CHAPTER 7
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Wheelchair Seat Lift: Device to Increase Accessibility of Wheelchair Users

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INTRODUCTION

People restricted to wheelchairs can experience limited access and difficulty of transfer due to the fixed height of their wheelchair. At the same time, people desire to be self-sufficient, and this fixed height restriction increases their dependence on others. because of the low height of a standard wheelchair, transfer between the wheelchair and other surfaces, such as chairs and beds, is difficult. Additionally, the environment is often unsuitable to their needs. Many standard surfaces and storage spaces, both inside and outside their home, are beyond their reach.

SUMMARY OF IMPACT

The goal of this project was to design and build a self-contained wheelchair seat-lifting device. The focus of our project involved creating a device that is safe, marketable, and practical.

Safety concerns revolved around the strength of the materials, including choosing materials strong enough to support the weight of a person, yet light enough to make the device portable. Simplicity and low cost are key in assuring marketability, as well as in the device's aesthetics. Making the seat lift easily removable and universal to any standard adult size wheelchair would add the appeal. Furthermore, this device must not require any modifications to the existing wheelchair.

The device must involve a simple and practical design, and preferably a self-contained mechanism. The main difficulty arises in finding a motor that produces enough power to lift the person, especially at low heights, and be small enough to fit under the seat.

TECHNICAL DESCRIPTION

Design options considered included: a four-post design, an inflatable bladder design, a hydraulic design, and a scissor arm mechanism. The four-post design is desirable because it could raise a person from a position in which the two platforms are initially flush. Unfortunately, such a configuration requires all four posts to be powered and all four motors to be precisely synchronized to avoid binding.

The bladder design consisted of an off-the-shelf, pneumatically powered, inflatable device, that eliminates the need for a rigid and complex transmission. This design, however, does not supply the necessary stability, and is therefore an unacceptable design choice.

Another design consideration invovles incorporating four hydraulic pistons mounted at the four comers of the seat. Since a piston's maximum compression generally equals one half its full extension, this design has a limited initial height.

The final design consists of two platforms containing a pair of scissor arms. The arms are attached, at their ends, to a bearing mechanism that slides along tracks on the inside surface of the platforms. The "sliders" inside the lower tracks ride along screws with opposing threads. Turning the threaded rods causes the sliders to move toward each other, the scissor arms to separate, and the seat to raise. Screw gears provide a large mechanical advantage, lowering the initial required torque, and making a low initial height possible. This design meets all of the project objectives and was selected for use in the wheelchair seat lift.

The method of power and motor location are important considerations for the wheelchair seat lift. It is necessary to power both threaded rods to avoid binding in the mechanism, wherein one side moves faster than the other, causing a torque about a vertical axis. Since employing two motors requires precise synchronization, one motor with a transmission is chosen as the power source for simplicity in this project.

The ideal location for the motor is between the two platforms. However, since a low initial height is desired, which happens to be, with the scissor design, where the torque is very large. To avoid this problem, two self-contained but separate units are designed, instead of one, consisting of: the seat-lifting mechanism as one unit, motor, gear reduction unit, and power source. The latter is located beneath the existing seat of the wheelchair, with the output shaft of the gear reduction connected to the threaded rods by a system of pulleys and timing belts.

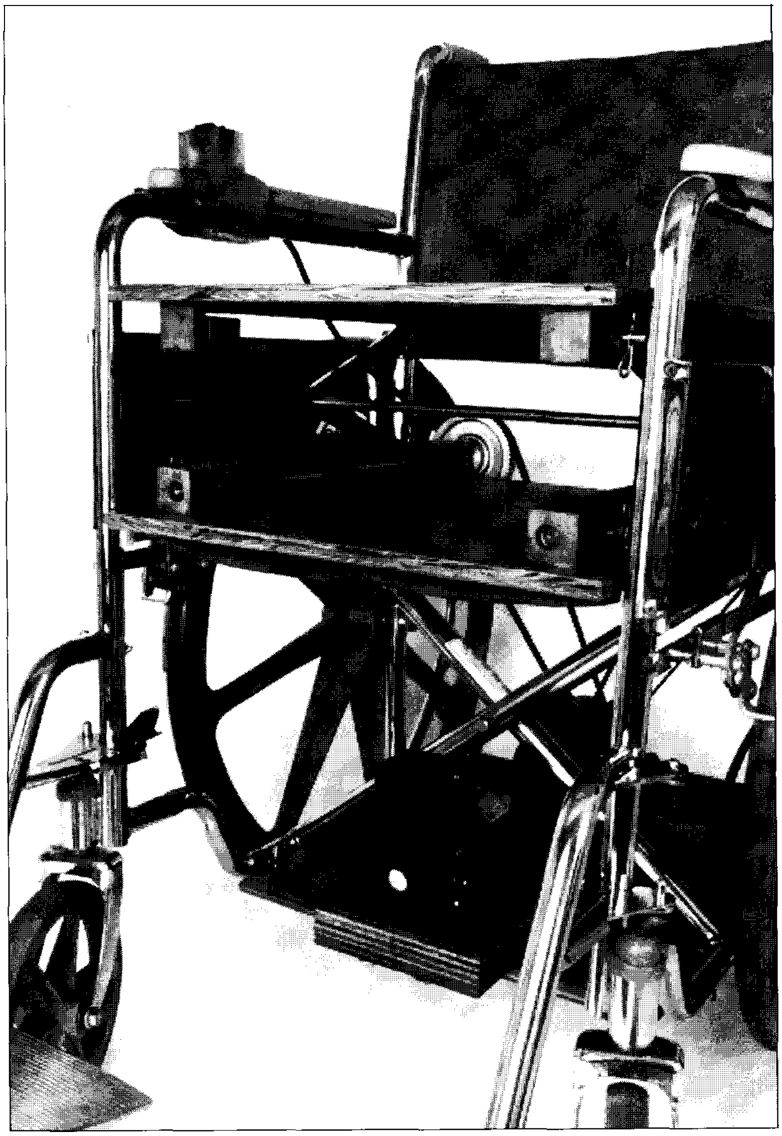

Figure 7.1. Seat-Lift Device.

