Chapter 11
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SHOULDER BRACE REPLACE A SLING AND ALLEVIATE ELBOW AND NECK PROBLEMS

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Consulting Physical Therapist: Meredith Reinhardt
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INTRODUCTION

When a person undergoes shoulder surgery or suffers shoulder dislocation, he/she is required to place the corresponding arm in a sling to allow the shoulder to heal. After the sling is used for six to eight weeks, complications can occur in the elbow, shoulders and neck.

Wearing a sling for an extended period of time causes two major complications in the elbow. The first major problem is adaptive shortening of the biceps brachii and brachioradialis. When a patient keeps a muscle in a shortened position for an extended period of time, the muscle actually shortens due to loss of tissue. This causes a reduced range of motion in the elbow. Another problem that also limits the range of motion in the elbow is capsular restriction in the humeral-unlar and humeral-radial joints.

In addition to problems in the elbow, complications may also occur in the shoulders and neck. Sustained pressure on the upper trapezius facilitates muscle contraction, causing a hypertonic upper trapezius. This contributes to cervical spine dysfunction and altered shoulder girdle mechanics.

With the occurrence of these problems, the patient may require extended physical therapy.

SUMMARY OF IMPACT

The present shoulder brace is to accomplish a wide range of goals. For medical purposes, it must meet minimum requirements to allow for proper healing: full support for the weight of the arm and maintenance of the shoulder in the proper healing position. To minimize other potential medical problems discussed previously, it should allow for free range of elbow motion. Using this brace to rehabilitate the shoulder will dramatically improve the comfort for the patient wearing it and allow for freedom of motion and greater use of the hand.

Figure 11.1. Finished Brace as Worn.

TECHNICAL DESCRIPTION

The shoulder brace consists of three major components: the support system, the arm brace and the rigid link between the two.

The support system is comprised primarily of three materials. First, a 4 x 19 inch piece of San-Splint® thermo-formable plastic is used for the major support and connection site of the rigid link and the straps. The size of the San-Splint® used is dependent on the rib cage size of the patient. The San-Splint® extends from the center of the spine to two inches short of the center of the sternum. This piece of material is positioned just below the pectoralis major and formed to the contour of the patient's body. The second material used is Kushionflex® self-adhesive, closed cell foam padding.

Finally, Velwrap™ strapping material is used to help support the weight of the arm and keep the San-Splint® in place.

The second major component of the shoulder brace was purchased as a complete unit: the IROM™ Elbow brace. This unit has Velcro closures around the arm and forearm. The brace has the capability to limit extension and flexion of the elbow with a simple pin adjustment.

The final component of the shoulder brace is the rigid link that connects the support system to the IROM™ Elbow brace. This link is made of low carbon steel. The rigid link extends around the outside of the arm and is fastened to the elbow brace as shown in Figure 11.2. This link is made to carefully position the shoulder. Specifically, it is in 10° of abduction, 15° of internal rotation, and 10° of flexion. This prototype is not adjustable. It could be modified to accommodate as many people and diagnoses as possible.

The total cost of materials and supplies is about $143 dollars.

Figure 11.2. Top View of Brace.

INDIVIDUALIZED WHEELCHAIR WORKSTATION

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INTRODUCTION

The Wheelchair Workstation is a unit designed to help school children with disabilities complete their tasks. This population was selected as the target for design because of the amount of time children spend in school. Accessible working sites are not always available. The unit provides a portable working surface as well as convenient storage for working materials. It consists of a storable tabletop, a beverage holder, and two storage compartments. The larger compartment fits larger items, such as books, while the smaller compartment is designed for pens, pencils, eyeglasses, etc. Both compartments feature lids that double as padded armrests. The major attribute of the unit is that its location on the chair ranges from a non-obtrusive storage position behind the chair, to a convenient working location at the user's side.

Figure 11.3. Unit in Stored Position.

Since the workstation is interchangeable with an existing wheelchair armrest, no modifications to the chair are required. This feature is important because such modifications may void a wheelchair manufacturer's warranty. Additionally, the unit can be removed when not in use, and replaced with the chair's original armrest component.

SUMMARY OF IMPACT

The Wheelchair Workstation is designed to make it easier for children in wheelchairs to do their schoolwork. The accommodations of the unit are expected to increase the user's independence and self-confidence.

TECHNICAL DESCRIPTION

The Wheelchair Workstation travels between the in-use and stored positions via a four-bar linkage mechanism. Two anodized aluminum links connect the workstation to a 0.1-inch stainless steel mounting plate, completing the four bars of the linkage. Stainless steel was selected for the mounting plate because of the large moment generated by the weight of the unit on the links.

The aesthetics of the Wheelchair Workstation were an important consideration in its design. Both storage compartments and padded armrests are upholstered in a synthetic leather to maintain a soft appearance.

The total cost of materials and supplies is about $465.

Figure 11.4. Unit in Use Position.

PAGE TURNER FOR INDIVIDUALS WITH DISABILITIES

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INTRODUCTION

The objective of this project was to design and build a device that would turn the pages of a book or magazine for individuals with limited or no upper body motion. A person with this type of disability may find it difficult or impossible to read independently.

Although this device was not designed with a specific person in mind, it can easily be modified to meet the needs of many individuals.

SUMMARY OF IMPACT

A page turning device was designed and built. It works with a variety of reading materials. This device helps to increase the independence of individuals who may otherwise not be able to turn pages.

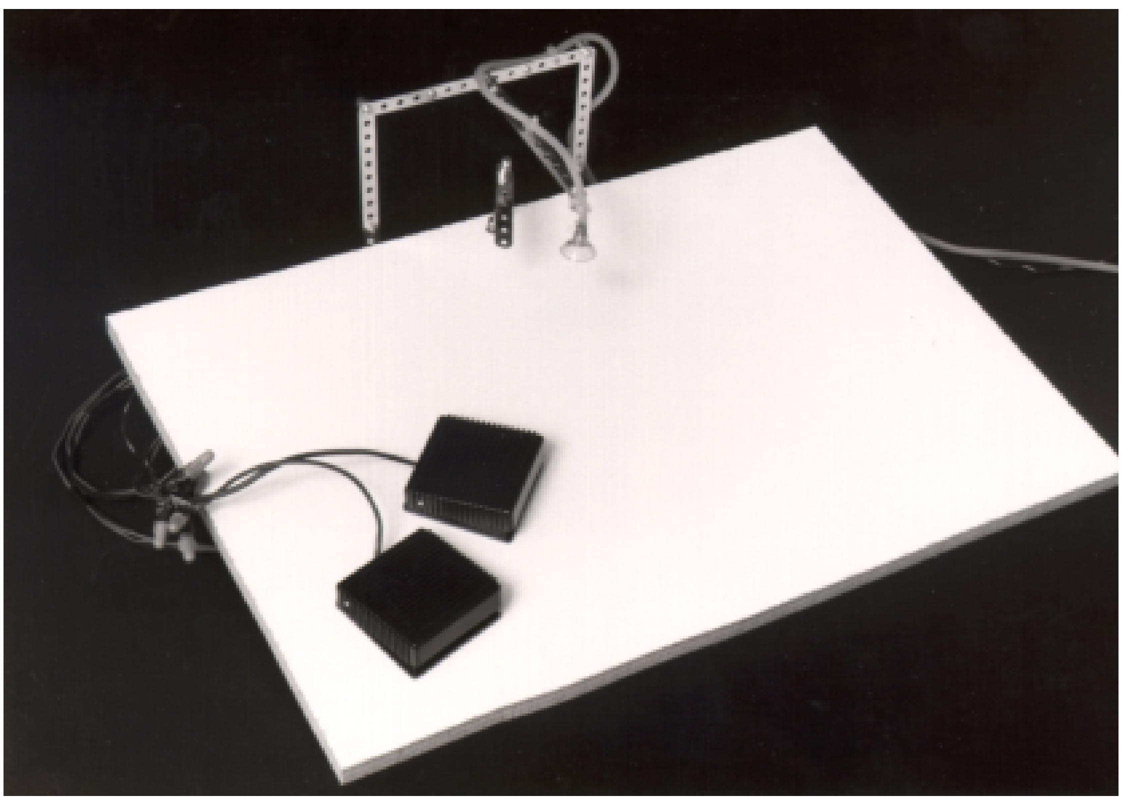

Figure 11.5. Finished Page Turner Unit.

TECHNICAL DESCRIPTION

The Page Turner consists of two main components: a vacuum component and a translational component.

The vacuum component consists of a submersible pump, an aspirator valve, and a water reservoir, although any suitable vacuum source would suffice.

The vacuum is used to lift the page. The amount of suction can be varied slightly by a valve on the vacuum line. This is done to compensate for different paper porosity.

The translational component consists of a 4-bar mechanism and a rotating arm.

The 4-bar mechanism moves the vacuum line from right to left as it holds the page.

After the 4-bar mechanism and vacuum line lift the page, the arm rotates 180°, turning the page during its motion.

Two 3-volt permanent magnet D.C. motors power the 4-bar mechanism and rotating arm. The motors are operated via foot pedal switches.

The total cost of materials and supplies is about $116.

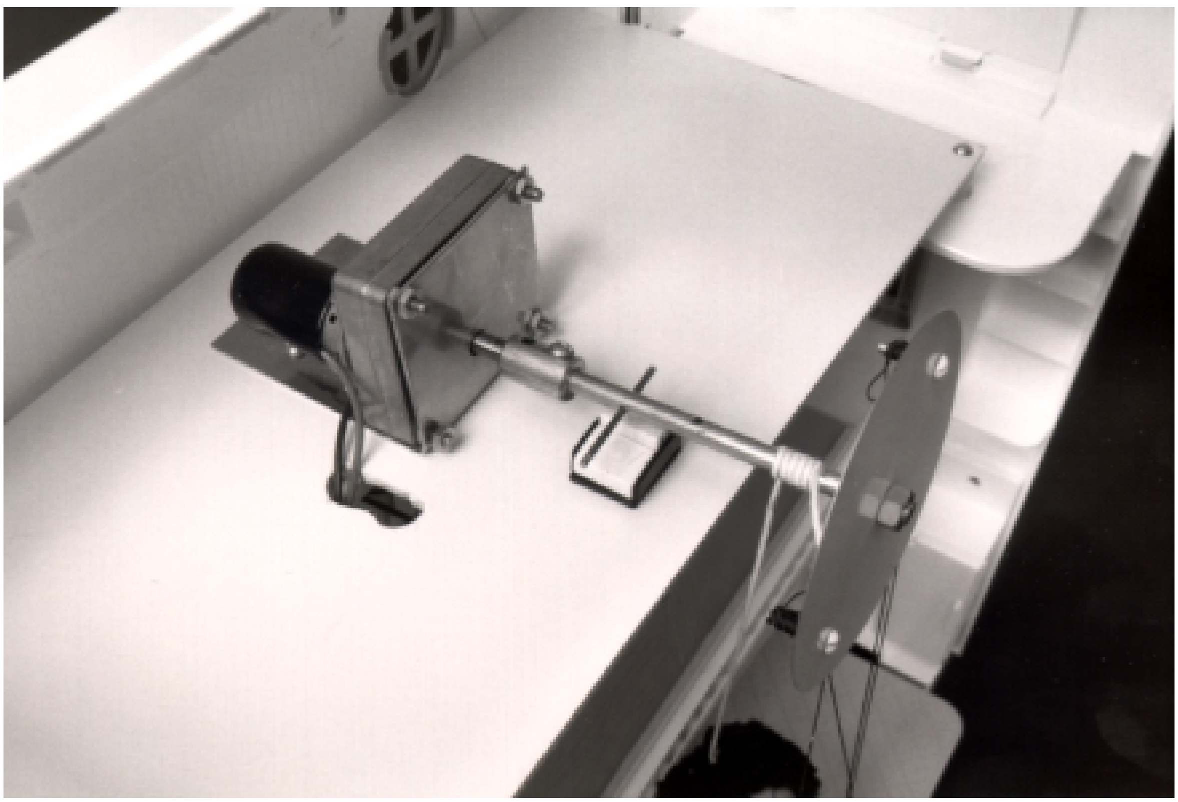

Figure 11.6. Close-up of the Translational Component of the Page Turner.

BED-WHEELCHAIR TRANSFER SYSTEM

Student Designers: Tiffany Bristow, Todd Esse, Nathaniel Getzel, Frank Robertson and Alex Roxin
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INTRODUCTION

A means of transfer from a bed to a wheelchair, and vice-versa, is essential for persons with quadriplegia. Currently, there are no transfer devices on the market that are easy to use, storable and affordable. Many involve discomfort or awkwardness for the user.

The Bed/Wheelchair Transfer System was designed to be less bulky, less expensive, and more comfortable for the user. In addition to alleviating constraints on storage and affordability, it also allows a family member or a friend to assist the patient without resorting to professional assistants.

