CHAPTER 7
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UPPER BODY WORKOUT DEVICE

Designers: Olivia Chang, Rish Sinha, Kevin Story, Prashant Swaminathan
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INTRODUCTION

Our client is a 21- year-old man with cerebral palsy. He wants to exercise his upper body to gain strength and improve his range of motion. The Upper Body Workout Device consists of a steel frame with a cable and pulley system on each side, allowing him to exercise each arm individually. Forearm sleeves attach in three different positions to allow workouts targeting the biceps, triceps, and deltoid muscles. Resistance is varied using free weights. The device also includes a repetition counter to provide motivation and to track progress.

SUMMARY OF IMPACT

The Upper Body Workout Device enables the client to exercise either arm in three different ways, complimenting the lower body exercises he can perform using a previously constructed device. The client's mother commented, "The possible positive ramifications of this device are immeasurable."

TECHNICAL DESCRIPTION

The Upper Body Workout Device (Fig. 7.1) consists of a steel frame, two upper pulleys, two lower pulleys, two drawer glides, two weight platforms and weight poles, three sets of tension cables, two metal hooks, two forearm sleeves and a repetition counter.

The steel frame is constructed from 2.5"x1.5" steel tubing, and weighs 150 lbs. The frame is 72" tall, 40" wide, and 48" long. The frame is split in half at the top and bottom crossbeams, held together by two 24'' angle braces bolted at 8 locations on each brace. At the top crossbeam, two 1" square holes provide clearance for the tension cables.

Two 2" diameter pulleys reside at the top of the frame. Two additional 1.5" diameter pulleys mount on the vertical beams, 6" from the ground. Two 24" x 1.5" drawer glides are mounted on the outside of the vertical beams, 10" off the ground. Two 4.5" x 5"

Fig. 7.1. Upper Body Workout Device.

L-brackets attach to the drawer glides, each holding a 6" x 7" High Density Polyethylene platform to hold weights.

Solid aluminum rods, 6" long x 1" diameter, provide mounting pins to stabilize the weights, each having a circular hole in the center.

Vinyl-coated 1/8" steel tension cables secure to the top of the drawer glides. These main cables loop around the top of the frame, over the upper pulleys, and through the clearance holes. At the user-end of each cable is a loop, created using standard cable hardware. Two additional sets of 20" long cables are

used for the shoulder-fly exercises. Additionally, two 78″ tension cables are permanently looped through the lower pulleys for the bicep exercise. For the shoulder fly and bicep exercises, the appropriate cables attach to the main cable using karabiners.

The forearm sleeves are modified from Ossur brand 10″ Vinyl Wrist Cock-Ups Two nylon straps made from seat-belt material, sewn near the wrist area and forearm area of the brace, provide attachment points for quick-link threaded connectors, each 6.25″ long x 7/32″ diameter. These connectors attach to the ends of the appropriate cables using karabiners.

A repetition counter, consisting of a microcontroller, LCD display and magnetic sensors, provides the user with a count of the number of repetitions for each exercise.

Fig. 7.2 shows the client with the overall device. The cost of components of the device is about $1300, including the cost of welding ($500) and powder-coating ($250), both of which were donated.

The client is wearing a forearm sleeve, and the repetition counter is visible on the left vertical support.

Fig. 7.2. Client and designers with the device.

SUPPORTIVE PLAYGROUND VEHICLE

Designers: Vanessa Kennedy, Ming Li, Emily Liu, Allen Yu
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INTRODUCTION

Due to congenital myopathy, our three-year-old client has difficulty playing independently and interacting with her peers on the playground. She cannot hold her head and trunk upright without assistance, and has little strength in her extremities. The goal of this project is to design and develop a safe, supportive vehicle she can use to be more active on the playground. The vehicle has a four-wheeled frame that allows for ease of entry. Pedals drive the rear wheels, while the client handlebar steers the front wheels. The rear handlebar allows an assistant to help the client in propelling forward. The seat and seat pads are tailored to support the client safely and comfortably. With this vehicle, the client can have more fun and interaction on the playground.

SUMMARY OF IMPACT

The supportive playground vehicle allows the client to be more interactive with her peers on the playground. She exercises her arm and leg muscles while propelling herself forward with new independence. This vehicle provides both a means of therapy and child friendly fun for the client. The client's therapist commented, "The vehicle is … increasing peer interaction during recess activities and putting her at the same level as her peers. And of course, there is the overall effect of strengthening her mobility and muscles." The client exclaimed, "I can't believe it! Fantastic!"

