CHAPTER 9
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ADAPTIVE LAPTOP CASE AND MOUNT FOR A WHEELCHAIR

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Client Coordinators: JD Bryant and the Bryant family
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INTRODUCTION

A simple vertical adjustment in the standard computer chair can raise the user to the desired height and the proper posture associated with it. A person in a wheelchair, however, often cannot get into a proper position because the height of his or her seat cannot be adjusted, and the armrests would hit the side of the desk if the chair were adjusted to the proper height. Some people who use wheelchairs thus use the computer from an awkward position, which could trigger a number of problems. The common solution to this problem is to attach a tray to the wheelchair and to place a laptop on it. Problems with this approach are a lack of work surface and inadequate stabilization of the laptop. Also, the tray mechanism may protrude from the wheelchair, which decreases mobility and is also a safety hazard. This project was designed with a particular client and a particular set of wheelchairs in mind. Based on the client's wheelchair and his project goals, the adaptive laptop mount and case were developed. The three main goals were to:

- To securely hold the laptop in place,
- To provide an extra work surface space, and
- To not reduce range of motion or clearance.

To securely hold the laptop and to provide an extra work surface, an existing laptop case was modified. To prevent hindering movement or clearance, an adjustable mount was devised that attaches under the seat with the main support bar rising vertically between the user's legs. For dismount, the design is such that the user can dismantle the main bar and laptop case by simply rotating two handles.

Figure 9.1. Adaptive Laptop Case and Mount for a Wheelchair.

SUMMARY OF IMPACT

Overall, the only specification not met was the ability to dismount while the laptop is still on the work surface, but this was because of clearance issues and client needs. The client can now use a computer without worrying about stability, clearance, or injuries due to improper posture.

TECHNICIAL DESCRIPTION

The project has three distinct parts:

- The laptop case and tray,
- The attachment, and
- The mount.

For aesthetic purposes, an existing laptop case was purchased as the external case and the internal shell and tray were designed. The dimensions of the Case Logic basic laptop carrying case are 11 x 16 x 3 inches. Allowing for the rounded corners, an interior shell of 0.25 inch thick Plexiglas was designed with dimensions of 10.5 x 15 x 2.5 inches. A 0.25-inch thick Plexiglas tray (10.5 x 10 inches) is hinged on top of the right side of the shell as a work surface for the right-handed client (Figure 9.2). A gap is left in the bottom surface of the shell so it can be hidden under the existing fabric of the case so that no part of the shell will show.

The attachment site is located on the outside of the bottom piece of Plexiglas and is made of two L-shaped, 0.25-inch thick Plexiglas wedges. A threaded hole is also provided between the two wedges for locking purposes. The horizontal portions of the L-shaped wedges slide into grooves on the solid aluminum block that is attached to the mount. A hole in the aluminum block lines up with the hole in the bottom of the shell for locking purposes. This is achieved through the use of a threaded key.

The mount is made of 7/8-inch solid aluminum rods that telescope from 1/8 inch thick, 1-inch stainless steel tubing. The pipes are fastened to the tubes by collars and screws. The attachment is a fixed solid aluminum rod that descends 18 inches (level with armrest), turns 90 degrees, and then extends 15 inches under the wheelchair seat. The top surface of the horizontally extending portion is flattened for the screw from the collar. A 6 x 6 inch cross of the 7/8-inch inside diameter stainless steel tubing sits around the aluminum rod. Two aluminum rods extend from both sides from the main cross and attach to another aluminum block. The aluminum block is 1 x 2 x 2 inches and has a ½ inch diameter hemisphere cut. It is attached to an identical block such that the hemispheres meet to form a 1-inch diameter hole through the combined 2 x 2 x 2 inches block. A pair of nuts and bolts attaches the blocks. The wheelchair has 1-inch bars as the attachments that run under the seat and through the 1-inch hole between the two blocks.

Analysis of the design showed that the mount is able to withstand 100 pounds of force with maximum deflection in magnitudes of micro-inches and maximum stresses in kPSI. These are all well within the limits of the materials. The Plexiglas case deformed less than 1/10 of an inch with the same load and had maximum stress in kPSI, which is also within the limits of the material. No permanent deformations were caused. Overall the complete mechanism, when installed, will be rated with a 50-pound limit and a safety factor well above 2.

The total cost of the project is $345.

