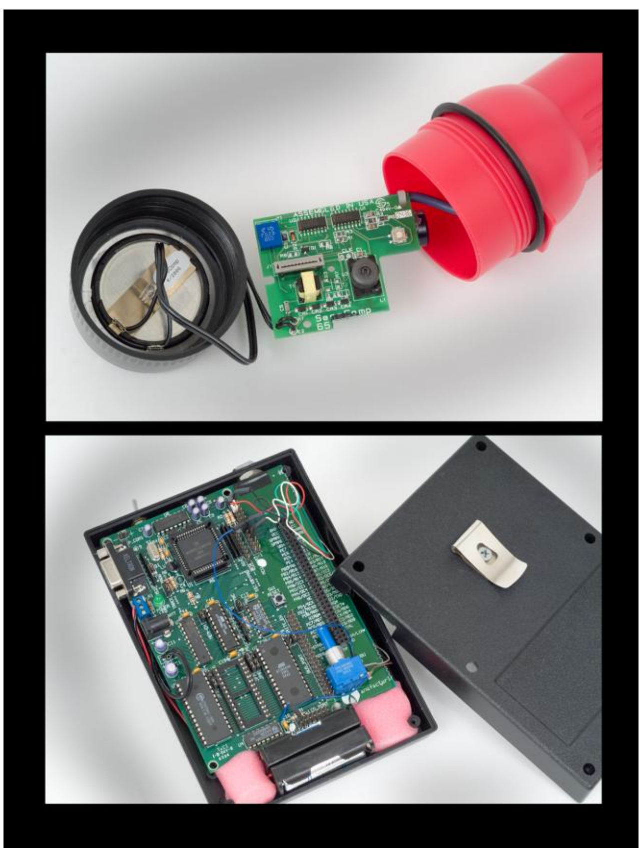

Fig. 11.68. Internal Components of Range Finder.

Fig. 11.69. Range Finder in Use.

RETRACTABLE STEP ACCESS FOR SCOOTERS

Designer: Jacqueline Kuczmanski
Client Coordinator: Renae Gullo
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INTRODUCTION

Although motorized scooters have adjustable settings, they still may not meet the needs of some people with dwarfism. The client in this case is approximately 2 ½′ tall (30″). It is difficult for her to get onto the seat, which is approximately 1 ½′ from the ground. The Retractable Step Access for Scooters was designed as an accessory that can be attached to the seat of motorized scooters. The lever-operated steps extend and retract to assist the client in getting on and off the scooter seat.

SUMMARY OF IMPACT

Prior to the Retractable Step Access, the client got up onto the scooter seat by climbing. Therefore, the Retractable Step Access increases the client's comfort and enhances safety while she gets on and off the scooter seat. In addition, its ease of use increases the client's independence.

TECHNICAL DESCRIPTION

The Retractable Step Access is designed as an accessory for a Sonic Pride Mobility Scooter (see Fig. 11.70). The motorized scooter disassembles into three components: 1) the rear wheels; 2) the platform with steering device; and 3) the seat. In this design, the Retractable Step Access attaches to the seat component of the motorized scooter. The seat component of the Sonic Pride consists of the plastic seat fastened to a steel support plate.

The Retractable Step Access base is a steel plate that fits between the plastic seat and the steel support plate of the Sonic Pride Scooter. Angle iron was welded to the base steel plate to provide for mounting locations and support (see Fig. 11.71). The actual steps are made of 6063 aluminum plates, supported by 6063 angled aluminum. For safety, the steps are covered with adhesive tread, which has a yellow strip to easily indicate its location. The steps

Fig. 11.70. Retractable Steps Installed on Scooter.

connect to the angle iron of the base with one inch steel flat bars that were cut and shaped into linkage arms; these linkage arms provide the means to extend and retract the steps.

The steps retract and extend by the use of a lever. The lever is constructed from half inch metal tubing. The tube construction provides the necessary strength to eliminate bending when a force is applied to bring the steps out of a locked position.

The steps lock in two positions: extension and retraction. To lock the steps in the extended position, the lever fits between two small cylinders that are welded to the steel base. The lever is held between these cylinders by an applied spring force. To remove the steps from their locked position, the lever must be pushed outwards; this action compresses the spring. As long as this force is applied (spring is compressed), the steps extend and retract freely. To lock the steps in the retracted position, the lever is pushed in front of the cylinders; the lever rests upon the front cylinder.

The total cost of this project was approximately $105.

Fig. 11.71. Retractable Step Access for Scooter.

Fig. 11.72. Retractable Steps in Extended Position.

WALKING STICK STOOL COMBINATION

Designer: Rachel LoSecco
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INTRODUCTION

Walking for extended periods of time can become tiresome for many people. A device was designed for those who walk with a walking stick and need an immediate, temporary place to rest. The walking stick stool combination allows the client who uses a walking stick to unfold the legs and raise the seat, thus converting the walking stick into a temporary stool.

SUMMARY OF IMPACT

The walking stick stool allows the client to rest while walking and when other seating is not available.