SUMMARY OF IMPACT

This design is intended to provide individuals with physical challenges a more affordable transfer device that will improve their quality of life.

TECHNICAL DESCRIPTION

The design for the Bed/Wheelchair Transfer System consists of three main components: the platform/ramp, the pulley system, and the transfer device.

Platform/Ramp

In order for the wheelchair to be raised to the height of the bed, it must rest on a platform. The platform is large enough to accommodate the dimensions of the standard wheelchair and strong enough to withstand the combined load of the wheelchair and person. The platform also stabilizes the wheelchair, locking it in place and assuring that no tipping or rocking occurs. In addition, the platform height is adjustable to accommodate a range of bed heights and can be easily pushed underneath the bed for storage.

The ramp is used to transport the wheelchair from ground level to the top of the platform. The ramp also accommodates the size of the wheelchair and can support a 350 lbf load. The ramp is easily joined to the platform by a hinge that must withstand a 150 lbf load and possible torque. The hinge also allows the ramp to be folded onto the platform and stored with it.

Pulley system

The pulley system supplies the power to slide the support carrying the 170 lbf load. The system is composed of several pulleys attached to ropes that are connected to a hand crank. Once the hand crank is activated, the pulleys help guide the sheet across to the wheelchair. The pulley system can be reversed by merely placing the support bars on the opposite side and using the hand-crank in the opposite direction.

Transfer Device

The transfer device is composed of a denim sheet that supports the person. It is lightweight and easy to apply and remove. It can support loads up to 170 lbf during transfer and offers as little friction as possible during sliding. The denim sheet also has removable supports made of wood to help distribute the person's weight throughout the sheet.

Integration of Components

The procedure for wheelchair bed transfer begins with the person moving the wheelchair up the ramp onto the platform and applying the brake. The person reclines the seat to a horizontal position. With the denim sheet already underneath the person, the assistant attaches the support bars to the sheet through the brass grommets. Using the hand-crank, the assistant transports the person from the wheelchair to the bed. Once the transfer is complete, the assistant detaches the support bars from the sheet. The denim sheet can either remain underneath the person or can be removed with assistance. This process can be reversed, transporting the person from the bed to the wheelchair, by simply placing the support bars on the opposite side as before and using the hand-crank in the opposite direction.

Several improvements can be made to this device. It would be worthwhile to design a platform with hydraulic legs. This would make the design more universal. Similarly, a small, efficient motor might take the place of the hand-crank. Lastly, the denim sheet could also be lined with Teflon material on the bottom to ensure minimal friction during the sliding of the sheet.

The total cost of materials and supplies is about $150.

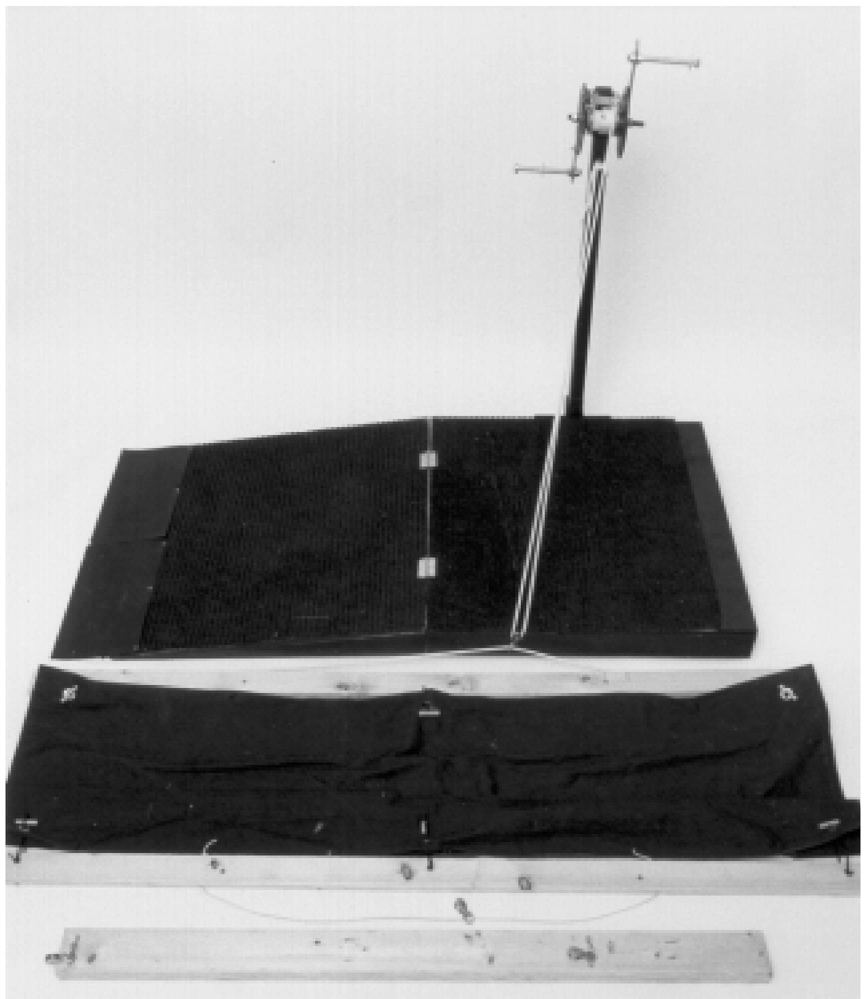

Figure 11.7. Components of the Wheelchair Transfer System.

PANTS AIDING DEVICE: AN ASSISTIVE CHAIR TO FACILITATE DRESSING AND UNDRESSING

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INTRODUCTION

The act of getting dressed independently seems to be trivial for most individuals. Yet for a person with paralysis of the legs, this task can be tedious. With the aid of a hoop-like ring, and a specially designed chair, the Pants Aiding Device (PAD) provides an easy, quick, and convenient solution.

SUMMARY OF IMPACT

The PAD consists of two main components: the chair and the PAD. Together, both are used in accomplishing the task of putting on pants.

The PAD is a hoop-like ring with two long handles and four clips for fastening on the pants (See Figure 11.9). Handle length is set to provide an easy way to slip the pants onto the feet of the individual. The PAD is adjustable, via hinges, to accommodate different waist sizes.

The chair itself has five main components: the leg apparatus, the harness, the pulley system, the hydraulic jack, and the rocker arm. Acting like a reclining chair, the leg apparatus serves to raise the legs of the individual. Once the heels are off the ground, the pants, through use of the PAD, can be pulled onto the legs. Upon lowering the legs back down, the PAD can be detached from the pants, and the individual can pull the pants up to his/her thighs. The act of pulling the pants under the buttocks area is especially challenging. The harness was designed for the upper body only, leaving the lower body free. One's arms extend through the harness that goes under the armpits. To the right of the person sitting in the chair are two handles, both of which are attached to the hydraulic jack. The closer of the two handles can be pumped up and down to activate the jack. As the jack goes up, the rocker arm creates a pivoting seesaw motion. The far end of the rocker arm is attached to a cord, which in turn travels up and over the pulley system to the harness. This motion pulls the individual up and off the seat. Once at a desirable height, the pants can be pulled the rest of the way onto the individual. The second of the two handles on the jack is the release valve. A quarter-turn counterclockwise allows the jack to retreat, and the individual to descend back onto the chair. The task of putting one's pants on is accomplished quickly, easily and efficiently.

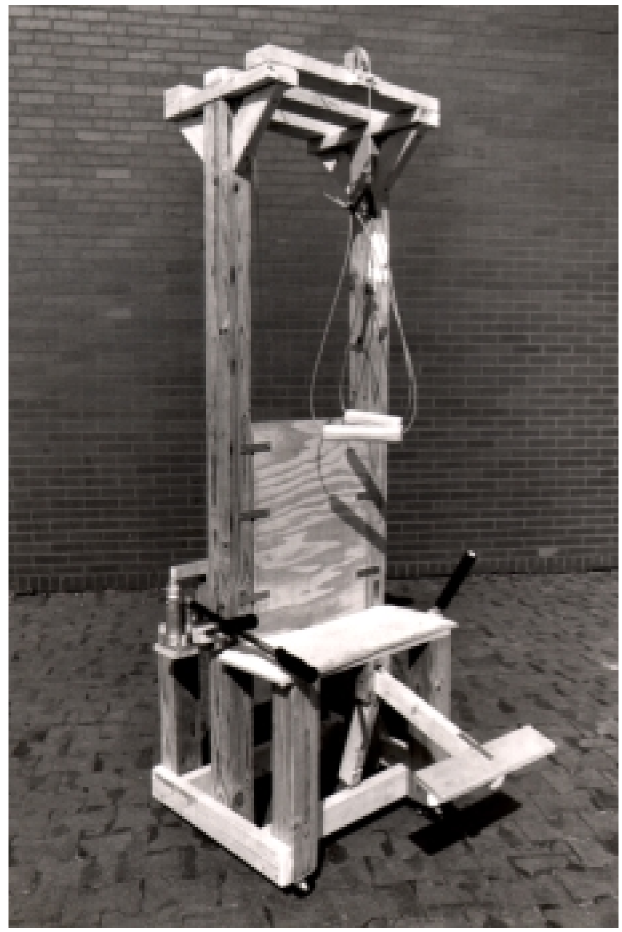

Figure 11.8. Basic Chair Arrangement.

TECHNICAL DESCRIPTION

Technically, the PAD is a simple device. The length of the rocker arm is designed to magnify the travel of the jack by a factor of about two; the length after the pin is about double the length before the pin. This allows less pumps of the jack to acquire a reasonable height for the individual. A vertical distance of three inches is accomplished with a mere 15 strokes of the jack and sufficient force on the harness, which a person can easily provide. The release valve only need be turned a quarter of a turn to allow the jack to descend.

For refinement, the leg apparatus could be constructed with adjustability to allow for different size legs. It is designed to rest on the calves of the individual, leaving the heels of the feet free for the purpose of putting on the pants. Also for refinement, the harness could be modified to apply pressure to the body, not just up on the shoulders. This would provide greater comfort and allow for maximum arm motion.

The total cost of materials and supplies is about $150.

Figure 11.9. Hoop-like Ring with Pants Attached.

A TELEPHONE CONTROL UNIT TO FACILITATE DIALING AND ANSWERING

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INTRODUCTION

It is virtually impossible for persons with quadriplegia to dial or answer a conventional telephone. Hence, a device was designed to enable persons with quadriplegia to use a telephone.

The Telephone Control Unit integrates a breath actuator, Cermatek dialing board, Motorola computer board, speaker and microphone interface and an LCD display. To use the telephone the user must be placed in front of the unit. He or she must respond to commands displayed on the LCD by use of the breath actuator. The LCD displays both commands and numbers according to a program contained on the Motorola computer board. The device then utilizes the Cermatek dialing board to simulate tones, and finally, to dial the input phone number. The user then interfaces with his/her caller via a speaker and microphone.

SUMMARY OF IMPACT

The Telephone Control Unit allows persons with quadriplegia to regain independence in using the telephone. It also affords the user privacy when using the device.

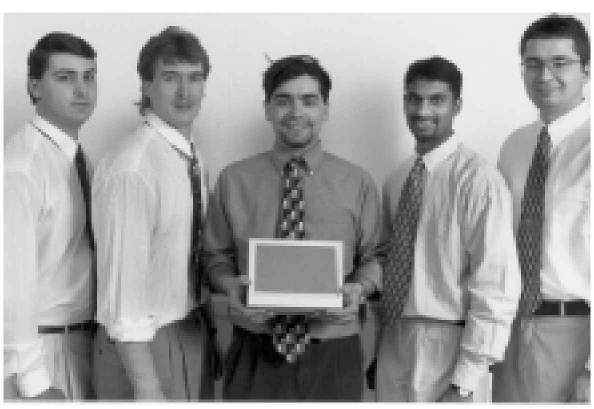

Figure 11.10. Finished Unit.

TECHNICAL DESCRIPTION

The Telephone Control Unit (Figure 11.11) contains five major components: a Motorola control board, a Cermatek dialing board, an LCD Display, a breath actuator and a speaker/microphone interface.

The Motorola control board is the most significant component of the device. It contains a computer chip that is programmed through interface with a PC. The program is structured in such a way that it allows the user to perform the same functions of a standard phone. These include manual dialing, memory dialing and flash. The Motorola control board receives its input from a breath actuator and then displays the output of the response on a LCD display.

The breath actuator is simply a pressure sensor box connected by a ¼-inch piece of flexible vinyl hose for input, and a wire lead connected to the Motorola control board as output. When the user blows into the hose, it simply closes a circuit that initiates a response to the Motorola control board. The pressure sensor is adjustable to as little as 1/4 PSI and up to 4 PSI. The responses made by the individual are prompted by the statements displayed on the LCD.