TECHNICAL DESCRIPTION

The Supportive Playground Vehicle (Fig. 7.3) uses the frame, wheel, and gear system of the Kettler Kettcar Classic. A highly adapted seat made from the Graco Turbo Booster seat is attached to the frame. The vehicle also has a modified client handlebar, custom made pedals, and a detachable assistant handlebar.

Fig. 7.3. Supportive Playground Vehicle

The vehicle frame is appropriated from the Kettcar, a four-wheeled playground vehicle. The frame is made of durable, high-carbon steel and measures 22"x 21"x 37". The gear and chain system is fully enclosed in a protective plastic case, and the wheels feature a long-lasting dual-layer safety tread.

The supportive seat uses a modified Graco Turbo Booster seat. Additions include six removable cushions: two side thigh cushions, two side head supports, a lumbar support, and a cylindrical neck support. All cushions are upholstered in mildew and water-resistant vinyl, and are attached with Velcro for easy removal and adjustment. For added safety, the supportive seat also includes a custom seat belt made from nylon webbing. The seat belt is comprised of a lap belt and two shoulder straps, and is adjustable through plastic D-ring fasteners.

The client handlebar is made from a 2" long x ¾" diameter length of metal conduit, bent into an ergonomic shape for maximum comfort and ease of steering for the client. The client handlebar is covered in sweat-and-shock-resistant cork tape, making it easy to grip and preventing the user's hands from slipping off.

The assistant handlebar is made from a 7' length of ¾" metal conduit, bent in a U shape so an assistant can comfortably push the vehicle. Also covered in cork tape, the assistant handlebar is removable, allowing the client optional independent movement as well minimizing size for storage and transportation. The height of the bar adjusts using a spring-plunger system, accommodating assistants of different heights. The width of the assistant handlebar is 22.5 ", and the possible heights are 46", 48", and 50".

The pedals of the vehicle include an HDPE plastic base and a PVC heel cup, made from a 2" length of 4" diameter pipe cut, shaped and sanded. The pedal base measures 6.5" x 3.5", and the heel cup measures 2.5" in height. A second base piece connects the custom pedal to the original pedal by compression; two wing nuts allow for adjustment of the fore and aft position. Finally, the pedals feature Velcro-adjustable canvas straps, securing the user's feet to the plastic base. The replacement cost for the device is approximately $300, not including the cost of the Kettcar.

Fig. 7.4. Client and designers with the Supportive Playground Vehicle.

CUSTOM POWERED SCOOTER

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INTRODUCTION

Our client is an active eleven-year-old boy. He has Thrombocytopenia with Absent Radius (TAR) syndrome, resulting in short arms, and his legs have limited strength and flexibility. He requires a device that will assist him in traveling but not be as cumbersome and restrictive as his electric wheel chair. The Custom Powered Scooter includes a custom seat, handlebars, auxiliary wheels for stability, and foot-controlled accelerator and brakes. A custom freewheel allows him to free scoot when he doesn't need motor power. The device gives the client more freedom in transporting himself.

SUMMARY OF IMPACT

The Personalized Scooter allows our client to be more independent. After several months of use, his mother commented, "The scooter … has been very useful and helpful for [him]. We take it to the library, the movies, and to church. On his new scooter, he is able to explore, learn and not worry about his legs hurting or being tired. He is also able to go around the block with our family and enjoy the outdoors!"

TECHNICAL DESCRIPTION

The Custom Powered Scooter (Fig. 7.5) is modified from an E200 Razor electric scooter. Custom additions include a free-wheel mechanism, adjustable seat, auxiliary wheels, extended handlebar, and foot-mounted brake and accelerator controls.

A one-way bearing (model CKS20, www.vxr.com,) incorporated into the back wheel allows the scooter to free-scoot. Two custom adaptors, machined from aluminum, secure the bearing to the rear wheel with a press fit. One adapter connects the outer surface of the bearing to a sprocket driven by the motor, and the other adapter connects the inner surface of the bearing to the hub of the rear center wheel.

Fig. 7.5. Custom Powered Scooter.

A threaded stainless steel rod 10mm in diameter serves as a rear axle to mount two auxiliary 8" pneumatic tires. A support frame, made from a ¼" thick x 1" wide x 21" long strip of steel, attaches to both sides of the axle from the scooter frame to prevent flexing of the axle. Wheel guards, made from aluminum strips ¼"x1"x16.5" long, attach to the back axle and cover each of the auxiliary wheels, preventing inadvertent catching of the wheels on low objects.

