CHAPTER 7
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DRUM ROLL, PLEASE : A CUSTOMIZED DRUM KIT

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INTRODUCTION

Our client is a 12-year old boy with TAR syndrome, which causes him to have short arms with limited strength and reach. The goal of this project was to modify a drum kit so he could play comfortably. Modifications included custom drumsticks for each hand, a drumstick-actuated cymbal damper, a contoured and padded seat, extensions for the tom drums to move them closer to his body, and a third leg on the bass drum to prevent tipping due to the tom extensions. With these modifications, the client can comfortably play all of the components in the drum kit.

SUMMARY OF IMPACT

The customized drum kit enables our client to indulge in his love of music and learn to play a musical instrument. "Before, I was always the triangle player," our client told us. His mother commented, "The drum kit has provided [him] with a cool activity to interact with his friends and increase his hand strength and coordination. He enjoys being able to do something that his peers do without being "different". He loves music and this project enabled him to do more than sing, as finding a way for him to play an instrument was hard for us. This project gave him the opportunity to do something he never would have been able to do."

TECHNICAL DESCRIPTION

The Customized Drum Kit (Figure 7.1) includes adaptations to the drum seat, drumsticks, tom extensions, cymbal damper, and the addition of a third bass drum leg. The drum seat is constructed from a 10" wide, saddle-shaped contoured piece of 2" thick wood covered by two layers of foam, upholstered by a mattress pad and black velvet fabric. The manufacturer's mount is screwed into the bottom of the seat via four ¼-20 wood screws. The resulting product is comfortable and supportive.

Fig. 7.1. Customized Drum Kit.

Custom drumsticks are provided for each hand. The left-hand drumstick is the standard 16" inches in length. Approximately 1" from the large end, a 3" diameter ball gives the client additional support for gripping. Three quarters of an inch past the ball toward the small end, the stick is narrowed from the original diameter of 0.55" down to 0.4", over a length of 3/4", giving the client a more secure gripping surface. The right-hand drumstick is lengthened by 4 inches by combining two drumsticks together. One stick is cut and the end lathed to 0.4" for 2" in length. The other stick is cut and the end drilled out to accept the "dowel" from the other stick. The two pieces are glued together. The end of this drumstick is wrapped in athletic tennis tape to facilitate grip.

The toms are the drums that sit on top of the bass drum. The tubes that normally connect them to the bass drum are extended via a tube connector. The new length of the extension can be adjusted between 4-16 inches. Because the longer moment arm increases the stress on the joint of the arm of the tom connector, a support tube is connected from the tube connector down to the support clamps of the bass drum. This vertical tube releases the stress on the joint.

The tom extensions move the center of mass of the bass/tom combination closer to the user, making the assembly more likely to tip. A third bass drum leg prevents tipping. This third leg consists of a 3″ long aluminum rod that connects to a 1″ stopper via a 1.5′′ long, ¼-20 threaded rod, and thereby allowing adjustable height. The aluminum rod attaches to one side of a hinge with two ¼-20 round head bolts. The other side of the hinge attaches to a metal strip residing securely between two bass drum support clamps.

The cymbal damper system attaches to the cymbal stand via a 1.8x2x1.2″ aluminum support block, which secures onto the stand with a ¼-20 threaded eye screw. Two 8″ aluminum levers attach to the block such that they can pivot as the client pushes on a striking pad attached between the levers on one end. Two dampers, made from tennis balls, dampen the cymbal vibrations when the client does so. A spring attached between the damper levers and the support block returns the system to the starting position after actuation. Total cost of the modifications is about $90.

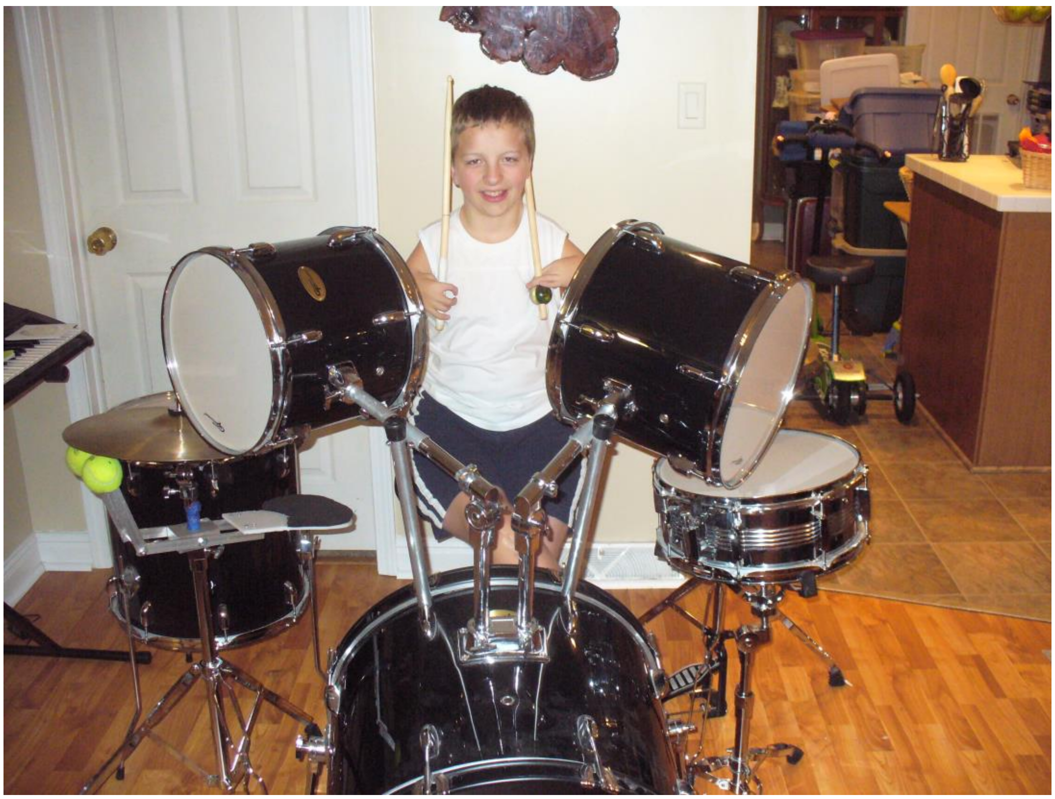

Fig. 7.2. Client using custom drum kit.