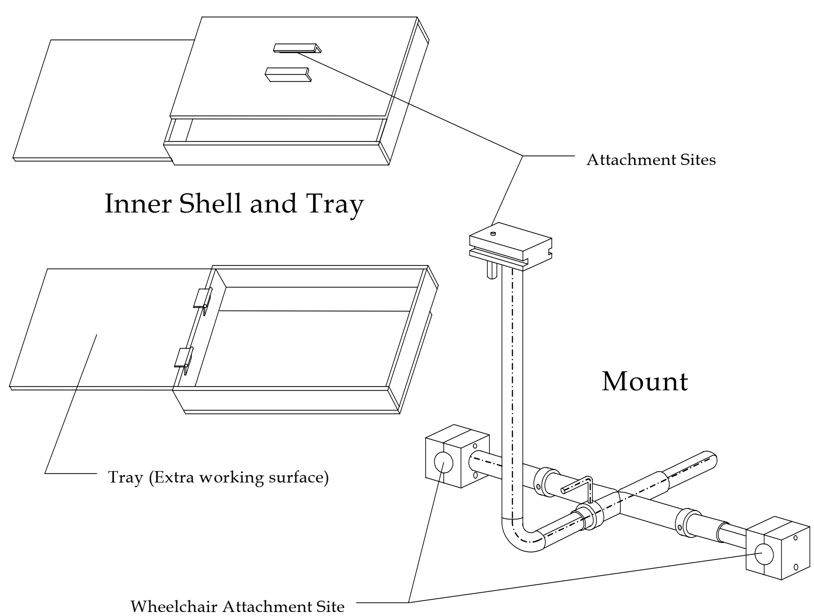

Figure 9.2. Case and Tray and Mount.

ADVANCEMENT CHAIR FOR CHILDREN WITH MUSCULAR DISABILITIES

Designers: Lindsay Ford and Nicole Baker
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Supervising Professors: Drs. Roger P. Rohrbach, Carolyn M. Sommerich
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INTRODUCTION

An advancement chair was designed for children with developmental muscular disabilities. The chair was needed to teach a group of children to sit properly. It was designed to resemble a standard chair, and to have adjustable as well as removable components. The chair's components can be adjusted according to seat height, seat depth, seat back height, and armrest height. The armrests can also be removed from the chair. The chair has supportive pelvic and trunk straps that can be adjusted or removed as well. Threaded knobs along with slots or holes allow for ranges of adjustments to be made.

SUMMARY OF IMPACT

For children with muscular disabilities, actions as simple as sitting up properly can be very difficult. Physical therapists work with such children on a daily basis to further develop their motor skills so that they may be able to perform actions, such as sitting in a chair, with little or no assistance. The methods that the physical therapists use to help these children are often inhibited because of the design of the chairs they are using. The current chairs, which resemble multifunctional wheelchairs, prevent the therapists from accessing the children from the sides of the chair. The new design will allow the therapists to use the chair for varied sizes of children and to access the children from the sides of the chair. The design will also allow the therapists to remove many of the chair's components, such as the armrests and restraining belts, as the children advance through their therapy. A physical therapist using this chair stated that the "children are obviously pleased to have a chair that actually fits."

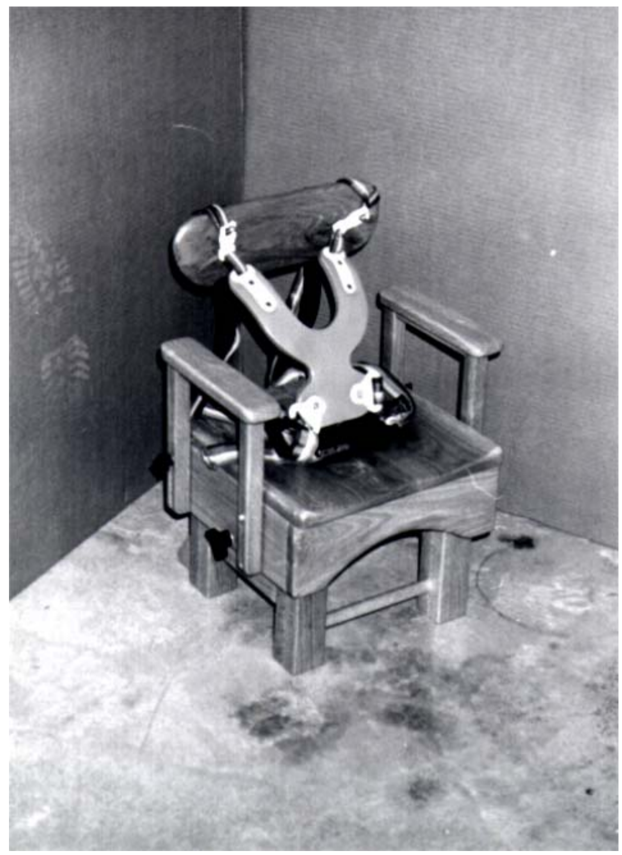

Figure 9.3. The Advancement Chair.

TECHNICAL DESCRIPTION

The advancement chair was designed for a particular group of children; however, due to the range of adjustability of its features, many children will be able to benefit from it in the future. The physical therapists requested a chair that will:

- Be used to teach children with little muscle control how to sit properly,

- Allow the therapists to access the children through the sides of the chair,
- Resemble a standard chair, and
- Have adjustable and removable components in order to benefit a larger population.

This chair is primarily made out of oak, although the back supports are made out of 9/16-inch-thick steel. The inner and outer rails are ¾ inch thick. The posts are 2 x 2 inches and are 7 1/2 inch long. The seat width is 13 inches, the seat length is 12 inches and the thickness is 1 inch. The seat has a distinct saddle cut to provide for maximum comfort of the buttocks. The armrests are 9 inches long, 2 inches wide and ¾ inch thick, and the armrest supports are 9(1/4) inches long, 1 inch wide and 1 inch thick. The seat, the inner and outer rails, the front and back rails and the legs are assembled together using wooden dowels.