A SchwinnTM No Pressure Bike Seat is attached to an aluminum plunger .995" in diameter and 1' long. The plunger is encased by a seat post and allows for 8" of height adjustment. The seat post is 1.25" in diameter at the base, 1" at the top, and 14" long. The seat post is secured to a plate on the scooter frame with a short, 3" long aluminum sleeve having a 2"

outer diameter and a 1.25″ inner diameter, which fits around and bolts to the base of the seat post.

The handbrake of the E200 was moved from the handlebars and is secured to the right side of a 20″ long, 7/8″diameter steel rod, attached to the front base of the scooter with a custom aluminum adapter. A plastic pedal allows the client to control the brake with his right foot. The hand throttle of the E200 was moved from the handlebars and secured to the left side of the steel rod. A plastic pedal allows the client to control the speed with his left foot.

Bicycle handlebars are bolted to a U-shaped bar attached to a handlebar stem. The handlebar stem fits into a 21.5″ long shaft of 1″ inner diameter bicycle tubing, which is welded to the neck of the scooter. Fig. 7.6 shows the client using the Custom Powered Scooter. The cost of the components for the device is approximately $380, not including the cost of the Razor E200.

Fig. 7.6. Client using the Custom Powered Scooter.

WHEELCHAIR-ATTACHED LAWN MOWER

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INTRODUCTION

Our client is a manual wheelchair user who wants to mow her own lawn. The goal of this project is to design a lightweight mower that can easily attach to her wheelchair. The design includes a plastic base with wheelchair attachments that allow the base to be suspended above the ground in front of the client's wheelchair without impeding the wheelchair's motion. Two cordless electric grass shearers attach to the base, providing a 12" cutting width. A switch in the upper attachment allows the client to easily turn the shearers on and off.

SUMMARY OF IMPACT

The device provides an even cut only on very smooth surfaces, because the shearers move up and down as the wheelchair travels over uneven terrain. Future work may consider a flexible suspension with a front wheel or wheels to help keep the shearers at a consistent height. Such devices were not considered because of concerns that they would make the front of the wheelchair too heavy for the client to "wheelie" as she desired for tight turns in her yard.

TECHNICAL DESCRIPTION

The main components of the Wheelchair Lawn Mower (Fig. 7.7) are the shearers, the base, the shearer-base mount, the support arms, the foot-bar hooks, and the L-bracket attachments. The commercial shearers (Homelite, model UT44170) weigh 2.1 pounds and have a battery life of about 1 hour.

The base is constructed from ½" thick high-density polyethylene (HDPE). The lateral length at the front is 19", and the width from front to back in the center is 11".

The shearer-base mount attaches the shearers to the base. A ½" threaded zinc rod (not shown) passes through existing holes in each shearer, and fastens into HDPE blocks, which attach to the base.

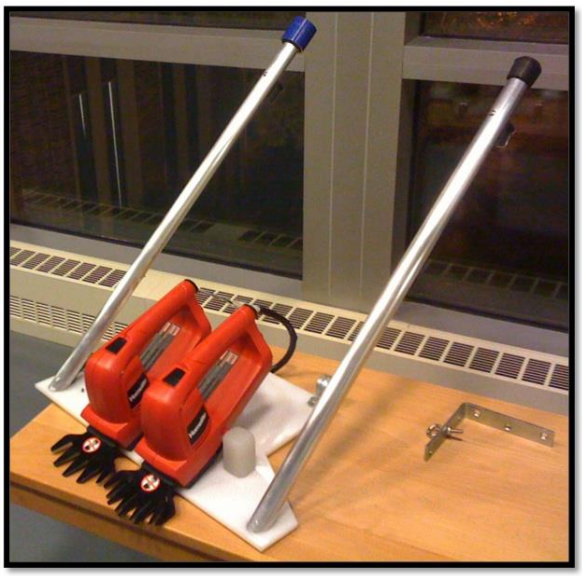

Fig. 7.7. Wheelchair-Attached Lawn Mower.

The support arms attach the base to the wheelchair near the seat. Constructed from 1" aluminum tubing, each support arm contains a solid aluminum rod press fit at the bottom end, which is threaded to provide a secure attachment to the base with a 3/8" bolt.

The device attaches to the footrest area of the wheelchair with two foot bar hooks, 1" diameter single-ended conduit clamps secured to the rear of the base with 3/8" bolts. The user slides these hooks over the footrest bar.