Design calculations included geometric, force, kinematic, and strength of materials analyses. Geometric analysis is performed to design the mechanism with a low initial height, while still maintaining stability in its final configuration. These computations yielded the link length, final base size, and the final scissor link angle.

A force analysis is performed to compute the torque, T, and rotational speed, ω, needed to power the mechanism. The device is designed for a 200 pound person and a safety factor of 1.5, resulting in a design load of 300 pounds; these loads provide a vertical force of 75 pounds at each link.

The resultant torque is calculated on the drive screws using the horizontal force, F_x at the bottom of each arm. The pertinent formulas for these calculations are:

$$F_x = (weight) \cot \phi$$

$$T_{raise} = F_x \frac{d_m}{2} \frac{(l + \pi \mu d_m)}{(\pi d_m - \mu l)}$$

$$T_{lower} = F_x \frac{d_m}{2} \frac{(\pi \mu d_m - l)}{(\pi d_m + \mu l)}$$

where d_m, 1, and μ are the mean diameter, lead (pitch for a single thread), and coefficient of friction of the screw, respectively, and ϕ is the link angle.

During the lowering process, the required torque is lower, since the person's weight aids in the process. Also, a self-locking condition is used in the design. This condition occurs when the force component from the weight of the person cannot overcome the frictional force component such that:

$$\mu > \tan \lambda$$

where λ is the lead angle of the screw. If this condition is imposed, the mechanism lowers when a net motor torque is applied on the drive screw. This eliminates the need for a locking mechanism and only requires a reversal of the electronic signal to the motor, producing a negative torque, to lower the person.

The kinematic analysis is necessary to determine the angular speed of the screw to raise the person in a given time. The velocity formula from the analysis is:

$$V_x = 2V_x \cot \phi$$

and integrated with respect to the link angle to find the total time to raise a person.

The strength of materials analyses included calculations of bending, shear stress, and buckling of the scissor arms. It also included analysis of the stress on the pins and the torsional stress on the threaded rods. The following table summaries these results.

Table 7.1. Stress Analysis

Component	Stress(10^3 psi)
Arm Bending	22.40
Arm Shear	0.591
Screw Torsion	2.762
Pin Shear	10.261
Arm Buckling	12.815
Critical Load	(10^3 lbs)

Total project cost was $650.


G. VALENTA

Adjustable Hold Walker: A Device to Maintain a Person Attached to a Walker

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INTRODUCTION

The main objective of this project was to redesign a device that holds a person's body to a walker. This holding device is being redesigned for Matthew Stein, a disabled teenager with limited muscle coordination. Previously, another student implemented a magnet as the holding device. A plate was strapped around Matthew and the plate was held to the walker by a magnet. This holding device, however, created a magnetic field that affected a recently implanted microchip that controls a pump inside Matthew's body.

SUMMARY OF IMPACT

When using the walker, Matthew must wear a body jacket to keep his upper body straight. In addition, Matthew's father (Dr. Stein) wanted the body jacket to solely maintain Matthew in a standing position when using the walker. Dr. Stein pointed out that Matthew, being a teenager, is still in a growing process and it would be a good idea to make the holding device height adjustable.

An important aspect of the project is to restrict new implementations to fit the original design. The new holding device should not be placed in a different position from the original. This would ensure the center of gravity of the walker to remain the same.

TECHNICAL DESCRIPTION

The adjustable walker consists of two parts. The first consists of an envelope type metal case designed so that a plate can slide into it. In the original design, after the magnet was removed, a limited space of 4 by 2 inches is left for new implementations. The envelope must fit in the limited space. The second part was to mold a metal plate to the outer shape of the body jacket so that it can be permanently attached. Welding a small bead between the plate that slides into the envelope and the plate molded to the body jacket will link the body jacket to the holding device (envelope).

Choosing the material was no problem. Mild steel was chosen due to its low cost, high strength and ease in machining. Weight presented no problem since all parts are relatively small, and all the weight will be carried by the walker, thus it will not be an inconvenience to Matthew. The steel was to be coated with corrosive resistant paint to prevent it from rusting.

The envelope needed angular mobility to make sure Matthew would be placed in an upright position when the "arm" attached to the holder device was either lowered or raised. Four hinges were made to connect the envelope to the "arm". Two hinges were welded to the arm and two at the bottom of the envelope. A pin through the hinges allowed the envelope to rotate. The pin carries most of Matthew's weight. The selection of the size of the pin is based on a safety factor of three.

Another hinge pin connection is needed to maintain the envelope rigid once the desired angle is obtained. It was agreed that the envelope should be maintained rigid by friction. Two smaller hinges were made and welded to the back of the envelope. The hinges were carefully placed to allow maximum rotation of the envelope. A pin (factor safety of two) goes through the hinges and holes made in two plates which maintain the envelope rigid. These two plates had slots to specifically allow a quarter of an inch screw to go through them. The slots allow the screw to slide from side to side, and therefore permited the envelope to be adjusted to the right angle. The screw, when tight, compresses the two plates against a section of the "arm" preventing the envelope from moving.

The plate that slides into the envelope must be prevented from sliding out. Matthew has limited muscle coordination and could accidentally detach himself from the holding device. To prevent this from happening a hand retractable pull ring plunger is implemented to the envelope. It allows easy access and quickness to secure or detach Matthew to or from the walker.

