CHAPTER 3
BINGHAMTON UNIVERSITY

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Corrective Hand Brace

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Client Coordinators: Daniel Cullin
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INTRODUCTION

The purpose of this project was to design corrective braces for people with multiple sclerosis who experience contractions of the hand during the night. The aid was designed to prevent the excessive cramping that occurs in the finger muscles during involuntary contraction. The braces are lightweight, ventilated, durable, and allow movement of the thumb and wrist.

SUMMARY OF IMPACT

After using the braces for one week the client was satisfied with the results. Before having the braces, she would spend up to an hour each morning massaging her fingers to help release painful contractions that caused her fingers to lock into a curled position. The client has reported that since using the braces, her fingers remain a little stiff but are moveable. In general, the braces are a success in the sense that her hands are usable in the morning, unlike before. However, she does feel that the braces need extra protection around the edges. There will be padding added to the braces to prevent any injury during the night. Neoprene will most likely be the padding used and it will be attached around the edge of the brace at the fingertips.

TECHNICAL DESCRIPTION

The braces have a simple design. They are made from Polypropylene thermoplastic that covers the hand from the heel of the palm to the fingertips. These braces are attached to the hand with cotton straps and Velcro. The straps are wrapped around the hand twice, once around the back of the wrist and then again over the knuckles. Two snaps are used to attach the straps to the thermoplastic. They can be released to allow for easy cleaning of the braces.

Since the braces are to be worn while sleeping, their design should allow for users to wear them as comfortably as possible for extensive periods of time. The optimal brace should be molded to the natural resting curvature of the hand and be adjustable. Choosing a material that is capable of remolding was beneficial to the final design. The person who uses these braces and finds any particular section uncomfortable can readjust that section using a hairdryer. After the section is hot enough and adjusted to the desired fit it can be hardened by placing it in cold water. This process should take no more than ten minutes. The benefit of using a hairdryer is that the heat does not affect the whole brace.

The designed brace is made from a 1/8-inch sheet of Polypropylene thermoplastic. The plastic is ventilated by pre-punched holes 1 inch apart and 1/8 inch in diameter. The final built design is 5 7/8 inches long, 4 inches wide and 2 ½ inches tall. The curvature of the brace allows the fingers to rotate downward approximately 65 degrees, which allows natural, comfortable positioning for the fingers. The sides of the braces are turned upward to add support to the sides of the hands. They are secured to the hand with cotton straps and Velcro. These straps are modified boxing wraps made of 100% breathable cotton. They have a length of 24 inches. Since they are not permanently secured to the brace they can be removed to allow the cleaning of the plastic and straps.

Figure 3.1. Corrective Hand Braces.

Crawling Support

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Client Coordinators: Judy Zeamer
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INTRODUCTION

A crawling device was designed for a two-year-old girl with cerebral palsy. Due to weakness in her arms and legs, the girl cannot support her own body. Consequently, she cannot maintain her body in a crawling position without support. This device assists her in maintaining the crawling position so that she can practice crawling without the assistance of another person.

SUMMARY OF IMPACT

Due to weaknesses in her limbs, the child does not have the strength required to sustain her body in a crawling position. This causes her to distort the position of her body and attempt to crawl incorrectly. With this device, the burden is removed from her limbs so that she is much more likely to learn to crawl properly. The correct techniques will help her eventually learn the skills needed to walk on her own.