ROCKSTAR GUITAR STAND

Designers: Rachel Belzer, Kristine Brown, Brendan Moore, Al Samost
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INTRODUCTION

Our client is an adult male who loves music and playing his guitar; however, due to cerebral palsy, he cannot hold the guitar and play it at the same time. The Rockstar Guitar Stand provides a safe and durable attachment for our client's wheelchair that supports his electric guitar as well as his keyboard. The apparatus attaches to the wheelchair armrests, and allows the guitar platform to adjust in height and angle for the most comfortable playing position.

SUMMARY OF IMPACT

Our client loves music and has a dream of being a rock star. The Rockstar Guitar Stand enables him to play the guitar independently once his aide sets it up. The device also securely holds his keyboard, which previously had to be set on a table in front of his wheelchair. Our client described the device as "cool" and "wonderful." His aide commented, "[He] asks for, and uses the Guitar Stand daily, either for his guitar or the piano. Having the guitar stand lets him pursue a very strong passion of his in a very real and independent way… it encourages his independence with communicating by adding meaningful activities for him to ask for during the day; playing the guitar and piano helps him find common ground with peers that may have a more difficult time realizing that [he] shares the same interests, and it has led to new friendships; finally, it helps him with his self-esteem and confidence, and with actualizing his own identity, he is the person he wants to be- The Rock Star!"

TECHNICAL DESCRIPTION

The Rockstar Guitar Stand (Figure 7.3) comprises three sections: the permanent section, the horizontal section, and the vertical section. The permanent section consists of two front brackets, two rear brackets, and two aluminum bracket tubes. The horizontal section consists of two aluminum rods, two bottom connectors, and a lower horizontal tube. The vertical section consists of two vertical tubes, two

Fig. 7.3. Rockstar Guitar Stand.

top connectors, an upper horizontal tube, a Variloc Plastic Hinge, a C-shaped guitar neck support, a Variloc Stainless Steel Hinge, and a guitar body support surface.

The permanent section components attach to the wheelchair under the armrests. Two custom-made aluminum front brackets attach to the vertical armrest posts using two ¼-20, 1.25" long socket cap screws. Two aluminum rear brackets attach similarly. Two aluminum bracket tubes, each 0.75" in diameter and 14" in length, extend through the holes of the front and rear brackets.

The horizontal section includes 0.6875" diameter, 26" long aluminum rods that slide into the aluminum bracket tubes. These rods secure to the aluminum bracket tubes using 1" long T-handle quick release pins, which insert through both sets of tubes. The aluminum rods attach to the two bottom connectors, which connect the aluminum rods to the lower horizontal aluminum tube. The lower horizontal aluminum tube is 0.75" in diameter and 22" in length.

The vertical section attaches to the horizontal section via the bottom connectors. Two vertical tubes insert into the appropriate holes in the bottom connectors, where they are secured using 1.5" long T-handle quick release pins. The vertical tubes attach to two top connectors, which, like the top connectors, are milled from solid aluminum blocks. The top right connector attaches to a Variloc Plastic Hinge, which allows simple, locking adjustment in angle. A foam-padded, C-shaped guitar neck support extends from the top of the plastic hinge. The top left connector attaches to a Variloc Stainless Steel Hinge. This hinge attaches to the guitar body support surface, which consists of a black wooden block on which the back of the guitar body rests. A metal J-shaped rod extends down from the block to support the bottom of the guitar body. Figure 7.4 shows the client using the Rockstar Guitar Stand. The cost of the components is approximately $290.

Fig. 7.4. Client using Rockstar Guitar Stand.

BIKE STABILITY DEVICE

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INTRODUCTION

Our client has difficulty stabilizing herself on her bike due to cancer related treatments and surgeries. The goal of this project is to create a device to provide stability during intervals of starting and stopping throughout a bike ride. The Bike Stability Device includes a rotational system and a wheel support system. The final prototype provides stability for the client and has the ability to rotate. A future project will address rider actuation so the rider can move the wheels off the ground as desired.

SUMMARY OF IMPACT

The bike stability device will enable our client to realize her dream of riding her bike again. Since she is stable once moving, having the ability to deploy and retract the wheels will give her the freedom and feel of cycling she desires.

TECHNICAL DESCRIPTION

The Bike Stability Device (Figure 7.5) consists of two systems: a rotational system and a wheel support system. The rotational system includes two sealed ball bearings rotating on a ¾″ diameter aluminum rod. The aluminum rod mounts into a triangular plate that is welded to a commercial bike rack, so that the rod protrudes horizontally. One bearing is pressed into a wheel support plate at the distal end of the rod, while the other fits into a stopper plate at the proximal end of the rod. The support plate is oriented vertically downward, while the stopper plate is oriented vertically upward. Both plates are made from ½″ thick aluminum. The wheel support plate is linked to the stopper plate via two ¼″ thick aluminum linkage plates mounted on the front and back edges, altogether forming a rectangle of ¼″ aluminum for stiffness. Two shaft collars hold the bearings in place on the rod. Two angular braces of ¼″ aluminum between the support and stopper plates further strengthen the system.

An extension spring attaches from the top of the stopper plate to the bike rack, biasing the system towards the down position at rest. A stopper plug, welded into the triangular plate, contacts the stopper plate to prevent rotation of the wheel support plate past vertical.

A wheel support system provides stability during leaning. The axle of each 12.5″ diameter pneumatic wheel screws into the support plate as well as a T-shaped section, which reinforces the support plate and limits bending. Each wheel attaches via ball bearings to its axle. The support plate rotates about the previously described rotation system. Cost of parts for the device was approximately $320.

Fig. 7.5. Bike Stability Device.

Fig. 7.6. Client using Bike Stability Device.

WHEELCHAIR LEAFBLOWER

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INTRODUCTION

Our client, a woman who uses a manual wheelchair, wanted to remove leaves that fall in her yard. A previous student design used a battery powered blower, which did not provide adequate power or duration. The Wheelchair Leaf blower includes a commercial gas-powered leaf blower that attaches behind the wheelchair seat. A flexible hose mounts to the wheelchair air port, and a throttle switch at the end of the hose allows her to easily vary the blower power. The hose end rests securely in a holster while she is traveling. The hose is long enough so that she can blow leaves with either her left or right hand, with a good range of motion. A custom starting station allows her to pull the cord to start the blower. With the Wheelchair Leaf blower, our client can now clear her yard of leaves independently.

SUMMARY OF IMPACT

The Wheelchair Leaf blower restores independence in a part of life that our client enjoys: yard work. According to our client, she is very happy with the device and intends to use it regularly. She said, "This [device] is my favorite piece of adaptive equipment ever. I really love being outdoors, and this is going to make everything better."

