BALL ROLLER AND CATCHER

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INTRODUCTION

Our client, a five-year old girl with Rett syndrome, cannot communicate verbally and has decreased motor coordination of her arms and limbs, resulting in limited interaction with her peers. To promote socialization, we developed a device that allows her to roll a ball to a classmate at the push of a button, as well as catch it when rolled back. A push-action solenoid in conjunction with a lever rolls the ball, while a ramp system catches the ball and holds it in place. With this device, our client can roll a ball back and forth with a classmate.

SUMMARY OF IMPACT

The device helps our client interact socially with her peers. She is currently mentally aware of her surroundings and the events around her, such as when a ball is rolled towards her, but because of her disability she is not able to respond. The Ball Roller and Catcher helps breach that barrier. As our supervisor remarks, “[she] will love playing with the device... [she] will benefit tremendously from playing with other students.”

TECHNICAL DESCRIPTION

The Ball Roller and Catcher (Fig. 8.1) case is made of ¼” thick acrylic. The side, rear and bottom panels attach to each other using acrylic cement. The front panel is hinged to a downward sloping ramp located inside the device and opens to double as the front ramp, which slopes in the opposite direction from the inner ramp.

Two sheets of acrylic are cemented to the inner ramp in the shape of the letter ‘V’, directing the ball into the correct position and then holding it in place in front of the rolling mechanism. The rolling mechanism consists of a push-action solenoid acting upon a lever to propel the ball out of the box. The lever is constructed from a 3” long, ½” diameter dowel rod. It is attached to the acrylic support structure, which is also cemented to the back ramp. The solenoid is suspended above one end of the lever and fastened to the rear panel. When the switch is pushed, the solenoid activates, pushes the lever, and propels the ball forward.

An infrared LED and matching phototransistor pair are mounted on the inner ramp, beneath where the ball rests when “caught”. When the ball rolls into this position, it activates a series of LEDs located on the V-shaped holder, illuminating the interior of the device.

A rechargeable 12V DC battery pack powers the circuitry. Both battery and recharger are located in compartments behind the V-shaped holder. The recharging cable plugs into a port on the rear of the device. The top panel of the Ball Roller and Catcher attaches with four screws, making it easy to remove to replace the battery.

Also located on the rear of the device are a power switch and a 1/8” jack for the actuating switch. A red LED next to the power switch indicates when the battery requires recharging, illuminating only when the battery voltage exceeds 10V. The total cost for parts for the device is approximately $400.
Fig. 8.1. Ball Roller and Catcher, with ball in “caught” position.

Fig. 8.2. Ball rolling into device.
INTRODUCTION
Our client is an independent, athletic woman who enjoys cycling. However, she is unable to ride a bicycle because of limited left knee flexion due to a car accident. The Pivoting Crank Arm allows her to cycle again. The device consists of a modified crank arm with a pivot joint. By allowing the pedal to drop to a lower height at the peak of the pedal motion, the pivot decreases the degree of knee flexion required for pedaling. The device was optimized for the individual client’s capabilities, but it can be adjusted for individuals with different degrees of knee flexion.

SUMMARY OF IMPACT
Prior to her accident, our client biked 25 to 35 miles every weekend. After the accident, she started swimming, but she “very much missed the physical activity in the open air that [she] got with cycling on country roads.” After using the device, she commented, “Thank you all very much for enabling me to bike again. I have been waiting for this moment for six years! It's so exhilarating!”

TECHNICAL DESCRIPTION
The Pivoting Crank Arm (Fig. 8.3) is comprised of a shortened mountain bike crank arm, an aluminum bar used in an overlapping fashion as a pivot, and a shoulder screw with associated bearing.

The crank arm is cut at a location designed to maximize the client’s power generation with each pedal stroke while still adhering to her range of motion. The outer section of the crank arm, containing the pedal, is 78 mm long, while the inner section, attached to the axle, is 127 mm long. These dimensions were determined after testing an adjustable version of the device with the client to establish her maximum amount of flexion within a comfortable range of motion, while keeping the total length from axle to pedal at the standard 170mm.