TECHNICAL DESCRIPTION

The walking stick stool combination consists of a one inch aluminum shaft with two assemblies and two parts welded to it. At the top of the shaft is a foam ergonomic handle. Just below the handle, there is a square-shaped aluminum part, which is called a stopper, welded to the shaft. This is to keep the seat from folding inward when weight is applied. Below the stopper, there is another aluminum part that slides up and down the shaft; this is referred to as the slider. Attached to the slider are the four aluminum arms for the seat part of the stool. At the other end of the arms, a nylon cloth seat is attached. This nylon cloth came from a children's camping chair that required some modification. It was attached to the arms using washers, fender washers, and screws. There is a hole in the center so the foam handle can come through it when in walking stick mode.

The legs are located on the shaft below the slider. This portion of the device came from an old tripod. These legs are permanently attached using a spring pin that is chained to the collar that holds the legs. For stability purposes, when in stool mode, there is an aluminum plate welded to the bottom of the shaft. When in walking stick mode, the slider is down, and the legs are folded inward; both are held in place with Velcro.

Fig. 11.73. Device Configuration While Acting as a Stool.

When changing to stool mode, the client should first undo the Velcro and manually open the legs. Then the client should remove the Velcro from the seat part, slide the slider into the stool position, and insert the spring pin. The spring pin is attached to the slider with a chain. The client may then rest on the stool. With this design, the client must use at least one leg to provide balance. At this time, the device is made for people who are five feet seven inches in height and 150 pounds or less in weight.

More adjustable and stable versions of this device are possible.

The total cost of this device was $64.

Fig. 11.74. Device Configuration While Acting as a Cane.

ADJUSTABLE SHOWER HEAD FOR PEOPLE WITH DISABILITIES

Designers: Thomas Nicholas and Surinder Singh
Supervising Professor: Dr. Joseph C. Mollendorf
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INTRODUCTION

People with disabilities are often not able to use a normal shower or bathtub system. Shower chairs and benches are designed to give the client support, but little has been done to aid someone with limited mobility of their extremities. This device was designed to bring the shower head and cleaning products closer to the client while showering.

SUMMARY OF IMPACT

This adjustable shower system allows clients to have a greater sense of independence as they will be able to adequately cleanse themselves without the assistance of others. It provides the client with a complete shower and also enhances the client's safety. This device was designed to be used in conjunction with a shower chair or bench.

TECHNICAL DESCRIPTION

The device's main component is the spring-roller system that is used to raise and lower the shower head and personal cleansing dispenser. The spring-rollers used in the prototype were taken from two sets of household miniature blinds and customized to fit the design specifications. The spring-rollers are to be operated in the same manner as the miniature blinds.

The hand-held shower head is connected to an 80" flexible brass hose, which connects to a three-way diverter valve. The diverter valve connects directly to the existing wall-mounted shower flange. The third flow direction allows for the connection of a normal shower head so that others can also use the shower.

The cleansing dispenser has two components for shampoo and shower gel. Also included with this device is a foot-wash basin. The basin was designed

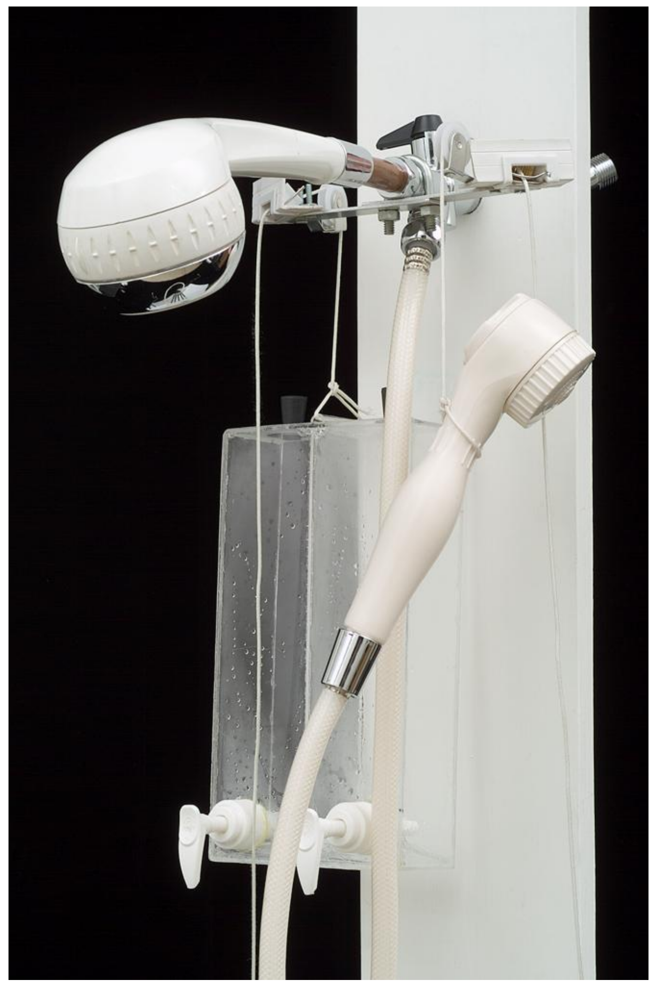

Fig. 11.75. Adjustable Shower Head and Dispenser.

with a slightly sloped bottom for drainage and sponges which help clean the patient's feet. Each of these components increases the patient's ability to adequately cleanse themselves.

The final cost of this project was $110.