A steel plate was welded to the bottom end of the two steel back supports to connect them. This steel plate has three parallel slots that enable seat depth adjustments to be made through the use of a threaded knob that is inserted through the middle slot and into a t-nut. This allows for compression to be made between the plate and the underside of the chair seat when the knob is tightened. The two outer slots each have wood screws that are used as guide pins. These will help to prevent any undesirable movements or wobbling of the chair back supports. The seat depth can adjust from a range of approximately 9 to 12 inches.

The seat height adjustment is made using a threaded knob similar to the knob for the seat depth adjustment. Four vertical holes are cut out of each inner side rail to allow a range of seat heights from 8.5 to 11.5 inches. The knobs on the left and right sides of the chair are placed in one of the holes corresponding to the desired seat height and are then tightened for compression between the inner and outer rails. This is done to prevent slipping. The side rails also contain guide pins that provide a smooth gliding adjustment of the seat.

The armrest adjustments are also made using a threaded knob. All armrest supports contain a slot allowing an adjustable armrest height of 5 to 8 inches. The knobs pass through the slots in the rear armrest supports and are tightened securely into a t-nut that is positioned on the inside of the outside rail. These knobs can be loosened and tightened so that the armrest can be adjusted to the desired height. In the front armrest supports, wood screws connect through the slots to the outside rail. Washers are located between the head of the wood screw and the top surface of the armrest support, and also under the armrest support above the outside rail. The wood screws remain tightened and act as a guide mechanism. The armrest is adjusted solely with the threaded knob. The wood screw, however, can be removed when the armrest must be detached from the chair.

There are two adjustable and removable positioning nylon belts attached to the chair. The thoracic belt consists of a padded thoracic support with two adjustable straps to support the upper portion of the trunk, in addition to a belt that has two points of attachment on the bottom of the padded support. The adjustable straps attach to the top of the backrest with two wood screws, each with washers between the wood surface and the head of the screws. The lower belts on the padded support attach in two places on the support, wrap around the child's body and fasten behind the chair. The pelvic positioning belt is attached to the rear top corners of the seat above the back supports with wood screws. The pelvic belt, similar to a standard seatbelt, fastens around the child's waist. These belts are used to hold the child in a proper sitting position while the physical therapists work with them. As the child progresses and can support him/herself, these belts may be removed.

The advancement chair contains two anti-tip brackets behind the two back legs. These brackets are safety devices that will prevent the chair from tipping over. The chair also has two stretchers connecting the two front posts together and the two back posts together. These stretchers add to the stability of the base of the chair.

The wood components of the advancement chair were manufactured in the furniture manufacturing facility at North Carolina State University. The steel components of the chair were manufactured in the shop of the Biological and Agricultural Engineering Department.

The approximate cost of the wood materials for the advancement chair is estimated to be $75 to $100. The hardware and steel components cost $145.

ADAPTIVE DRUM SET FOR A PERSON WITH PARAPLEDGIA

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INTRODUCTION

A standard drum set includes two pedals for activating the bass drum and hi-hat cymbals. An individual with paraplegia has little or no use of the lower half of the body and cannot play this instrument effectively. The goal of this project is to develop adaptations to the drum set to allow the client to play the bass drum and hi-hat pedals. Although the drummer could use an existing electronic drum machine to produce similar sounds, he wants to play a standard drum set.

SUMMARY OF IMPACT

The client had dreams of becoming a musician when a tragic roofing accident left him paralyzed from the waist down. He says that he misses playing drums more than anything else, even more than walking. This project allows him to play his drum set and enjoy the healing therapy of music once again. Although this project is designed for a specific person, it could be adapted to any drum set with a few dimensional changes. Other drummers with paraplegia or able-bodied drummers who want to use other body parts to play more instruments could benefit from this design.

TECHNICAL DESCRIPTION

The designer, the drummer, and the design consultants determined six design specifications. The hi-hat apparatus should allow for alternation between the open and closed hi-hat positions, and the bass drum should be actuated through elbow activation. More specifically, the drummer wants two elbow activators, one for each arm, so that he can have the option to use the right or left arm to play the instrument. The bass drum apparatus should also allow the drummer to control the impact force of the beater on the bass drum. Moreover, the drummer wants to "feel" the forces in the elbow actuators, just as an able-bodied drummer can "feel" the forces through his foot on the pedal. If the drummer can feel the forces through the elbow mechanism, he will be able to more accurately control the impact forces acting on the bass drum. These impact forces are important in determining the type of sound that the bass drum will produce. Since timing is critical in music, the devices should operate with a delay of less than one tenth of a second. Finally, the devices must be designed so that they cannot be dropped, and they must operate quietly so as not to interfere with the music.