The aluminum bar attaches to the outer crank arm portion with four ¼”-20 machine screws. The pivoting sections attach together with a shoulder screw, which rides in a sealed ball bearing in the aluminum bar to minimize rotational friction. After passing through the bearing, the shoulder screw threads into the inner portion of the crank arm. This threaded connection is secured with thread-lock compound as well as a set screw. A slight gap between the overlapping portions of the crank arm and aluminum bar accommodates a delrin washer to facilitate smooth rotation.

Figure 8.4 shows a picture of the client riding her modified bike. The replacement cost for the pivoting crank arm is about $90.
Fig. 8.4. Client using the Pivoting Crank Arm.
CAMERA SUPPORTS FOR A BOY WITH LIMITED REACH

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INTRODUCTION
Two camera supports were developed to allow our client, a ten year-old boy with TAR syndrome, to take pictures while using his powered wheelchair or ambulating. Since he has limited arm reach, the devices enable him to use a tripod and microphone boom system to easily position a camera both horizontally and vertically, while taking pictures with a remote. Both devices are unobtrusive and easily detachable so the client can take the devices wherever he goes.

SUMMARY OF IMPACT
The Camera Supports allow the client to take pictures easily and independently. The client’s mother commented, “This device gives him a sense of independence, which is fantastic.” About pictures he took at Disneyworld and the Duke Gardens, the client said, “I like being able to be like the adults who are taking pictures. It made me feel like I was a professional photographer. I think my pictures were better than some of the ones my parents and grandparents took.”

TECHNICAL DESCRIPTION
The camera wheelchair support (Fig. 8.5, left) includes a base made of ½” black high-density polyethylene (HDPE). Two knob screws firmly secure the base on top of the left armrest of the client’s wheelchair. A commercial microphone boom threads into the front, center portion of the base. A 3/8” threaded rod, bent at a 90° angle, attaches the end of the microphone boom. A ¼-20 threaded rod is threaded into the top of the 3/8” rod, providing the proper attachment for a commercial tripod head. The threaded rods are secured with thread lock compound.

A custom camera case provides a robust attachment for an aluminum lever, which the client uses to point the camera. This camera case, built for the Pentax T10 camera, consists of six pieces of 3/8” thick Delrin. The back of the camera case includes a rectangular cutout portion (3.5” x 1.75”) for the LCD display screen as well a cutout (0.375” x 0.5”) for two buttons to change the mode of the camera. The front of the camera case includes a 2” diameter circular cutout for the lens. The front piece also includes a 2.625” x 0.625” rectangular cut-out in the upper left corner for flash and remote sensor access. The bottom piece includes a ¼-20 Helicoil that threads onto the tripod head, and a cutout to allow easy access to the battery and memory card compartment. A 2.5” x 1” rectangular HDPE piece with a 0.5” hole in the center is screwed into the side of the camera case. The aluminum lever fits into the HDPE hole and is secured with a 10-32 thumbscrew. The lever is 15” long with black tennis grip and a racquetball on the end added for comfort. The inside of the camera case is lined with foam padding to hold the camera securely and reduce vibration.

The camera belt support (Fig. 8.5., right panel) is constructed from a back-support belt (McGuire-Nicholas), which fits the client comfortably. A sheath pocket (Fiskars) is used as a holder for the microphone boom. This pocket attaches to the support belt at any desired location using the clip on its rear side. The microphone boom is sewn tightly
into the Sheath Pocket. To provide additional support for the microphone boom, a rifle sling (Yukon) attaches to the vertical portion of the boom using a bike helmet buckle. This arrangement allows the neck strap to easily detach from the boom. A \( \frac{1}{4}'' \) threaded rod is attached to the end of the microphone boom and bent 90\(^\circ\) to screw into the bottom of the camera case.

Because the sensor for the remote is located on the front of the camera, while the client uses the remote from the rear, a mirror is attached to the camera case to reflect the signal. A string attached to the remote prevents the client from misplacing or dropping the remote. In addition, a pointer is affixed to the string to help the client press camera buttons. The Pentax T10 camera was chosen for its large touch-screen display and its ability to operate remotely. Cost of parts for the camera wheelchair support is approximately $325 and cost of parts for the camera belt support is approximately $300.