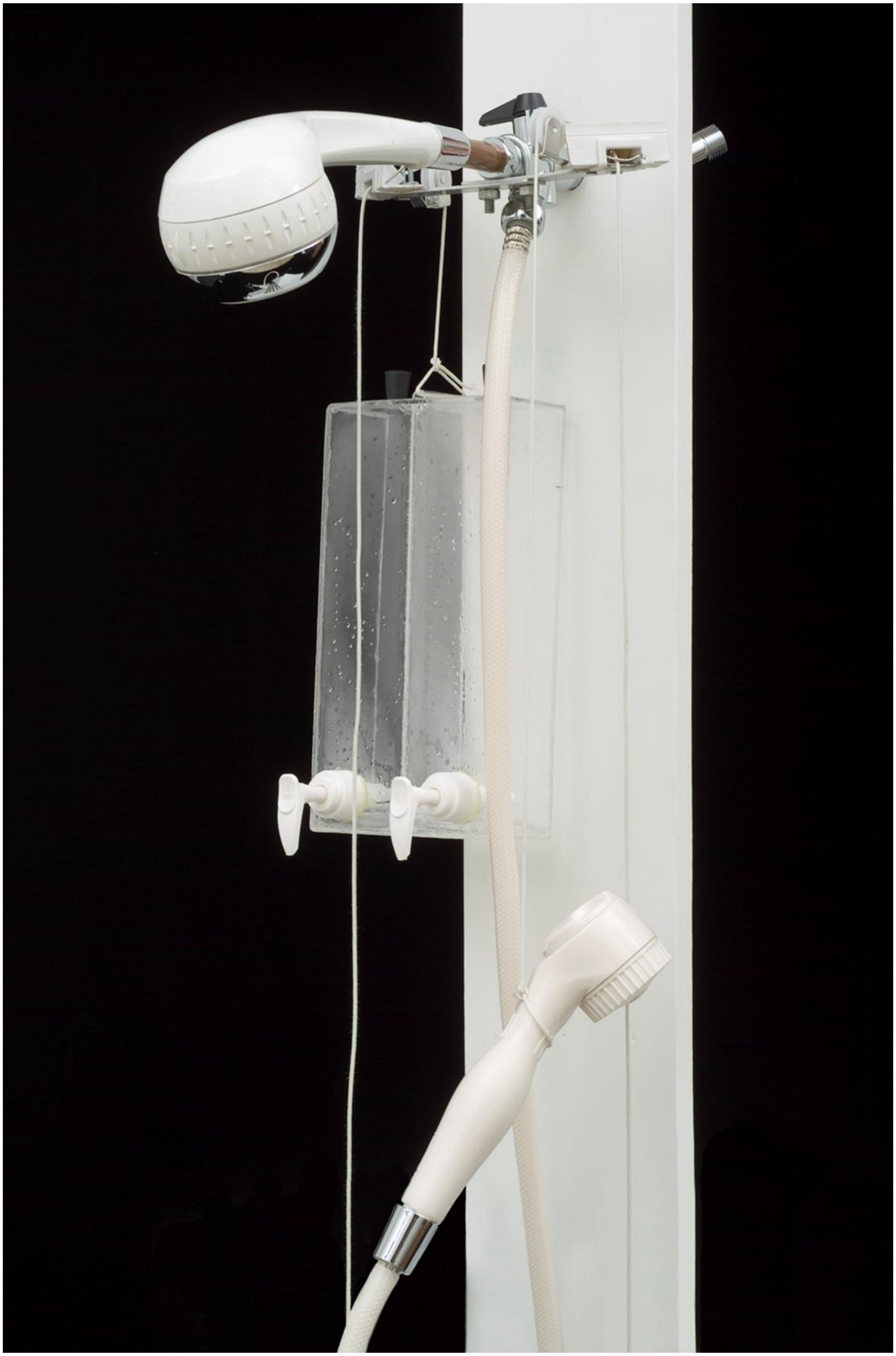

Fig. 11.76. Device with Shower Head Lowered.

REDESIGN OF A QUAD-CANE BASE: TERRAIN ADAPTIVE AND SHOCK ABSORBING WALKING CANE

Designer: William Ofori-Atta
Supervising Professor: Dr. Joseph C. Mollendorf
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INTRODUCTION

Current quad canes do not adapt to the surface of contact or absorb shock. This new design will reduce falls on terrains such as cracked pavement, gravel, and uneven surfaces. Since the feet of quad-canes are rigid, the cane is unbalanced on uneven surfaces. This causes slips and falls, which can result in injuries to users.

SUMMARY OF IMPACT

This new design will enable the cane to be flexible on uneven surfaces and also absorb shock. This will reduce the number of falls caused by slips on rough and uneven surfaces.

TECHNICAL DESCRIPTION

To make the quad-cane terrain adaptive, the base of the cane was redesigned (see Fig. 11.78). The materials used for the new base included four square aluminum plates, measuring three by three inches, with a one inch radius located at the right corner of the base. The base also includes four one inch hollow aluminum studs and a square steel plate with holes drilled at the four corners. The feet utilize four 12-14-lb compression springs with a one inch inside diameter and a height of three inches; each spring was inserted into non-slip rubber cane tips. For the base spring, a 50-70-lb compression spring, with a height of three inches and an inside diameter of two inches was used.

The four aluminum plates had a stud welded to their centers and were then bolted to the steel plate with three inches of space between two sets of plates. The steel spring is encased in two steel tubes to limit the degree of movement to 15 degrees. It was then welded to the center steel piece. A regular cane shaft with a height adjustable button was then welded to the top of the encased spring. This base spring will serve as a shock absorber for the device.