A plate is molded to the outer shape of the body jacket and held in place with five screws. A second thin galvanized plate is molded to the inner shape of the body jacket to distribute the load due to the screws through a larger area. This is done to prevent the head of the screws from perforating the body jacket.

The final design is achieved according to the original plan without any unpleasant surprises. The cost of parts was about $30. This does not include the cost of the mild steel used.

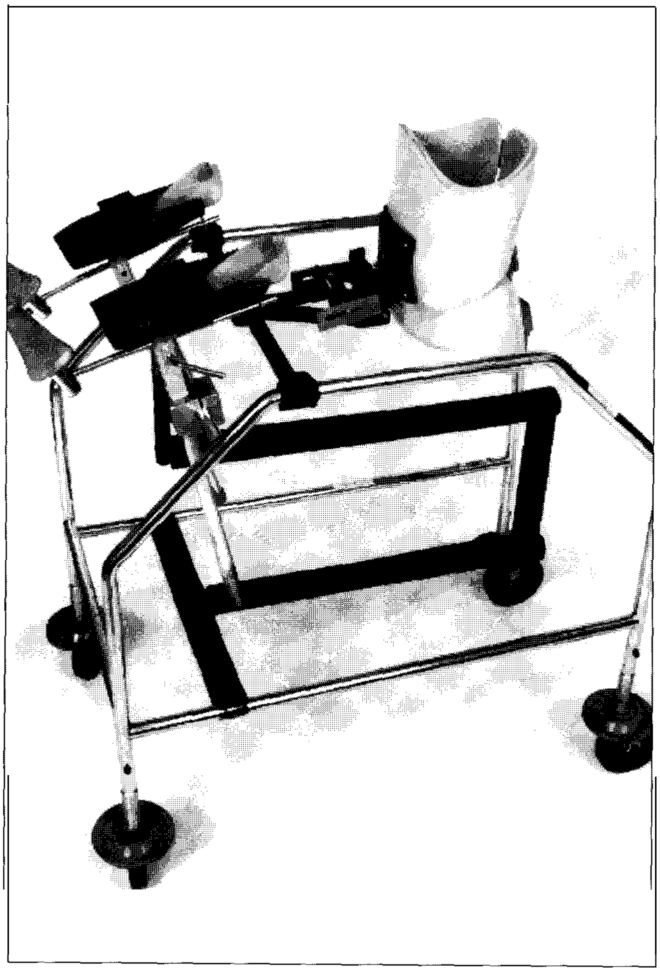

Figure 7.2. Adjustable Hold Walker.

Wheelchair-Mounted Camera Control Mechanism: A Device Used to Facilitate the Use of a Standard Automatic Camera for a Wheelchair Bound Individual

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INTRODUCTION

Raymond Holcomb, a wheelchair bound individual, wants to operate a camera. Raymond has minimal use of his limbs; only his hands function effectively. The main objective of this project is to build a device that will allow people in Raymond's predicament to operate a standard, automatic camera.

SUMMARY OF IMPACT

The wheelchair-mounted camera control mechanism (see Figure 7.3) is a device that attaches to a standard, powered wheelchair, allowing Raymond to operate a camera using only his hands. Raymond is able to adjust the camera to his eye position and take the desired photograph. The device lowers out of the way when he is not taking photographs and does not add to the width of a standard powered wheelchair, so as not to impede the mobility of the wheelchair. The device is simple enough for someone to easily attach and detach it from the wheelchair, it is easily assembled, and it utilizes accessible or easily manufactured parts.

TECHNICAL DESCRIPTION

The wheelchair-mounted camera control mechanism is adjustable with four degrees of freedom. Using a hand-held control system, the user is able to adjust the camera to his eye position and take the desired photograph.

The lifting mechanism employed in the device utilizes part of a standard camera tripod. The tripod employs a hand-cranked rack and pinion gear that is modified to accommodate a motor, and allows for adjustment to the user's eye level. The device employs an X-Y positioning mechanism that utilizes slide tubes, roller assemblies, and power screw to adjust the camera to the users' eye position. The device also tilts the camera, allowing for different angled photographs. A solenoid switch allows the user to shoot the picture under remote control. All the motors utilized in the device operate on a 12 or 24 volt power source that is already present on a standard, powered wheelchair.

Total project cost is about $400, including the camera.