Fig. 8.6. Client using camera wheelchair support (left) and belt support (right).
MOBILE CLEANING STATION

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INTRODUCTION
Our five-year-old client loves to clean the house, but this task is difficult because he has cerebral palsy and uses a walker to ambulate. We built the Mobile Cleaning Station to help him clean independently while standing upright. This wooden cart holds cleaning equipment and doubles as a stable anterior walker. It moves forward only when hand-brakes are released, giving the user full control over mobility. The Mobile Cleaning Station is durable, portable, and easy to store. Using the station, our client can clean around the house by himself, as well as strengthen his hips and mid-trunk through standing and walking.

SUMMARY OF IMPACT
The Mobile Cleaning Station allows our client to perform cleaning activities independently while in an upright position. The client’s mother noted, “This is the next developmental stage for [him]. You want him weight bearing and walking, not just standing. [The Mobile Cleaning Station] allows him to strengthen himself that way.” The client himself was extremely pleased with the device and described it as “very good.”

TECHNICAL DESCRIPTION
The Mobile Cleaning Station (Fig. 8.7) includes a wooden base with two 2” diameter swivel casters in front. The cart base is constructed from 3/4” and 1/2” thick plywood secured using wood glue. The middle 5” diameter wheels are attached to the base using a threaded rod secured with three copper straps. Aluminum blocks in the back corners of the base anchor the attachments for the removable side support rails. These rails are made of 3/4” galvanized steel conduit piping and add stability to the cart, preventing tipping forwards and backwards. Swivel casters are attached to the end of the side support rails. Each side support is attached to the main cart body by sliding over a vertical aluminum rod, which is secured in the aluminum block. Two spring plungers on each vertical rod fasten the side supports in place. The side supports can be easily installed and removed by depressing the spring plungers. The aluminum blocks also anchor the sides, back, and bottom of the base, which are bolted into the blocks.
The vertical supports for the handlebars are made of ¾" by 2½" hardwood, while the handlebar is a 22" long piece of 7/8" diameter aluminum tubing, with handgrips attached on either side. The handlebar is height-adjustable through a range of four inches. Each vertical support consists of two pieces of hardwood secured together by knob screws tightened into threaded inserts. Loosening the knob screws allows the handlebars to be raised or lowered.

The base accommodates a sweeper vacuum as well as a child-sized mop and broom. An upper wooden basket is made of ½” plywood and intended for storage of smaller items such as a duster. Three metal spring clamps along the front side of the basket hold the handles of the vacuum, mop, and broom in an organized fashion.

Brakes on the middle wheels allow the user to control the mobility of the cart. The brake parts are modified from walker brakes, and include a brake pad and spring. The brake pads are controlled by one brake lever on the left side of the handlebar. When the brake lever is not depressed, the brake pads are applied, making the cart difficult to push. Depressing the brake lever raises both brake pads, allowing the cart to move.

Padding on the back of the basket and handgrips on the side support rails increase user comfort. Corner bumpers on the front of the cart make the station safe for furniture. Red accents throughout the device – basket, middle wheels, and hand grips – make the Mobile Cleaning Station more attractive to young users. Fig. 8.8 shows the client using the sweeper vacuum. The cost of all components of the device is approximately $350.

Fig. 8.8. Client using the Mobile Cleaning Station
WHEELCHAIR SHOPPING AID

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INTRODUCTION
Individuals in manual wheelchairs often have trouble grocery shopping because they find it difficult to move a shopping cart while wheeling their chairs. The goal of this project was to develop an easily attachable shopping aid that provides a stable location for groceries. The shopping aid resembles a hand-held shopping basket that is stably fixed to the front of the wheelchair. The Wheelchair Shopping Aid quickly attaches to the wheelchair’s frame and the detachable grocery basket folds for compact storage. The device gives the shopper easy access to groceries while allowing them to simultaneously operate their wheelchair.

SUMMARY OF IMPACT
The Wheelchair Shopping Aid enables our client to shop freely and ergonomically. Since he is an active, independent individual, this device will give him a shopping method that allows him the same level of independence he has when completing other common tasks. The client says, “This shopping aid will allow me to shop much more efficiently, quickly and with less frustration than the typical shopping experience of a wheelchair user. This is a great step toward greater independence.”