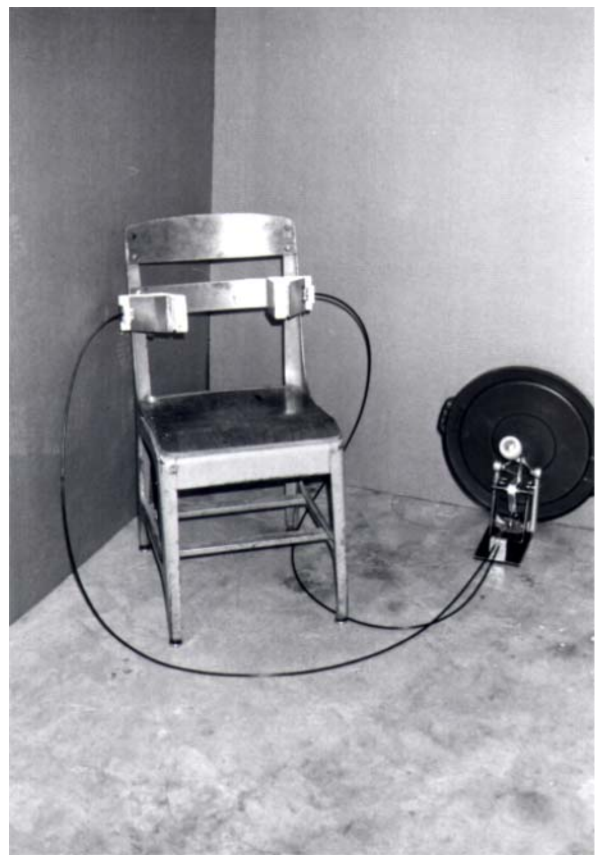

Figure 9.4. Bass Drum/Beater Assembly and Elbow Actuators in Position for Use.

A mechanical device based on a sheathed cable is designed to operate the bass drum pedal. Aluminum clamps secure the cable's sheath, allowing the cable to move freely through the sheath. A vertical force is required to activate the bass drum beater. Since the beater sits so close to the floor, the cable would have to be sharply bent to provide the vertical force necessary to activate the beater. Therefore, the L-shaped bell crank is necessary to convert horizontal force to vertical force. Horizontal force provided by the drummer's elbow activation of the sheathed cable is translated to a vertical force on the beater by the bell crank. The spring-loaded beater returns the device to its resting position after activation.

The bass drum apparatus was analyzed to determine that the forces required on the elbow apparatus were equivalent to the forces acting on the beater. The forces required to act on the beater were measured with a force gauge at 0.5 cm intervals along the entire trajectory. Then the forces acting on the sheathed cable were calculated for the same displacement. The resulting forces were very close, indicating that the drummer should be able to "feel" and precisely control the impact forces of the beater on the bass drum. The hi-hat is adapted using a drop-clutch, a device available on the market. The device is activated by hitting a lever with the drumstick, allowing for alternation between the open and closed hi-hat positions. Both devices met design specifications.

The total cost of the project is approximately $281.

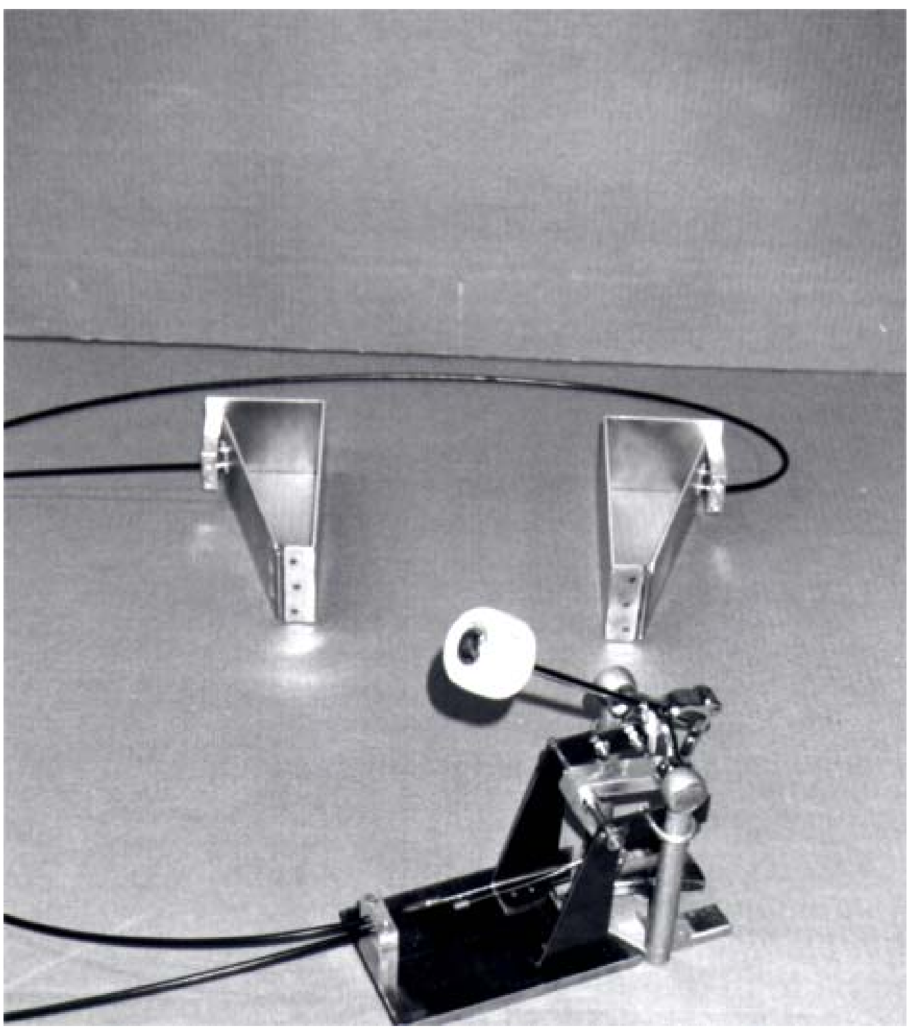

Figure 9.5. Close-Up of Bass Drum/Beater Assembly and Elbow Actuators.