Fig. 11.77. Terrain Adaptive and Shock Absorbing Walking Cane.

The four compression springs are tight-fitted on the studs at the bottom of the aluminum plates. On uneven surfaces, as the user's weight is shifted while using the cane, the springs will deflect and adapt to the surface of contact.

The cost of parts and materials was about $55.

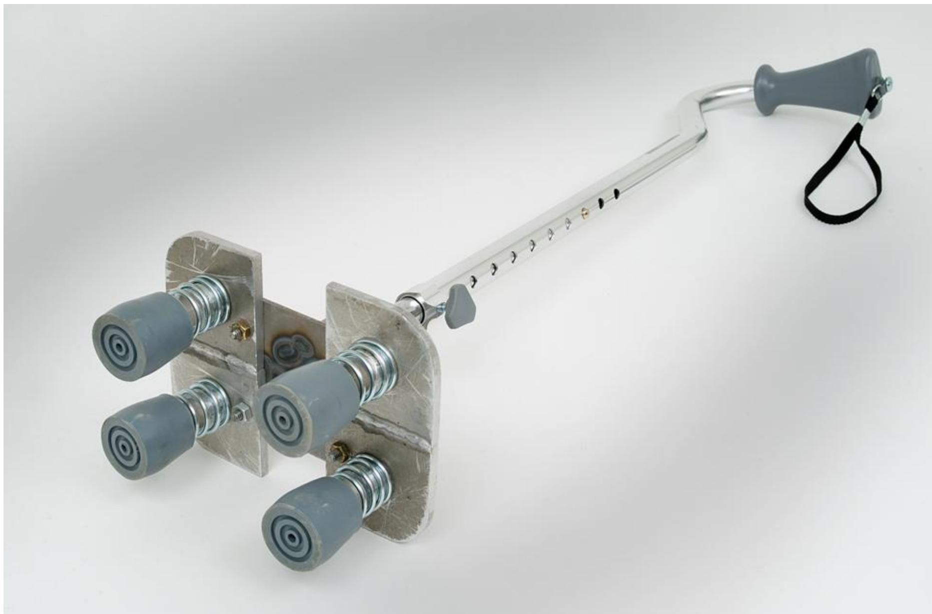

Fig. 11.78. Modified Base of Walking Cane.

Fig. 11.79. Terrain Adaptive and Shock Absorbing Walking Cane on Rough Surface.

THERAPEUTIC DEVICE TO IMPROVE BALANCE FOR THE ELDERLY

Designer: Mary Russell
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INTRODUCTION

As an individual grows older, his or her lower extremities weaken, increasing the chance of a severe injury. The use of a therapeutic device may not only decrease fall risk but also decrease the cost of fall injuries.

SUMMARY OF IMPACT

Many products on the market assist individuals with walking and moving short distances. However, very few of these products help to improve balance therapeutically. This design is unique in that it targets elderly individuals who want to avoid using walkers in their everyday lives.

TECHNICAL DESCRIPTION

The device consists of a 1.5″ thick plywood platform (see Fig. 11.80) that measures 3′ x 4′ and provides a safe and supportive surface. Attached to the top of the platform are three separate sections of PVC pipe. The front section of the PVC pipe consists of a T-design with three legs and dimensions of 36″ x 37″, while the two U-shape side pieces have two legs each with dimensions of 23.75″ x 37.5″. At the end of these legs, a PVC adapter is threaded into a metal flange. This flange is then screwed into the platform using one and a quarter inch wood screws.

In the middle of the platform, the individual stands on two balance discs, one for each foot, which are 14″ in diameter with a thickness of two inches (see Fig. 11.81). This allows the individual to improve his or her balance, and the PVC pieces available if support is needed.

Using superglue, the four strain gauges are mounted, 90 degrees apart from each other in the center of each individual leg. These strain gauges have been wired to obtain bending loads. A data acquisition system was connected to the strain gauges for measuring the output when a force is applied to any of the PVC sections. Once received, the data is converted into a Microsoft Excel document and manipulated as necessary. This allows a physical therapist to evaluate which side of the body is weaker and needs more concentrated therapy.

The main component of this data acquisition system is a Motorola 68HC11 Microcontroller (MCU). The MCU provides digital data inputs, digital data outputs, and analog data inputs. These inputs and outputs can be manipulated with software running in the MCU chip.

The MCU circuit board also contains support hardware, which includes spring switches for operator input, 16 character LCD display for operator visual information, a solid-state piezo beeper module for operator audible information, a standard serial port operating at 9600 baud for program development, a debugging system for the final product, data output to be recorded on a PC, MAC or other computer, a strain gauge conditioner to amplify force information from the balance and present data to the MCU as a DC signal ranging from zero to five volts, and a battery pack to provide portable operation.

The total cost of the project was $212.

Fig. 11.80. Therapeutic Device to Improve Balance for Elderly, in Use.

WIRELESS INFRARED TRANSMITTING FIRE ALARM WITH VIBRATING BAND RECEIVER

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INTRODUCTION

The fire alarm is a common safety feature readily available in many public locations. It is a customary invention with some differences among models that typically involve a bell and a light that responds to heat or smoke exposure. A modified fire alarm (see Fig. 11.82) was designed for people with impaired hearing. Since this device uses more than a blinking light to warn people of a fire, people with poor hearing will now be able to sleep or relax with more comfort.