TECHNICAL DESCRIPTION
The Wheelchair Shopping Aid (Fig. 8.9.) includes a shopping basket, a basket tray, and two frame clamps. The collapsible basket is a commercially available product from Garnet Hill. It has a sturdy, lightweight aluminum frame and a rubber-cushioned handle that makes it ideal for grocery shopping. The basket material is durable polyester, which is held to the frame with Velcro straps. The Velcro straps also wrap around the handles of a commercial, wire-mesh shower tote (not shown), which allow the tote to attach inside the basket as a compartment to hold fruits and other delicate groceries. The collapsible basket folds flat for compact storage once the plastic side stabilizers are removed.

Fig 8.9. Wheelchair Shopping Aid attached to client's wheelchair.

The rectangular basket tray is constructed from ½” thick high-density polyethylene. Five 0.8” diameter holes are drilled into the tray, which serve as receptacles for the plastic pegs on the bottom of the collapsible basket. The peg holes prevent the shopping basket from sliding off the surface. For added stability, two Velcro strips sewn to the bottom of the basket attach to mating strips on the tray to prevent the basket from tipping. Two steel T-hinges are attached to the bottom of the basket tray. Screwed onto the long arm of these hinges are ½” diameter aluminum support rods, which insert into frame clamps. The hinges allow the support rods to fold up for compact storage.

The aluminum frame clamps consist of two components that tighten around the wheelchair frame using two brass knob screws. Vertical holes in the clamps with diameters of ½” provide mounting
locations for the support rods. Figure 8.10 shows the client using the device. The replacement cost for the device is approximately $130.

Fig. 8.10. Client using the Wheelchair Shopping Aid.
INTRODUCTION

Our client, a 20-year old male with cerebral palsy, wanted to exercise his legs to gain strength as well as to enhance his cardiovascular fitness. Because no commercial devices met his needs, the Custom Workout Station was designed. The device sits on the floor in front of the client’s wheelchair, and has two pedals to which his feet attach. The resistance for each pedal can be adjusted independently by applying free weights of different values. The client exercises his quadriceps by pushing his legs downward, which lifts the weights vertically using tension cables and pulleys.

SUMMARY OF IMPACT

The Custom Workout Station helps promote quadriceps strength, improves cardiovascular fitness, and deters muscular atrophy. The device is currently being used regularly. According to our client’s mother, “the device does exactly what [our PT] and I wanted and envisioned; he is really working his quads which he could never do before.”

TECHNICAL DESCRIPTION

The Custom Workout Station (Fig. 8.11) is comprised of a base, two slider towers, two lever arms, two pulley platforms, two weight platforms, two cycling pedals and two tension cords and pulleys. The 18”x24” base is constructed of blue ½” thick Ultra High Molecular Weight Polyethylene (UHMW-PE) with routed edges. A rubber mat attached with Velcro to the bottom of the base prevents the device from slipping while in use. Two metal handles on the base allow for easy transport.

The two slider towers are made of white UHMW-PE blocks, 2”x1”x 18” long. Three white 4”-long support blocks help stabilize the towers: one block between the towers, and one on the front of each tower.

A commercial pivot nub is attached to the top of each front support block. 17” long lever arms, made from 1” square aluminum tubing, are secured to the 3”-long extensions of the pivot nubs. An eyehook attached to each lever arm provides an attachment point for a 3/16” tension cord, made from plastic-coated cable. Cycling pedals with toe straps are fixed to the lever arms with custom nuts that reside within each lever arm. Each lever arm is capped with a plastic rectangular stopper.

The 2”x2” pulley platforms, made from ½” thick blue UHMW-PE, are mounted to the two slider towers. Affixed to the top of each is a 2” diameter pulley. Aluminum safety brackets installed over the pulleys prevent the tension cords from misaligning with the pulleys.

18” drawer slides, attached to the rear of the slider towers, allow the aluminum weight platforms to move vertically as the user exercises. The weight platforms are attached to the slides with L-brackets. Each tension cord connects to the eye-screw on the lever arm at one end, over the pulley and down to the weight platform L-bracket at the other.
The aluminum weight platforms each hold a 6” long, 1” diameter aluminum post, onto which the weights are placed. Foam padding on the platforms reduces noise and vibration as the weights are raised and lowered. Figure 8.12 shows the client using the custom workout station. The cost of the components for the device is approximately $400.