Fig. 7.7. Client starting the Wheelchair Leaf blower.

TECHNICAL DESCRIPTION

The Wheelchair Leaf blower (Figure 7.8) comprises a Stihl 86 CE hand-held leaf blower, an HDPE mount, a flexible hose, a throttle extension switch, a holster assembly, and a starting station. The Stihl 86CE leaf blower was selected for its blend of power, light weight, and ease of use. It has a 190 mph air speed rating, while weighing only 9.7 lbs. The leaf blower mounts to a 11"x16", ½" thick piece of high-density polyethylene (HDPE) using short sections of 1/16" insulated cable attached to eye screws in the HDPE and looped over three sections of the blower: one around the nozzle, one around the handle, and one around the base. Hooks fashioned from aluminum sheet attach the HDPE mount to the wheelchair rear frame member. A conduit clamp attaches the lower portion of the mount to the tip-stopper on the bottom of the wheelchair, making the leaf blower system stable when starting and traveling.

A 3' long, 3"diameter flexible plastic duct hose attaches to the blower output port, and terminates in a fan-shaped piece of rigid plastic at the blowing end. Between the flexible hose and the rigid end is a commercial throttle extension switch, which provides a handle and an easy way for the user to vary the blower power from idle to maximum output. The switch includes a locking mechanism so the user can keep the blower at maximum without continuously squeezing the trigger. An extended cable, made using bicycle derailleur cable and housing, connects the trigger switch to the throttle lever on the leaf blower using a custom bracket on the HDPE mount.

Zip ties tether the cable to the blower hose so they move in tandem as the user flexes the hose while blowing.

A custom holster assembly holds the leaf blower hose end while traveling. The holster includes a 1″ L-bracket that attaches the assembly to a slot previously mounted below the wheelchair seat. The holster arm, constructed using parts modified from a microphone stand and camera tripod, terminates in an 8″ long piece of schedule 40 black PVC, cut lengthwise to create a U-shaped channel in which the hose end fits snugly. A Velcro strap keeps the hose end from vibrating out of the channel. The holster assembly keeps the hose end at a slightly downward and outward angle, so that the user can lock the throttle switch at maximum power while wheeling her chair with both hands, thereby blowing leaves while traveling.

The starting station includes a 3′ long arm made from pressure treated wood, attached to an oak tree in the client′s back yard. A polypropylene rope loops over a 3″ diameter plastic pulley at the top outer end of the arm, and terminates on the tree side in a 3″ wide, two-pronged hook created from aluminum sheet. Three pieces of 2x4″ pressure treated wood, staked to the ground, locate the optimal parking area for starting. To start the blower, the user backs into the parking area, and then reaches behind the chair to attach the rope hook to the pull-cord handle of the leaf blower. She then grasps knots in the rope, shown in Figure 7.7, and pulls quickly to start the blower. After unhooking the pulley rope, she is ready to begin blowing leaves. Testing revealed that the user can generate more force using knots in the rope than with a handle on the rope end, since she can then pull with both arms in a more fluid motion. The cost of the components for the device is approximately $520.

Fig. 7.8. Wheelchair Leaf blower.

HAND-POWERED MOBILITY DEVICE

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INTRODUCTION

Children with spina bifida experience partial or complete paralysis of the lower extremities, often requiring an upper extremity powered mobility device in order to travel. In the United States, these devices are either easy to purchase at a local store or to build using a variety of commonly found materials. In countries like Kenya, however, materials are both scarce and expensive given the average income. As a result, young children in Kenya with spina bifida often rely on oversized wheelchairs, if any mobility device at all, to move around. The goal of this project was to develop a hand powered mobility device sized for children aged 2-5 years old that was cheaper than current alternatives, and that could be easily constructed from materials found in Kenya. The device features wheels that children can spin by hand to propel themselves, as well as a reclining seatback that allows the child to lie down while moving. Using this hand powered mobility device provides young children with spina bifida a more convenient, fun, affordable and easier-to-use mobility device.

SUMMARY OF IMPACT

The device provides a durable, sustainable, and low-cost mobility solution for Kenyan children with spina bifida. By providing them with the ability to travel independently, this chair allows children to comfortably navigate their homes and engage in their communities. During testing with a local client with spina bifida, the client's mother commented, "This device is safe and is easy for my son to turn. I think the wheels work better than his [expensive] wheelchair."

TECHNICAL DESCRIPTION

The Hand-Powered Mobility Device has three main technical features: reclining seat back, wheel locking mechanism, and hand-powered propulsion.

The main frame of the device is constructed from wood to keep it feasible and sustainable for people to construct it in Kenya. The frame of the device consists of two U-shaped wooden frames attached together with a second plank of wood to provide more strength and support to the joints.

Fig. 7.9. Client using the Hand-Powered Mobility Device.

The seatback reclines using two door hinges that attach to the main frame. A T-bar, attached to the rear main frame using a small hinge, supports the seat back at a 100° upright position, or can be disengaged to change to a 180° reclining position. Two L-brackets attached to the seatback provide a "stopper" to secure the T-bar in place in the upright position. Velcro straps prevent the T-bar from moving out of the L-brackets on rough terrain.

The wheel-locking mechanism keeps the device stationary while the user enters and exits the device. Two door latches attached to the bottom of the device are released into the wheel spokes to lock the wheels in position.

The child propels the device by manually spinning two 12'' pneumatic bicycle wheels. A common axle, connected to the bottom frame via one L-bracket on each side, provides stability for the cantilevered wheels. Three caster wheels, two in the front and one in the rear, provide stability and make the device easy to turn.

Leg guards attached to the front frame keep the clients' legs from sliding off the device, and an adjustable seat belt keeps the user securely fastened. Removable, Velcro-secured Cushions add comfort and prevent pressure sores on the clients' back and legs. Finally, spoke guards on both sides of each wheel protect the client from possible finger injuries that could arise from spinning spokes. Cost of parts for the device was about $290.

Fig. 7.10. Hand-Powered Mobility Device.

EASYSHRINK: A DEVICE FOR SAFELY APPLYING SHRINK WRAP

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INTRODUCTION

The goal of this project was to create a device that enables employees with disabilities at OE Enterprises, Inc. to safely and reliably apply shrink wrap to vitamin supplement bottles. EasyShrink physically isolates the heat gun from its user using a wooden insulating box. A metal control box with a push button and knob creates easy activation of the automated turntable for a set time interval. This device empowers employees to perform the shrink wrapping task without fear of injury.