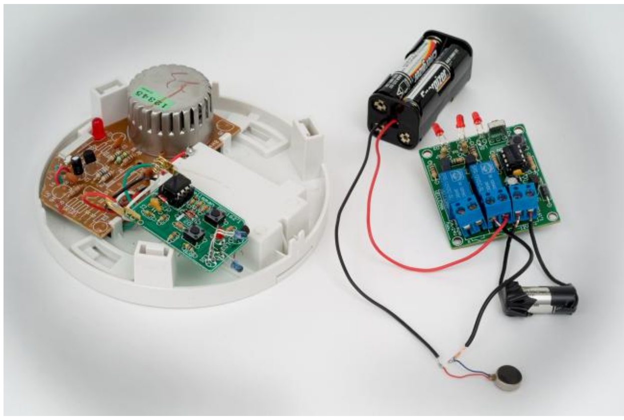

Fig. 11.82. Modified Fire Alarm.

SUMMARY OF IMPACT

The device helps people with disabilities sleep more safely. Similar products on the market vibrate a bed or pillow to wake the user. This product allows the user to sleep or rest anywhere, as long as he or she is wearing the device.

TECHNICAL DESCRIPTION

The initial system requirements for this project consisted of a comfortable and durable band, transmitter with a strong enough range, and reasonable budget. The project consisted of wireless infrared transmitter and receiver, standard fire alarm, and vibrating DC motor. The transmitter and receiver were built from kits ordered from ApogeeKits, specifically the MK161 and MK162. They were infrared, small, and required some intensive assembly.

The transmitter was modified and mounted onto the fire alarm in place of the bell. By wiring the transmitter directly through the fire alarm, no supplemental battery source was required. The fire alarm/transmitter sends a signal in bursts of three and runs off of a nine volt battery.

The second part of the product is the receiving kit (see Fig. 11.83). As the three bursts of IR transmission are received, the kit responds accordingly. The kit is built with two separate circuit dry switch loops. It runs off a 12-volt battery for maximum life. The dry switch loops have no current flowing through them from the receiver itself; they are simply switches that close and allow flow when the transmitter fires. Wired through one of these closed loop circuits is a DC Samsung a670 vibrating phone motor. This motor is small, yet powerful enough to be noticed by the user. It is wired to collection of four one and a half volt batteries (AAs). When the loop is closed, the six volts flow through the motor and the motor begins to vibrate.

This entire assembly is placed into an arm band typically used for an I-pod. It has a clear front to allow for minimum IR interference, as well as an adjustable strap for maximum comfort. It has a Velcro case to make it easy for the user to change the battery.

The total cost of all the equipment combined was $85.

Fig. 11.83. Armband Receiving Kit.

ADJUSTABLE TEMPERATURE PRESET DOUBLE-KNOB FAUCET ATTACHMENT

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INTRODUCTION

Currently, new houses come equipped with easy-to-use bathroom and kitchen sinks that allow a person to control water temperature and flow rates in various ways. Many home owners with older faucets still find themselves twisting and fiddling with the faucet knobs to get the desired flow rate and temperature. This may sound like a simple task, but it can prove to be a nuisance for a person with a disability such as arthritis. This design is intended to alleviate the nuisance of fidgeting with knobs in order to achieve a desired water flow temperature.

SUMMARY OF IMPACT

This attachment allows users to set the water flow temperature that best suits the task they do most frequently in the bathroom or kitchen sink. The simple design and low number of components helps make the attachment more affordable. The attachment easily installs onto a standard double-knob faucet tap, allowing the user to control both taps at the same time. This attachment gives any homeowner the option of having an easy-to-use faucet in their home without the cost of a brand new, high-priced faucet.

TECHNICAL DESCRIPTION

This design uses a simple three-bar mechanism that allows the attachment to turn both taps in unison with the push of a handle. A key feature of this design is the adjustable bar located on the cold water tap (see Fig. 11.85 and Fig. 11.86). The adjustable bar is located on the cold water tap because the pressure on the cold water tap is usually higher than the pressure on the hot water tap. This pressure difference may be due to the restricted flow of the hot water through the water heater. This causes the water mixture to be cold when both taps are opened all the way. This attachment allows the user to regulate the hot and cold water ratio by adjusting the length of the bar on the cold water tap.

Fig. 11.84. Adjustable Temperature Preset Double Knob Faucet Attachment.

Fig. 11.85. Device with Both Taps Set Equally.

Extending the length on the cold water tap decreases the cold water flow rate with respect to the hot water flow rate. This gives the user a warmer water mixture if desired. Once the user finds a comfortable water flow temperature during use, they can attain that same temperature at any other times through the push of a handle. The adjustable bar on the cold water tap extends to about three times the length of the bar attached to the hot water tap. This allows the user to get a mixture of water that is fairly warm.

The final cost of this project was $32.

Fig. 11.86. Device with Adjusted Cold Water Tap.

Fig. 11.87. Device Configuration When Faucet is Turned On.