MODIFICATIONS TO A DYNAMIC STANDER FOR A CHILD WITH SPINA BIFIDA

Designers: Lanita Nicole McClelland, Mikki Shea Deitz
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INTRODUCTION

A child in a center for newborns to five year-olds with developmental disabilities has spina bifida. Due to the abnormality of development of the spinal cord, the client has reduced function in her lower extremities. She uses a wheelchair and a ready racer, which were usable means of mobility but were not customized for her. The child was also using a device called a Dynamic Stander, which allowed her to stand and roll places on her own, as well as support her own body weight. In addition to enabling mobility, this device also teaches weight bearing and the sit-stand-sit sequencing, as well as control of the head, hands, and trunk. A problem with the Dynamic Stander was that it was not customized for the child and did not provide sufficient lateral support. Therefore, the goal of this project was to modify the support pads and the standing platform on the existing Dynamic Stander to better meet the needs of the child. These modifications combined comfortable support with easy and convenient mobility.

SUMMARY OF IMPACT

A modified Dynamic Stander is very similar to a wheelchair except that the child stands on a platform instead of sitting in a seat. It allows the child to be mobile and upright. This device also has trunk and leg support for better stability and is designed to teach the child to support her own body weight. Additionally, this device could impact the child socially since inclusion is easier when a person is upright and mobile. This new modified stander helps the child interact with peers in educational, recreational and therapeutic activities. The Dynamic Stander allows the child to meet her friends face-to-face. This child is expected to be able to use this modified stander until she is five years old. At that time, this stander will remain at the center to be used by other children with similar problems.

TECHNICAL DESCRIPTION

Two separate but identical blocks of wood are mounted onto the original platform piece. The blocks are made out of a lightweight wood, and each block is made up of nine separate boards. Each of these boards are approximately 13 inches long, 4.5 inches wide, and 0.25 inches thick. Velcro attaches the boards to one another so they are easily removable to accommodate the child's leg discrepancy of 0.30 inches and her expected growth. The nine boards and Velcro made each block a total of 2.75 inches high. Each piece of Velcro is 0.0625 inches thick. Two holes were drilled in each of the bottom boards, which allowed them to be mounted safely and securely to the original platform with flathead screws. With the addition of the platform, the child’s standing height increased from 30 inches to 32.75 inches, making it possible for her to reach the wheels. The separate blocks compensated for the 0.30-inch difference, allowing the child’s legs to be completely level.

The new lateral supports stabilize the child's pelvic area. They are made out of comfortable, cushioned pads that are screw to the frame of the original stander. These supports are removable for convenience and stability. The addition of lateral support at the vertex of the leaning angle decreases the angle at which the pelvic area is off center with respect to the body. With the addition of these lateral supports, the angle is decreased to 15 degrees from the center of the body to the pelvic area. The supports decrease the angle by 45 degrees and give the child the ability to stand upright comfortably without the aid of knee immbolizers.

The foot supports, made of Aquaplast-T, are attached to the newly designed platform. The child's heels are traced on the top two platforms to guide placement of the supports. They are attached to the platforms by flathead screws. Since the foot supports cannot be removed, the two blocks with these supports will be the permanent top blocks of the platform. The foot supports help to keep the child's foot in place.

The center purchased the Dynamic Stander. The approximate cost of the materials used for the modifications is $268.

Figure 9.6. Dynamic Stander.

MODIFICATION OF A TRICYCLE FOR A CHILD WITH CEREBRAL PALSY

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INTRODUCTION

A five-year-old boy with cerebral palsy was unable to use a traditional tricycle because it did not provide adequate restraint and support. Since the client is able to move his feet reciprocally, his physical therapist believes that a modified tricycle would be a good way to provide a therapeutic workout and be a fun, new activity. The modifications include a new pedal design, the addition of safety belts and harnesses, and a modified handlebar and push bar.

SUMMARY OF IMPACT

Many children with cerebral palsy can benefit from modified tricycles. Modified tricycles provide a fun and new outdoor activity. These types of devices also promote a sense of accomplishment. The tricycle shown in Figure 9.7 is built around the client's dimensions but could be used for other children with similar disabilities.

TECHNICAL DESCRIPTION

The design specifications of the tricycle require that:

- The new pedals provide a larger surface area for the foot, ankle support, and toe and ankle restraint;
- The seat have straps that mate with an existing chest harness and a lap belt;
- The handlebars be pulled in closer to the client's chest;
- The push bar be removable and adjustable; and
- The tricycle be safe.