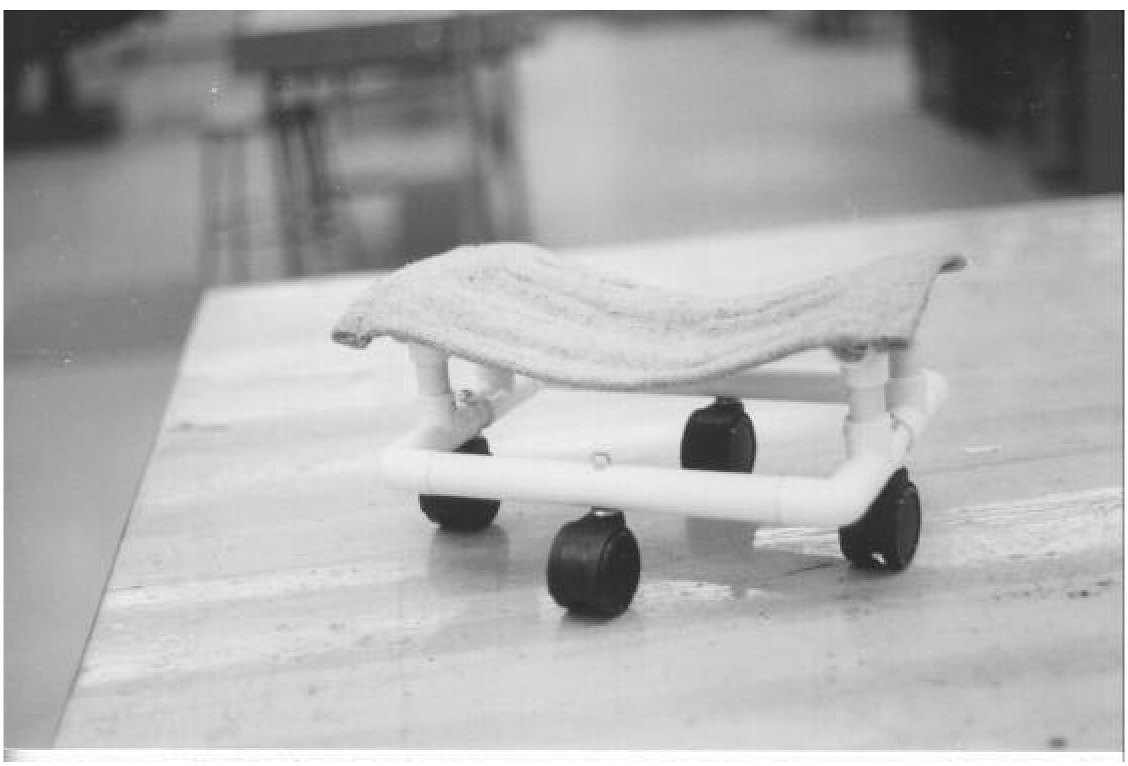

Figure 3.2. Crawling Support.

TECHNICAL DESCRIPTION

The crawler consists of a rectangular PVC frame attached to four fully rotational wheels. A cloth is attached to the frame by four vertical uprights coming off the base. The device is designed so that the child's torso rests on the cloth while her hands and knees are on the ground. The wheels allow her to propel herself with her hands and knees across a floor with little effort. With her body firmly supported by the cloth, her weight does not fall on her limbs. With this device, she can practice her crawling skills successfully since her weight does not interfere with the movement of her arms.

As the child crawls on the floor using the device the weight of her body is distributed symmetrically onto the four uprights. The symmetrical design ensures that the crawler will remain balanced and that it will seldom tilt in any direction because her weight serves as load acting on the geometrical center of the crawling aid. A sturdy device permits a safer and more comfortable ride. The wheels are placed on the sides of the device away from the child's hands.

Another important feature of this crawling aid is that the height from the ground to the top surface of the crawler can be adjusted. Two vinyl straps beneath the cloth support can be loosened or tightened as desired. Loosening the straps causes the cloth to loosen, decreasing the overall height of the crawler. Additionally, two sets of progressively longer uprights were presented to the client so that the device can be later adapted to allow for the child's continued growth, thereby ensuring that she will be able to use it for a long time. By simple removal of some screws, the PVC pipes can be replaced with longer or shorter pipes as needed.

The cloth support, the casters and miscellaneous screws and nuts cost a total of $35. A professional upholsterer was called upon to sew the fabric for the device. The PVC tubes used for the frame were obtained without charge from a Binghamton University machine shop. Had this material been purchased, the total cost of the supplies would have come to $45. Commercial crawling aids are available from various manufacturers at costs ranging from $150 to $300. By purchasing the raw materials and assembling the device, over $100 was saved.

Figure 3.3. Client Using Crawling Support.

Large Desktop and Storage Area Desk for a Young Child

Designer: Ben Rosenkrans
Client Coordinators: Donna Boisvert
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Supervising Professor: Richard Culver, Ph.D.
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INTRODUCTION

A large desktop and storage area was designed for a young child with cerebral palsy. The desk involved modification of an existing classroom desk rather than use of all new materials, to help the child as well as the other children in his class adjust easily to the new design. A folding surface on the left side of the desk, supported by a folding table brace. When pulled out, it allows for additional support on the left side. The right side of the desktop folds up to the right for easy access to the storage area inside the desk. Also, a wire basket is mounted on the right side of the desk for additional storage.

SUMMARY OF IMPACT

A seven-year-old boy with cerebral palsy has difficulty gripping things with his right hand and has a brace on his right leg for support. His previous classroom desk consisted of two regular desks pushed together for a larger desktop, and a Rubbermaid container on top for book storage. He had occasionally fallen out of his chair because he had no support on his left side. The boy's physical therapist recommended some type of support on which he comfortably could rest his left arm to prevent him from falling again. The boy was being encouraged to use his right arm and hand more to develop movement. The new desk provides a larger desktop that allows for two books opened next to one another on its surface. It also provides support for the boy's left side and an easily accessible storage area.

Figure 3.4. Large Desktop and Storage Area Desk.

TECHNICAL DESCRIPTION

The desk is modified from an existing classroom desk to make it look as much like the rest of the children's desks as possible. The frame and legs are exactly like the rest of the desks, with the exception of a brace between the legs. The purpose for the brace is to give the desk more durability. The brace consists of a piece of pipe serving as a spacer between the legs. A piece of threaded rod running inside the pipe extends through a hole in a brace on each leg; it is tightened down with a hex nut and lock washer on each end. The desktop material is a pressboard base with Formica coating on top, taken from an existing desk to ensure similarity to the other desks in the classroom.