HYDRAULIC HEIGHT-ADJUSTABLE KITCHEN ASSIST CHAIR

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INTRODUCTION

This device was designed to assist people with weak legs in performing everyday kitchen tasks. Preparing food can take a long time, and it is hard for people with weak legs to stand for extended periods of time. This device provides a place for a person to sit while preparing a meal. The person is able to sit at a normal table height, or they can raise the chair so they can reach high countertops without getting up from the chair.

SUMMARY OF IMPACT

The Hydraulic Height-Adjustable Kitchen Assist Chair (see Fig. 11.88) is a rolling chair that allows a person to maneuver around the kitchen with great freedom. As an alternative to a wheelchair, this chair is not bulky and is height adjustable so that a person can comfortably reach countertops of various heights. The hydraulic hand pump (see Fig. 11.89) allows the person to raise and lower the chair without getting up from it. It also provides a mode for exercise to help strengthen the person's upper body.

Fig. 11.88. Hydraulic Height-Adjustable Kitchen Assist Chair.

TECHNICAL DESCRIPTION

The Kitchen Assist Chair was designed to be highly maneuverable and compact enough so it can be used in kitchens of all sizes. For this reason, a computer chair was chosen to be converted into the assisting chair. The computer chair rolls easily and can fit in relatively small areas. The base of the chair has five legs arranged in a star shape. There is one caster on each leg of the base. Each leg measures 12" from the centerline of the base.

A hydraulic foot pump has been installed between the seat and the chair base. This pump allows a person to raise or lower the seat without getting up from the chair. The pump has seven and a half inches of travel, as the seat of the chair can rise from

Fig. 11.89. Hydraulic Hand Pump Assembly.

24" to 31.5" from the ground. Since the chair was designed to serve a person with weak legs, the hydraulic pump was converted from a foot pump to a hand pump. The hand pump is operated by gripping the handle near the back of the chair and pushing it forward. The hand pump is made out of half inch Chrome Allium tubing, selected because of the material's rigidity and strength. Two angled brackets were used to increase the strength of the hand pump at the 90 degree bend. The hand pump was designed so that it can be easily operated at the lowest and highest positions of the chair, while not being in the way of the person sitting in the chair as he or she performs kitchen tasks. The handle is angled backwards so that it will not prevent the chair from sliding comfortably underneath a table. Finally, a cushioned grip was added to the hand pump for comfort.

Two adapters have been constructed from 6061 aluminum to connect the three components of the chair. The first adapter connects the hydraulic pump and the seat. The second adapter is pressed onto the shaft of the pump, and then the seat is pressed onto the outside of the adapter. The second adapter connects the base of the chair and the hydraulic pump. This adapter also houses a ball bearing that allows the pump and seat section of the chair to rotate 360 degrees.

The cost of the project was approximately $170.

Fig. 11.90. Kitchen Assist Chair in Use.

Fig. 11.91. Full Stroke of the Pump Handle Shown, as Compared to Fig. 11.90.

WALKER WITH SKI ATTACHMENT AND BRAKES

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INTRODUCTION

A device was designed to help individuals who use a walker travel through snowy or icy conditions with more ease than the conventional wheel and stud walker.

SUMMARY OF IMPACT

The simplicity of the design makes it a practical and user-friendly device. This walker (see Fig. 11.92) may be easily operated by anyone who already uses a walker during his or her everyday life.

TECHNICAL DESCRIPTION

The Walker with Ski Attachment and Brakes was developed by modifying a pre-existing walker. A conventional walker design was slightly modified to allow for skis and a braking system to be attached in a way that still allows use of the walker as it was originally designed.

Traditional snow skis were shortened and holes were drilled and chamfered to allow the skis to be attached to the posts of the walker. The front posts are attached to the ski using a Delrin bracket, which was machined to allow the front posts to swivel from front to back to allow the braking system to work. Two stainless steel bolts hold each Delrin bracket to the ski through the bottom of the ski.

The rear posts of the walker (see Fig. 11.93) have a machined aluminum brake peg. Also attached to the rear post is a brake plunger used on traditional walkers. This brake plunger works by pushing down on the back of the walker, which produces downward movement of the rear post. A hole was drilled through the back of the ski to allow the brake peg to go through the ski when someone pushes down on the back of the walker. When the brake plunger is fully compressed, the brake peg will come through the ski and into contact with the snow or ice (see Fig. 11.94); this will halt forward movement of the walker. When the walker needs to be slowed down or stopped, all the user has to do is push down on the back of the walker.

Fig. 11.92. Walker with Ski Attachment and Brakes in Use.

The total cost of the project was $20.

Fig. 11.93. Walker Braking System.

Fig. 11.94. Braking System Configuration When Walker is Pushed Downward.

PILL CAPSULE OPENER

Designer: Kristin A. Terragnoli
Client Coordinator: Tammy M. Milillo
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INTRODUCTION

There are large numbers of patients taking prescribed medication who cannot swallow traditional pill tablets for certain reasons. Some medicines come in a powder form administered via a plastic pill capsule that dissolves faster and results in more efficient drug release and effect. The Pill Capsule Opener provides a way to separate the two halves of a capsule and pour out the contents in a controlled fashion for oral consumption by spoon.

SUMMARY OF IMPACT

This device was designed for a student with cerebral palsy who lacks the muscle control required to swallow pills as well as the motor skills required to separate the tiny pill capsule and successfully empty the contents. Before the fabrication of this device, the patient had to rely on health care aides or other assistants to prepare the medication for her consumption. This device offers invaluable independence by allowing many people with handicaps to self-administer their encapsulated medication. It assists those with limited strength or dexterity and enables those who cannot swallow pills to enjoy the benefits of pill capsules as opposed to traditional pill tablets.