SUMMARY OF IMPACT

Employees at OE have been eager to use EasyShrink because it makes shrink wrapping safe and easy. "Nobody is afraid of using [the EasyShrink]. Actually, everybody wants to use this," said James Hurst, an OE staff member who oversees the shrink wrapping task. "This is the best thing. It's helped us out a lot, and we want another one." Regardless of size, the device can shrink wrap each bottle within 20 seconds. Since its introduction, the EasyShrink has increased total bottle output from 250 a day to 700 a day. In addition, multiple employees can perform the task with ease, and a few veterans now work independently without supervision.

TECHNICAL DESCRIPTION

EasyShrink (Figure 7.12) consists of three key components: a wooden insulating box, a metal controller box, and an automated turntable, all of which mount on a consolidating platform of plywood. The insulating box (13″x8⅝″x10¾″) isolates the high-temperature Master Appliance heat gun from the user. The heat gun rests on a stabilizing wooden block (3.5″x1.5″x1.5″), and its nozzle protrudes into a 5″ long, 2″ diameter aluminum heat sleeve. The heat sleeve fits snuggly into an aperture in the box facing the motorized turntable, allowing hot air flow to be directed outside. A hinge on the top of the box allows for insertion and removal of the heat

Fig. 7.11. An employee shrink wraps a nutritional supplement bottle using the EasyShrink.

gun. The heat gun's power cord connects to a 3-prong outlet on the metal controller box (9″x5″x6″). Handles affixed to the box sides make the device easy to lift and transport.

The controller box attaches to the side of the insulating box. On top are a turntable activation button and a timing knob to set the desired time for shrink wrap application. When the user pushes the button, the heat gun and turntable are both activated for the time set by the timing knob. A modified Velleman interval timer provides a one-shot interval adjustable up to 35 sec, and an Omron AC relay powers the heat gun and turntable for that interval. A main power cable extends from the controller box to a surge protector, providing an emergency switch to shut off the entire system if necessary.

The turntable rests on a rectangular wooden platform. A DC gear motor, rotating at 12.5 RPM, mounts to a wooden box on the platform. A circular motor mount of 1.5″ diameter attaches to an 11″ diameter wooden turntable.

Countersunk holes in the turntable allow stabilizing pins to hold different sized bottles upright. Three circular disks accommodate different bottle sizes. Bottles are wrapped upside-down, so these disks are slightly smaller than the respective bottle lids. Wrapping upside-down allows all bottles to be wrapped without adjusting the height of the heat gun or turntable. The disks remain centered using protruding screws mounted in the turntable and respective holes on the bottom of each disk. The replacement cost for the device is $230.

Fig. 7.12. EasyShrink.

PORTABLE SUNSHADE

Designers: Henry Hwang, John Lee, Tamara Louie, Nicholas Ong
Client Coordinator: Kimi Dew, Goodwill Industries of Eastern North Carolina (GIENC)
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INTRODUCTION

The nature facilities at the Goodwill Industries of Eastern North Carolina (GIENC) are used to produce gardening products and to provide pleasant gardening experiences for people with disabilities. During the hot summer months, staff members and people with disabilities work at these facilities under direct sunlight. The goal of this project was to provide a portable sunshade device to GIENC. The device consists of a sixty square foot UV-resistant shade attached to a frame of galvanized steel, mounted on four wheeled poles for mobility. When the device is deployed, the users can work in a shaded area and enjoy a respite from the sun's light and heat.

SUMMARY OF IMPACT

The portable sunshade allows our clients to enjoy gardening under the shade during summer. The supervisor at GIENC commented, "The portable sunshade creates a space for shade while our groups of adults with disabilities are working in the raised planters and other places on the farm tolerating more time outside and providing UV protection for a large number of people. It is also a mobile device that makes it handy to move about easily with just a couple of people."

TECHNICAL DESCRIPTION

The Portable Sunshade (Figure 7.13) includes a mesh tarp, a sunshade canopy, aluminum supports, four 90° connectors, four lockable wheels, four aluminum disks, and handles. The mesh tarp is a commercially available product from Tarp Cover Sales. It is a black polypropylene mesh tarp with 100% UV protection and 73% shading. The tarp attaches to the sunshade canopy using bungee cords and metal grommets at 18" intervals on the tarp edges.

The sunshade canopy is modified from a commercially available product by Outdoor Canopy, with horizontal dimensions of 6′ x 10′ and a 7′7″ height. The commercial product, which had a peaked roof, was modified to have a flat top frame by replacing the top connectors with 3-way 90° connectors. This flat roof, combined with the mesh nature of the tarp, make the device far less prone to being moved by the wind. All of the poles are made from 1 3/8′ diameter galvanized steel, custom

Fig. 7.13. Portable Sunshade.

powder-coated green for durability and aesthetics. The poles attach to connectors using eye screws.

Custom aluminum supports attach at the top corners to provide stability. These supports are made from round-edged, 3/16″ thick corrosion resistant aluminum bars, each 1/5″ wide and 20″ long. The supports attach to the vertical poles using ¼-20 bolts and nylon-inserted nuts.

Pneumatic 8″ lockable wheels from Waxman Consumer Group attach to the footpads of the vertical poles using custom aluminum disks, each 1″ thick and 6″ in diameter. The wheels provide a simple foot-actuated locking mechanism to prevent the device from rolling, and their large size makes moving over rough terrain easy. The wheels and the footpads attach to threaded holes in the bottom and top of the aluminum disks respectively, using ¼-20 screws and threadlock. Handles made from cushioned grip tape mount at a 4′ height on the vertical poles to make the device easier to transport, especially if the metal poles become hot from sun exposure. The cost for the device is approximately $580.

Fig. 7.14. Client using Portable Sunshade.

IRON CHEF: COOKING ADAPTATIONS

Designers: Katie Apibunyopas, Seung Yun Lee, David Song
Client Coordinator: Fay Tripp, OTR, Lenox Baker Hospital
Supervising Professors: Kevin Caves and Richard Goldberg
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INTRODUCTION

Our client, Joshua, is a teenage boy who was diagnosed with a primary brain tumor and experienced a stroke as a result of surgery to remove the tumor. The stroke left Joshua both paralyzed on the left side of his body and cortically blind. Through physical therapy, he has been able to regain motor function in his left leg and shoulder but still has limited motion, strength and sensation in his left arm. He retained full control and strength in the right side of his body and is able to stand and walk independently. He has full cognitive comprehension and verbal abilities.