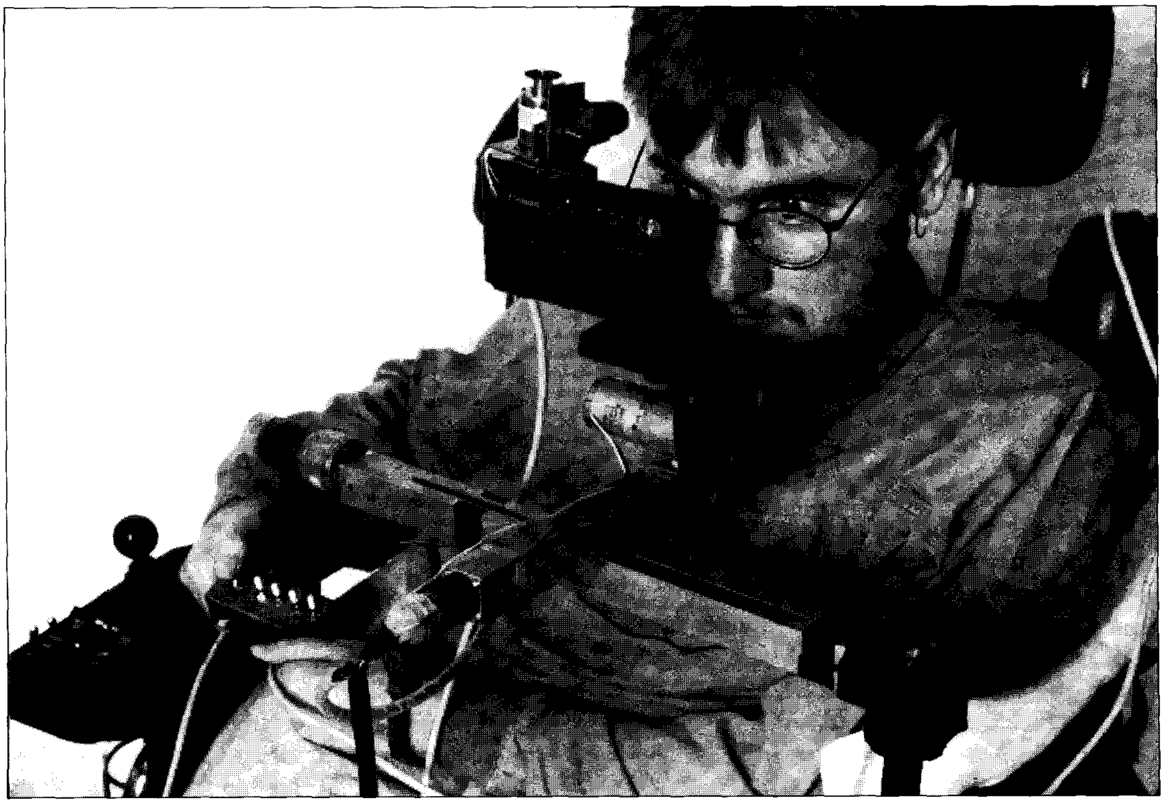

Figure 7.3. Wheelchair-Mounted Camera Control Mechanism.

Low Noise Cast Cutter: A Device to Eliminate Fear in Patients

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INTRODUCTION

The main objective of this project was to fabricate a cast cutter that would eliminate the fear a patient experiences when having a cast removed. This is especially true in children with disabilities. The fear is a result of the noise emission from current cast cutters. The saw blade of the cast cutter merely oscillates so as not to cut skin. This oscillation is achieved in the current cast cutter by a motor and a four-bar-linkage. The number of moving parts in the current cast cutter prove to be the source of the noise. So, logically, a new cast cutter must be fabricated with less moving parts.

SUMMARY OF IMPACT

A quiet cast cutter is essential to eliminate the fear experienced by the patient, because possibly with this fear comes violence (kicking, swinging, screaming). This violence puts the patient and practitioner at an increased risk of injury. The new cast cutter should closely match the current cast cutter in size, shape, weight, and cost (usual retail is about $700).

TECHNICAL DESCRIPTION

The main goal here is to decrease the number of moving parts, which will in turn, eliminate some of the noise produced. Instead of utilizing a four-bar-linkage to create an oscillation, a DC permanent magnet motor connected to an AC input voltage is used. This configuration is modeled as a second order differential equation (below) with a sinusoidal input and negligible damping effects.

$$I\frac{d^2\theta}{dt^2} = T\sin\omega_{dr}t = \frac{P}{\omega_{dr}}\sin\omega_{dr}t$$

By tuning the input power and the inertia of the rotor of the motor, the oscillation characteristics (that is, stroke size and speed) of the new cast cutter can be matched to the current cast cutter. The current cast cutter operates with a stroke size of eight degrees in each direction and a stroke speed of about 17,000 oscillations per minute. Solving for the inertia in terms of these values yields an unobtainable inertia.

For design considerations, it is important to determine whether the cast cutter's cutting ability is a function of the stroke speed or the input power. Upon experimentation, the cutting ability depended more on the power than the speed. This fact enabled a lower oscillation speed to be used in the design. This design change increased the required inertia to realistic levels.

A 24 VDC motor, with the proper rotor inertia, is used in the project. A transformer is used to step down the alternating voltage from 120 to 24 VAC. Also, since the motor will not be rotating, the motor cannot dissipate heat as effectively. So, the cutter is equipped with a cooling fan. The design requires that the motor be transformed into something that looks like the current cast cutter. This was done by attaching a hand-unit onto one end of the motor and running a shaft (rigidly connected to the motor rotor) through the hand-unit to a saw blade at the other end (see Figure 7.4). The new cast cutter matches the current one in size and weight. Even though the new one does not have as much excess power as the current one, it effectively cuts the primary casting materials (fiberglass and plaster bandage) .

Total project cost was about $200.