TECHNICAL DESCRIPTION

The design consists of a 5 ¾″ x 8 ¾″ base supporting a 6″ x 3″ x 4 1/4″ raised platform into which a 2″ diameter hole was drilled to accommodate either a 3 1/2 or 5-ounce Dixie® cup (see Fig. 11.95). A hinge unit was glued to the left of the hole. This hinge unit consists of symmetrical 2 ¼ inch by 2 inch pieces of wood with holes drilled to precisely fit a 1.45″ (Size 7) laboratory stopper made from styrene butadiene rubber. This stopper has a 1/5″ hole in the center where a pill capsule with an approximate diameter of 3/16″ (roughly 6-mm) can be inserted (see Fig. 11.96). The two pieces are connected by two 5/8″ x ¾″ brass hinges. The pill is placed into the lower half and the upper half can be lowered onto

Fig. 11.95. Pill Capsule Opener.

Fig. 11.96. Pill Capsule Opener with Pill Capsule in Place.

the pill via the hinges. The capsule is separated when the upper half is lifted upwards; the top of the capsule remains stuck in the upper half and the bottom of the capsule containing the medication remains stuck in the lower (see Fig. 11.97). This unit is attached using two 2 1/2″ by 2″ pieces of wood, which are both glued to the platform. The unit is connected to the rightmost piece with two more brass hinges; the left piece provides stability when in the horizontal position. After rotating backward 180 degrees via the rear hinge and separating the pill capsule, the rear hinges will lock and the unit can then be rotated 180 degrees to the right (see Fig. 11.98). This enables the medication to fall from the bottom half into the cup positioned in place; this eliminates any mess and ensures that 100 percent of the medicine dose is administered. The cup can then be removed and the contents eaten. Accessibility features include 3/8 inch wooden dowels for leverage and ease of use. An attached 5/32 inch Allen key is used to force the empty capsule halves back out of the stopper holes. This device also makes use of removable/replaceable rubber stoppers and a removable "tray" below the bottom stopper for stability when force is applied from the top.

The total cost of this project was $98.

Fig. 11.97. Device Configuration after Pill Capsule Has Been Split.

Fig. 11.98. Pill Contents Being Poured into Positioned Cup.

COLLAPSIBLE AND TRUNK-LOADING SHOPPING CART

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INTRODUCTION

A shopping cart (see Fig. 11.99) was designed to load completely into the trunk of an automobile with ease in order to eliminate the task of having to transfer individual contents (e.g.: bags of groceries) from the cart to the trunk.

SUMMARY OF IMPACT

This type of cart can be used by anyone, but will be most beneficial to those who have difficulty in bending down to lift heavy objects, or those who have trouble gripping individual shopping bags, such as people with arthritis, to transfer bags from the cart to the trunk.

TECHNICAL DESCRIPTION

The collapsible and trunk-loading shopping cart has legs that retract, allowing the cart to fit with ease into the trunk or cargo hold of an automobile. The cart was designed to be pushed up against the back of a car (with an open trunk) and simply slide into the trunk with minimal effort.

The cart was also designed with ergonomics in mind; the handle is located at a comfortable height of 40″ from the ground when it is fully extended. The storage area of the cart is roughly 8,000 cubic inches; this volume is comparable to most shopping carts found at grocery stores. The entire cart measures 24″ in width, making it the perfect size to navigate through grocery store aisles and check-out lanes.

After shopping is completed, the cart is brought to the back of a car with an open trunk (see Fig. 11.101). The cart is then pushed up against the bumper, and a set of small casters catch the lip of the trunk to support it. When pushed a bit further, the front legs start to fold back, leaving the cart supported by both the trunk and the cart's rear legs, which are still on the ground (see Fig. 11.102). Once the front legs are

Fig. 11.99. Collapsible and Trunk-Loading Shopping Cart.

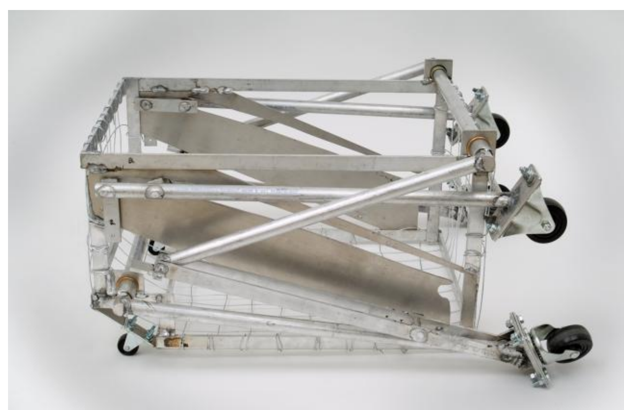

Fig. 11.100. Shopping Cart in Collapsed Configuration.

fully folded and the cart is pushed as far in as it can go, the user must release the rear legs and push them forward on a guiding track (see Fig. 11.103). This will fully retract the rear legs of the shopping cart. At this point, the cart is fully lodged inside the trunk (see Fig. 11.104), which can then be closed. Once at the destination, the cart can be unloaded in a similar (reverse) fashion to the loading process and taken directly to its target location. Although the actual cart can be made from another material, the prototype was made from Aluminum with bronze bearings in order to keep it as light as possible.