Fig. 8.12. Client using the Custom Workout Station.
CREATIVE PLAY STATION: ASSISTED IMAGINATIVE PLAY FOR CHILDREN WITH HYPOTONIA

Client Coordinators: Lynn Carswell, SLP
Designers: Weixin Lin, Whitney Stewart, Lin Yang
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INTRODUCTION
Our client is a bright two year old boy with an active imagination. He has an undiagnosed metabolic condition, leading to severe hypotonia. As a result, he lacks the ability to pick up or maneuver toys. He loves to pretend play with stuffed animals or other toy figures, but currently can only do this with the assistance of a parent or therapist.

The goal of our project is to develop a creative play station where the client can engage with animals or people in common daily activities. The device is designed for independent use and basic interaction. It is designed around a “puppy theme”, inspired by the strong relationship between our client and his pet beagle, Lulu. The play station offers our client three choices of activities with a stuffed animal dog that resembles Lulu: 1) feeding Lulu (a spoon moves up and down in front of a toy beagle’s mouth); 2) grooming Lulu (a yellow brush moves in circular motion to “groom” the toy beagle); and 3) Lulu watching a squirrel at play (a toy squirrel moves in a circular motion around a “tree” in front of the toy beagle). The device has bright colors and provides audio feedback to motivate active participation. Our client can use the device while seating in his “Kid Kart” chair. It is relatively small and lightweight so that an adult can easily put it away when it is not being used.

SUMMARY OF IMPACT
Once the client became comfortable with the Creative Play Station, he chose to engage with each of the three activities frequently. The play-station allows our client to think about and personally initiate the different scenarios provided by the device. This provides him with a fun and entertaining way to achieve important developmental milestones while providing more independence. Our clinical advisor, Lynn Carswell, SLP, told us “I believe many children with physical limitations, who presently have no opportunity to engage independently in imaginative play, would enjoy using this toy.” His mother added, “I think he loves this! I think it’s perfect!”

TECHNICAL DESCRIPTION
Motions of all three activities are controlled with the Lego Mindstorms NXT robotics kit, including a programmable controller, motors and gears. The client begins an activity by pressing one of the three commercial pushbuttons. This activates the corresponding motion from the Lego Mindstorms controller. In addition, the system starts playing an audio track, using a programmable uMP3 module (Rogue Robotics, Toronto ON). Each sound track consists of music and speech appropriate for the particular activity and it plays on two battery-
powered speakers. To further stimulate our client’s imagination, a free-standing acrylic trifold which features colorful outdoor and living room scenes is included in the device.

The device has three mono audio jacks, so that any commercial switches can be plugged in to activate the device. They are connected directly to the three input jacks on the Lego Mindstorms NXT controller. They are also connected directly to the uMP3 player to activate the corresponding songs. The controller outputs are connected directly to Lego servo motors, which operate the motions of each activity.

The software is written in LabView, using the LabView Toolkit for Lego Mindstorms, and stored in Flash memory in the Lego controller. The device is programmed so that a single press of the button starts the activity for a period of time. When that period is over, Josh must release and press the button again in order to restart the activity. The controller can run off a rechargeable battery or by an adapter connected wall power. The controller also powers the uMP3 player.

The play station is divided into an indoor section and an outdoor section which are partitioned using acrylic “walls”. The toy beagle, (elevated on a stand) surrounded by the feeding and the grooming stations, is located in the indoor section. The squirrel station is located in the outdoor section. The tree is made of a PVC pipe decorated with textured color paper. The play station is decorated with colored foam, textured paper and fabrics. The acrylic stand is collapsible for easy storage, and the pictures are laminated for durability. The mechanical and electronic components are located inside a large plastic enclosure to preserve them. The activities are mounted on top of the enclosure.

Total cost of the device is $685, including the full cost of the Lego Mindstorms robotics kit.

Fig. 8.14. The Lego gear mechanism is located inside an enclosure.
INTRODUCTION
Our client is an adult male with quadriplegia. He spends most of his time in bed or in a manual wheelchair. Unless a nurse is present to assist him, he is not able to switch between activities he enjoys such as reading, watching TV, and using his computer. He does, however, have control of his head and neck and is skilled with both a mouth stick and sip-and-puff switch. We developed a custom worktable that can be placed in front of the client, and it enables him to switch between activities utilizing his mouthstick skills. We designed the table so that it is quick and easy to set up, as well as portable and height adjustable to allow for use when in bed or a chair. It uses a motorized lazy Susan to allow the client to independently switch between different activities. It is compact so that the client can reach everything with his mouthstick.

