

# CHAPTER 6

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# THERAPEUTIC WRIST AND FOREARM BRACE

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## INTRODUCTION

The purpose of this therapeutic design is to develop an effective, easy-to-use extension to improve hand function for an individual with contracted wrists due to cerebral palsy. The design criteria for the brace were defined by the client's needs, which include frequent trips to clinics to receive physical

and occupational therapy. The new therapy brace will help the individual independently accomplish frequent extension exercises. The design is composed of a wrist and forearm brace with polyester elastics for extension.



Figure 6.1. Therapeutic Brace with Elastic Strips

## SUMMARY OF IMPACT

This therapeutic brace (shown in Figures 6.1 and 6.2) has removable extension tools as well as a safe attachment tool. Consistent use of the device will increase range of motion and soft tissue integrity, which is essential in the maintenance of proper positioning. The device also provides rigid, consistent support of the client's wrist. Furthermore, the device is adjustable over time, so that the amount of extension can be progressively increased as the client's tolerance improves.

## TECHNICAL DESCRIPTION

The device is composed of a commercial wrist and forearm brace, Velcro, and double stranded strips of polyester elastics. Three strips of Velcro were attached by a seamstress along the brace and on the area between the wrist and fingers. Two double strands of five, seven and nine centimeter-long polyester elastics were attached, with Velcro hooks sewn onto both ends. Force of extension, produced

by the elastics at four different increasing positions on the brace, was measured using a force meter. The values were approximately 9.2, 12.1, 15.6, and 18.6N. The strongest elastic strip was found to have the ability to provide the client with full wrist extension while the other strips provide varying degrees of extension. Other technical aspects include a means of securing the device that will not hinder or compromise the blood circulation in the client's hand or cause a pooling of fluid in the distal extremity. As a therapeutic device, it is able to take slow, constant stretching to provide the best results on the soft tissues. Also, the positioning of the device is comfortable enough to allow the client to sleep with it on. This provides increased benefits to the client at night because the muscles are more relaxed during sleep and, therefore, would be more susceptible to the stretching effects.

The overall cost of materials for the therapeutic brace was \$46.



Figure 6.2. Client Using Therapeutic Brace

# ADAPTOR FOR EXERCISE BICYCLE PEDAL

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## INTRODUCTION

An individual with Parkinson's disease firmly believes in the use of continued exercise to slow the progression of the disease. He first discovered he had Parkinson's ten years ago and his main symptom was tremor in his left hand. Today his disease has progressed to other areas of his body, including his legs. He has trouble using his favorite piece of exercise equipment, the recumbent exercise bicycle, because his legs are unable to maintain a constant rhythm with the bike. With one leg cycling faster than the other, his feet often slip off the pedals, having the potential to cause injury. He requested to have his exercise bike modified to adapt to his needs. The exercise bicycle pedal adaptor has been designed to allow him to exercise with the recumbent exercise bicycle, even when he is experiencing symptoms of reduced leg muscle control. This device allows the client to easily secure his feet to the bike, and provides him with the freedom to use his bike at home, as well as the bikes at the gym.

## SUMMARY OF IMPACT

The device, shown in Figures 6.3 and 6.4, allows the client to resume his exercise schedule. This, in turn, will provide him with a better quality of life and possibly slow the progression of Parkinson's disease.

## TECHNICAL DESCRIPTION

This device was designed with two components, which simplify attachment and removal for the client. The two components, the pedal attachment and the foot attachment, are connected through an inter-device connection. The pedal attachment required a design that would not damage the existing pedal. Therefore the final design is a thin aluminum platform with rubber stoppers attached to its base, along with nylon straps and plastic clips for attachment to the existing pedal. This design allows the device to fit easily over the existing pedal