Joshua enjoys cooking, but as a result of his disabilities, has not been able to do so without the help of his mother. For this project, we developed several custom devices that enable him to prepare his three favorite dishes with minimal assistance: spaghetti and meat sauce; steak with mashed potatoes and a vegetable; and chicken quesadilla. These dishes require many different cooking tasks that are difficult for Joshua to accomplish with standard cooking utensils.

STATEMENT OF IMPACT

While Joshua still required some supervision and assistance after initially receiving the devices, his mother was confident that with practice he would become more independent. Additionally, she reported: "Making it safe is very important and they we're able to do that. He is not going to burn himself. And the cutting board, wow, that is a device. They did an amazing job with the cutting board, making sure that it is very safe." Joshua told the team: "I love it and it's going to definitely help with my independence in the kitchen. Soon enough I will be making everyone dinner ... I'll open my own four star restaurant!"

Fig. 7.15. Client using Iron Chef

TECHNICAL DESCRIPTION

The team created three devices to assist Joshua with cooking tasks: a modified George Foreman grill, custom modified spatula/tongs, and a custom cutting board.

<u>A. Modified George Foreman Grill.</u> In order to grill steak, chicken and vegetables, we selected the G4

George Foreman grill (GRP94WR), which consists of two grilling surfaces, in which the top plate folds down onto the food to be cooked. The grill comes with removable plates for easy cleaning, a large cooking surface area, and a temperature knob that allows the grill to be turned off even when plugged in. We added rubber tactile cues around the temperature knob to help him set the grill to the appropriate temperature. To use, the client puts the food on the grill, closes the lid and waits for it to cook. This eliminates the need for Joshua to flip the piece of food and, for safety reasons, limits the amount of exposed heated surface while it cooks. To provide additional safety, we added a shield made of heat resistant polyetherimide plastic. We milled a handle into the shield, and attached it to the top part of the grill with two hinges. When the grill is opened, the shield extends over the grilling surface to prevent his hand from coming in contact with the hot grill plate. In the closed position, the shield extends forward and prevents Joshua from accidentally reaching into the grill or into the hot grease that drips out. When the unit is closed, the exposed upper surface also gets hot, so we provided a heat-resistant cover, made of potholder material. This cover is attached with Velcro.

<u>B. Custom Spatula.</u> We attached two oversized, pancake spatulas to a set of barbeque tongs (Figure 7.16). With the larger surface area of the spatulas and their ability to clamp the food in place, he will be able to easily move food on and off the grill without having to balance it. We machined grooves into the spatula heads that match the grooves of the George Foreman grill. The front edge of the top spatula was bent to make a rake-like shape to help scrape food off of the grill. The larger spatula face, which provides roughly 9 square inches of surface area, accommodates larger pieces of food such as a quesadilla.

<u>C: Cutting Board.</u> We created a modified cutting board that can be operated with one hand. The cutting board has a sliding food holder that slides in small increments towards an attached knife (Figure 7.16). This allows Joshua to slide food in fixed increments and then locate the stainless steel knife to slice the food. The cut pieces slide directly into a removable container on the other side of the knife so that Joshua can collect and carry them elsewhere in the kitchen. The knife is held in place with a removable pin to allow for washing of the knife. The pin slides in a slot over a distance of 2" and rotates about the point of the pin to allow for a slicing motion. The knife rests on a 4" block on the edge of the cutting board to allow for food to be slid under the knife into position without exposing too much of the knife blade.

The total cost of the three devices was $375.

Fig. 7.16. Iron Chef Devices (clockwise from top left): Modified Grill, Spatula/Tongs, and Cutting Device

.

VOICE TRAINER

Designers: Calvin Lee, Joe Hoerner, Morgan Fox
Client Coordinator: Meredith Nye, SLP, CCC, Duke University Medical Center
Supervising Professors: Kevin Caves and Richard Goldberg
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INTRODUCTION

People with Parkinson's disease (PD) often develop speech and voice disorders. Our client, an older woman with PD, experiences these common symptoms as she is prone to gradually lowering the volume of her voice and has little vocal endurance. Many patients with compromised speech secondary to PD, including our client, undergo the Lee Silverman Voice Treatment (LSVT), a method of therapy that seeks to improve speech and voice by focusing on improving vocal loudness.

In LSVT therapy sessions, patients are reminded to speak more loudly when their voice drops below an appropriate volume, and they also undergo various vocal loudness exercises. LSVT has been shown in multiple studies to be an effective program in treating speech and voice disorders. Therapy is intense, requiring patients to commit to four consecutive weeks of daily therapy sessions intended to habituate speaking loudly. We developed the voice trainer to support LSVT therapy by providing biofeedback on voice volume throughout the day.

STATEMENT OF IMPACT

Our client's therapist reported: "The device will be helpful in giving patients biofeedback to help ensure they are speaking with sufficient volume. It often falls to the user's caregiver or spouse to remind the user to speak up and it is not uncommon for this to lead to resentment. This device will definitely help improve the user's quality of life."

TECHNICAL DESCRIPTION

The team developed a microprocessor-based device that measures vocal and ambient volumes and gives feedback if the user is not speaking loudly enough. It can be worn or carried and monitors speaking volume continuously. If the speaking volume is not loud enough compared to the ambient volume, a red LED is illuminated and a vibration motor is activated.

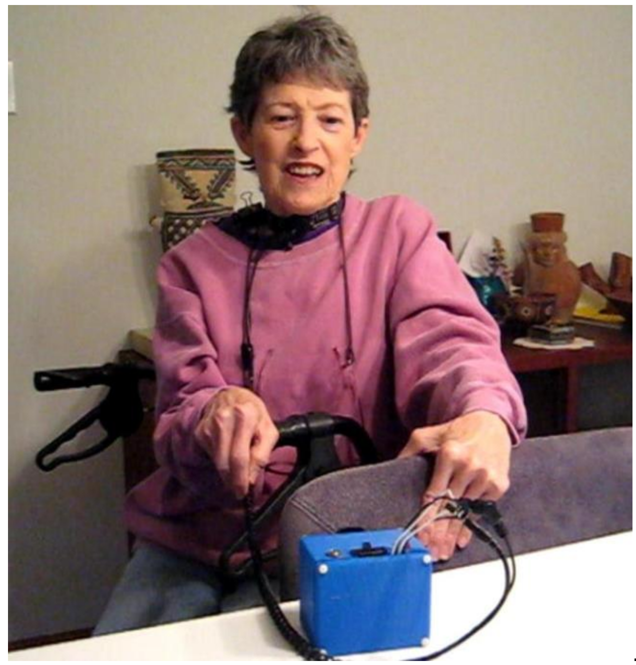

Fig. 7.17. Client using the device.