The LCD is a 40 by 2 character display that allows a large viewing area for easy readability. Statements pertaining to telephone functions, for example, “manual dialing” or “memory dialing” are shown on the display. Brackets are placed around one statement at a time. The brackets move to each subsequent statement about every 1.5 seconds and scroll back to the original statement, with a complete cycle of up to 60 seconds. When the user blows into the breath actuator, the function corresponding to the statement will be initiated. After 60 seconds, the whole sequence resets itself. When the user attains the telephone number he or she wishes to dial on the LCD, the number is transferred to an analog signal, which is then sent to the Cermatek board.

The Cermatek board is the interface between the Motorola control board and a standard phone line. The Cermatek board converts the analog signal of each number into a dialing tone. The sequence of numbers is then dialed on a standard phone line, making the desired contact.

The user may communicate through a mounted speaker and microphone. These components can be adjusted for comfort. When in place, the speaker and microphone unit can be screwed tightly into position.

If the Telephone Control Unit were to be mass-produced, the programming costs could be eliminated and the device could be made for about $275.

The total cost of materials and supplies is about $396.

Figure 11.11. Components.

CELLO SUPPORT: A WHEELCHAIR ATTACHMENT FOR CELLO PLAYING

Student Designers: Matthew Gounis and Andrew Tyo
Client Coordinator: Professor John A. Neal, Ph.D.
Supervising Professor: Joseph C. Mollendorf, Ph.D.
Technical Advisors: Daniel Cook, Kenneth Peebles and Roger Teagarden
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INTRODUCTION

The goal of this project was to design and build a wheelchair attachment that would allow a person in a wheelchair to play the cello. It was originally developed for a client with spina bifida, a congenital condition in which the spinal column does not fully close during fetal development. The client's legs are paralyzed, but upper body control is good. This wheelchair modification may be of use for individuals with other disabilities that impair use of the legs, such as cerebral palsy.

The wheelchair attachment is designed to support the instrument by its endpin. Thus, the cello is held in place while the musician bows and fingers the instrument.

SUMMARY OF IMPACT

The ability to play an instrument has the potential to positively impact a child's mental and physical development. Learning to play the cello helps children exercise and improve their fine and gross motor skills. The wheelchair modifications described here are designed to assist persons with limited or no use of their legs in supporting the cello for the proper playing position.

TECHNICAL DESCRIPTION

The brace is conveniently designed to quickly slide into the existing footrest mounts of the wheelchair. The cello support is easily attached to the chair, requiring minimal assistance.

The brace may be used by musicians of various heights and playing styles. Its arms telescope to varying lengths. The telescoping arms are locked in place by a pair of stainless steel quick release pins. The clearance between the sliding structural components was carefully chosen to prevent galling, as well as to eliminate excessive play. The endpin can be positioned as close as 14 inches from the front wheels of the chair to a maximum distance of 26 inches.

Figure 11.12. Wheelchair with Cello Support.

The endpin of the cello is held in place by a lightweight, aluminum tube that is attached to the brace by a locking clamp. The clamp is fully adjustable in its position along the front strut of the brace and can be freely rotated and locked in all planes. The emphasis placed on cello positioning was a critical aspect of the final design.

The cello brace is primarily constructed of aluminum. Aluminum tubing provides for adequate strength to support the cello and is lightweight so as not to be cumbersome to the cellist. Anodization should be considered for increased durability and part life.

The total cost of materials and supplies was about $435.

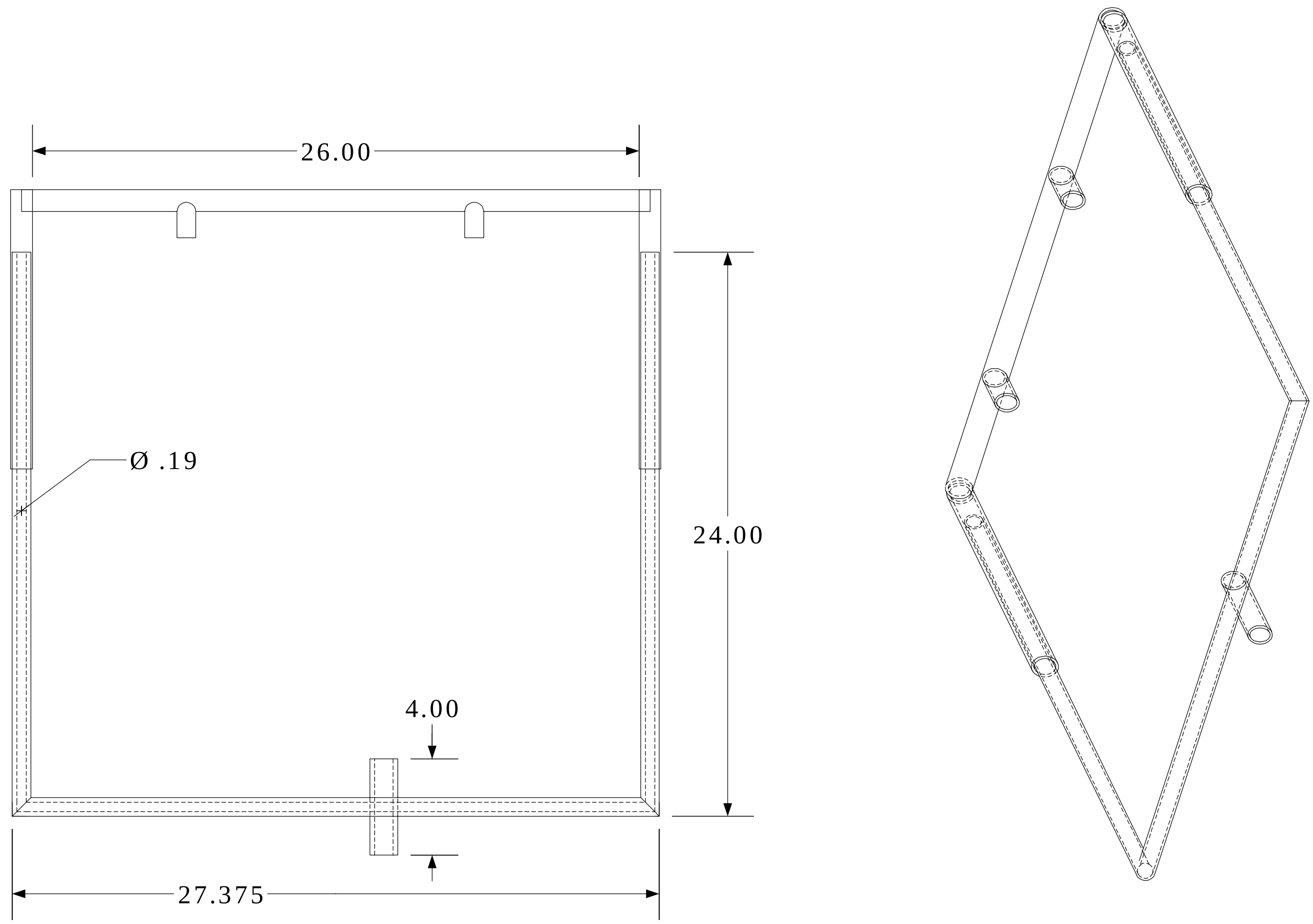

Figure 11.13. CAD Drawing of Cello Brace.

HEATED GLOVES

Student Designer: Wayne A. Willis
Client Coordinator: Chad Welles, Manzella Glove Company
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INTRODUCTION

During the colder months, the outdoor activities of people with arthritis can be hindered due to inadequate heat retention in winter gloves. Joint pain and hand cramping may occur while shoveling snow or waiting for a bus. Gloves are often not warm enough to facilitate such activities. To solve this problem, a battery-operated glove was designed to provide heat by means of electrical resistance.

SUMMARY OF IMPACT

The heated glove is warmer than conventional gloves because of the battery source and insulation used. OUTLAST™ SIERRA TRF2 is a thin (1.72 mm), insulative fiber that works interactively with the wearer to maintain a comfortable temperature barrier against cold weather. It absorbs and retains excess body heat, distributing it uniformly throughout the fabric to minimize cold spots. With such a superb insulator, there is less heat lost to the environment and less power draw on the battery, resulting in longer battery life. The outer layer is made from a thin, breathable material called Thermal Stretch™. The thinness of the glove allows for better dexterity as well. Overall, it results in a warmer, yet less bulky glove that provides maximum comfort.

TECHNICAL DESCRIPTION

First, the pattern for the glove was traced onto a composite layer of material consisting of OUTLAST™ insulation and Thermal Stretch™. The pattern was then cut out to form the top and bottom layers of the actual glove. Placing the outer shell material (Thermal Stretch™) back to back, the glove was then sewn. The heating element in the glove is made from Nichrome wire with a resistance of 6.750 Ω/ft. Approximately three feet of wire was wrapped around small rubber tubing, which was subsequently sewn onto the back-hand layer of the insulative fiber. This portion was then covered with a thin layer of cloth to prevent contact between the heated wire and the wearer's skin.

Figure 11.13. Interior of Glove.

Once the thumb was sewn in and the and the glove turned right side out, construction was complete.

When connected to the power source, adequate heat was provided at 12-volts and 0.25 amps. Thus, a 12-volt Nicad battery pack with a 1200 mAh rating can last for about 4.8 hours of constant use. Replacing the batteries, however, could be quite costly, so it is suggested that the user purchase a battery re-charger.

The materials were provided at no cost.

Figure 11.14. Glove with Battery.

ADAPTIVE TV REMOTE CONTROLLER

Designers: Alison Callaghan and Rajah Gray
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INTRODUCTION
Ordinary off-the-shelf universal remote control devices are not designed with the needs of people who have limited use of their arms or hands in mind. An adaptive TV remote controller was designed to facilitate TV viewing for such individuals.

SUMMARY OF IMPACT
The design is intended to lessen the amount of movement needed to scroll through channels. The need to hit the switch each time a new channel is desired is eliminated by the presence of the control unit. The user can now hold down the switch while watching as the channels scroll up, and release the switch when the desired channel is reached. While the switch is held, the control unit simulates a user input of "channel-up."

TECHNICAL DESCRIPTION
Essentially, the control unit is a junction box between the user switch and the remote. Power for the control unit (4 AA batteries) is independent of the remote controller's power source (2 AAA batteries) and is located within the control unit itself. An extra power source was required because the device's own power source did not provide the necessary six volts required to power the control unit.

The Adaptive TV Remote Controller addresses a problem important to persons with limited arm or hand use.

The total cost of materials and supplies was about $120.

Roger Krupski and William Willerth provided much-valued assistance in the circuit design for the control unit.

Figure 11.15. Control Unit and TV Remote.

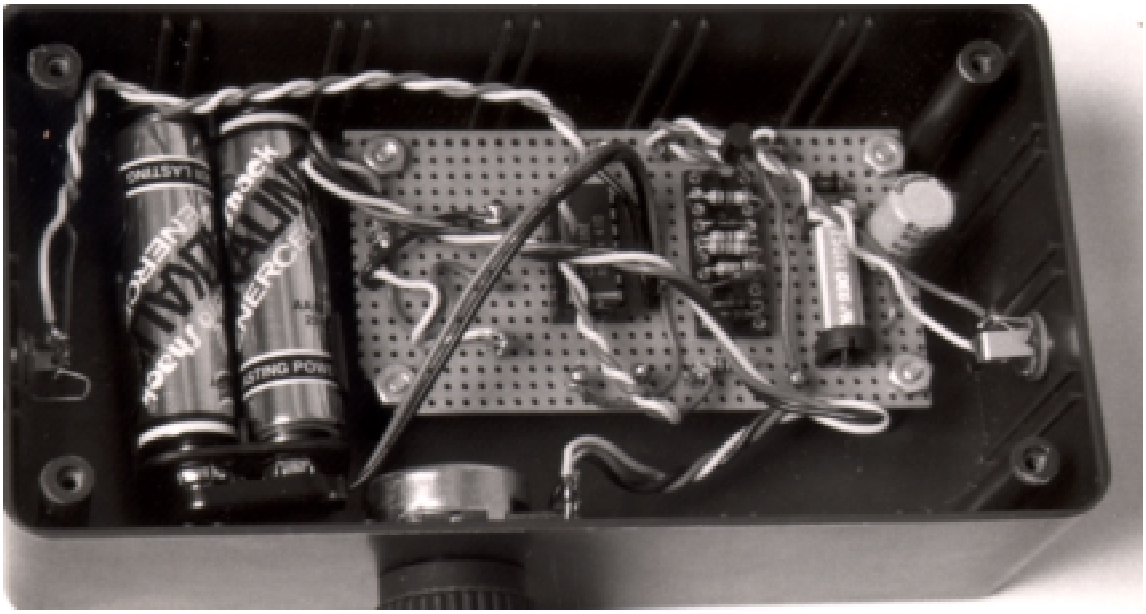

Figure 11.16. Inside View of Control Unit.