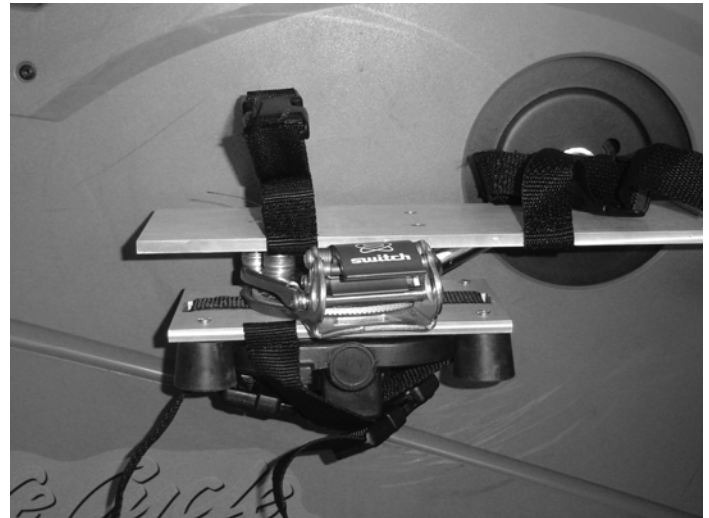


Figure 6.3. Adaptor for Exercise Bicycle Pedal

and then be secured using the clips and tightened with the nylon straps. Based on the dimensions of the pedal, the platform is a rectangle of 6.75" by 4". The rubber stoppers are secured to the platform using 6-32 flat-head machine screws. These screw from the top of the platform into coupling nuts that were previously glued into the center of the rubber stoppers. The base of the inter-device attachment then screws into the top center of the pedal attachment platform using 1/4- inch flat head machine screws.

The foot attachment component of the design utilizes aluminum pieces, 1/4 in. washers, 1/4 in. (1 in. long) screws, 6-32 (1 in. long) screws, plastic clips, and nylon straps to secure the client's foot to the pedal connection portion of the device. The main base plate is made of a 12x4x1/4 inch sheet of aluminum which has sections milled for the attachment of: the nylon straps, five 1/4 in. (1 in. long) screws, and two 6-32 (1 in. long) screws. The back plate, a 1/2x4x1 inch block of aluminum, has sections milled for two 6-32 screws. The foot attachment portion of the device is constructed in three major steps: (1) The main base plate and the back plate are

connected using two 6-32 (1 in. long) screws. (2) The foot attachment portion of the inter-device connection is attached to the main base plate in the following manner: each of the five  $\frac{1}{4}$  in. (1 in. long) screws is slid through the corresponding hole on the inter-device connection, through nine  $\frac{1}{4}$  in. washers, and finally screwed into the main base plate. (3) The nylon straps are slid through the milled holes on the main base plate and sewn to the plastic clips.

The inter-device attachment is a clip-in snowboard binding. This binding allows the two components to remain separate during attachment, yet to be easily

attached together just before beginning the exercise activity. Once exercise is completed, a pull on the lever on the outer end of the binding is the only action required to separate the two device components. This action allows the client to detach the pedal attachment from the pedal, and the foot attachment from the foot.

The total of cost of parts and materials for the adaptor was approximately \$50.



Figure 6.4. Adaptor for Exercise Bicycle Pedal, Attached to Existing Pedal

# DEVICE FOR STRETCHING LEG MUSCLES

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## INTRODUCTION

The purpose of this design project is to build an exercise device to help a client with Becker Muscular Dystrophy to stretch his leg muscles. The individual uses a motorized scooter for locomotion most of the day, and his legs receive limited exercise. The device was designed to enable him to perform leg extension while remaining seated in his motorized scooter.

## SUMMARY OF IMPACT

The device (see Figure 6.5) allows the client to stretch his legs while remaining in his scooter. This is also likely to provide him some upper extremity exercise benefit as well. The simple nature of the

device allows the client to maintain independence while exercising.

## TECHNICAL DESCRIPTION

The overall structure of the Leg Stretch Exercise device was made with two-by-four pieces of wood. Wood screws, bolts, and T-brackets were used for assembly. Two pulleys were attached to the arms of the device through which cords were passed. On one end of the cords, custom foot rests were attached while handles were attached to the other ends. The foot rests were made with polyester cloth and cotton.

The cost of parts/material was approximately \$200.