The total cost of this project was $325.

Fig. 11.101. Shopping Cart at Start of Loading Process.

Fig. 11.102. Front Legs Collapse toward Rear as Cart is Pushed into Trunk

Fig. 11.103. Operator Slides Shopping Cart Rear Legs Forward.

Fig. 11.104. Shopping Cart in Collapsed Position within Trunk.

MECHANICAL WINDOW OPENER FOR DOUBLE HUNG WINDOWS

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INTRODUCTION

The freedom to easily open and close windows is a luxury not always afforded to people with physical disabilities. This product addresses the issues of reduced ability to operate windows due to physical impairment. People with reduced motor control may experience difficulty operating windows and may injure themselves attempting to open windows. This device allows them the ability to open and close windows with the push of a button.

SUMMARY OF IMPACT

This device returns the freedom of window control to individuals who have lost the ability to safely and easily open their own windows. The mechanical window opener helps to save time and effort and prevents potential injury. This device may be used for public and private spaces of any kind where mechanically controlled windows are desired. Facilities such as nursing homes or extended care facilities could install this device to allow guests the ease of opening and closing their own windows without having to call for assistance. Staff and maintenance workers would also be able to operate an abundance of windows with minimal physical exertion. The window opener is designed as an aftermarket product, which allows the user to mount the unit directly to his or her preinstalled windows.

TECHNICAL DESCRIPTION

The case of the unit (see Fig. 11.106) is constructed out of one quarter inch thick polycarbonate acrylic and is sectioned internally to hold and secure the mechanical components. The face of the case unscrews to allow the unit to be mounted. The entire unit mounts to the window frame (indoors) via two lag screws. The window can now be permanently unlocked because the unit will act as a locking mechanism when not in operation. An angle bracket is fixed to the window and then

Fig. 11.105. Mechanical Window Opener for Double Hung Windows.

connected to the unit's connecting bar, which will be responsible for moving the window. The connecting bar is a machined 'L'-shaped bar that connects the unit to the window. The connecting bar is what lifts the window when the motor is operated. A power converter is included with the unit and must be plugged into a standard wall outlet and connected to the port on the bottom of the unit. The user can then operate the window by manually pressing the 'UP' or 'DOWN' buttons on the face of the device (see Fig. 11.107). When the unit is energized, the internal motor turns the lead screw on which the connecting bar is threaded. The lead screw is composed of a ½" diameter course-threaded rod. Both ends of the lead screw are machined and fit inside a fixed bearing at either end. The gear-motor is connected to one end of the lead screw and is responsible for turning the screw when the device is activated. The connecting bar travels up or down the lead screw depending on the motor direction and carries the window with it. The connecting rod also travels along a guide bar that is fixed inside the case. The guide bar helps to reduce the amount of torque required to move the window by preventing the connecting bar from turning during operation. A linear bearing is installed to reduce drag along the guide bar. The window can be stopped at any position along the travel distance but will automatically stop when it reaches the installed limit switches. The next evolution of the window opener is to include a remote control device to further assist in the safe and easy operation of pre-installed windows.

The cost of this project was approximately $180.

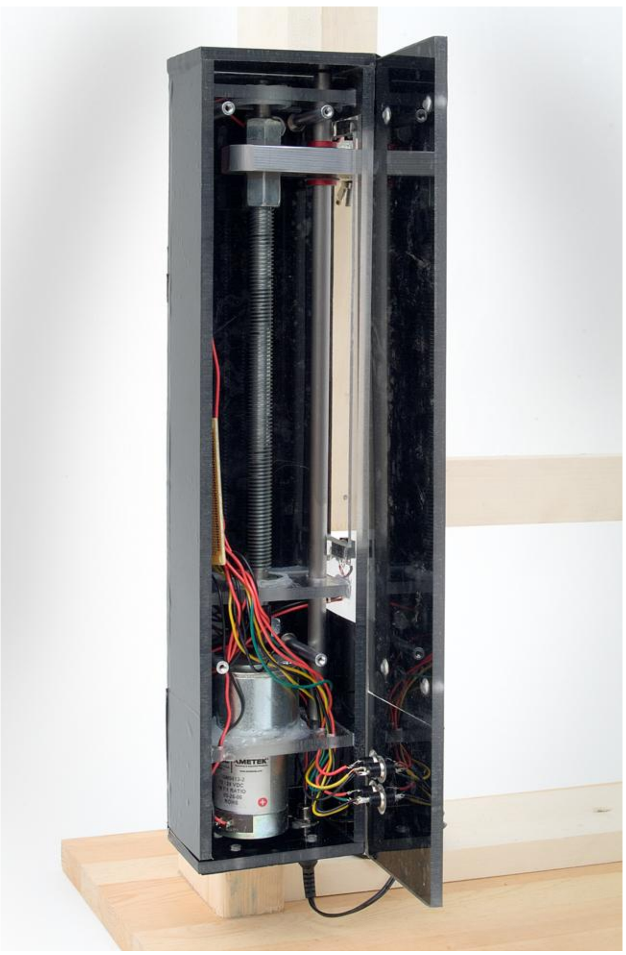

Fig. 11.106. Casing and Internal Components.

Fig. 11.107. Switches Used for Operation.