The right side of the base of the desktop is hinged, allowing easier access to the desk's inside storage area. The right side rests on a steel plate that is attached to the bottom of the stationary portion of the desk for support. A rubber stopper is attached to the outer right side of the desk to prevent the hinged top from bending too far. A ten-inch wide folding section is attached to the left side of the desk to provide a larger workspace area. It is equipped with a folding table leg brace for support that allows the child to fold the section up and down. The folding section consists of two pieces of desktop on top of each other, with slots located in the bottom piece. Four bolts screw into the bottom of the top piece through the slots, allowing the top piece to slide forward toward the child for support.

A wire storage basket is attached to the right leg of the desk to provide an additional storage area. A brace around the desk's leg is adjustable, allowing the basket to be raised and lowered. The basket can be removed from the desk to allow legs of different sizes to be attached to the desk. A groove was cut into the stationary left side of the desk for storage of pens, pencils, etc. The groove has an extension to the edge of the desk surface to allow for easy cleaning. Edging was placed around the outside perimeter of the desk to prevent objects from sliding off. The edging is made of wood molding with a varnish applied to the finish. The edging is attached with nails to the side of the desk.

The total cost of materials for the desk is about $100. This price includes painting supplies, film, and hardware for the desk. Two existing desks were donated by Tioga Hills Elementary School for use in the project.

Adaptive Tricycle

Designers: Herbie Mann, Chris Kuntz, Susan Tewksbury
Client Coordinators: Renee Packer
Handicapped Children's Association
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INTRODUCTION

An adaptive tricycle was designed for a three-year-old girl with cerebral palsy. She cannot operate a tricycle by herself. The purpose of this project was to modify a standard tricycle that she can operate independently and use effectively to improve her strength.

SUMMARY OF IMPACT

The client is a three-year-old girl with cerebral palsy. The physical therapist (PT) currently works with her on a tricycle to help her develop her outside leg muscles. The PT must help support the girl's upper torso and push her along as she attempts to pedal. She enjoys riding the tricycle, and both the PT and the girl's mother think it will be an enjoyable way for her to get the therapy she needs. The goal was to get the child to walk without the use of a walker, which she currently needs. The adaptive tricycle enables her to exercise her legs while engaging in an activity she likes.

TECHNICAL DESCRIPTION

The child for whom the tricycle was designed is approximately three feet tall. She has limited use of her legs, is deaf, and has not learned to speak, although she is beginning to learn sign language. Her legs tend to cross at the knees in a scissors-like manner. She is unable to sit up straight without additional support.

A standard tricycle was purchased and modified. A back support of PVC pipe was added, along with two nylon straps and a Velcro fastener, to belt the client in at the chest and waist. Blocks were added to the pedals to shorten the leg reach. Two straps and a heel guard were attached to the pedal blocks to keep the child's feet in the proper position. The pedal blocks were made from two square pieces of wood, so that one can be removed as the child gets taller. A vinyl variable anti-scissoring device was created and attached to the center bar. Upright handlebars were then attached to the existing handlebars to further help her maintain an upright position. An adjustable bolt attached to the front fork over the front wheel was added to create friction on the front tire to vary the resistance. The seat and handlebars can be raised to accommodate the child as she grows.

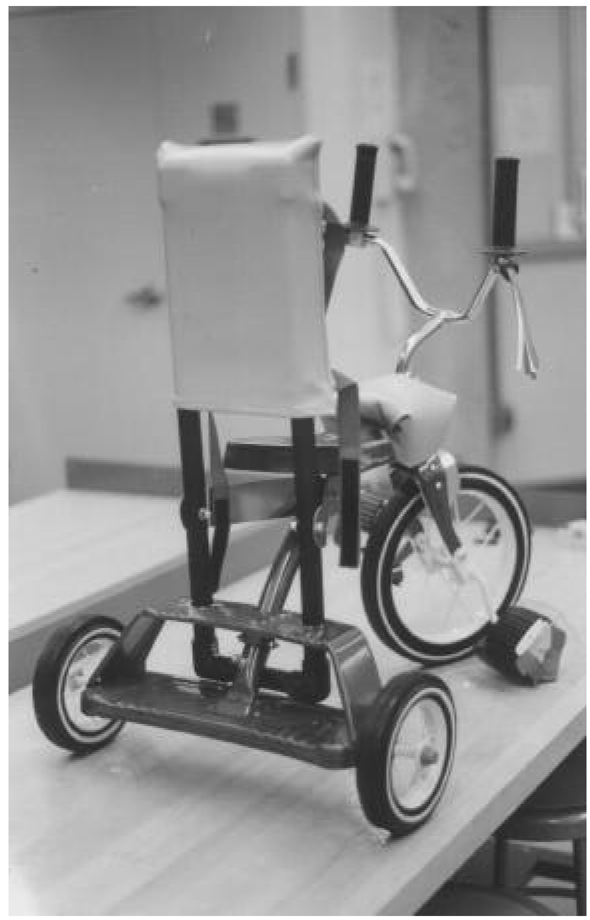

Figure 3.5. Adaptive Tricycle.

In the process of developing this design, a two-wheel bicycle with training wheels was considered.