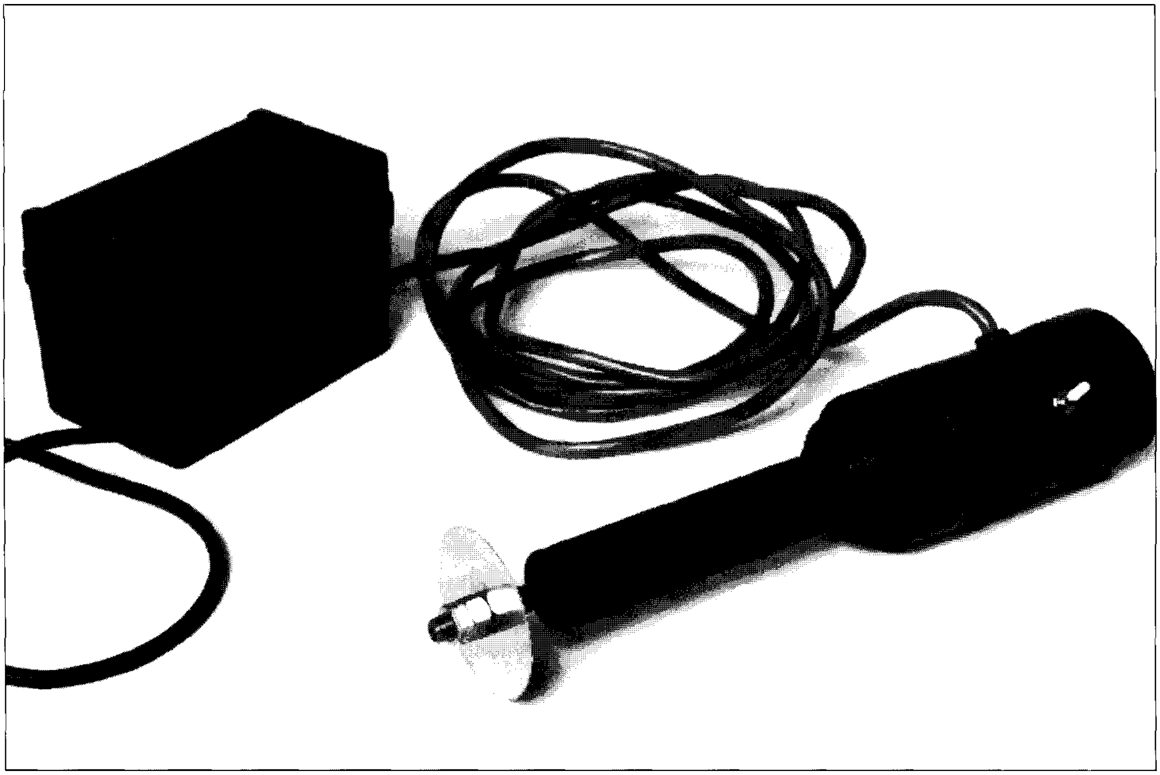

Figure 7.4. Cast Cutter and Power Pack.

Cause Switch and Effect Devices: Mechanized Toys used for Therapeutic Purposes

Student *Designer: C.E. Green*
Therapist: Christina Robach, Children's Hospital of Buffalo
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INTRODUCTION

The cause switch and effect devices project is a therapeutic appliance used to teach mentally disabled children the concept of cause and effect. An existing Fisher-Price piano cause switch is modified in this project so that there are only two large keys. When the child presses one of the two keys (the left or the right), a corresponding effect device is activated. Currently the only effect device is a modified tape player. Since each child has a different degree of disability, this lone effect device does not interest all children.

The purpose of this project was to create another effect device to work in conjunction with the piano. A commercially available toy was selected to be modified. The Disney cartoon-music box is mechanized, and used with the existing cause switch. This particular toy was selected because it was both visually and aurally stimulating, as well as compact and transportable.

SUMMARY OF IMPACT

The toy was demonstrated in its original mode of operation to a number of people. All of the viewers found the toy to be interesting. The toy should also stimulate the disabled children and provide them the incentive to learn the basic principles of cause and effect. A dual purpose for this therapeutic appliance is to assist physically disabled children, enabling them to play with toys they could not otherwise operate.

TECHNICAL DESCRIPTION

Originally the power for the music box was provided by a coiled spring, loaded via a wind-up knob located on the front of the unit. A gear train, originating from the music box, turned the cartoon scroll. RPM and torque requirements needed to be calculated for design considerations. A small motor with appropriate RPM and torque specifications is used to replace the original spring mechanism.

The music box is modified by adjusting a specially made square steel part over its original shaft. The motor's shaft is fitted with a square-holed sleeve. This sleeve matched the modified music box shaft.

The motor is fastened to a wooden platform, and then placed on the front of the toy where the original wind-up knob is located. As to not detract from the toy's appearance, the motor and platform are enclosed by a thin metal housing. For safety reasons, all sharp edges are smoothed. This housing is decorated with a Disney-theme contact paper.

The new power system uses two 1.5-V, high capacity, rechargeable batteries. The electronic circuit design incorporates a specially made recharging system that requires minimal maintenance by the user. To recharge the batteries, the toy needs only to be plugged into an electrical outlet for several hours.

A Plexiglas housing, with two separate compartments, contains the battery pack and the electronic circuit, respectively. The compartment containing the circuit is secured with screws on both sides of the lid. However, the batteries may be accessed by adjusting the (removable) sliding lid. This housing is located on the back of the toy. The necessary wires to the motor run inside the toy such that no wires are exposed on the outside of the toy. Again, the Disney contact paper decorates the Plexiglas housing.

The total cost to modify and mechanize the cartoon-music box was approximately $80.

Figure 7.5. A Mechanized Toy used for Therapeutic Purposes.

Cause and Effect Toys

Student Designers: Julia Schaff and Joseph Mittnight
Client Coordinator: Children's Hospital
Supervising Professor: Dr. Joseph C. Mollendorf
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INTRODUCTION

The main goal of this project is to alter two commercially purchased toys into cause and effect toys. These toys are used by disabled children that have limited motions and have communication difficulties.

SUMMARY OF IMPACT

Many little children have little or no reaction to stimuli due to physical and/or mental disabilities. Most of these children are unable to play with toys in the normal fashion. The first part of this project involved adapting a simple toy to produce an electrical output that could activate an effect toy. The toy chosen for this part is the Disney "Play 'N Pop" activity toy by Mattel. The toy is recommended for children 9-36 months old. It is felt that this was an appropriate age group for the project, considering the physical challenges of the children.

The second part of the project involved motorizing a toy so that a physical input from the children would not be needed. The toy would be activated from an electrical input supplied from a cause switch like the one designed in the first part of the project. To more fully stimulate the children, auditory and visual stimulation is used. One of the motions of our effect toy is also accompanied by a ringing bell.