SUMMARY OF IMPACT
This custom work table will provide the client with increased independence. Through the use of this device he will be able to choose between reading a book, controlling the television remote, and using his computer at any time. The client commented, "It's really nice that I will always be able to reach my mouth stick and my sip-and-puff straw."

TECHNICAL DESCRIPTION
The final design uses a donated hospital table as the base for the device. The table rolls on wheels and it is height adjustable so that it can be adjusted to fit the client’s bed or chair. Because the table is designed to roll up to a bed from the side, it includes a cantilever design with a support on one end. To prevent the table from bowing under the weight of the lazy-Susan, book, and computer, the table is reinforced with a solid wooden beam underneath.

For the lazy Susan, a 24” diameter circle of ¾” oak is mounted onto lazy-Susan bearings, which are mounted on top of the table. In addition, a 1.5” diameter hole is cut through the center of the oak and the table to allow wires from the computer to pass through. This also prevents tangling of the wires during rotation. The oak circle is stained to match the color of the hospital table.

The book stand consists of two wooden triangles that support the back of a commercial book holder and two wooden cubes that prevent the base from slipping forward without interfering with page
turning. The holder can be easily removed by simply leaning it forward and lifting up.

A commercial large-buttoned remote control is used to control the television, which can be accessed by the client with the use of his mouth stick. The remote control is Velcroed onto a raised stand on the table, in a location that is easy for our client to access.

The client accesses the different activities with a sip-and-puff straw and a mouth stick. A circular wooden tube holds the sip-and-puff straw. The tube has an adjustable screw that holds the straw in place. This is mounted onto the rotating lazy Susan. The mouth stick holder is made of a piece of PVC cut in half and capped at one end. The capped end is screwed to a flexible gooseneck device, which is reinforced with a second gooseneck for additional support. The goosenecks allow the mouth stick holder to always be available to the client. A button mount is fashioned around the lower half of the holder to allow the client easy access to the control buttons. These are mounted to the stationary part of the table so that they are always within reach.

A commercial motorized rotary tool is used to rotate the wheel. It is attached to a 4” diameter hard foam circle that pushes against the outer edge of the 24” lazy Susan. As the foam circle slowly rotates, it rotates the lazy Susan. The motor is attached to the back of the table along with the control circuit. The circuit consists of a voltage regulator and two relays. Power comes from a 12V DC wall transformer, which is fed to the regulator that drops the voltage to 1.86V. This is fed to the relay coils, which control the voltage polarity that goes to the rotary tool, allowing rotation in either direction. The circuit is controlled by two large, normally-open pushbuttons. When the user presses a button, it closes the corresponding relay, starting rotation of the table. Each button rotates the table in a different direction. The circuit also contains two normally-closed buttons that function as limit switches. They are positioned under the lazy Susan and when depressed by a wooden knob underneath the rotating oak circle, they become open circuits and stop rotation in one direction. This prevents the table from rotating more than 360 degrees in either direction, which would cause the wires to tangle.

Total cost of the device is $240.

Fig. 8.16. Client using his mouth-stick to rotate the lazy Susan.
SEW SIMPLE: THE “FOOT FREE” SEWING SOLUTION

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INTRODUCTION:
Our client is a creative and intelligent ten-year-old girl with a desire to learn how to sew on a sewing machine. Due to a spinal cord injury, she has no mobility of her lower body and depends on her arms to balance and stabilize her upper body. As a result, she cannot use any standard sewing machines that are operated by a foot pedal. This project focuses on the design of an entire “sewing station”, complete with a hand-operated machine and modified craft table that will allow our client to sew independently. It has a table that allows for easy wheelchair access, and for sewing at an appropriate height while seated in her wheelchair. It permits her to maintain comfort and balance while using the sewing machine. It is height adjustable so that it can grow with her, and is also easy to store.

SUMMARY OF IMPACT:
Our client’s mother remarked, “I am so pleased with the conscientious design with its focus on growth and safety. I’m looking forward to [her] increased independence in operating the machine and accessing everything she needs for her ‘creations’.” When sitting at the workstation for the first time, our client had only three words for our design team: “This is great!”