Resistance would have been easier to develop and the bicycle would have been more stable. However, the client was unable to pedal the two-wheel bicycle because the pedals were underneath her instead of in front of her. Another alternative considered was a four-wheel car with push pedals to propel it. This concept was not chosen because of the difference in motion required to pedal the car relative to the tricycle. One of the main goals of this design was to create some type of bicycle that would aid in developing the outside leg muscles of the client. A pushing motion would not accomplish this to the degree that a rotating motion would.

The design involves an adaptation of a standard tricycle and allows the child to operate the tricycle independently. This design will also enable the PT to vary the resistance in an effort to strengthen the child's legs. She will then be able to concentrate on pedaling the tricycle since she will be adequately supported and secured on the tricycle.

The final cost of this project is $70. The standard tricycle costs $33, with the additional parts needed to modify the tricycle totaling $37. The cost of adaptive tricycles currently on the market range from $500 to $900, making this design more practical and affordable for the client.

Computer Mouse Modification

Designers: Michelle Cristofaro, Michael Feinberg, Lucy Zhang
Client Coordinators: Bonnie Cole
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Supervising Professor: Richard Culver, Ph.D.
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INTRODUCTION

A computer mouse was modified for handicapped children between the ages of 18 months and 4 years. The children using the mouse for an Apple 2E computer tend to move it erratically and click too quickly on the button. The mouse can only be controlled with one hand since some of the children have limited hand movement. The mouse has to be easy for them to use so they can concentrate better on the program they are using.

SUMMARY OF IMPACT

Conversations with a client coordinator and observations of children using the standard mouse led to an understanding of the children's problems with the mouse. When they touched it, their fingers automatically touched the top of the button. As a result, they were clicking on it without even knowing it, which caused the program they were working with to do things they did not want it to do. Also, the mouse was getting turned around in different directions; it wouldn't always move in the same direction on the screen, which caused confusion. The children also picked up the mouse off the table or moved it randomly. It is thus important to control its range of motion.

TECHNICAL DESCRIPTION

An arm, fashioned after a drafting machine, was mounted on a 19 by 17-inch piece of Lexan plastic, covered with four foam rubber "mouse" pads. The arm is made out of two sets of two parallel 1/4 by ½-inch aluminum bars. The arms are heavy enough to control the motion, while strong enough to endure heavy use by the children. On the end of the arm is a Lexan bracket that holds the mouse and orients it properly. This design can be used with any standard-sized mouse. On the top of the bracket, a ball is mounted on a one-inch wide strip of plastic that fits over the top of the mouse. The children will grab the ball, and since their hands are so small, they will not be able to click the button unless they pick their hands up completely off the ball. The plastic strip also prevents the mouse from being lifted out of the bracket. The screws attaching the arm to the mouse pad surface can be tightened in order to make movement of the mouse more difficult.

The new design works well for handicapped children. It keeps the mouse in the right orientation while also limiting the motion so the children don't become confused. Hence, they are able to concentrate more on learning with the program they are using on the computer than on how the mouse works.

The total cost of the modified computer mouse is $91.