It was also requested that the aesthetic value of the tricycle be maintained. The Ketler Jumbo Color Trike was selected as the tricycle to modify. It provides a lower center of gravity than most tricycles. It has an existing push bar that can be modified, a chair versus a seat, and a lockable steering column and the pedals have a free wheeling option.

The pedals are constructed of 1/8-inch thick aluminum, 7 ½ x 4 inches. The ankle support has a 2-inch radius, following the curve of the base of the pedal and extends upward 3 ½ inches. The new pedals are attached to the current pedals with four size 10 screws. Three pieces of 1-inch tubular webbing form the toe restraint and are secured to the pedal with a ¼ inch screw. The straps are adjustable with the aid of Velcro. A one-inch Velcro cinch strap secures the ankle on the pedal. The safety straps are attached from the back of the chair to a 7 x 7 x 1/8 inch aluminum plate that is secured with 3/16-inch flare rivets. The straps are constructed of 1-inch tubular webbing and 1-inch side release buckles. A seat belt is attached to the frame at the base of the seat to aid in securing the rider's position. It is constructed of 1 ½ inch flat webbing and is adjusted with 1½-inch side release buckles. The existing handlebars are rotated 180 degrees so that they are closer to the client's chest. The existing push bar is modified so that the bar is now a T-bar. All rough, pointed, and sharp edges were filed down and bar ends are covered with grips for safety. New parts are painted in primary colors like the tricycle so that the aesthetic value is not compromised.

The total cost for the parts and labor necessary to complete this project was $300.

Figure 9.7. Modified Tricycle.

ADJUSTABLE TRAY FOR USE WITH A VARIETY OF CHAIRS

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INTRODUCTION

An adjustable tray has been designed for the children at a Center for children with developmental disabilities. The table fits a variety of chairs and allows the children to perform many activities, including eating, drawing, and playing. The table consists of a steel framework with a plywood tabletop. The final product adjusts in height from 16 to 20 inches, tilts from zero to 90 degrees, and is painted to be appealing to the children and adults. There are rubber slip-resistant patches on the bottom of the framework. It supports a weight of 100 pounds placed at any point on the table.

SUMMARY OF IMPACT

The center aims to help children become more independent from an early age. The adjustable tray can help them develop at a faster pace by making it easier for them to perform everyday activities. The shape of the tabletop fits around the body to give more arm support when the child is eating or playing at the table. The tabletop tilts to adjust to a comfortable angle that complements the angle of the arm and wrist so that the child can draw or write with less discomfort. The height of the table adjusts so children of all sizes may benefit. The table is easy for the supervisors to adjust so it can be changed several times a day to accommodate any child. All safety factors have been taken into consideration since small children use the table.

TECHNICAL DESCRIPTION

This table was designed for children between the ages of zero to three years. Some of the major design requirements are that it:

- Raise and lower in height,
- Tilt,
- Fit around most chairs,
- Have a large working area, and
- Be safe to use.

The tabletop is made of ¾ inch plywood. It is U-shaped to fit around the child's body. A groove is cut along the edges of the table to catch any loose food or writing utensils before they fall to the floor. A 3/8 inch steel plate is bolted to the bottom of the plywood to allow the framework to be welded to it.

The framework of the table is made of steel tubing. The base is 1 inch black pipe and the outer bars are ¾ inch black pipe. These pieces are welded together. Side-by-side dual bars that protrude towards the center of the tabletop support the table. These provide maximum accessibility from chairs without compromising strength. There are inner bars with holes spaced 1 inch apart that slide up and down inside the outer bars to adjust the height of the tray from 16 to 20 inches. There are two metal plates welded to the underside of the tabletop that allow the table to tilt. A 3/8-inch bolt is used as a pivot point between the tilt plates and the inner bars. A carriage bolt is used to slide through the slots in these plates to tilt the tray from zero degrees to 90 degrees.

Several calculations were made to determine the appropriate size of some of the most vulnerable parts in the table, including the thickness of the steel plate and the diameter of the bolts used. It has been designed to support a weight of 100 pounds placed at any point on the tabletop. Special alterations were made to some small parts to ensure that there were no loose parts that could choke a child. It was also examined to make sure no sharp edges were present that could cut the children.

One of the design objectives for this project was that it cost less than comparable items on the market, which cost $500 or more. The total cost of the parts for this project, including paint, was $53, much less than similar commercially available items.

Figure 9.8. Client with Adjustable Tray.

A PROGRAMMABLE POSITION-ADJUSTABLE BED

Designer: William S. Turner
Design Consultant and Client Coordinator: Dr. Larry F. Stikeleather
Supervising Professors: Drs. Roger P. Rohrbach, Larry F. Stikeleather, Susan M. Blanchard
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INTRODUCTION:

A mechanical bed has been designed for a person with quadriplegia and dwarfism, to reduce the need for an attendant during the night. This type of bed cyclically redistributes the weight of the client during his sleep. The bed consists of three components:

- The bed well,
- An elliptical ring, and
- A base.