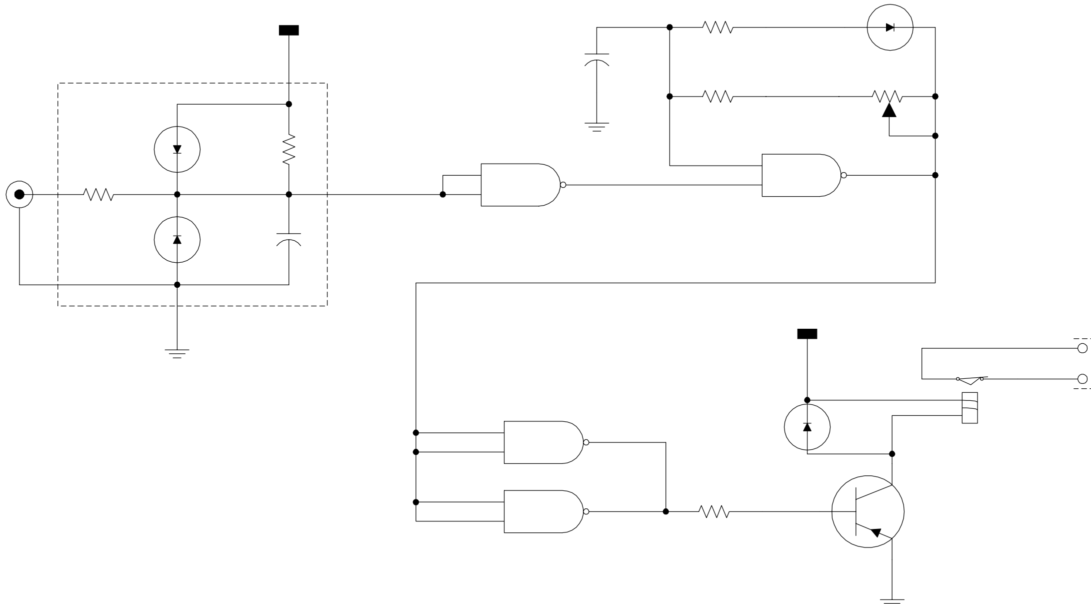

Figure 11.17. Schematic of Control Box Circuit

HYDRAULIC WHEELCHAIR SEAT TO FACILITATE TRANSFERS

Student Designers: Christopher Granelli and Keith Donaldson
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INTRODUCTION

People in wheelchairs who lack upper body strength often have difficulty transferring to and from the wheelchair. Often, they need assistance with transfers. Commercially available wheelchairs that provide aid for transfers are expensive. This design is a hydraulically operated wheelchair seat to assist a person in getting into and out of the wheelchair. Upon exiting the chair, the individual presses a switch that engages the hydraulic unit. A piston/cylinder pushes a hinged seat from underneath, which causes the seat to pivot about its front edge. The modification was kept as simple as possible for safety, ease of use, durability, and cost savings.

Figure 11.18. Seat in Normal Position.

Figure 11.19. Seat in Raised Position.

SUMMARY OF IMPACT

This modification provides an affordable alternative to personal assistance for wheelchair transfers. It can be made to mount on any ordinary wheelchair without interfering with regular activities. It is hoped that it will increase users' independence.

TECHNICAL DESCRIPTION

As in any typical wheelchair, cross-braces support the frame. These braces had to be moved forward to make space for this modification. At the rear of the frame additional support was added to help keep it rigid. At the base of our modification is a 17 by 24 by 3/8-inch aluminum plate that serves as a mounting surface for a hydraulic power unit, hydraulic cylinder, and battery.

The single-acting hydraulic power unit consists of a motor, pump, solenoid, and reservoir. See the schematic in Figure 11.20 for details. The motor is powered by a 12-volt, 720-amps continuous-use marine battery. The pump is rated at 1.6 gal / min at 2500 psi and is supplied by the internal reservoir. Oil from the reservoir travels through the pump and into the 1 ½-inch bore, 6-inch stroke piston that raises the seat. The setup can lift a maximum of 3750 lbs. Because the power unit is single acting, the weight of the user is used to cause the piston to down stroke. The solenoid acts as a release valve on the down stroke, which allows the oil to bleed back into the reservoir.

The seat was mounted with four hinges and pivots around the front edge. When the piston is at full stroke, the seat is inclined at a 35° angle from the normal seating position. This angle provides sufficient leverage to assist the user in exiting the chair.

The total cost of materials and supplies is about $510.

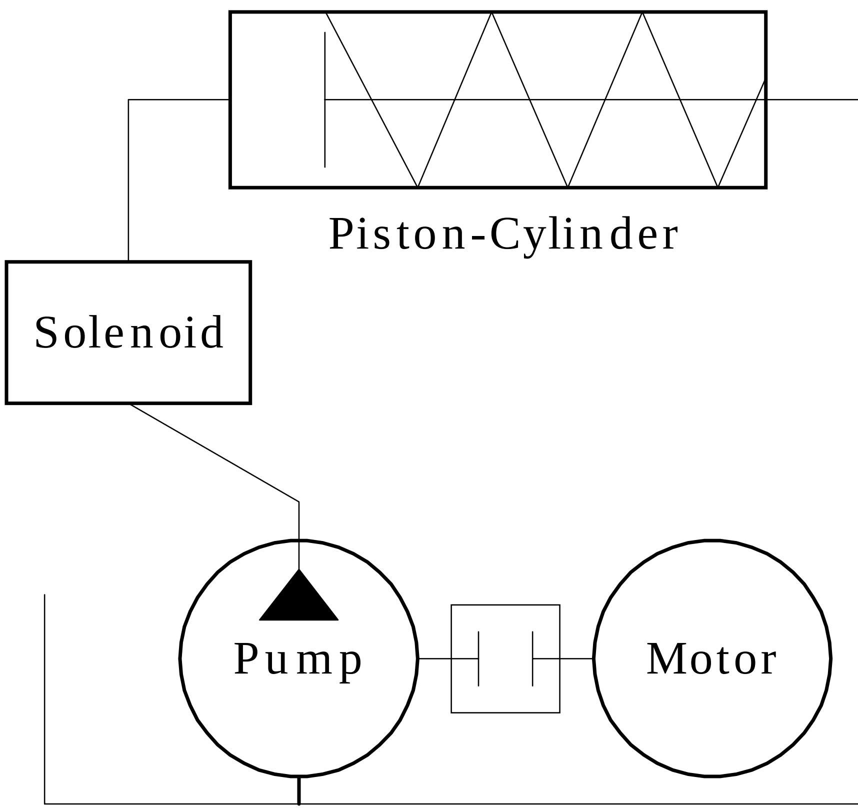

Figure 11.20. Schematic of Power Unit.

ENTRY & EXIT AID FOR AN ADULT CAR SEAT

Designers: Kristin Hatch and Joseph Segreto
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INTRODUCTION

Getting into and out of a car is a challenge for many individuals with limited mobility. Existing car seats tend to be small and low to the ground. Car doors tend to further limit accessibility. An assistive device designed to alleviate this issue was previously built. However, this device had significant disadvantages: it was specified for only one car; installation was difficult; and major car alterations were needed. The current design project was focused on achieving easy access to and from a car while eliminating prior disadvantages.

SUMMARY OF IMPACT

An assistive device was designed to provide easy and safe access to and from an automobile. Installation is quick and easy, and no alterations to the car are needed. The design is universal for most cars with bucket seats. It will allow more freedom, greater ease, and less frustration for persons with limited mobility.

TECHNICAL DESCRIPTION

The main components of the car seat attachment are: a base plate with U-shaped frame, two sliding rails, a mounting board, a rotating turntable, a seat, and four lockable straps. The two rails attach to the inside of the base plate, 10 inches apart from on another.

The rails are 18 inches when collapsed and 35 inches when fully extended. The mounting board attaches between the two rails. The turntable is sandwiched between the mounting board and the seat and secured to both. Two straps wrap around the attachment, perpendicular to the rails. The two remaining straps attach at the end of the U frame.

The device is designed to rest on the front passenger seat of a car, with the device's seat facing forward. The straps wrap around the car seat, fastening it to the car seat's rails. A cushion is placed under the rear of the base. This allows the device to be level on any seat to which it is fastened.

Figure 11.21. Car Seat Attachment Placed on Passenger Seat of Car.

Operation of the device is simple. To exit the car, the mounting plate and seat slides the passenger out of the car along the two rails. The seat is then turned clockwise, facing the user away from the car. Entering the car is accomplished by reversing this procedure.

This design is easy and safe to use, quick to install, and requires no car alterations. It affords increased independence for the user and reduces caregiver burden.

The total cost of materials and supplies is about $95.

Figure 11.22. Car Seat Attachment Extended Out of the Car.

THE GRAPPLING WALKING CANE: A DEVICE TO FACILITATE WALKING AND OBJECT ACQUISITION

Student Designers: Eugene Darlak and David Palen
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INTRODUCTION

Most human movements involve some stress on the back. For persons with back injuries, even simple spontaneous movements, such as those involved in leaning over to pick up an object, can lead to a pinched nerve, torn ligament, or strained muscle.

A device was designed to help people with limited mobility grasp objects at a distance without bending over. Essential crieria were that it be easy to use, aesthetically pleasing, lightweight, and easy to maintain

The grappling walking cane was an ideal base for the design because of its common use and existing market. The cane is made of aluminum and plastic, so it is lightweight. With its extension, the cane is over three feet long, eliminating the need to bend over.

Figure 11.23. Grappling Cane.

SUMMARY OF IMPACT

It is hoped that the Grappling Walking Cane will aid a substantial number of people who have limited mobility by allowing them to obtain objects that would normally be out of their reach, and that it will reduce the possibility of aggravating back injuries. The mechanical system allows for grasping and holding a large variety of objects.

Figure 11.24. Mechanical Extension Grasping an Object.

TECHNICAL DESCRIPTION

A motor turns a threaded rod, causing a claw to move down a guiding channel. The grip is based on the force of the motor jamming the outer surface of the claws into the bottom of the cane.

The electrical system (see Figure 11.24) is based upon a simple 3-volt motor that can change direction through alterations in electrical polarity.

The cane can be used for grasping a wide range of objects, particularly anything with a handle or ring around which the extension can fit.

The total cost of materials and supplies is about $86.

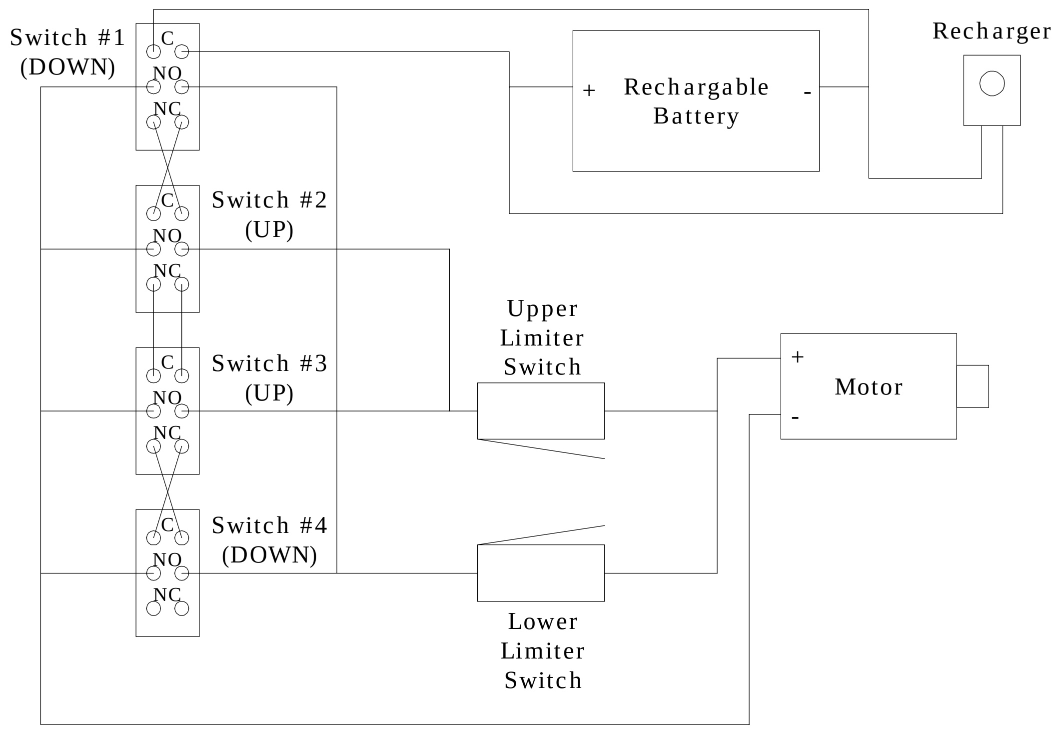

Figure 11.24. Circuit Diagram.