If the speech is loud enough, a green LED is illuminated and there is no vibrational feedback.

The device uses an omnidirectional microphone to measure the speaking and ambient volume and a throat microphone to detect whether or not the user is speaking. The throat microphone used in this device is a Socom Paintball Throat Microphone (RAP4 #001981). It has an adjustable strap with a magnetic connector that provides a snug but comfortable fit. The microphone works by sensing the user's vocal vibrations, so it does not pick up sounds from other peoples' speech or ambient noise. Although signal magnitude increases with speech volume, this microphone cannot be used to reliably measure volume because signal magnitude is very sensitive to positioning and tightness of the strap. The omnidirectional microphone was taken from a Communications Ultra-Light Headset (RadioShack #19-315). Because the microphone is omnidirectional, its signal is not sensitive to positioning. This microphone is attached to the throat microphone strap, rather than on the user's clothing, in order to ensure consistent microphone placement and to consolidate wires (Figure 7.18).

Both microphone signals are input to a custom circuit, which filters and amplifies the signals and passes them to an Arduino Mini microcontroller. This microcontroller was chosen because it is easy to program, yet powerful enough to rapidly sample and process the analog inputs. It samples the throat and omnidirectional microphones signals, determines whether speech is sufficiently loud, and gives an appropriate output.

A small, ABS-plastic case was fabricated and the device can be kept in a pocket or clipped onto an article of clothing (Figure7.17). The case contains the PCB, microcontroller, rechargeable 7.4V, 800mAh Polymer Lithium-ion battery, on/off switch, and feedback mechanisms. It is designed so that feedback can be easily noticed by the user; the vibration motor is positioned to maximize sensation and the LEDs are placed in a convenient location.

The total cost of the device was $232.

Fig. 7.18. The Voice Trainer. The microprocessor and circuitry are inside the enclosure in the top of the photograph, and the throat microphone and omnidirectional microphone are at the bottom.

VERTICAL DISPLAY STAND

Designers: Laura Struzyna, Alexandra Sterling, AlessondraSpeidel
Client Coordinator: Catherine Alguire, OT, Jen Michalenok, Lisa Stinnett, Durham Public Schools
Supervising Professors: Kevin Caves and Richard Goldberg
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INTRODUCTION

We created a transportable, adjustable display stand for a special needs classroom in a local elementary school. Our clients have a number of different neurological disorders, including Angelman's Syndrome, spastic quadriplegic cerebral palsy, and cortical vision impairment (CVI).

To interact with and instruct the students, the teachers use a variety of educational materials including books, papers, toys, binders, as well as felt and magnetic items. It is difficult for the teachers to hold the materials in the appropriate location in front of the student and to instruct the student at the same time. Staff have tried several different commercially existing products that partially satisfy the clients' needs. Tripod easels with magnetic whiteboards are currently available, and 3M offers an adjustable monitor arm that can be swiveled, tilted, and moved vertically for optimal positioning. However, there is no single existing commercial product that is sturdy or versatile enough to incorporate and display all of the materials in a manner that is comfortable and effective for all users. To address these needs, we developed the Vertical Display Stand, which enables teachers and staff to display a variety of educational materials while the teacher is free to move around and interact with the student more easily.

STATEMENT OF IMPACT

One of the teachers stated: "This is amazing! The design is fantastic. It gives us all of the opportunities that we are going to need in order to allow for our students to access their materials and do partner-assisted scanning. So, this is really everything we wanted to have happen for them. I am really excited to use this!" The school occupational therapist reported: "The needs and concerns were complex and challenging – they were all well addressed by the product design. Thank you for contributing to the daily education of countless students with multi-handicapping conditions!"

Fig. 7.19. Front view of the Vertical Display Stand.

TECHNICAL DESCRIPTION

The vertical display stand design looks like an easel, as seen in Figure 7.19. It has an adjustable central board that allows for the display of the teachers' various educational materials at multiple angles. The stand is designed so that the teachers can push the clients up to it in their wheelchairs.

The structure is made of oak plywood and coated with a washable black satin polyurethane coating. The stand is about 40″ wide and 60″ tall. The central display board is about 40″ x 25″. The bottom of the board is 28.5″ above the ground to allow room for the students' wheelchairs and reaches a height of 53.5″ to accommodate the vertical visual ranges of all the students.

The central display board has several unique features. The entire board can tilted in 10 degree increments, from 30 degrees forward, to 10 degrees back. The board has a built in white board door mounted on hinges to allow the teacher to sit behind the board, open the door to write on the board, then close to show the student. There is another hinged section of the display board, designed to facilitate face-to-face, partner assisted communication techniques. The entire display board is covered with black felt and there is a black felt cover for the white board that attaches with magnets that are inlaid on the display board. There is also a separate yellow felt cover that attaches with magnets to provide a high contract background for students that need it. The magnets can also be used by the teachers to easily place items for students to make visual selections.

A set of shelf brackets is mounted to the front of the display board. We provided a narrow shelf that can be used to hold books and papers as well as a clear office folder holder that the teachers use to hold their custom made binder books.

To address specific visual impairments, the display stand includes a visor and focal task lighting. A swing away visor was installed on the top of the stand to block out the overhead lights. Two gooseneck lights, mounted to the front of the stand, provide task lighting. Both lights use low temperature, energy smart soft white bulbs. The lights are plugged into a power strip that sits out of reach of students, underneath the visor at the top left of the left A-frame base. The power strip has a six-foot cord that allows it to be plugged into a nearby outlet. Remaining outlets on the power strip can be used for other electronic devices the teachers want to use with the students.

The total cost of the device was $447.

Fig. 7.20. Teacher using the device with a client.

MOVIN ON UP

Designers: Sam Lipman, Nicole Rothfusz, and Kelly Waldman
Client Coordinator: Charlotte Hughes, PT, Orange County Schools
Supervising Professors: Kevin Caves and Richard Goldberg
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INTRODUCTION

Molly is a middle school student who uses a manual wheelchair due to a spinal cord injury. She has paraplegia at the T-3 level and does not have motor control or sensation below mid-sternum, but has full movement of her head, neck, shoulders, arms, wrists, and fingers. She is strong in both pulling and pushing motions. Molly is able to maneuver her manual wheelchair independently and can transfer independently between horizontal surfaces that differ less than 2 inches in height using a depression lift in which she lifts her body weight up with her arms.