The bed well is attached to the outer ring with pins that are held in self-aligning bearings. The outer ring pins are held in place by another set of self-aligning bearings that are turned 90 degrees in position from the inner pins. The bed well is a piece of fiberglass in the shape of a half oval sphere, anchored to a metal ring. The interior of the bed well is lined with isotonic foam, which is gravity and heat responsive. The bed well rotates about two pins located on the long axis of the bed. The outer ring rotates on two pins on the short axis of the bed. Rotation on both axes produces a gimble arrangement. The movement of the bed and outer ring is controlled through actuators.

SUMMARY OF IMPACT:

Every year, millions of dollars are spent on treating bedsores or pressure sores that can be prevented. Caused by prolonged pressures that constrict blood vessels, bedsores appear in bedridden and immobile persons as ulcerated necrotic tissue. A client who receives preventative care is much more likely to live happily and be spared the agony and expense of direct medical intrusion. The mechanical adjusting bed's underlying design principles are set to apply to all similar situations of individuals with quadriplegia. Although designed specifically for the size of this client, the bed would provide any user with a means of repositioning body weight during the course of night, thus eliminating the need for an attendant. The automated turning mechanism can be deemed invaluable when considering the time, energy and money it can save.

TECHNICAL DESCRIPTION:

The mechanical position adjusting bed was designed with a particular client in mind. The specific requirements of the bed were that it:

- Be able to hold at least 200 pounds of weight, three times the client's body weight,
- Transverse a range between negative 20 and positive 50 degrees at the head position (The bed is considered to be at position 0 when the top of the bed well and rings are parallel with the floor.);
- Transverse a range of motion from negative 45 degrees to positive 45 degrees in the short axis, which rocks the client from side to side,
- Make it possible to eliminate the use of a night attendant, and
- Be fairly easy to use.

The base of the bed apparatus is made of six steel 2 x2 inches square tubing pieces, each having a length of 32 inches and a wall thickness of ¼ inch. Four lengths in an "I" configuration form the bottom and two lengths centered on the "I" ends are used for legs. The height of the base is 34 inches. Located approximately 3.5 inches from the top of each vertical leg is a self-aligning bearing. The bearings, each having a diameter of ½ inch for insertion of pins, are bolted to the legs.

The outer ring of the apparatus consists of 16.8 feet of 2 x ¼ inch steel flat bar fashioned into the oval design, and a 24-inch extension bar. The extension bar is centered on the short axis and extends from the bottom of the ring towards the floor. In the zero position of the bed, the extension bar is parallel to the vertical legs and perpendicular to the floor. Two pins are welded into place along the short axis to hold the ring between the self-aligning bearings of the base. Along the long axis, two self-aligning bearings are attached to hold the well of the bed. These bearings are the same as those attached to the base.

The bed well consists of approximately 13.5 feet of 2 x ¼ inch steel flat bar, fashioned into the oval design. Chicken wire is used to fashion the mold of the bed well. Fiberglass is bonded to the chicken wire. Two pins are welded in place on the long axis. Placement of the pins on the long axis allows the client to be moved from side to side. The interior lining of the bed well is overlaid with isotonic foam that is 2 inches thick.

The bed well and outer ring move independently of each other using actuators. The actuator for moving the bed well connects the extension bar of the outer ring and the short axis of the bed. It is held in place by bearings that allow rotational movement. The actuator controlling the motion of the outer ring is attached between the base leg that is opposite to the side of the extension bar and the outer ring that is offset from the short axis. This allows the proper torque force to be obtained in order to turn the ring. The position control is accomplished via an electronic programmable temperature controller connected to a low wattage heater element. It drives linear position via a paraffin based heat motor. This combination provides low cost, silent, and reliable control of the bed's position as a function of time during the sleeping period.

The approximate cost of this apparatus is $432.

Figure 9.9. Programmable, Position Adjustable Bed.

VOICE ACTIVATED TOY CAR

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INTRODUCTION

A voice activated toy car has been built for a child with developmental disabilities. The client will be able to use voice commands to direct the toy as he pleases, which will also tempt him to speak. The car was also built so that the voice commands could be changeable at any given point in time. To achieve these goals, the controller of a toy car was modified so that its impulses for movement came from a voice board rather than from mechanical movement of buttons.

SUMMARY OF IMPACT

The client has autism and Down Syndrome. Because these disorders are often associated with language delays and impairments, it is important that communication skills be taught to the client. An important method of psychological conditioning is to reward behavior that is warranted and to provide no reward for unacceptable behavior. In this client's case, the behavioral goal to meet is to speak, and the reward for this is the movement of the toy car in response to that spoken command. Another important feature of the car is the ability to change the types of spoken commands that can be used. Because the user trains each command, it would be the user's preference as to what word is chosen. This would allow the client's caretakers to change the commands to something new as soon as he masters the old commands. Ideally, this will help the client learn to speak new words.

TECHNICAL DESCRIPTION

The circuit of the controller is made up of three boards:

- The transmitter remote board of the Tyco toy car,
- The basic stamp microcontroller, and
- The HM2007 voice recognition board.