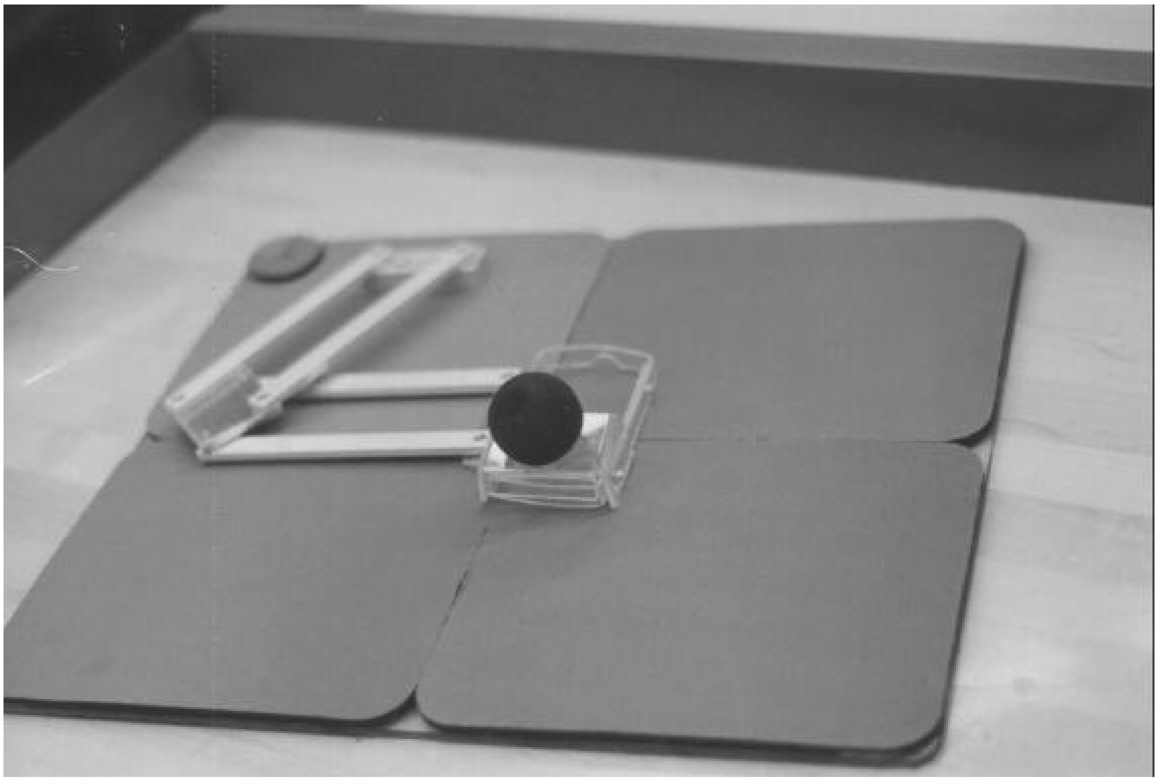

Figure 3.6. Modified Computer Mouse.

Standing Aid Design A

Designers: Robert Brathwaite, Michael DeBlasis, Matthew O'Connell
Client Coordinators: Eric Lopez, Binghamton University
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INTRODUCTION

The standing aid will assist a paraplegic adult in the upright position. This version (Design A) is designed for self-reliance. Although the aid is large in size, it is collapsible, which makes it portable to some degree. This device is also constructed for working environments.

SUMMARY OF IMPACT

The device meets the basic needs of the client. The device must support the body of a person who cannot stand up. As the client is independent, a feature was added to assist him in standing in and out of the device. It includes a safety mechanism that will prevent him from falling. The device is portable when collapsed. The client will be able to separate the standing aid into several components and transfer it. The device can also be used as a workstation; giving the client the opportunity to work, eat, and perform many other activities.

Figure 3.7. Standing Aid Design A.

TECHNICAL DESCRIPTION

Design A is a shortened set of parallel bars with a front board. The bars are bent inward 75 degrees for a more comfortable lifting process for the client. The front board is composed of an angle iron, a pad, a winch, several bungee cords, and a wooden table. Angle irons are used for the front cross support that is bolted to the side of the bars. Attached to the angle iron is a winch, which is a safety feature the client requested. While he is lifting himself into the standing position, a bungee cord is used to pull up the slack in the winch strap. The retraction of the winch is powered by the bungee cords that are wrapped around the spindle of the winch while the cable is retracted. The tension of the bungee cords is enough to retract the slack in the cable while the user pulls himself up along the parallel bars. The winch has a self-locking mechanism that will prevent the user from falling to the ground in case he loses his grip. At the side of the pad there is a release lever which runs through a cable to the release latch on the winch. This lever is needed since the table is blocking the winch.

The table is made of plywood and is padded. At the client's request, the table is two feet wide by one and a half feet deep. The frame is steel and is extremely strong. Steel was chosen over PVC because a large moment is produced at the feet during the lifting process. Once standing, there is very little stress on the other frame components.

The final cost of Design A is $150.

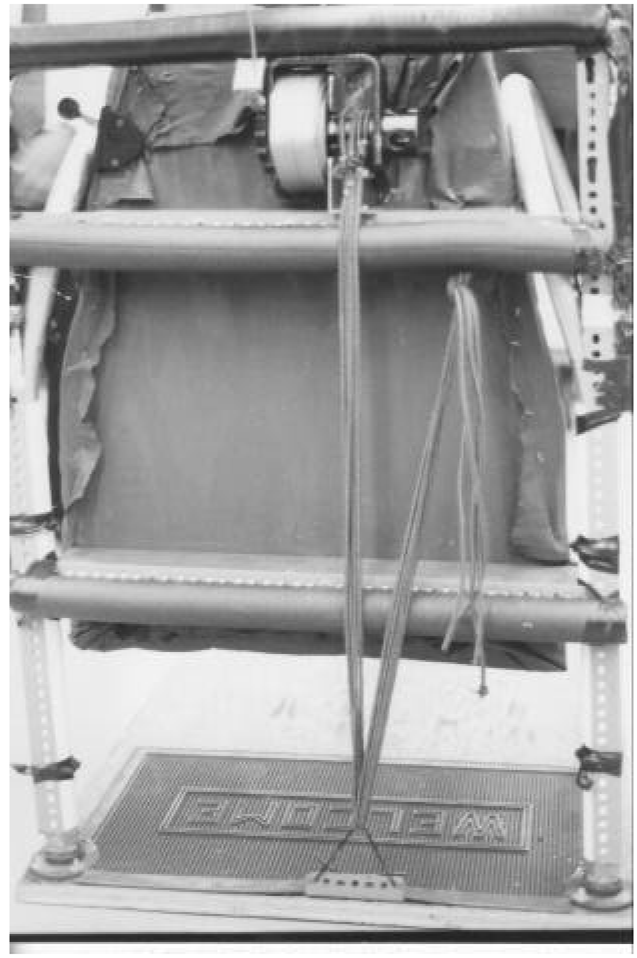

Figure 3.8. Rear View of Standing Aid Showing Winch.