Molly is in a technology class where the other students sit on stools at elevated tables. She is currently unable to do this because the stools in the classroom do not provide adequate support and she is unable to raise and lower herself the ten inches between her wheelchair and the height of the stool. In order to work at these elevated tables, we developed a device that will enable her to raise and lower herself independently, while also providing the necessary cushioning and postural support..

STATEMENT OF IMPACT

The physical therapist reported "Molly is excited about the device as it allows her to use the same desks as her peers and it will give [Molly] access to the lab table for years to come." Additionally, while utilizing the device, Molly exclaimed several times: "I feel so high!" and "I'm higher than a table for once!"

TECHNICAL DESCRIPTION

We modified a commercial drafting chair, the Global Deluxe Fabric Drafting Chair (purchased from Staples), which uses a gas spring to adjust the height of the chair over a ten-inch range. Like typical office chairs, when the user unlocks the pneumatic gas spring assembly, the chair rises when no weight is placed on the seat, and lowers when the user is seated. New adjustable armrests and support poles were designed so that the client can perform a depression lift, de-weight the seat and subsequently activate the pneumatic gas spring assembly to raise the chair in a series of increments. Once the client raises the chair to the desired height, the chair mechanism can slide forward along tracks, so the client can pull herself in to work at the elevated table. The device is pictured in Fig. 7.21.

Fig. 7.21. Movin On Up Chair, raised position with base in open position.

We made several modifications so that Molly could deweight herself to easily raise and lower the chair. We added a bicycle brake handle and cable to pull on the lever mechanism that unlocks the gas spring. The brake handles attached to the right armrest and when squeezed, the brake lever pulls on the cable, which lifts the unlocking lever. The chair will go up if the client puts no weight on the seat by performing a depression lift, and down when she sits in the seat.

To facilitate the depression lift, we constructed armrests that can adjust in height. A pair of vertical, 4′ long 1″ square aluminum tubes support the armrests. Each tube has four 3/8″ bolts driven through them to create different supporting heights for the armrests. The armrests are constructed from 2″x4″ wood, which are each attached to 2″x3″ rectangular tubes of ¼″ thick pieces of aluminum that are 7″ in length. There is a 1 1/8″ x 2″ rectangular hole cut from the back of the metal tube. The vertical supporting bars fit through this hole, so that the armrests can slide up and down the supporting bars, and stay in place at the height of any of the bolts.

The modified drafting chair is mounted to a custom T-shaped wooden base constructed from two pieces of plywood that measured 25″x28′x1/2″. The plywood bases are connected via four side drawer slides, to allow the client to slide the chair up to the desk to work as close as she would like. Each pair of drawer slides can support up to 100lbs. The top base piece has six non-castor wheels that support the device when the sliders are in the open position as the client transfers in. The two wheels in the back also allow the device to be easily transported between classrooms.

For increased safety, it was necessary to prevent the base from swiveling while transferring. A locking mechanism was fashioned out of a 1 ½″x3″ rectangular aluminum tube with a 1/8″ thickness. The mechanism catches a horizontal stabilizer support for the armrest poles and locks automatically when the seat is lowered to its lowest position. This prevents any swivel movement while the chair is in the lowest position and enables a safe transfer.

The total cost of the device was $486.

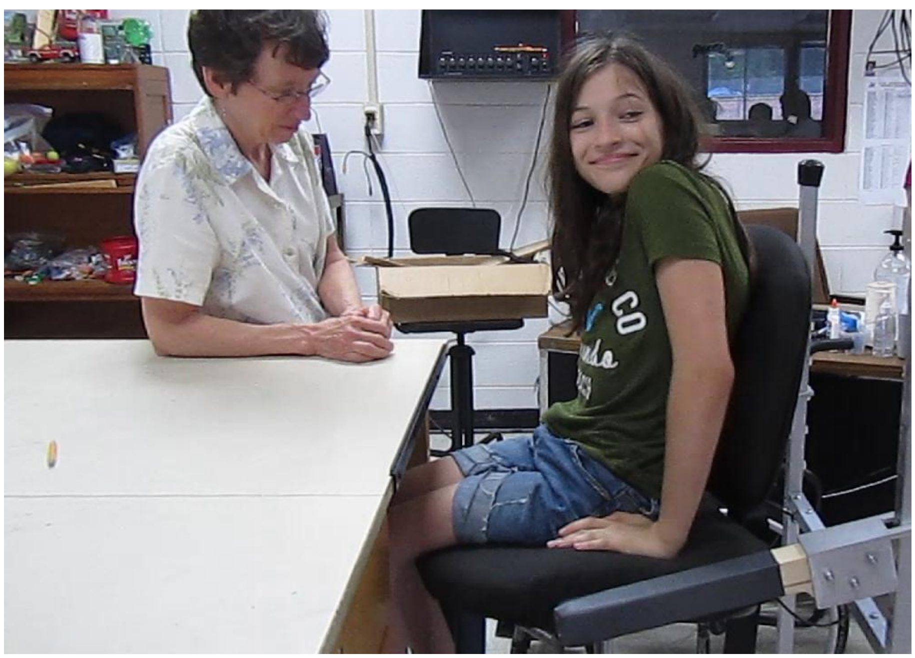

Fig. 7.22. The client using the device with her physical therapist.

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POOL CHAIR

Designers: Luke Li, Andy Pettit, Xinli Zhang
Client Coordinator: Jean Bridges, Lenox Baker Hospital, Duke University Medical Center, Durham NC
Supervising Professors: Kevin Caves and Richard Goldberg
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INTRODUCTION

Lenox Baker Hospital offers Aquatic Physical Therapy (APT) conducted by physical therapists. Physical therapists utilize the buoyancy, viscosity, and hydrostatic pressure of the water to help support the body by diminishing the effects of gravity. The water also helps reduce stress on joints and muscles, while improving circulation due to the compressive forces of the water. The patients at Lenox Baker undergo APT to help relieve or recover from arthritis, chronic pain, balance impairments, obesity, and profound weakness.