Figure 6.5. Device for Stretching Leg Muscles

# MOBILITY AID PROTECTIVE DEVICE

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## INTRODUCTION

The Mobility Aid Protective Device (see Figure 6.6) was designed to offer lightweight, easily-removable environmental protection for an electric mobility aid while being carried on an existing car carrier lift. The Mobility Aid Protective Device is essentially a lightweight, aluminum frame covered with a waterproof, UV- resistant material. The device mounts on an existing car carrier lift and utilizes a collapsible fabric door that is retractable by the use of a mechanical pulley system. This enables the owner to drive the mobility aid into the device and close the cover while the lift is lowered, then raise the lift. It was designed to offer environmental protection for a specific model of mobility aid and lift, but could easily be adapted to many models of mobility aids and lifts, with slight modifications from the original design.

## SUMMARY OF IMPACT

The Hover Round Activa is an electrically-operated personal mobility device used by people with physical disabilities who would otherwise be using a conventional wheelchair. The owners must transport them when they drive and travel. As a result, these machines are often very susceptible to premature degradation caused by exposure to the sun and other environmental elements. These mobility aids are costly pieces of equipment, and consequently increasing the device's usable life is of great interest to those who purchase them. The Mobility Aid Protective Device provides a moderate level of environmental and travel protection while being transported or stored on the car carrier (see Figure 6.7). The final device is simple and easy to use. It is also relatively lightweight and easily removable from the lift assembly. It will extend the useful life of the scooter for its owner.

## TECHNICAL DESCRIPTION

The structure of the device is made from welded 1"x 0.5"x 0.125" rectangular box aluminum type 6063. The design requires 42' of this material at a total

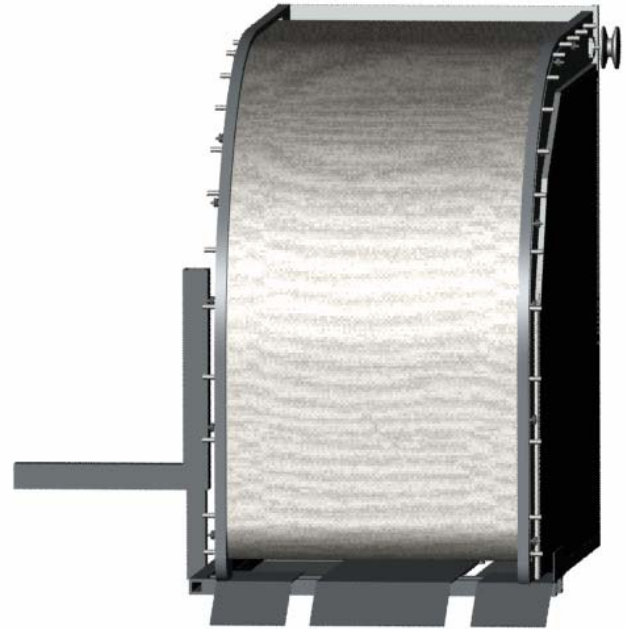


Figure 6.6. Mobility Aid Protective Device

weight of 15 lbs. Also, there is a complete floor made from 0.09" aluminum (6061) plate and welded to the lower edge of the frame. This floor has been machined to allow the design to fit directly on the existing lift. The floor is drilled to accommodate four 0.25" bolts with which to secure the device to the lift. Pre-existing holes in the lift's floor allowed the design to mount to the lift without any modifications to the lift itself.

The design has an easy and dependable way to raise and lower the cloth roll top cover. It has a cable and pulley system driven by a 12 VDC reversible motor that will operate cables on both sides of the frame in order to assure that the cover will raise and lower dependably without binding. The 12 VDC reversible gear-motor will provide up to 15 Watts of output power at 44 RPM, which gives the retractable cover a speed of approximately one foot per second. The gear-motor connects directly to the existing 12 VDC line used for the lift mechanism and is fused at 15 amps. A two-pole double throw rocker switch and



limiting switches control direction and movement of the cover. This design allows the operator to open the cover by simply throwing a switch, and close the cover by throwing the switch in the opposite direction.