To hold the base up, the support arms connect to an L-bracket attachment on each side of the wheelchair. Each L-bracket attachment includes an eye bolt fastened to a 5'' x 1'' x 1/8'' L-bracket, one end of which slides into a slot below the seat. These slots are attached for a previous project. The eye of the bolt provides an attachment location for support arm hooks fastened to the upper ends of each

support arm. To mount the device, the user slides in the L-bracket attachments, puts the foot bar hooks over the footrest bar, and then puts the support arm hooks into the eye bolt ends.

The power switches for both shearers are wired in parallel, and the wires extended to the top of the right support arm, where a single toggle switch allows easy on/off control. The replacement cost for this device is approximately $200.

Fig. 7.8. Client using the device.

UNIVERSALLY ACCESSIBLE CONTACT CEMENT APPLICATOR

Designers: Ian Gong, Jing Guo, Mike Kotecki, David Tainter
Client Coordinators: Joe Bumgarner, Jamie Gills, OE Enterprises
Supervising Professor: Larry Bohs
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INTRODUCTION

The goal of this project is to create a device that enables employees with disabilities at OE Enterprises, Inc. to quickly and safely apply contact cement to pieces of foam insulation. Contact cement is used to glue foam pieces together to make insulation elbow joints. The Universally Accessible Contact Cement Applicator allows employees to swipe pieces of foam across a rotating roller to apply a thin, even layer of contact cement. The disposable roller is housed within a removable glue tray fabricated from high-density polyethylene. Glue trays housing either 9" or 4 ½" rollers can be inserted depending on the size of the foam pieces. A D-profile connection attaches the axle of the roller to a DC motor, which rotates the roller. The device makes the task of applying contact cement to foam pieces more accessible to a wide range of employees.

SUMMARY OF IMPACT

The device provides employees with a quick, easy, and safe way of applying contact cement to pieces of foam insulation. Replacing the former method of hand brushing, the device increases the accessibility of this employment opportunity. The adjustable glue scraper ensures that a desired amount of contact cement stays on the exposed part of the roller during use. Jamie Gillis, OE's Business Development Manager, reported that the device not only increased efficiency, but allowed clients who could not previously perform the task to do so. One OE client, after using the device, said "That's a real good unit. I like that much better than brushing."

TECHNICAL DESCRIPTION

The Contact Cement Applicator is comprised of a base, glue trays, roller mechanism, glue scraper, and drive motor. The base, constructed from ½" High Density Polyethylene (HDPE) includes vertical side walls that house the glue trays. Rubber feet on the bottom of the base prevent movement as the client exerts forces during use. HDPE withstands the solvents in both the contact cement and the lacquer thinner used for cleaning.

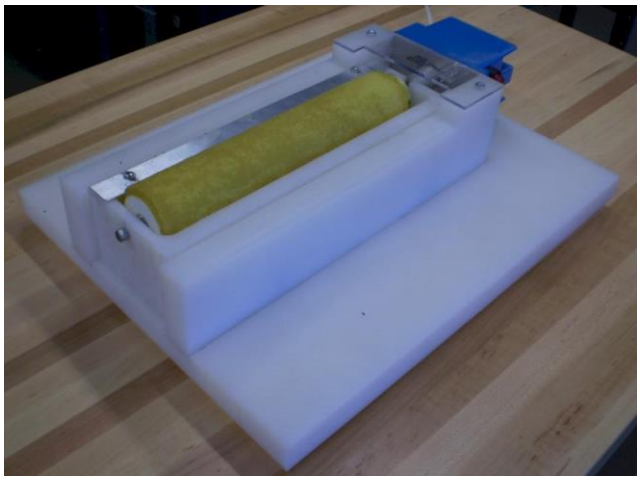

Fig. 7.9. Universally Accessible Contact Cement Applicator

Two HDPE glue trays are included, one for a 9" roller, and the other for a 4.5" roller, to help conserve glue on narrower pieces of foam. Holes on either end of the glue trays accommodate the roller axle, allowing the roller to rest just above the bottom of the glue tray.

The roller mechanism includes the roller axle, onto which a commercial glue roller slides. At one end of the roller axle, a D-profile connector allows the axle to mate easily with the shaft of the drive motor. An adjustable scraper, made of sheet aluminum, mounts to the edge of one of the base side walls to remove excess glue from the roller.

The drive motor is a 12V DC gear motor that runs at a speed of 6.8rpm. An insulating electrical box

houses the motor. An LED switch attached to the box exterior provides easy on/off control, and a DC wall adapter supplies power to the motor.