TECHNICAL DESCRIPTION

The first focus of our project is selecting the appropriate cause toy. A toy is desired that exercises various levels of ability and motion.

The original toy consisted of 5 mechanisms that operate either by turning, pushing or switching, and these actions triggered doors to open through spring mechanisms. The spring mechanisms are disconnected to keep the doors shut.

A simple electrical switch to activate the effect toy is utilized in the design. A micro-switch is used and activated when a roller is pressed down approximately 4 millimeters. The internal levers of the toy proved to be very useful in the design of the switching systems. For two of the mechanisms, no lever modification was necessary. For two of the remaining three mechanisms, levers were not used and the switch was placed underneath the mechanism itself. For the final mechanism, there was not enough clearance for a switch so a simple extension was used to increase the clearance of the lever.

For the second part of the project, a commercially available toy is modified into an effect toy. An effect toy has large moving parts, but requires no direct interaction with the child; the toy is activated electronically by a cause toy.

Operationally, two motors are placed on the toy, one under the base of the toy to turn the horizontal wheel and one on the side to turn the vertical wheel.

A box is used to hold the motor under the base of the toy. The top and bottom of the box are built of wood for ease of handling and strength, while the sides are made of clear plastic. The box is also used to hold the battery supply and the charging circuit. The effect toy is able to be plugged into any wall outlet to charge the eight rechargeable batteries that power the motors.

The motor for the vertical wheel is mounted next to the toy in a tower. The tower is constructed in the same manner as the box under the toy, and its only purpose is to hold the motor in place. Since the motor in the tower is in a small space, three holes are drilled into the top of the tower to allow for cooling.

Total project cost was about $300.

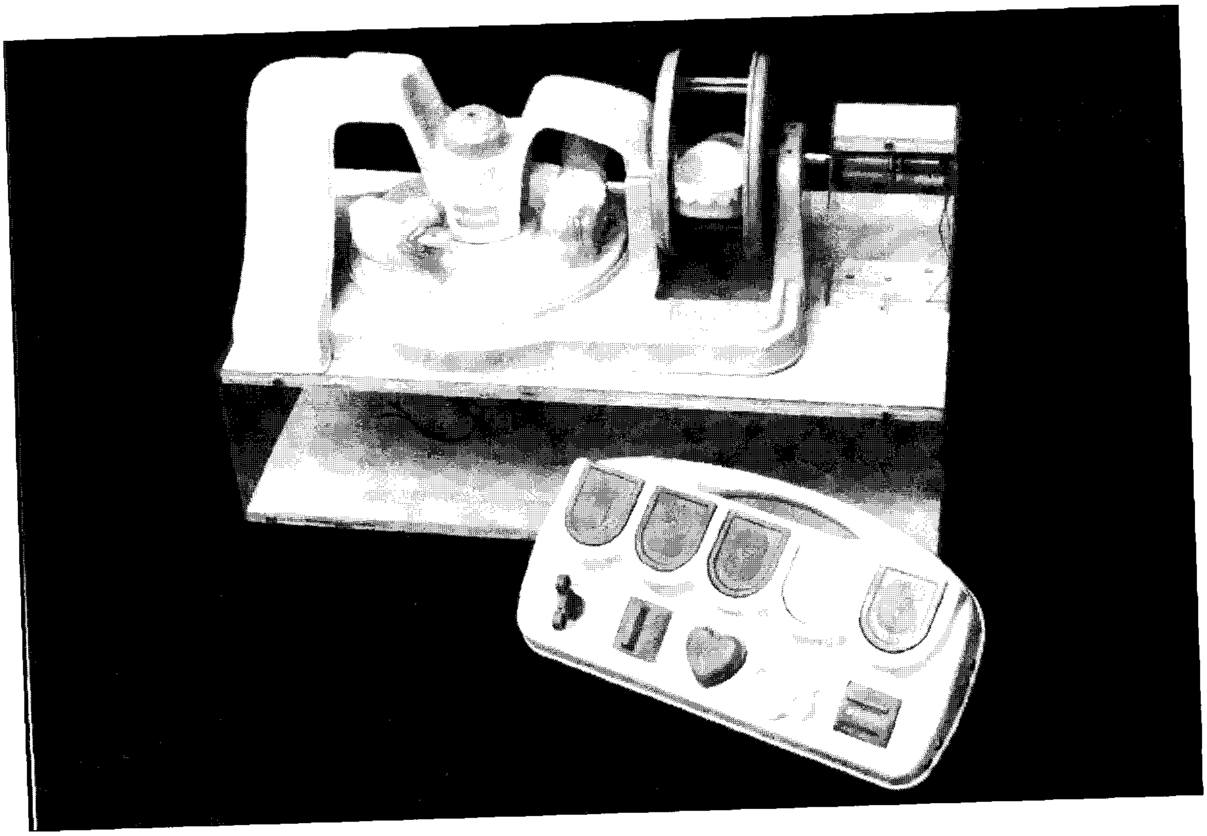

Figure 7.6. Cause Switch and Effect Device Toy.

Appliance Elevator: Automated Shelving Unit for Kitchen Counters

Student Designers: David Kretschmann, Jeff Fleischmann, Tony Povinelli
Supervising Professor: Dr. Joseph C. Mollendorf
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INTRODUCTION

The project goal consisted of the development of a device that would accommodate the hidden storage and counter top level accessibility of kitchen appliances. The need for such a device was due to the existence of physical disabilities that prevent people from lifting or repeatedly moving heavy objects, and the increase in the number of kitchen appliances people own.