RELEASABLE KNEE IMMOBILIZER FOR PATIENTS WITH KNEE INJURY

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Supervising Professor: Joseph C. Mollendorf, Ph.D.
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INTRODUCTION

An inexpensive alternative to flexible knee braces was designed to increase comfort and compliance for patients who wear immobilzers following knee injury or surgery. Immobilizers are worn for support and protection during healing of the knee joint. Often, when patients sit for long periods of time or engage in activities in which the brace is cumbersome or uncomfortable (e.g., driving a car or using a rest rooms), they remove the knee immobilizer. It may also be removed for exercise. Because of the inconvenience of repeated application and removal, patients may choose to leave the immobilizer off, contrary to physician recommendation.

Flexible braces permit locking or flexing of the knee joint. They are designed to support the knee of a walking patient. They range in price from $250 to for a non-custom brace to $1000 or more for a custom-fit carbon fiber composite unit.

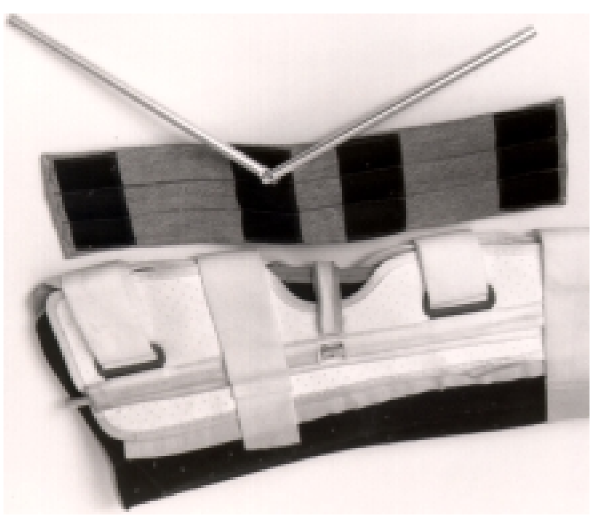

Figure 11.26. Immobilizer Components.

Figure 11.27. Immobilizer “Locked”.

SUMMARY OF IMPACT

The design of the Releasable Knee Immobilizer allows patients to “unlock” the brace for the purposes of sitting, driving, and other activities that provide sufficient support for the knee and leg, even though it is in the flexed position. Benefits include support of the joint and surrounding structures to promote healing, increased comfort, improved compliance with doctors’ instructions, ease of operation, and a cost that is approximately 10% of flexible knee braces on the market.

TECHNICAL DESCRIPTION

The Releasable Knee Immobilizer consists of four main components (Figure 11.26). The body of the immobilizer consists of a 3/8-inch thick piece of open cell foam that has a backing of a felt material with Velcro adhered to it.

Secured to this foam are 1) a nylon sleeve containing the metal bars that provide lateral support to the knee joint, and 2) two pieces of white vinyl attached to Velcro straps and buckles, which are used to wrap the immobilizer around the injured leg. One of the bars is shown outside its sleeve in Figure 11.26.

A cloth pouch contains the three metal bars that are placed behind the knee to prohibit bending of the joint. This pouch is attached to the foam with Velcro.

The immobilizer is applied by placing the sculpted area of the immobilizer even with the knee joint, wrapping the foam around the leg, and tightly securing the four Velcro straps. To unlock the brace without removing it, the cloth pouch containing the metal stays is removed from behind the knee, allowing the knee to bend.

The solid metal rods that normally provide lateral support to the knee have been replaced by rods that contain an overlapping, split-type joint. Half of a cylinder (down the long axis of the rod) has been machined off of each rod, and then the two pieces were joined with a pin. The overlapping portions prevent flexing of the rod along the axis of the pin (see Figure 11.26, bottom item). The rod can bend in the same direction as the knee, providing lateral support when the immobilizer is locked.

To return the immobilizer to its rigid form, the leg is straightened and the cloth pouch is reapplied to the foam via the Velcro strips. Some care is required in aligning the pouch with the rest of the brace to maintain proper support. This is not particularly difficult and becomes easier with practice.

Figure 11.27 shows the immobilizer in the locked position on a seated individual. Figure 11.28 shows the immobilizer in its unlocked position. The cloth pouch containing the metal stays that go behind the knee are shown in the foreground.

Figure 11.28. Immobilizer “Unlocked”.

The Releasable Knee Immobilizer successfully meets the design goals. It provides needed support for the knee, increases comfort and compliance, and offers a release system that is quicker and easier than removing the immobilizer. Additionally, is cost is attractively low.

Total cost of materials and supplies is approximately $30.

The authors thank Karen Burg for assistance in sewing, and the machine shop staff at SUNY-Buffalo for machine work.

MEAL TRANSPORTER HOT PLATE FOR MEALS ON WHEELS

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INTRODUCTION

Meals on Wheels is a non-profit organization that delivers hot meals to seniors and persons with disabilities. A volunteer transports twelve hot meals in an insulated container over the course of one hour. Health codes specify that the food temperatures must be maintained at 140 degrees Fahrenheit.

The meal transporter hot plate is designed for a particular delivery container. The hot plate does not require a power source while in use and is lightweight. The energy released from the plate will compensate for the loss of heat when the container door is opened. This allows the volunteer to complete a one-hour delivery period while maintaining the required temperature at which food must be served.

SUMMARY OF IMPACT

The meal transporter hot plate will facilitate daily delivery and kitchen operations. The design promotes an increase of heat transfer capabilities. This will allow food to stay warm for longer delivery periods, allowing Meals on Wheels volunteers to reach more clients and increase the overall efficiency of their daily routines.

The original design was an electric hot plate that required frequent repairs. Now, after the initial investment, there will be a decrease in overall expenditures because the hot plate presently described does not require additional maintenance. Also, because it is lightweight, it will reduce delivery person fatigue.

TECHNICAL DESCRIPTION

One design constraint was to make the hot plate fit perfectly in the base of its transporter. The final dimensions are 13 by 17 by 1 inches. The design involves a base, a cover, and an O-ring gasket. The base consists of a thick plate with a pocketed center. An O-ring groove is cut from the perimeter of the base where gasket material is placed.

The heat storage material, PCM, ISO-T90, has a heat of fusion of 70 BTU per pound. During the phase change, 280 BTU are released. Fifty-five percent of the heat release occurs during the phase change.

The heat plate requires two hours of heat addition at 250 degrees F to reach its full potential.

The total cost of materials and supplies was about $270.

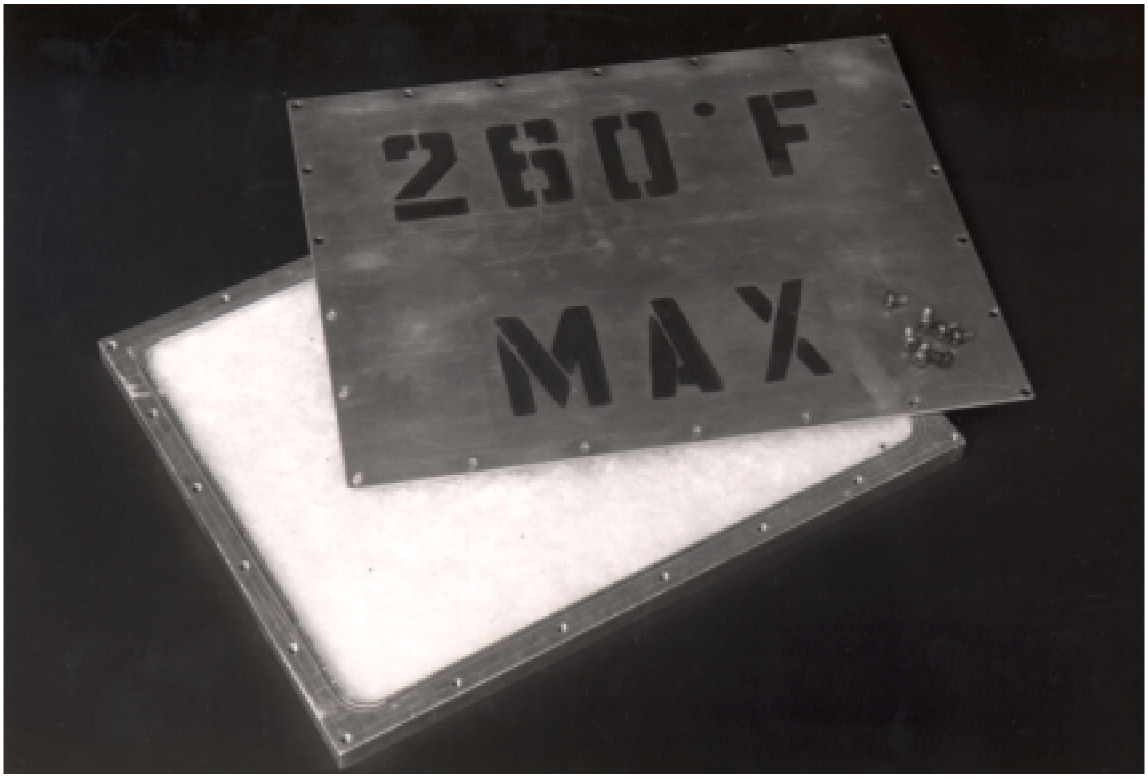

Figure 11.29. The Interior Components of the Meal Transporter Hot Plate.

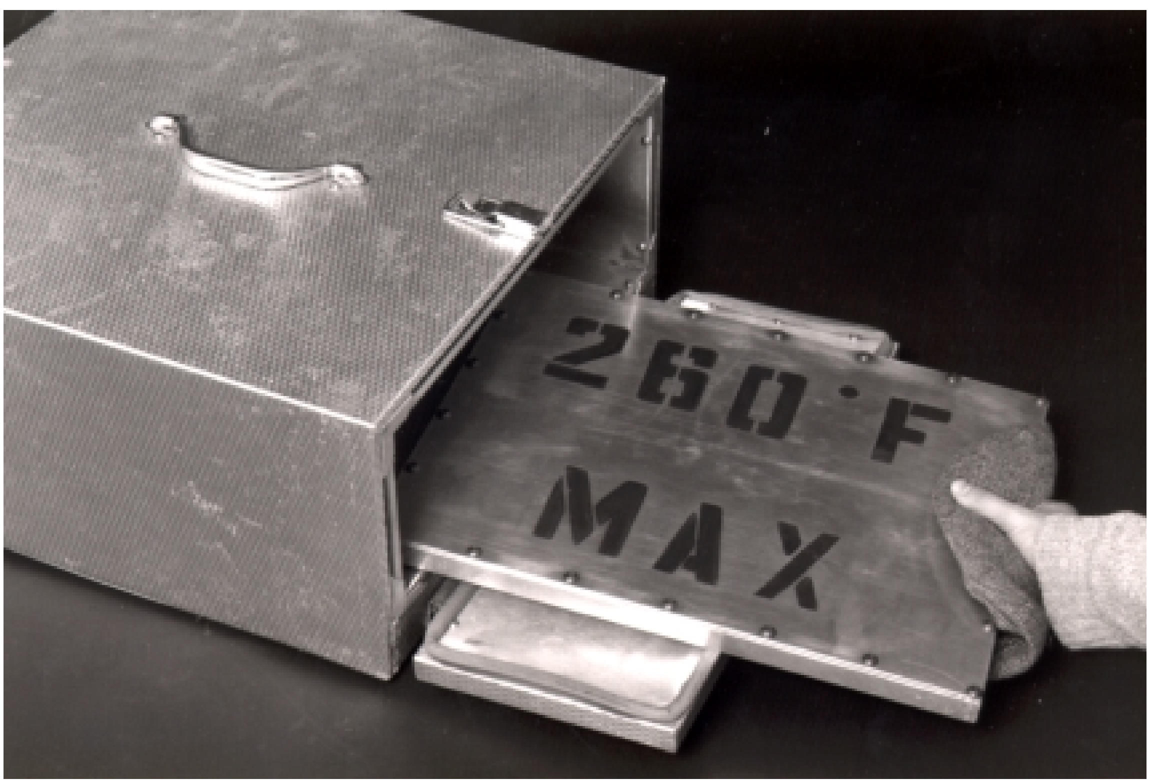

Figure 11.30. Meal Transporter Hot Plate.

AUTOMATED PAGE TURNER

Student Designers: Mark Forest, Matt Kelly, Jeff Olenjniczak and Brian Rasbach
Supervising Professor: Joseph C. Mollendorf, Ph.D.
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INTRODUCTION

A device was designed to turn the pages of a book or magazine with the simple push of a button. This device enables a person with limited use of his or her hands or arms to read without the assistance of others.