TECHNICAL DESCRIPTION:
The final design is based around the Brother CS6100 sewing machine, which uses hand-controlled technology with buttons for power and speed control, rather than requiring the use of a foot pedal. The sewing action is controlled via a push button that is located directly above the needle, and a slider button to the right of the power button controls the speed of the needle which can range from very slow to very fast speeds. The machine is housed in a height adjustable sewing station complete with a hand crank mechanism to allow for multiple positions of the machine. The machine rests on a platform that can be moved up and down independently from the surrounding table. Auxiliary clip-on lighting, a detachable power strip, a bungee leg-securing system, Velcro pockets for storage, and free-standing sewing boxes for additional storage are included in the design.

For the height adjustability, the legs of a craft table are modified to decrease the height of the table from 28.5” to 26.5” by removing a two inch section from each leg. An insert is machined from solid, square aluminum bars that fit inside the tubes that make the legs of the table. ¼-20 screw holes are tapped into the block to allow for up to 2.25 inches of height to be added back in ¼ inch increments. This allows our client to fit perfectly under the table, thereby reducing fatigue in her arms, back, and neck. It is also the mechanism by which the table can be adjusted as she grows.

A custom Plexiglas template is fabricated from ¼ inch Plexiglas using a laser cutter. When placed
around the machine in its lowered position, it provides a continuous workspace between the sewing machine work surface and the surrounding table, and it reduces the risk of dropping fabric or needles to the floor. Slim hexagonal screws are inserted periodically around the perimeter of the inset and provide ledges for stabilizing the insert while in use. The design also includes a laser etch of the client’s name.

The cost of the device is $325, excluding the cost of the sewing machine.
INTRODUCTION
Persons with spinal cord injuries and other disabilities are not able to play golf without the aid of a supportive device. Currently, commercial “single rider carts” are available, which provide support to the golfer. However, these are expensive and not always necessary for activities like practicing at a driving range. We developed a supportive golf chair that enables persons with disabilities to play golf at a driving range. The golfer sits on our chair, which provides additional support with belts at the waist and chest. The golfer can independently adjust the height of the chair using a hand-operated hydraulic pump. The device has attached wheels for mobility, and is stable.

SUMMARY OF IMPACT
In testing with several clients with a variety of disabilities, each of them felt the golf chair was safe and effective. One individual with two lower limb amputations stated, “It works great and I felt very comfortable in it.”

TECHNICAL DESCRIPTION
The basis for the design is a commercially available salon chair. Existing models of this type have a hydraulic pump which is normally controlled with a foot pedal. Since hand control is necessary for golfers who are amputees or don’t have full strength in their legs, the foot pedal is replaced with longer lever arms on both sides in this design. The lever arms have telescoping attachments, which are particularly helpful as the seat rises. The seat height adjusts between 25.5” and 32.5”, which meets the specifications given by the client coordinators. The hydraulic pump is rated to support individuals up to 350 pounds.

The base of the salon chair is raised by placing pressure treated wooden decking and other weather treated wood materials underneath it. The total height of the chair is raised 4.5 inches to bring the chair to a minimum height of 25.5”. Because rotation of the seat is not desired during a golf swing, custom metal poles are installed to impede rotation while still allowing the chair to move smoothly up and down.

The chair has waist and chest belts to support our clients during their golf swings. These seat belts were purchased from local auto parts dealers. They provide easily adjustable support and are quick to engage and disengage. The waist belts are secured tightly to metal brackets on the bottom of the chair. The back belts are secured tightly to the wooden decking that spans the rear of the chair.
The back of the seat slides horizontally to provide support for individuals with higher order spinal cord injuries who lack trunk support. The back adjusts up to eight inches forward. It is held in place with handles attached to threaded rods that screw into an imbedded T-nut. The chair has this locking mechanism and a track inside the wooden arms on both sides.

For portability, a hand truck is attached to the rear of the chair. The hand truck is secured tightly with four metal brackets to the base of the chair and with two metal brackets at seat height. An individual can move the chair by tilting it back and pulling or pushing it on its wheels.

Total cost of the device is $485.