Standing Aid Design B

Designers: Robert Brathwaite, Michael DeBlasis, Matthew O'Connell
Client Coordinators: Russ Smith, Chenango Valley Industries
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INTRODUCTION

The standing aid will assist a paraplegic person in the upright position. This version (Design B) is designed for users who have assistance from others in getting in and out of the device. Design B is much smaller, lighter, and portable in comparison to Design A. Although the aid is large, it is collapsible, which makes it portable to some degree. This device is also constructed for working environments.

SUMMARY OF IMPACT

The design of this device was based on the basic needs of the client. The device must support the body of a person who cannot stand up. The client is not fully independent, and will require assistance getting into and out of the device. The device is portable when collapsed. The client will be able to disassemble the device into several components and transfer it. The standing aid can also be used as a work station, giving the client the opportunity to work, eat, and perform many other activities while in the device.

TECHNICAL DESCRIPTION

Design B consists of a PVC frame, a padded board, a plywood base, a Velcro harness, and a wooden table. The PVC frame can be detached from the plywood base via four hitch pins. These two sections of the aid are then transportable. The Velcro harness was tested at 100 lb. The PVC frame was used because of its smooth edges and its ease of assembly. Unlike design A, this design will not have a large bending moment about the feet during lifting.

The final cost of Design B is $68.

Figure 3.9. Standing Aid Design B.

Wheelchair Lift

Designers: Michael Ballou, Danielle Gorlitsky, Kahlil Zaloom
Client Coordinators: Daniel Cullin
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Supervising Professor: Richard Culver, Ph.D.
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INTRODUCTION

An adult male with multiple sclerosis recently moved to a home with a seven-inch step between the house and the attached garage. Since he is confined to a wheelchair, this step poses a problem. Initially, it seemed that a simple ramp would be the easiest and most economical solution. However the garage is small and a ramp with an appropriate slope would span halfway across the floor, leaving no room for a vehicle. A lift was designed to allow the client to go from his house to the garage and vice versa, while leaving enough room for a car to be stored in the garage.

SUMMARY OF IMPACT

The client will be able to move freely, easily, and safely between his garage and living quarters. His previous makeshift platform and ramp permitted him to get around, but it is not a very convenient setup. The design of this lift could be modified to fit the needs of other situations. For larger lifting ranges, larger sprockets could be used to further increase the power of the lift and longer crank arms used to accommodate the higher destination. This design may constitute a cheaper alternative for private ownership and small ranges.

TECHNICAL DESCRIPTION

The mechanism of the lift is simple, yet efficient and reliable. It uses four crank arms at each corner of the platform to lift or lower the passenger. The platform itself is 35 by 45 inches. It is made of ¾-inch plywood supported by a frame of 1 ½ by 1 ½-inch angle steel and 1 by 1/8-inch steel strap. The frame of the lift is made of 2 by 1 ½-inch angle steel, 1 by 1/8-inch steel strap, and 1 1/2 by ½-inch steel bar.

The power source of the lift is a 1/2 hp chain-driven garage door opener. The garage door opener was chosen because it already contains the electronics to be operated by remote control, and has an easily adjusted limiting switch and many safety features and checks. Its speed and lift capabilities are not appropriate for this application so both are changed by a double reduction gear train. The garage door opener turns an 8-tooth sprocket at 2 revolutions per second. This is linked by chain to a 60-tooth sprocket as the initial step of the gear train. Keyed to this 60-tooth sprocket is a 10-tooth sprocket that is linked by chain to another 60-tooth sprocket which, in turn, is connected to the lifting mechanism. This is the second stage of the gear train, after which the maximum lift force system is 375 lb. This 60-tooth sprocket is keyed to a 5/8-inch solid steel shaft that runs across the lift and is supported at either end by vertical 1 ½ by ½-inch steel supports with bronze bearings. Also keyed to this shaft are two 24-tooth sprockets and two crank arms that lift the platform. The two 24-tooth sprockets are linked by chains that run down the sides of the lift to two similar 24-tooth sprockets attached by 5/8-inch shafts to the other two crank arms to lift the other end of the platform.

Most commercial lifts used for wheelchairs are designed for ranges between three feet and fifteen feet. Lifts cost thousands of dollars even for the smallest models. The material for the lift cost only $420. The garage door used as the power source cost $150. The collection of various sprockets and bearings cost $245. The steel and plywood used for construction of the frame and platform cost $25.

Figure 3.10. Wheelchair Lift

Hand Powered Tricycle

Designers: J. P. Adler, Daniel Batt, Timothy Phillips
Client Coordinators: Bonnie Cole
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INTRODUCTION

The Handicapped Children's Association (HCA) requested an exercise and recreation device for children with limited or no use of their legs. A hand powered tricycle was already in use at HCA for this purpose, but its poor design and lack of adjustability made it unsuitable for their needs. Furthermore, it was not durable enough to withstand the rigors of use by dozens of children.

SUMMARY OF IMPACT

The design was intended to rectify the problems with the existing tricycle by modifying it or presenting an entirely new solution. The design was based on a tricycle platform. HCA criteria included durability, safety, proper fit to children, trunk and foot support, and simplicity of operation. The tricycle is very popular with the children and staff of HCA and is used almost continuously.