SUMMARY OF IMPACT

The main goal of this project was to create a page-turner that reliably turns a single page at a time, forward or backward. Reliability problems constitute the greatest flaw in existing page turning devices. Operation of the present device is initiated via a two-button panel, one button for turning one page forward, and the other for turning one page backward.

The entire device is contained on an inclined easel. The reading material rests on an adjustable sliding stopper attached to the easel. This accommodates different sizes of reading material and enables viewing of the book or magazine at a comfortable angle.

The page-turner is powered by a DC battery pack, making the device portable.

TECHNICAL DESCRIPTION

The automated page turner grabs and lifts a single page of reading material. A metal "finger", with adhesive at its tip, is attached to an armature that stands over the center of the book in the "ready" position. The armature consists of a series of three interacting four-bar linkages. Each linkage has a distinctive function in providing the armature with the necessary degrees of freedom to reach and / or lift each page.

The armature is driven from side to side by a high torque gear-motor, mounted at the top left of an inclined easel. When one of the operating buttons is pressed, the motor moves the main linkage to the appropriate side of the book (whether forward or backward) until the finger touches the page. The linkage then changes directions and returns to the "ready position."

The metal finger employs a second linkage to attach it to the floating link in the main linkage. This suspension linkage serves three purposes. First, it accommodates the varying thickness of different books, and of sections within the same book. Second, it suspends the finger in a vertical fashion out over the book in a plane parallel to that contained by the main linkage. Third, the armature has a built-in ratcheting linkage that automatically advances the reel of adhesive during the return stroke of every forward page advancement. This ensures that a fresh portion of adhesive is available following every forward cycle.

Another principle component is a timing belt with two pulleys, mounted within the plane of the easel. This mechanism is driven by the right pulley, which is powered by another high torque gear-motor. The pulley on the right side a simple idler pulley.

Extending several inches out from the loop created by the timing belt and two pulleys are two lightweight aluminum members. These members are located at exactly opposite positions on the belt, and constitute the final component the page encounters before coming to rest in its new position. After the armature lifts the page, the belt mechanism advances the page by sweeping the aluminum members in the appropriate direction. For forward movement, the members sweep left to right and for backward movement, the members sweep right to left. These members then come to rest after the belt completes exactly one half revolution. This forces the members to exchange their original resting positions. The belt mechanism is then ready for another cycle in either direction.

This device is equipped with a mounting system to accommodate various sizes of reading material. The book or magazine to be read is placed on a vertically adjustable sliding rail. The book and the rail together slide vertically until the book meets a positive stop at the top of the easel. The rail is then tightened down using two knobs, which hold the reading material in position for the adhesive armature to operate correctly.

The prototype shown in these photographs is a electro-mechanically driven proof-of-concept design. Everything that needs to occur mechanically is complete and occurs without human intervention. However, the electrically coordinated timing of this device is incomplete. At this point, the device cannot operate without human intervention to manage the timing of the two main devices it employs. Ideally, a microprocessor will coordinate the correct interaction of the working mechanisms.

The total cost of materials and supplies is approximately $280.

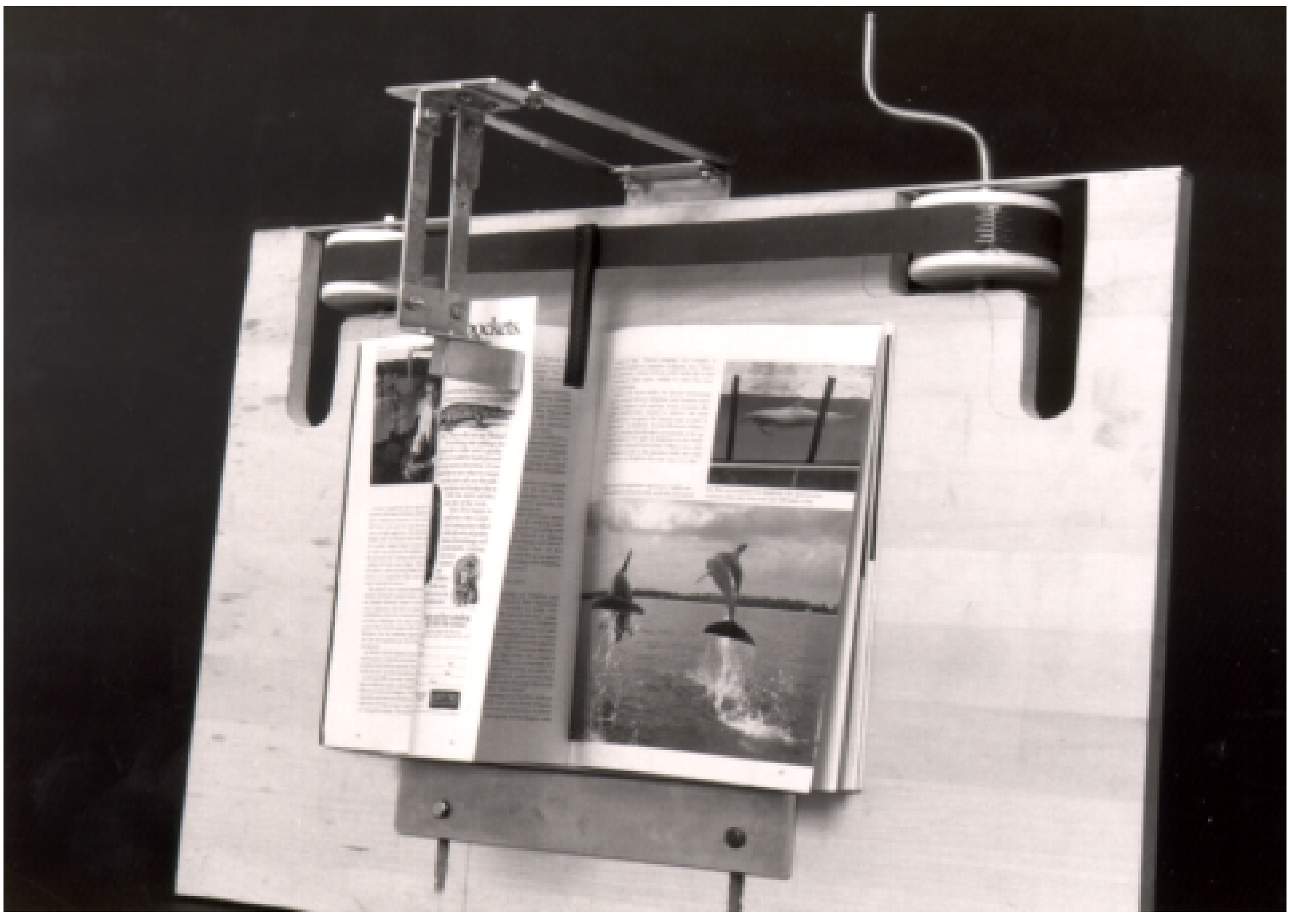

Figure 11.31. Page Turner Prototype.

AUTOMATED DOLL HOUSE

Student Designer: David Johnston and Mark W. O'Connor
Supervising Professor: Joseph C. Mollendorf, Ph.D.
Mechanical and Aerospace Engineering Department
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INTRODUCTION

An automated dollhouse was designed and built for a five-year-old child born with arms that end at the elbow. She is unable to play with most available toys. The device was designed with a spring-loaded rocker switch. When the switch is pushed, music is played and the doll begins to march in place inside the dollhouse. Manipulation of the doll is achieved through a system of strings connected to a motor. This allows the child to play with a doll.

SUMMARY OF IMPACT

The automated dollhouse was intended to help improve the client's motor skills, to keep her amused, and to facilitate her learning of cause-and-effect relationships. In order to accomplish these goals, it was important that the toy be entertaining. Music accompanies the motion of the doll to maintain her attention.

TECHNICAL DESCRIPTION

The control unit is a simple spring-loaded switch that controls a motor. The motor is powered by a 12-volt battery and is geared down to 32 rpm. As the motor rotates clockwise, a bar on the motor shaft flips a switch that changes the polarity and causes the motor to reverse direction. After about 60 degrees of rotation, the bar on the shaft flips the switch back, returning the shaft rotation to a clockwise direction. This causes an oscillatory effect on the shaft.

A circular plate is attached to the end of the shaft. Strings are attached to each end of the circle. The strings, in turn, are attached to the arms and legs of the doll. The strings are aligned such that when the left arm and right leg rise, the opposite arm and leg fall.

The doll is secured in a harness made of an L bracket and two screws. The L bracket is fastened to the dollhouse floor with two plates and four wing nuts. The batteries, motor assembly with doll, and control panel can be removed from the dollhouse. This allows the dollhouse to fold up for easy storage.

Music from a *Fisher Price* toy was added. The control button was tied into the *Fisher Price* toy so when the button is pushed one of three melodies is played. There are three additional buttons on the toy that light up and play a preprogrammed tune when pushed.

The total cost of materials and supplies was about $92.

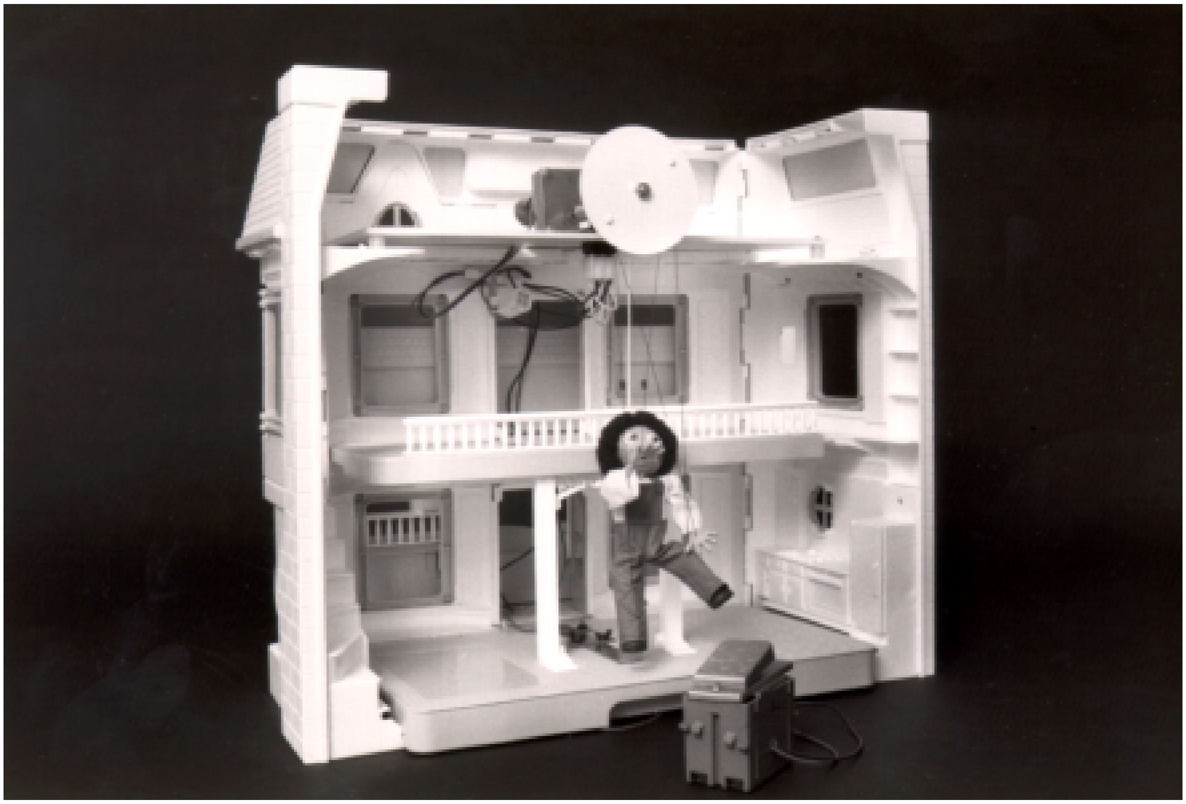

Figure 11.32. Doll Inside Doll House.

A SELF-SHIFTING SEAT CUSHION TO PREVENT BED SORES

Student Designers: David J. Halady, Richard A. Walpole and Daniel P. Wiegand
Supervising Professor: Joseph C. Mollendorf, Ph.D.
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INTRODUCTION

The medical industry spends approximately 7 billion dollars a year on the treatment and prevention of decubitus ulcers (bed sores). A bedsore may form when a critical pressure is incident on the skin for an extended period of time. Such is the case of immobile persons who are wheelchair and bed bound. One solution is to develop a seat cushion that shifts the immobile person in a pattern similar to that of a mobile person. The seat cushion detects areas where bedsores are likely to form and shifts these high-pressure zones around. It is important to note that the wheelchair cushion is only one application of such a product. Now that proof-of-concept is complete, a cushion the size of a bed mattress could easily be made using the same technique.