A clear protective plate over the D-profile connector prevents injury due to moving parts, and maintains visibility for aligning the D-profile connector and the motor shaft.

The device is designed for easy cleaning. The glue tray can be detached from the frame and electrical components of the device and submerged in lacquer thinner. After 30-60 minutes, the supervisor can then clean the glue tray with stripping gloves and a metal-bristled brush. The roller can easily be removed and discarded after each day's use. The cost of parts for the device is approximately $150.

Fig. 7.10. Client using device.

INTERACTIVE DELIVERY CART

Designers: Anumeha Goel, Linda Qu, Karen Schroeder, Alaina Pleatman
Client Coordinator: Susan Parker, PT, Durham County Schools
Supervising Professor: Dr. Larry Bohs
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INTRODUCTION

Elementary school students with disabilities often have difficulty interacting with teachers and other children due to cognitive and physical limitations. The goal of this project is to design a delivery cart that serves as both a learning and therapeutic tool, providing a safe, customized, and fun device from which the students learn to assume responsibility and practice essential skills. Students make deliveries of items such as newspapers to other people and classrooms throughout the school. Key features include color-coded bins, left-right signaling, braking, and handle height adjustment. The delivery cart is a unique resource in a special needs classroom and equips children to integrate work and social environments as they grow older.

SUMMARY OF IMPACT

The delivery cart is a unique therapeutic device for elementary school students with disabilities, helping to promote motor skills as well as work ethic and responsibility. It is accessible to students with a wide range of ages and physical abilities. The design is safe, adaptable, and interactive, allowing teachers and therapists to gradually add accessories as students develop their cognitive and motor skills. Our supervisor commented, "Because the device was made for several targeted children it will certainly benefit them, but I am very pleased that it can benefit multiple users, even in the future. It's wonderful for teaching a multi-step task, in that some steps can be added or eliminated commensurate with the child's skill level."

TECHNICAL DESCRIPTION

The main components of the Interactive Delivery Cart are a height-adjustable handle, hand brakes, dashboard for holding a communication device and task cards, color-coded bins, turn signals, a base for additional storage, tip-stoppers and wheelchair adaptation accessories. The cart is modified from a commercial shopping cart.

Fig. 7.11. Interactive Delivery Cart

The custom-bent handlebar adjusts in height for use by both children and adults. Knob screws on either side loosen and tighten the vertical supports to slide the handle to the desired position. Tennis grip tape allows for a comfortable grasp.

Hand brakes, modified from commercial walker brakes, allow users to slow themselves down when moving on uneven surfaces or downhill. The brake handles are secured to the left and right undersides of the handlebar, and are squeezed to engage the rubber-coated brake friction levers, which are mounted near each rear wheel.

The dashboard is constructed of 0.125" thick acrylic and features a ledge to hold the student's communication device. A Velcro strip directly above the communication device displays task cards corresponding to the color-coded individual bins; these cards may be selected from the task card binder. The dashboard is securely supported on the back wall of the cart's large basket.

Color-coded bins, lined with colored felt, allow children to learn and distinguish between various colors in association with the delivery tasks. The

bins are easily removed according to the teacher or supervisor's preference. Red vinyl covering the cart sides makes the design more aesthetically pleasing and reduces sharp corners.

The base is constructed from 0.25" clear acrylic and is useful for additional or bulky item storage. The front edge curves upward as a ledge to prevent items stored on the base from falling. Tip-stoppers attached to the front corners of the cart frame normally ride 1/8" above the ground, but make contact if the cart is tipped laterally.

To help reinforce the concept of left and right, a custom circuit voices a recorded message, "Turning left" or "Turning Right", as well as lighting one of two turn signals as the cart makes a turn. The circuit detects the rotation of the front center wheel with reed relays and a magnet using an ATTiny2313 microcontroller. It is powered by a 9V battery. Replacement cost is about $240.

Fig. 7.12. Client using the Interactive Delivery Vehicle.

BIRDIE BUDDY – WHEELCHAIR MOUNTED CAMERA AND BINOCULARS

Designers: Kaicheng Liang, Shaun Lim, Xuan Ding, Claire Vinson
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INTRODUCTION

Our client, an avid photographer and birdwatcher with quadriplegia, desires a way to hold his camera and binoculars steady. The Birdie Buddy clamps securely to a bar on the wheelchair base frame, unfolds from a compact form on the side of the wheelchair and holds a camera or binoculars at eye level. The device can be conveniently activated, stored, or removed from the wheelchair. The device provides firm support of the weight of the camera or binoculars, convenient switching between the two pieces of equipment, and an adjustable viewing angle.