TECHNICAL DESCRIPTION

A commercial two-child foot-powered tricycle was modified. The benefits of this base tricycle included a good, low ride height, wide wheel track, long wheelbase, strong construction, and allowance for easy modification. From this base the foot cranks and the forward seat were removed, and the handlebars and tubular structure were modified. A hand crank assembly and chain drive mechanism were designed to power the tricycle. Placement of the child was most crucial in conforming to design seat constraints. Of particular concern were the ease of turning and the powering of the tricycle with the same assembly. Although it is inherently difficult to meet these two criteria simultaneously the level of difficulty was reduced by adjusting the gear ratio and the geometry of the steering mechanism.

The final design features a hand crank assembly placed on the end of a moment arm support attached to the old handlebar mount. From that assembly, a chain runs down to the front drive wheel. The whole front fork assembly had its geometry changed to fit the measurements of what was considered an averaged size child for the HCA. A chain guard was fabricated to keep little fingers away from the chain and sprocket.

The total cost to buy the components and materials came to $155. The cheapest commercially available model found by the authors was over $370.

Figure 3.11. Hand Powered Tricycle

Pedal Car Modification

Designers: Sam Adeyinka, Michael Ferrari, Matthew Kmetz
Client Coordinators: Judy Zeamer
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Supervising Professor: Richard Culver, Ph.D.
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INTRODUCTION

A vehicle was designed for a four-year-old child who has only partial use of his legs and right arm. Because of these constraints, the vehicle must be propelled, steered, and stopped solely by the client's left arm and hand. The solution was to motorize a commercially available pedal car.

SUMMARY OF IMPACT

The child's parents requested a vehicle that he can operate on his own. He had a pedal car, which he could not use. Although the car is ideally propelled by a child's legs and feet, the client does not have enough leg strength, especially in a seated position, to accomplish this.

With this design, the vehicle is powered, steered, and stopped purely by the left arm and hand. Power from the motor enables the child to use the car for long lengths of time without tiring himself. The child will also be able to maneuver the vehicle easily over many different types of terrain. The electric motor limits the speed of the car and can even be used for braking, ensuring added safety. It also allows the child to use primarily his left hand to steer the vehicle.

Figure 3.12. Modified Pedal Car.

TECHNICAL DESCRIPTION

The car selected for this project is manufactured by the Little Tykes company. The pedals were removed from the vehicle and the bottom of the car was closed up to give the client a place to rest his feet and secure his legs. A 12 volt motor and gear box purchased from Power Wheels are attached to each of the front wheels. Wire is run from the motors, through the batteries, and into a switch that is installed on the left handle of the car. The switch selected is from a power window in an automobile. The switch is wired so that, when pressed in one direction, the car goes forward and, when pressed in the other direction, the car goes in reverse. When the button is released it snaps back to the neutral position and the motors come slowly to a halt. The wire is also run through a kill switch under the seat of the vehicle. The connection is made when someone sits down on the seat and is broken when the person stands up, so the client cannot accidentally start the car if he is standing up. A Velcro seat belt was also added for safety. The steering mechanism was modified slightly in an attempt to make it easier for the client to maneuver the vehicle. A thrust bearing was added under the steering bar where plastic and metal had been rubbing against each other.

The final cost of this project was $278.

Figure 3.13. Close-Up of Motor and Handle.

Bicycle Trailer

Designers: William Grivas, Michael Miele, Anthony Tyska
Client Coordinators: Judy Zeamer
High Risk Birth Clinic
Supervising Professor: Richard Culver, Ph.D.
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INTRODUCTION

The purpose of the system is to allow the parents of a child with quadriplegia to bring their child along for a bicycle ride. The overall system is light enough and compact enough to be pulled by a bicycle. The system is also comfortable for the client.

SUMMARY OF IMPACT

The client has no control of any major muscles. Typical bicycle configurations preclude her ability to accompany her parents on a bicycle ride. The challenge in this design project was to allow the client to enjoy a normal bicycle ride in comfortable and safe positions. Models already available were expensive and did not permit the client to relax in a comfortable position.

Figure 3.14. Bicycle Trailer.

TECHNICAL DESCRIPTION

The final design entails a commercial bicycle trailer frame. 20-inch off road tires on standard wheels are incorporated to add support and stability, and to supply smoother ride characteristics (due to a wider surface contact area than standard tires). PVC supports are added at critical locations of the chair frame structure to reinforce sections directly attached to the sling seat holding the client.

The trailer frame customizer kit that was acquired from Equinox Industries of Cottage Grove, Oregon was easily modified. The aluminum frame design allows for easy incorporation of the chair support structure using a three-step procedure. First, the seat structure is drilled to allow the four mounting pins on the aluminum frame to be inserted into the PVC base. Second, a bead of adhesive silicone caulking is sandwiched between the chair structure and the aluminum frame. Finally, six adjustable hose clamps are used to completely secure the two pieces into one unit. PVC reinforcement bars are then added at the maximum shear and bending points.