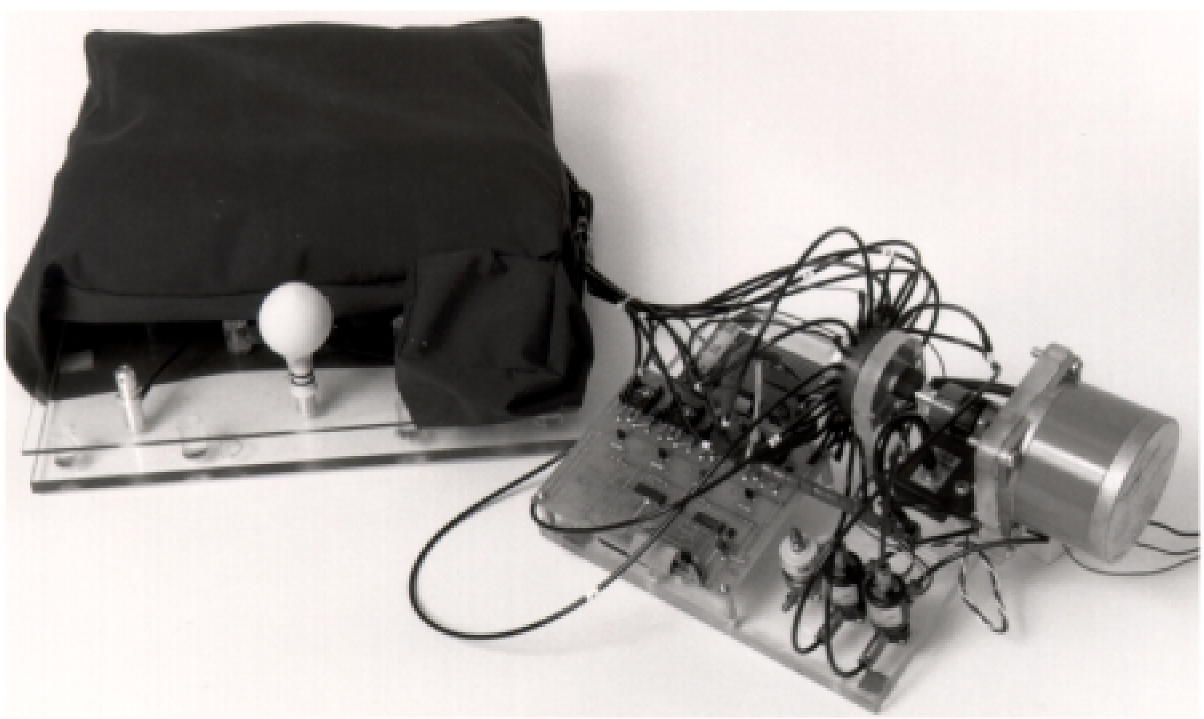

Figure 11.33. Self-Shifting Seat Cushion Prototype.

SUMMARY OF IMPACT

The Self-Shifting Seat Cushion has potential to be implemented in many hospitals and other health care institutions, alleviating physical pain and reducing medical costs.

TECHNICAL DESCRIPTION

This cushion seeks out high-pressure areas and distributes the pressure to other areas. This process is done repeatedly to stop tissue breakdown.

The seat cushion is in the shape of a square consisting of nine (three by three) airtight cells, each of which is connected to a pneumatic wafer valve with small diameter tubing.

Upon powering up the system, the seat cushion begins to fill with air. Once all the cells are filled, the patient sits on the cushion. The next step is to sample and vary the pressures. If the pressure in a cell is too high, as determined by set points within an EVBU, air is exhausted. With the pressure reduced, the surrounding cells will have to make up the difference in the loss of support in that region. Hence, the high-pressure areas will be shifted to a new area for a short time. In this manner, no single area will have too high a pressure for an extended period of time.

The total cost of materials and supplies is about $550.

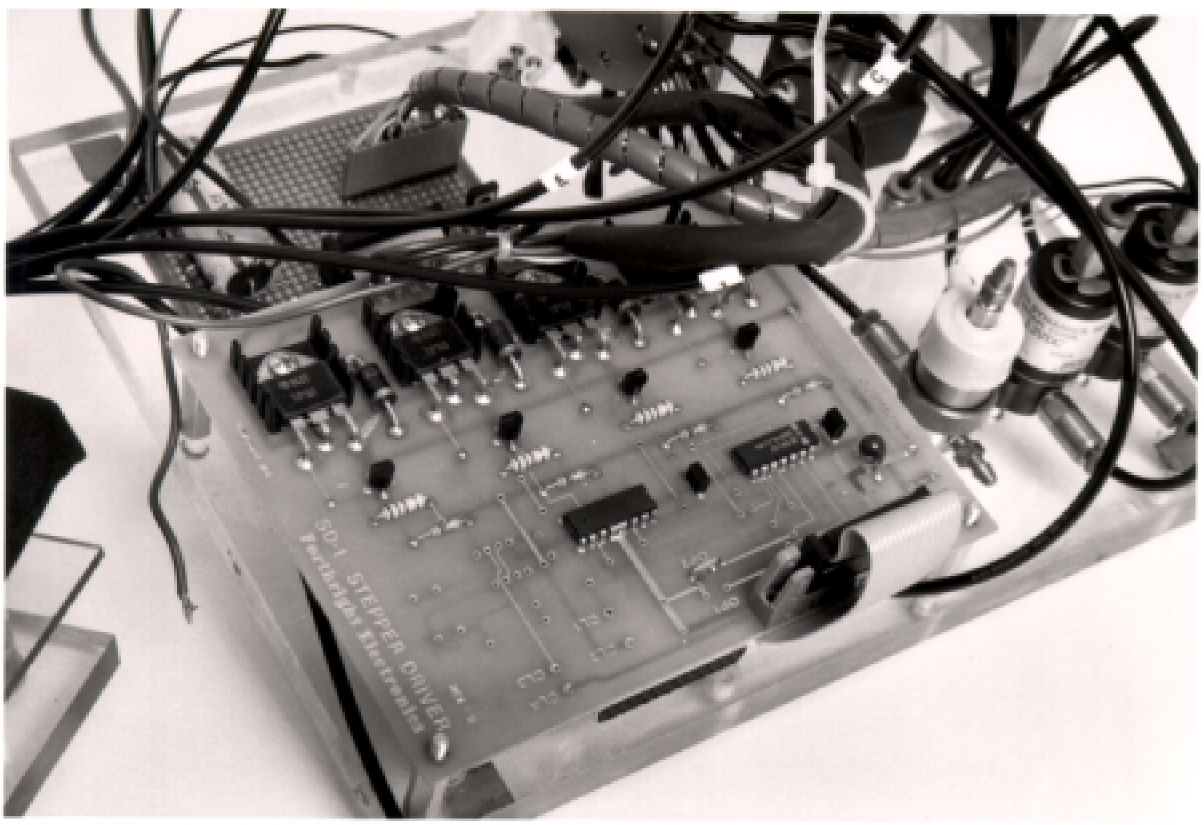

Figure 11.34. Control Board for Self-Shifting Seat Cushion.

HEIGHT ADJUSTABLE WHEELCHAIR TO FACILITATE HORIZONTAL TRANSFERS

Student Designers: Clifford J. Solowiej, Jeremy Francis and Jon Bechtel
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State University of New York at Buffalo, Buffalo, NY 14260-4400

INTRODUCTION

This project addresses a serious problem faced by caregivers who assist in the horizontal transfer of the patients in wheelchairs: back injuries due to incorrect lifting methods. This device may also alleviate patients' mobility problems associated with height constraints.

Figure 11.35. Full View of Wheelchair.

SUMMARY OF IMPACT

There are no known devices that perform the same functions as the Height Adjustable Wheelchair. The mechanism is designed to help reduce physical strains on caregivers. Since the operation of the device involves simply pushing a button, individuals with adequate use of their hands can use this device to transport themselves and increase independence in such environments as the bathroom and / or kitchen.

TECHNICAL DESCRIPTION

The mechanism is composed of two main assemblies: a stationary platform and a chair. The platform is constructed of a rectangular sheet of aluminum, providing a stable housing for the hydraulic system and the wheels. The chair is made of aluminum tubing with four, single-acting, hydraulic cylinders (9" stroke) fitted to each corner. The ends of the piston rods are fastened to the mounts that are bolted to the platform.

The hydraulic circuit is rather simple. For the chair to move in the upward direction, output from the HPU is channeled into a flow divider. From this, four output lines receive equal volumetric flow rates of fluid that are sent directly to each cylinder. This provides a stable and level movement of the chair as the cylinders are actuated. Chair movement in the downward direction is achieved by energizing a solenoid relief valve on the HPU. This allows the internal springs in the cylinders to push the fluid back through the lines and flow divider to the hydraulic reservoir.

The wheelchair is fitted with three brakes, one on each front wheel and the third on the left rear wheel. When the chair is in its full vertical position, sufficient torque can develop on the wheels causing a tendency for the chair to move. The brakes ensure that the chair will stay in place during the operation of transporting an individual from the chair to a bed.

The total cost of materials and supplies was about $1,400.

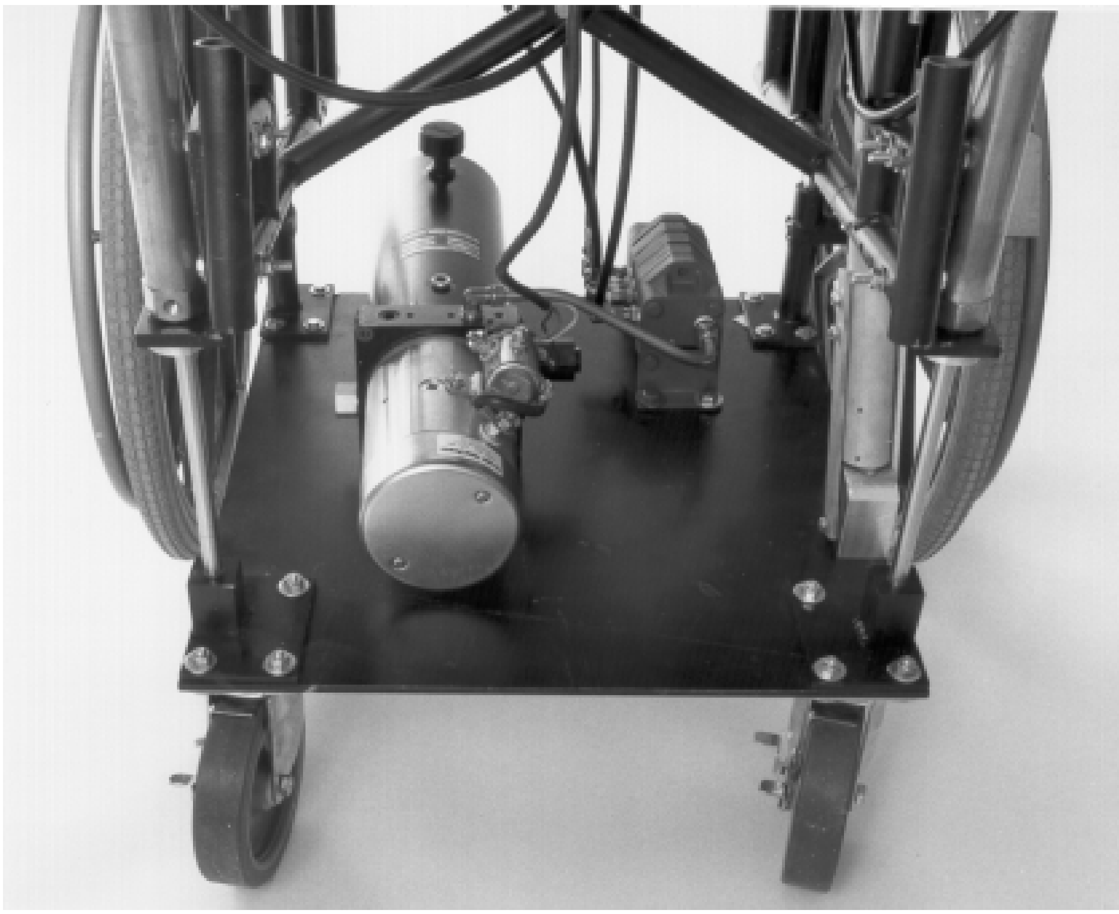

Figure 11.36. Close-up of Hydraulic System for the Adjustable Height Wheelchair.