Fig. 8.20. Client using the golf chair.
INTRODUCTION
Our client is a two year old boy who has limited trunk support and limited control of his limbs as a result of cerebral palsy. We developed a device that exercises and strengthens his trunk and limbs. Our final design is a chair that can bounce up-and-down as well as side-to-side. By kicking his legs, our client generates a gentle up-and-down bouncing motion. By twisting his body, he is rewarded with a side-to-side bouncing motion. Through continued use of the bouncer, the client will develop his leg and trunk muscles while performing an activity he enjoys.

SUMMARY OF IMPACT
Our client’s mother remarked, “The ‘Bouncer’ team created a dynamic, size-appropriate bouncer seat for our son to allow him to continue an activity that he loves - kicking! The final product is something that our son will be able to enjoy for years to come.”

TECHNICAL DESCRIPTION
The base of the device is made of furniture grade PVC pipe and serves to elevate the chair from the ground so that it can safely bounce without making contact with the floor. Furniture grade PVC was ordered in “Duke blue” colors to enhance its aesthetic appeal.

The seating system is a chair from commercially available stroller, with the legs cut off. Made of lightweight metal and plastic, the chair features a mechanism that allows for simple reclining of the chair’s back. A custom safety harness was fabricated from neoprene and secured with buckles.
Fig. 8.22. Client using the Bouncer Chair.
ASSISTIVE BOCCIA RAMP

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INTRODUCTION
Boccia is a variation of the game Bocce, enjoyed by individuals with varying degrees of disability. The object of boccia is to throw a ball closest to a target ball. Assistive devices such as ramps allow people with significant physical impairments to participate competitively. The Assistive Boccia Ramp was designed for an eleven-year old client with Thrombocytopenia with Absent Radius (TAR syndrome), a rare condition in which the individual is born without a radius bone, resulting in very short arms. He has limited hand strength, making gripping and throwing balls difficult. Additionally, our client has difficulty standing for prolonged periods of time as a result of surgeries in his legs.

SUMMARY OF IMPACT
Our client's mother stated: “With his physical limitations due to the TAR syndrome, there are few recreational sports [he] can master. This ramp will allow him to experience Boccia to the fullest of his capabilities because it was built with features that tailor specifically to him.”

TECHNICAL DESCRIPTION
The ramp consists of a chute with a custom base, handles and a release mechanism. To use the ramp, the player sets the angle and aims it for the shot. Then the player positions the ball behind one of the four “gates”, each at a different height, depending on how much momentum is desired. Finally, the player releases the ball.

The chute is made from a single piece of a 5” diameter PVC pipe, cut in half along its long axis, and it attaches to a curved PVC “elbow” which allows the ball to smoothly roll onto the floor. These parts are cemented together and provide a continuous surface over which the ball can roll without losing momentum.

Fig. 8.23. Assistive Boccia Ramp.

The bottom of the ramp rests on the floor. The chute is also connected about 2/3 of the way up to two parallel 18” long legs with a bolt and star knob which allows adjustment of the ramp angle and height of the shot. These legs are connected at the
bottom to the base with a similar knob that allows for adjustment of leg angle. At each connection site, there is a solid wood block which serves as a stable connector piece. These connector pieces also bear a majority of the weight and force exerted on the device. The bottom connector is reinforced with 4 L-brackets to ensure stability. We mounted trapezoidal stoppers to limit the adjustment range of both the ramp angle and leg angle. This mechanism ensures that the lower connector piece will not experience too much torque nor will the ramp tilt on the player or out of reach of the player’s arms.

The base incorporates a lazy Susan so that the ramp may be rotated easily to aim the shot. The base is 12” x 18” and can be separated from the legs for storage. There is adequate space on either side for the player to place his feet.

There are two handles at the top of the chute which allow the user to hold and maneuver the ramp. The cushion ensures that if the top of the chute is resting on the player’s chest, it will not cause discomfort.

The release mechanism, located on the top right side of the chute, has a small handle which can be rotated clockwise in order to open the four gates which block the chute. All gates are lifted simultaneously. The gates extend approximately 1.5 feet down the ramp, giving the player significant control over the potential energy of the ball.

The handle is easy to hold and turn. The player can place the ball directly behind the desired gate, or place it behind the top gate and briefly turn the release handle to let the ball fall down to the desired gate. At that point, he can then turn the release handle and let the ball roll down the chute.

Fig. 8.24. Client using the Boccia Ramp, with the ball resting on the top release gate.