The maximum dimensions of the constructed system are as follows: 42 inches in length, 31 inches in width, and 31 inches in height. The manufacturer's stated capacity for the aluminum base is 150 pounds. The PVC structure has been laboratory tested with these loads and there is no problem when such a load is placed on the structure. The client weighs only 47 pounds; therefore, this system has a minimum safety factor of three. The overall weight of the system when unoccupied is approximately 45 to 50 pounds.

A stress analysis was performed on several parts of the PVC structure when loaded with 50 pounds (the approximate weight of the client). The analysis indicated that that no one part of the system is under an amount of stress that would pose a danger to the client. For example, the pipe under the seat that is in compression has a normal stress of about 15.8 psi, and a shear stress of approximately 6900 psi. These calculated values are significantly less than the yield stress values for the material, and as a result, are deemed to be at safe levels.

Many additional features were added to the system ensure the client's safety. Velcro straps and buckles are added on the Cordura seat to keep the client in a safe position. The footrest is padded and straps are sewn on to prevent major movement of the client's legs. In order to increase visibility in the evening, reflectors were added to the back end of the system. Finally, a universal joint connects to the bicycle to prevent any possible overturning of the system. The final cost for the system was $371.

Figure 3.15. Trailer Attached to Bicycle

Wheelchair Table

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INTRODUCTION

A college student confined to a wheelchair had difficulties using the regular classroom tables and desks provided by Binghamton University. Although the university distributes specialized desks for individuals with handicaps, the client finds their availability and usefulness unsatisfactory. He requested a device upon which he can work and write.

SUMMARY OF IMPACT

Nothing presently on the market adequately suits the client's needs. Most available trays require wheelchairs with armrests or are situated on the person's lap; both scenarios were considered inadequate for the client. The design chosen consists of a detachable table and ball joint with an adjustable support rod. It provides the adequate size and portability the client demands.

Overall, the needs of the client have been met through the design and assembly of the final device. The final accessory table is highlighted with the rotational and adaptable qualities he requested. This device was designed based upon the geometry of the wheelchair as well as the needs of the client. Due to the complexity and wide variety found in the geometry of wheelchairs, it would be rather difficult to standardize most of the parts in the final device.

Figure 3.16. Client with Wheelchair Table.

TECHNICAL DESCRIPTION

A low profile vise that includes a ball joint is used to add rigidity to the support of the system. The vise attaches to a small plate of acrylic that is bonded to an acrylic tabletop. In order to increase the stability of the table, machined aluminum parts are attached to the chair's support bars. A telescoping music stand serves as a support rod, which allows for displacement of the table in a vertical direction.

As with any device manufactured for use in public, this table must protect the client and others from harm. In the evaluation of the safety of the design, the weight, geometry, and the durability of the table were considered. This table is assembled to handle minimal loads up to 20 pounds, well above any load applied in the client's daily use of the device. An aluminum support rod with a one-inch diameter provides the desired stability. The support rod connects to the table near the centroid of the rectangular tabletop, thus resulting in a small moment arm to any applied loads. The rigid attachment of the aluminum connection joints adds to the stability of the device.

The final device came to a cost of $87, well below the cost of similar products on the market that usually range above $200.

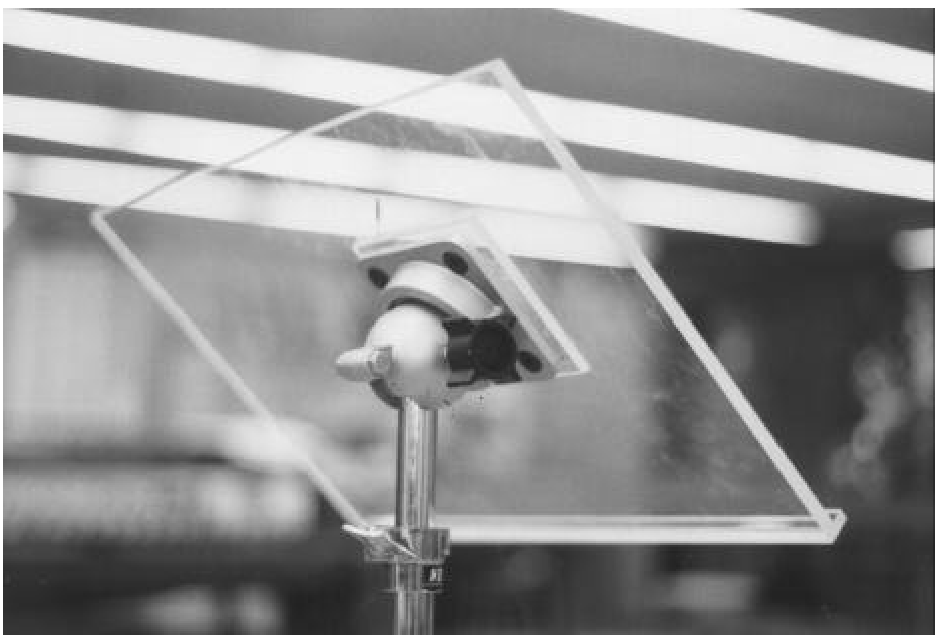

Figure 3.17. Close Up of Wheelchair Table