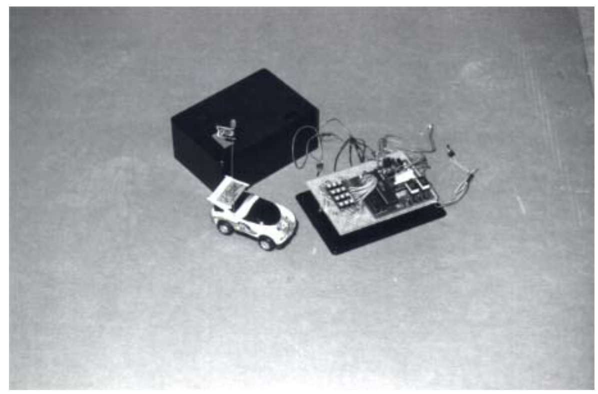

Figure 9.10. Voice Activated Toy Car and Controller.

The toy car has two motors, each connected to one back wheel. The transmitter remote board contains four inputs. The left two inputs control the front and back movements of the left motor while the other two inputs control the right motor. The controller inputs include a wire connected to 5 V and a detached leaf that is connected to ground. In the original controller, the pressed button would compress the leaf to touch the wire and complete the circuit, thereby signaling the respective motor to move. In the modified controller, the 5 V wire is connected to the output pins of the microcontroller.

The output of the microcontroller was programmed to output 5 V or to be set to ground. If the output pin were set to 5 V (HIGH), then it would cancel out the 5 V of the wire and produce no movement. If the output pin were set to ground (LOW), then the circuit would be complete and movement would occur. The basic stamp microcontroller is programmed using a serial port connection with the computer in order to send impulses by setting specific output pins to LOW depending on the 4 bit data received from the voice board.

The voice board works by storing voice patterns in predefined slots associated with a specific number.

When the user presses the number five on the keypad, then the TRN button, and then speaks the command in the microphone, the voice patterns are stored in slot five of the RAM. When the user is operating the car and speaks the same command, the chip matches the voice pattern with the existing voice pattern in the RAM and outputs the binary form of the slot number. As previously stated, the 4-bit output of the slot number goes to the inputs of the microcontroller, where it is interpreted. To understand how the program works, it is important to follow an example. Suppose that a command "left" was given which matched with slot 6 of the voice board. The 4-bit form of the output would be 0110, which would be sent to the microcontroller. The microcontroller program would then detect that the states of its input pins are LOW, HIGH, HIGH, and LOW. The program would then run the function LEFT which would set the pin connected to the right wheel forward to LOW and create a loop of LOW and HIGH for the pin connected to the left forward wheel. This would move the right wheel faster than the left wheel in the car and thus turn the car to the left. In order to spin the car, the program has to set the right wheel forward and the left wheel backward, which pivots the car on its axis.

Analysis of the car was done to test command recognition. The results showed that recognition depended on the type of commands used. Good commands were recognized at higher percentages than bad commands. Commands that have more than two syllables and do not contain part of other commands (such as 'ward' in forward and backward) are considered good commands.

The total cost for the project was $422.

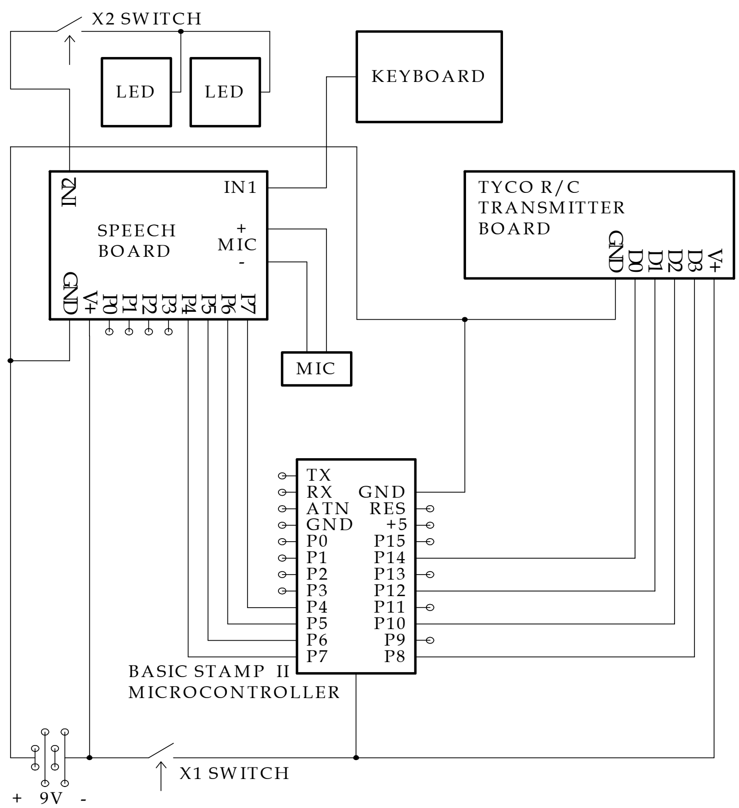

Figure 9.11. Schematic of the Controller's Circuit.