ELECTRIC FINGER TO TURN ON THE STENTIEN SYSTEM

Student Designer: Chung Park
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INTRODUCTION

A device was designed to press the power switch on a Macintosh computer's keyboard once the user turns on the main power of the Stentien System, a system that enables a person with a disability to use the programs in the computer. It connects and disconnects the AC power to the power strip via an infrared signal controller. The computer and other equipment, such as printer and monitor, are plugged into the power strip. However, the system is neither programmed nor equipped to turn on the power switch. Therefore, someone else has to press the power switch for the user. Hence, there was a need for a device that presses the Macintosh power switch when the user turns on the Stentien System.

SUMMARY OF IMPACT

This Electric Finger has three components: an AC-DC converter, the clamping device and the switch-pressing device. The AC-DC converter is plugged into the power strip of the Stentien System. The clamping device with the switch-pressing device is attached on the far right side of the keyboard. The switch-pressing device is placed such that the rod from the motor shaft lines up with the power switch. The power line from the AC-DC converter is plugged into the socket on the back of the Electric Finger.

When the user turns the Stentien System on, the AC power is sent to all the computer components, including the electric finger. After a small time delay, the motor turns for one second

In case of failure on the first trial, which does not happen under normal conditions, the device can be tried again after five to 10 minutes, allowing the capacitors to discharge. If an able-bodied person is available, the discharging can be done in an instant by pressing the two switches on the back of the box.

Figure 11.37. Electric Finger Mounted on Keyboard.

TECHNICAL DESCRIPTION

This Electric Finger has two major components: the mechanical parts (switch-pressing arm and clamping device) and the electric circuit that controls the electric operating device. The required force to press the power switch on the Macintosh keyboard is about 0.6 Newtons. The difference in height when the key is pressed and released is 4 mm. A clamping device holds the entire assembly on the keyboard and must keep the package stable while it is in motion. Since it pushes the power switch key against its own holding force, the motion creates a reacting force on the clamp.

The circuit in the Electric Finger consists of two input sources and two power lines for the circuit and the motor. The basic concept for the circuit is derived from the Schmitt trigger design. Since the trigger executes a certain amount of exponential voltage increase into a step response, the triggering tie can be set by adjusting the time of the exponential increase of the voltage.

The cost of materials and supplies is about $150.

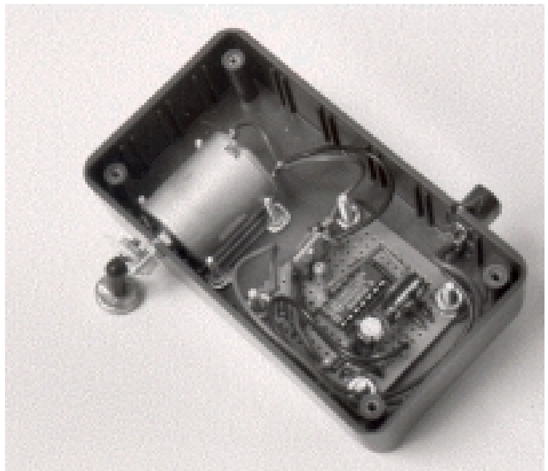

Figure 11.38. Electric Finger Motor and Circuit Board.

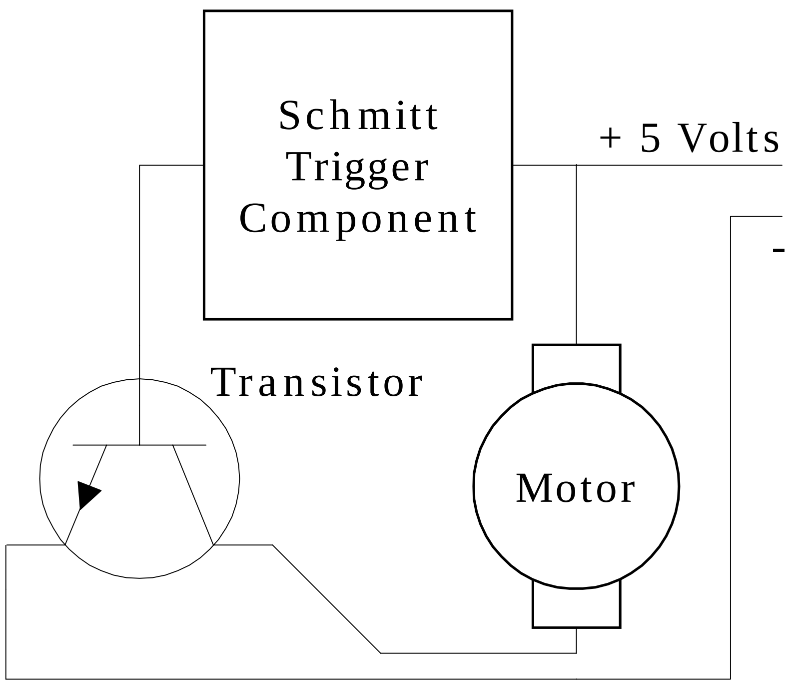

Figure 11.39. Simplified Circuit for the Electric Finger.

HAND SPORT SUPPORT

Designer: Mark Hepworth
Supervising Professor: Joseph C. Mollendorf, Ph.D.
Mechanical and Aerospace Engineering Department
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INTRODUCTION

People with hand problems, such as arthritis, sensitive joints or muscles, or poor hand function, may find it painful or difficult to play sports that require hand strength and movement. The Hand Sport Support is an exoskeletal device that augments strength during sports activity. The device is attached to the forearm and palm area of the user. Hand-held sporting equipment, such as a tennis racquet, baseball bat, golf club, can be attached to the device, shown in Figure 11.40. When the user strikes a ball, the force from the equipment is directed away from the hand and translated to the forearm.

SUMMARY OF IMPACT

The Hand Sport Support was developed to assist individuals who have problems participating in sports due to a hand disability. The device is designed to direct impact forces from the equipment away from the hand to the forearm. Other devices in the marketplace merely support or act as a "Band-Aid" to the hand. The Hand Sport Support moves with the hand and simulates the wrist movement of the user. Other supports and devices in the marketplace restrict movement and become a hindrance. This device is adjustable so that users can change the strap length to the desired fit, as shown in Figure 11.41.

TECHNICAL DESCRIPTION

The part of the device that supports sporting equipment with varying handle widths is made from aluminum tubing four inches long with a 1.5-inch diameter. A finger screw is used to fix the equipment handle in place inside the tube. The tube is attached to a Teflon disk that is two inches in diameter and geared so that a pin can be placed in the teeth to stop rotation. A Teflon disk rotates on a Plexiglas forearm attachment that was constructed to the shape of a plaster mold of the forearm. The forearm attachment contains a fixed aluminum pin that pivots into and away from the gear. The forearm attachment has a Teflon support that runs the length of the Plexiglas, limiting part flexing. Closed cell foam is placed on the underside of the device, between the palm side of the forearm and the forearm attachment for dampening.

The total cost of materials and supplies is about $25.

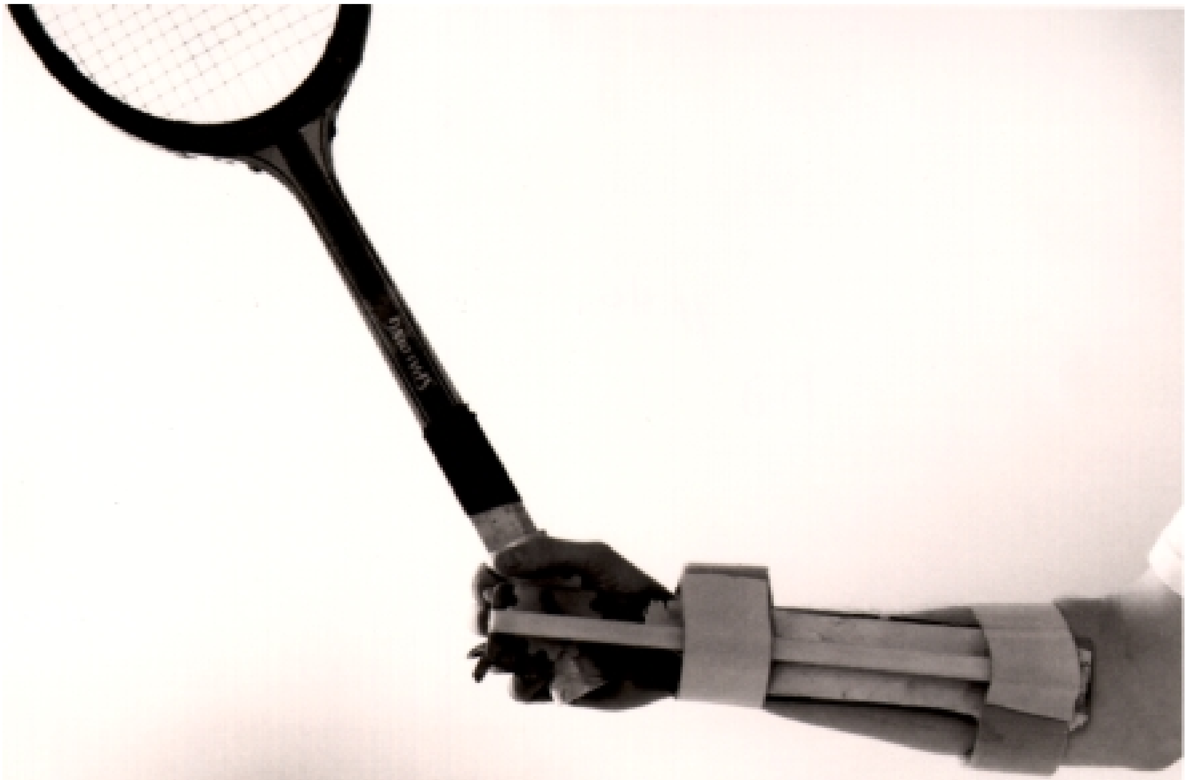

Figure 11.40. Hand Support with Tennis Racquet.

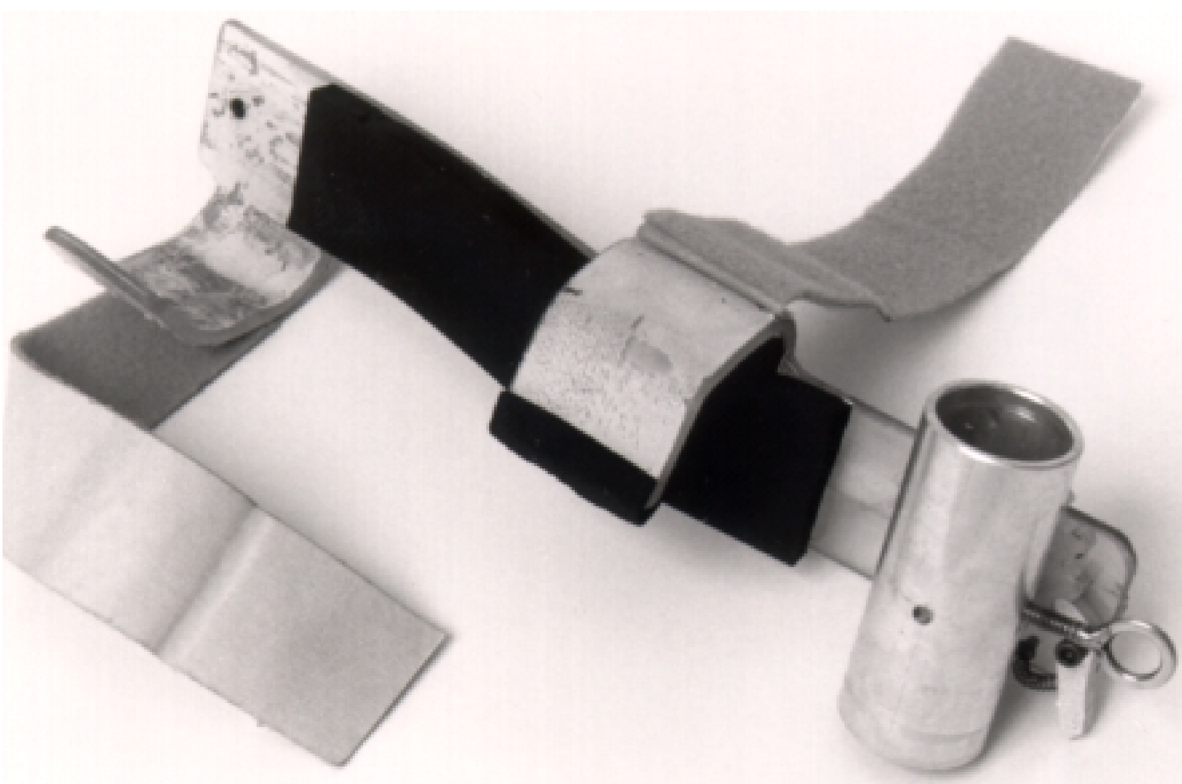

Figure 11.41. Hand Support Unit.