SUMMARY OF IMPACT

This device offers those people that have physical disabilities the freedom to store and retrieve their small kitchen appliances with minimal effort and pain. Currently, an individual must lift and carry an appliance from either a wall cabinet or a base counter cabinet. This shelving unit automatically transports several appliances to and from storage to counter top level, where the appliance is then moved to the desired location on the counter top.

TECHNICAL DESCRIPTION

The device is comprised of three subassemblies, the drive mechanism, the shelves, and the main frame. When completely assembled they maximize the number of appliances capable of being stored, while minimizing the loss of existing counter space.

The first subassembly, the drive mechanism, is an 81 inch long by 1 $\frac{1}{2}$" diameter, 4 TPI, and semi-hardened acme threaded shaft that is powered by an AC motor. A portion of the two ends of the threaded shaft was machined down to a diameter of one inch, to allow the connection of two one-inch diameter thrust bearings. These bearings provided support for the shaft while allowing smooth and uninhibited rotation. The purpose for the shaft is to convert its rotational motion into the vertical translational motion of the shelves.

To aid the drive mechanism are two brass support rods. These support rods prevent the shelves from freely rotating down the shaft and forcing the conversion of rotational to translational motion.

The second subassembly, the shelves, are circular and operate similarly to a “Lazy-Susan.” The actual storage shelf is a 20” diameter piece of wood that has a center hole cut into it to allow passage of the threaded shaft. This shelf is attached to the top of a 12” diameter bearing, which provides it with independent rotational movement about the shaft. This gives the user access to the entire shelf, maximizing the number of appliances. To the bottom of the bearing is attached another piece of wood with a 12” diameter. The final part of the shelves is the nut and flange. The nut is made out of brass and is threaded on both the interior and exterior. The interior thread is matched to fit on the threaded shaft, and the exterior thread exists for the mounting of the flange. The flange is five inches in diameter and contains four holes, where two of the holes are used for the attachment of the bottom circular piece of wood, and the other two holes are for the two brass support rods.

The third subassembly is the main frame, which houses and supports the shelves and drive mechanism. The frame is designed to be a free standing structure that is constructed out of wood allowing it to be easily incorporated into the comer of an existing kitchen counter.

The frame consists of a 24” square top and bottom plate that are connected by four 2x4 wooden studs, braced by several wooden horizontal cross braces, much like the construction of a house wall. The total height of the frame is 79 inches. The bottom plate supports the threaded shaft of the drive mechanism and the top plate supports the motor and motor mount.

The total cost was approximately $1000.

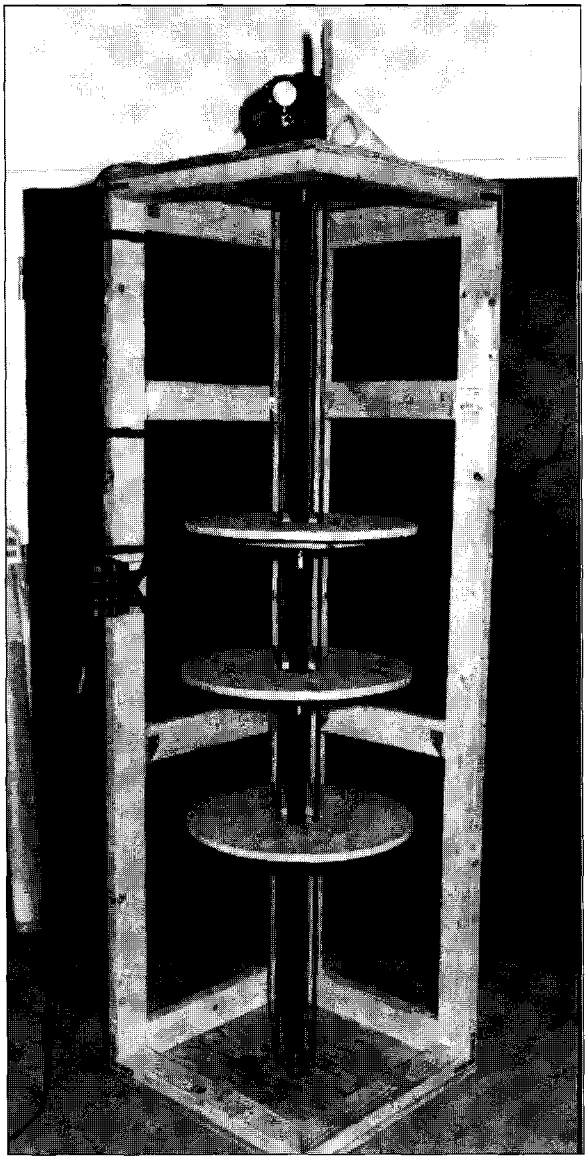

Figure 7.7. Automated Shelving Unit for Kitchen Counters

The Stove Top Stirrer: A Device to Facilitate the Stirring of Food

Student Designers: Steven Brown and Lori Chayka
Supervising Professor: Dr. Joseph C. Mollendorf
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INTRODUCTION

Kitchen remodeling has become a popular means of assisting physically limited people. Modifications are also performed on kitchen appliances to accommodate the special needs of such people. Currently, however, there is no device to stir food on a stove top for those who find it difficult or even painful. The purpose of this project was to design and build such an appliance.

SUMMARY OF IMPACT

Those who are limited physically usually experience the need to do as much as possible without the help of others. The stove top stirrer can aid such independence.

Once mounted on a stove top, the device can be used with pots ranging in diameter from 5 to 10 inches. The Stove Top Stirrer produces enough torque to stir food with viscosities up to 1.48 Pa-s. With choices of low, medium, and high, the user is able to select how quickly he or she wants the food stirred. A timer is another option incorporated in the design. The appliance will either stir constantly or in intervals, with an on time of 10 seconds and an off time of 20 or 50 seconds.