The motor, which is externally mounted on this version, turns a 0.5" diameter steel shaft through means of a flexible coupling. The shaft is supported by two sealed ball bearing assemblies and has two 3" diameter drive sheaves mounted externally at each end. These sheaves motivate two 1/16" diameter stainless steel cables. The retractable fabric cover has eight 0.3" diameter plastic dowels that are sewn into the cover to provide stiffness. These dowels project out the side of the retractable cover and ride in a machined groove in the frame. The cables are guided through holes at the ends of each successive dowel. The cables are then secured only to the dowel furthest from the driven sheaves on

each side, and operate in a looped arrangement to raise and lower the flexible cover. This arrangement controls the direction of the cover's movement as well as securing the cover to the frame. The cable's tension is controlled by the use of spring-loaded tensioning pulleys. Six smaller, intermediate pulleys are located along the path of the cables and control the direction of the cables. These pulleys are also equipped with ball bearings to enhance durability.

All of the mechanical components weigh approximately six pounds. This gives a total weight of 45 pounds, including the cloth required to cover the device. At a total of 45 lbs, the mobility aid is well within the weight capacity of the mechanical lift.

The total cost of parts and materials was approximately \$550.00.



Figure 6.7. Mobility Aid Protective Device, Mounted on a Car

# SENSORY BOX

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## INTRODUCTION

The sensory box (shown in Figure 6.8) was designed to provide sensory stimulation for children with varied neurological disorders. The sensory box is simply two boxes joined together, that allow for multiple positioning of the children as a therapist works with them. The sensory box is used to help capture the children's attention and allow them to explore different textures, sounds, and skills at random or with the therapist's direction. This device will be used in classrooms K-8 for children with various neurological disorders. The sensory box will allow therapists to customize an environment specifically tailored for the needs of each child to better help them learn and aid in development.

## SUMMARY OF IMPACT

The design specifications for the sensory box were defined according to the needs of the children and the therapists. The therapists needed a device capable of being adaptable to each child. The sensory box was designed to be sturdy and safe, which allows both self-exploration and therapist-guided exploration of the different sensory devices.

## TECHNICAL DESCRIPTION

The overall design includes panels to create the sides and tops of the box, which were made from HDPE, a material similar to that used in school playground equipment. This material was selected because of its structural integrity, durability, and machinability. It was available in a variety of colors that added to the

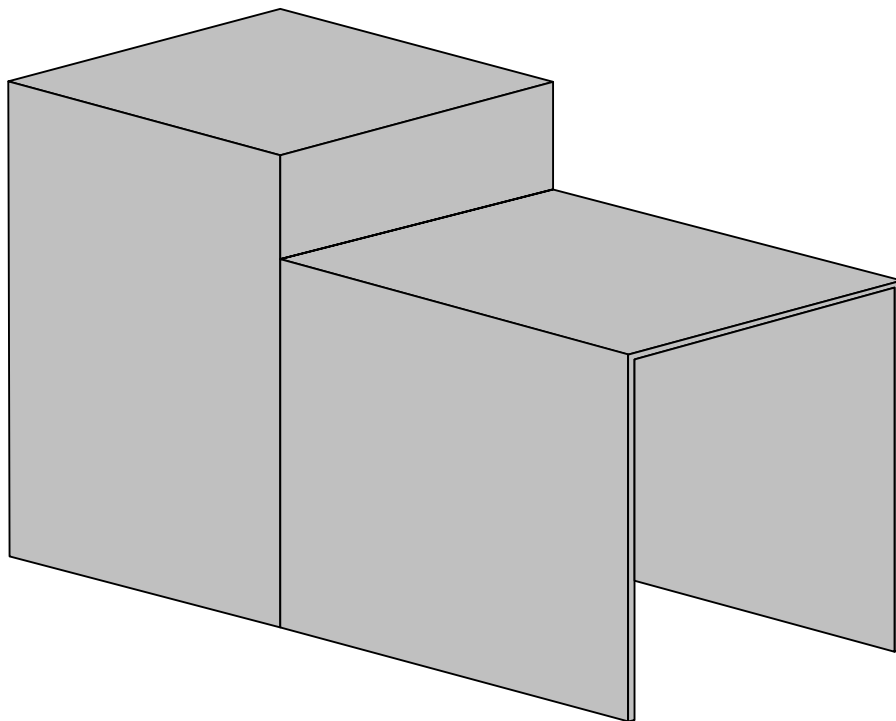


Figure 6.8. Sketch of Sensory Box

sensory appeal of the sensory box. The panels were cut using an ordinary table saw with a blade designed for cutting plastics. After the panels were cut, the sharp angles on the sides of each panel were removed with a 3/16" round over bit. This treatment was applied to every surface that was cut, to ensure that no sharp edges were exposed.