For patients who need assistance in entering the pool, physical therapists transfer them to a water wheelchair, and then roll them down a narrow ramp into the water. The ramp includes a narrow, 180 degree turn that is difficult to maneuver. They have a commercial PVC wheelchair that can be used for patients that weigh in excess of 250 lbs., but it is difficult to maneuver for heavy patients. This is due to the force of the patient's weight on the rotating front casters, making them resistant to rotation. In addition, the pool wheelchairs are subjected to water and chlorine exposure for around 6 hours a day, leading to the constant need for repair and replacement of the tires and axles. To address all of these concerns, we developed a pool wheelchair that is easy to maneuver up and down the narrow ramp into the pool (figure 7.23). It is durable and can accommodate patients who weigh up to 400 lbs.

STATEMENT OF IMPACT

The Physical Therapists at Lenox Baker found that the Pool Chair is safe, effective, and easy to use. One PT commented that "The firmness of the seat is perfect. If we need any extra padding for the seat we'll just use towels." And a patient stated that "the central bar you have is great. It's nice because it reminds you there are bars beneath the seat. I also like the removable arm because it gives you more flexibility in transferring into the chair… I had no problems getting into or out of the chair." Finally, a PT stated that "Can we just have you make a few more?"

Fig. 7.23. The Pool Chair.

TECHNICAL DESCRIPTION

Our design was based on a three-wheel frame made out of furniture-grade PVC. Preliminary research and testing showed that this would provide a much smaller turning radius than a conventional four-wheel design, making it easier to navigate the ramp at Lenox Baker. The device contains four main components: frame, front caster, rear wheels, and seat.

The frame of our water wheelchair is constructed out of furniture grade PVC (1.5" Diameter). Our design uses a base in the shape of a pentagon to incorporate our three-wheel design and provide the support necessary for a 400 lb. client. Our decision to include only three wheels required us to provide additional vertical supports. These supports, which connect the pentagon base and seat, provide our wheelchair with necessary vertical support and allow the seat to be at a comfortable height. A removable armrest was also constructed to facilitate side transfers. This modification also allows wider patients to sit comfortably in the chair. The PVC pipes and fittings were connected using Oatey's Clear Advanced Cement. The product has been approved for use in extended water exposure situations (plumbing).

The front wheel is a stainless steel swivel caster, which is threaded into a 6″ piece (1.5″ Diameter) of solid PVC. This is connected to our frame using Oatey's Clear Advanced Cement. The rear wheels consist of commercial wheelchair wheels. These have solid tires, and are attached using a quick release axle and four washers. This allows the wheel to be easily and rapidly assembled and disassembled. PVC caps have been designed which cover the axle and limit water exposure.

We created a seat made of cross-hatched nylon straps and heavy-duty canvas. The nylon straps are rated for 1,000 lbs. and are sewn to the canvas. Upholstery thread approved for outdoor (water exposure) use was used to sew the straps. Nylon straps and canvas were used due to the additional safety measures a nylon seat would provide. The final cover was attached to the PVC frame using anchor rope (approved for extended water exposure) and heavy upholstery grommets.

The total cost of the Pool Chair is $517.

Fig. 7.24. Client going down the ramp at the pool.

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BLAZING SADDLES

Designers: Fernando Iglesia, Wade Sidley, Shin Chang
Client Coordinator: Margie Muenzer, PT, North Carolina Therapeutic Riding Center
Supervising Professors: Kevin Caves and Richard Goldberg
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INTRODUCTION

Therapeutic horseback riding is a technique that uses the motion of riding a horse to build strength, and improve trunk tone and muscular endurance as well as balance and posture. Used in conjunction with dexterity exercises, such as holding the reigns, therapeutic riding is a powerful tool. Our client has spastic quadriplegia cerebral palsy and he uses therapeutic riding to improve his trunk strength, posture, coordination and dexterity. However, our client does not have the trunk tone to balance on the saddle without leaning forward or to one side. In addition, our client becomes very nervous when attempting to straighten his posture because he feels as if he will fall off the back of the saddle. As such, while he rides, he needs to have his legs and ankles held down by assistants to help him balance and feel safe.

In order to provide the client with more independence and safety while riding, we developed several saddle attachments. A raised, horizontal bar connects to the front of the saddle. By gripping onto this bar, the client has additional support and sits more upright while riding. A back support connects to the rear of the saddle. It provides physical support and makes the client feel safer. Both attachments are adjustable, so they can be used for other riders. In addition, the attachments are removable and do not alter the original saddle in any way.

STATEMENT OF IMPACT

Our device enables our client, as well as other horseback riders with postural issues, to ride with greater support and confidence than afforded by conventional saddle designs. The physical therapist at the riding center said: "Without the device, he's tense through his body and he's putting a lot of weight through his arms because he's feeling pretty insecure in the saddle. With the new attachments, it lightens him up and he's able to sit up and look around a lot better and able to reach things much more confidently and easily, so I think it'll really enable him to enjoy his riding and be more functional."

Fig. 7.25. Custom attachments to provide additional support in therapeutic horseback riding; the raised horizontal bar at the front of the saddle and the backrest at the rear of the saddle.

TECHNICAL DESCRIPTION

Our project consists of two separate, removable attachments to a saddle that are designed to help our client with balancing and posture while horseback riding.

The raised bar attachment consists of a base, made from an aluminum plate, and an adjustable bar structure. The base slides underneath the top layer of the saddle, and the rider's weight and Velcro straps hold it in place. The bar structure consists of four bars in a rectangular shape. There are two horizontal bars, made from steel conduit pipes, and four connector joints. The two vertical bars are telescoping tubes with spring pins (adapted from crutches) that can be lifted in 1-inch intervals to accommodate a variety of horseback riders. The top bar is covered by tennis grip tape and two cut open tennis balls cover the top connector joints, which provides a gripping location and covers sharp edges for safety reasons. The result of the design is a handlebar that is sufficiently rigid and strong enough to support the client pushing on it in order to support himself while horseback riding. There is ample padding in the saddle, so that neither the rider nor the horse can feel the metal base that is inserted in the saddle.

The backrest consists of a cushion that is mounted to a supporting structure. This structure is made from two plywood boards connected at a right angle using 4 corner brackets along the back. The cushion itself was taken from an Otto Bock wheelchair headrest with the metal supports cut to size. The entire structure is 6″ long and 9″ wide. The height of the backrest can be adjusted from a minimum of 9¼″ to a maximum of 13½″. The backrest is designed to fit into the saddle by sliding under the back cushion. The backrest cushion can be moved up and down the metal supports it by loosening screws and manually sliding the cushion.

The total cost of this project is $384.

Fig. 7.26. Client using the saddle attachments.