TECHNICAL DESCRIPTION

The first task of the project involved choosing a motor for the device. This decision is based on how much torque is required to stir a majority of food types. The motor chosen is from a 200W Black & Decker Power-Pro-Mixer.

While testing the motor, the rotation was determined to rotate too quickly for the intended device. To solve this problem, a 10:1 speed reducer is used, and resulted in desirable rotation speeds. The speed reducer also facilitated the decision of motor placement. Since food particles and heat could ruin the motor, the motor is placed 8 inches to the left of the cooking area. The speed reducer enabled the transfer of motor rotation in a 90° angle.

A magnet is used to hold the appliance to the stove top. If the user chooses to mount the device on an adjacent counter top, the magnet can easily be removed and a block of appropriate height attached. This modification might be necessary for small stove tops.

Fastened to the magnet is an aluminum box. This box houses the speed and timer controls as well as their circuitry. Attached to this box is a 9” PVC tube 3” in diameter. This tube contains the motor that is securely attached $2\frac{1}{4}$" from the top of the tube. The heat produced by the motor is also a design consideration. The cover of the PVC tube has been modified to contain four slits. The motor is equipped with a fan and is located 1" from the top of the tube to allow air flow through the slits in the PVC cover. The back of the aluminum box is also furnished with slits to allow maximum air circulation.

The motor is attached to the speed reducer through several connections. The shaft of a beater, which came with the mixer, has been secured onto its original opening in the motor. The opposite end of this beater has been press fit into a $\frac{1}{2}$" diameter stainless steel shaft. The other end of the latter shaft is connected to the speed reducer by a coupler. This entire connection is enclosed in a $1\frac{1}{4}$" diameter PVC tube. The speed reducer is enclosed in a Plexiglas box.

Also enclosed in the Plexiglas is the coupler attaching the speed reducer to a vertical shaft leading to the rest of the stirring mechanism. The actual stirring rods are made of Teflon, a plastic that can resist the heat encountered on a stove top. The rods are designed to allow large food particles to pass through, and not accumulate in the device. There are three stirring rods, one of which is stationary. The remaining two allow for the diameter adjustment. The diameter adjustment is accomplished by the use of two spring plungers attached to a stainless steel rod. Once the spring plungers are in one of the three possible positions the user releases a lever and the pins drop securely into place.

For cleaning purposes, the entire stirring mechanism is detachable by a pin connecting two vertical shafts near the Plexiglas box. Detachment of the stirrers is also necessary to the removal of the pot.

Total project cost was $340.

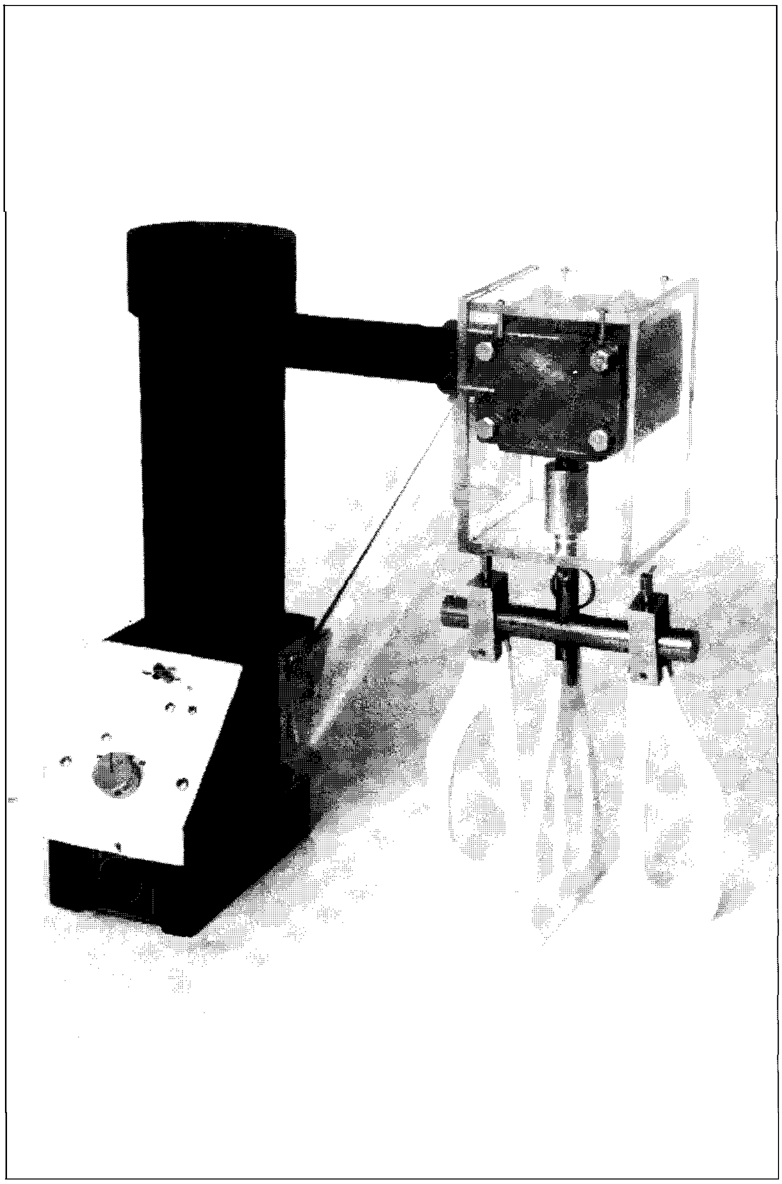

Figure 7.0. Stove Top Stirrer.