Each panel was connected to the others with 1-1/2" double wide corner braces. Cutouts for these braces were machined out using a router and a 3/4" straight bit. A cutout guide was manufactured to help in the exact placement and size of each cutout. The cutouts allowed the braces to be recessed into the material, reducing the exposure to sharp angles.

The panels and braces were all fastened together using 10-32 x 1/2" button head socket cap screws with matching nylon insert locknuts. These were again chosen to reduce exposure to any sharp angles as well as ensure that the connections stayed tight and secure. The holes for these screws were drilled out using a 13/64" bit.

With the sensory box being closely related to the design of playground equipment, ASTM standards regulating the design of playground equipment were utilized to ensure that the sensory box was designed using tested and accepted safety standards. The ASTM standard regulating the design of playground equipment is ASTM F1487-01.

The sensory box was designed so that off-the-shelf sensory items could be used. Therapists selected different toys and devices from various toy stores for their ability to provide sensory learning experiences for children. The toys were attached to the box using industrial strength Velcro. Velcro was chosen because of its versatility and because it also provided sensory stimulation when the student came in contact with it. An added bonus of using Velcro is that as toys wear out and break, the therapists can easily replace them and add new toys they feel would provide a different sensory experience.

The total cost of materials and sensory items was approximately \$950.

# CLUTCH REACHING AND GRIPPING DEVICE

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## INTRODUCTION

The CLUTCH Reaching and Gripping (CRG) device (see Figure 6.9) is for an individual with muscular dystrophy. He uses a motorized scooter for mobility and needs the assistance of such a device to grasp and collect items that are out of his reach.

## SUMMARY OF IMPACT

The design criteria for the CRG were based on the client's own specifications. He currently uses a similar device, which needs improvements. The individual stated that he often has pain in his forearms due to the fact that he must continually compress the trigger to keep the prongs of the current device closed. Also, he stated that the short length of the device restricted him from utilizing the device for the purpose of getting dressed. The CRG eliminates these problems by providing the client with a device that is normally closed (i.e. he only has

to squeeze the trigger to open the prongs, after which it closes automatically), and is additionally longer in length.

## TECHNICAL DESCRIPTION

The CRG is made of steel machine screws, steel picture wire, acetyl copolymer and rubber bands. The gripping prongs trigger and trigger attachment pieces were all custom-machined out of a block of acetyl copolymer. An acetyl copolymer tube was also utilized in the design. Holes were cut in the tube and steel wire was passed through to either end. The wire was attached to both the trigger and the gripping prongs. Rubber bands were fitted around the prongs to keep them closed.

The cost of parts/material for the CLUTCH Reaching and Gripping prototype was approximately \$200.

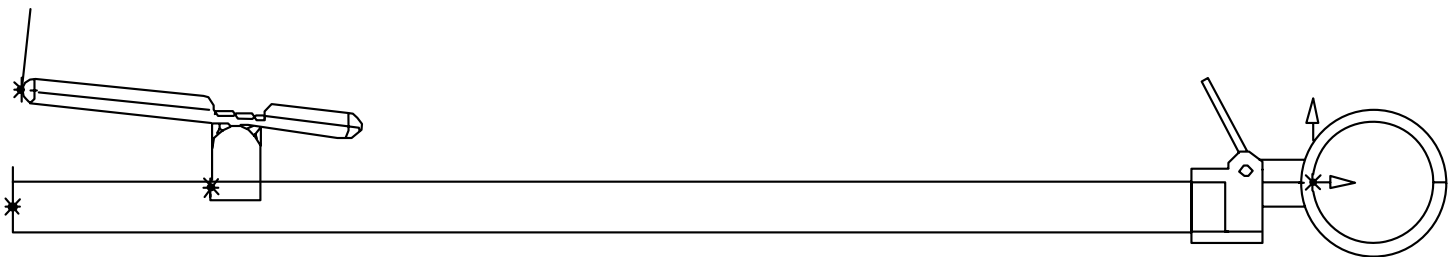


Figure 6.9. Schematic of CLUTCH Reaching and Gripping Device