SUMMARY OF IMPACT

The Birdie Buddy gives our client greater independence. Before his accident, he was an avid birdwatcher and photographer. He commented, "It allows me to independently load my binoculars or camera on a tripod of sorts, which mounts to my chair. The device is flexible enough in that it allows me many different angles for viewing ... this device is a wonderful item that now greatly enhances the enjoyment of bird watching! ... I love it!"

TECHNICAL DESCRIPTION

The Birdie Buddy is composed of four parts including a hinged clamp, which is affixed to the left side of the client's wheelchair, a moving arm, a camera mount and a binoculars mount. The clamp makes use of a curved surface as well as an L-plate to ensure a stable connection between the wheelchair base and the rest of the device. The clamp secures to the wheelchair frame with a single four-arm knob screw.

The moving arm lifts upward and rotates, providing resting and viewing positions. The mechanism involves a grooved cylinder, within which a solid rod with a set screw moves. The groove guides the movement of the solid rod, such that the user lifts and rotates from the resting to the viewing position. The bottom of the arm contains a protruding set screw which keys into a corresponding slot in the base, fixing its orientation. A horizontal member at the top of the moving arm contains a vertical hole that accepts either the camera or binoculars mount.

Fig. 7.13. Birdie Buddy with binoculars attached to client's wheelchair.

Both the camera and binoculars mounts use a modified microphone stand hinge mounted to a solid aluminum pin. To use the device, the user slides the pin into the corresponding hole in the horizontal member, and rotates the hinge to obtain the desired viewing angle. Friction within the hinge holds the camera or binoculars steady. The cost of parts is approximately $230.

Fig. 7.14.The client using the camera with the Birdie Buddy.

WHEELCHAIR LAWNMOWER

Designers: Shwetadwip Chowdhury, Shekar Eswarakrishnan, Wei Han, Xiao Li
Client Coordinators: Pam Duncan
Supervising Professors: Kevin Caves and Richard Goldberg
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INTRODUCTION

Rhonda is an avid gardener and enjoys working outside, tending her garden and lawn. Several years ago, she sustained a spinal cord injury and as a result, she now relies on a manual wheelchair for mobility. She cannot push a lawn mower and push her wheelchair at the same time and has to ask for help or pay someone to maintain her lawn. She has good upper body strength and can propel her chair throughout her yard, and she is highly motivated to be independent again with lawn care.

The purpose of this project is to enable our client to mow her lawn independently, efficiently, and safely, while sitting in her wheelchair. To accomplish this task, a string line trimmer is modified with operation similar to using an upright vacuum cleaner, pushing and pulling with one arm. A mount is added to the client's wheelchair so that she can easily transport the mower to and from her shed. The overall design is effective in allowing our client to mow her lawn independently and efficiently.

SUMMARY OF IMPACT

This device gives our client the ability to mow her grass, which she has not been able to do since her spinal cord injury. It also enables her to do an activity that she has always loved and enjoyed. Our client said "I am so excited about this mower. When I was walking, I used to love mowing my grass. Now I can do it again. My yard is my haven - this will be perfect!"

TECHNICAL DESCRIPTION

The design consists of three major components including a string line trimmer, wheels to provide support and mobility, and a mounting device to secure the trimmer on the wheelchair.

A commercially available trimmer (Worx GT String Trimmer/Edger) is chosen because of its high capacity, lightweight lithium battery and its adjustability. The trimmer has an extendable shaft and a rotating joint that allows adjustment of the angle of the handle relative to the cutting head. A locking mechanism is removed from the joint to allow free motion of the handle (e.g. like an upright vacuum cleaner) to ensure the string remains level while cutting.

Fig. 7.15. Client lifting the lawn mower device.

Support and mobility is achieved by attaching wheels to the string trimmer. The weight is supported by the two large wheels on either side of the cutting head. In addition, a pair of small wheels is attached directly behind the trimmer to provide additional points of contact with the ground so that the cutting head remains level. The side wheels are adapted from a pull cart for golf bags, and they are attached to the trimmer by a custom connector fabricated from HDPE plastic. The rear wheels are attached to the trimmer's edging guard.

A mower mount is connected to the front of the client's wheelchair to hold the mower while Rhonda moves to different locations in her yard, or to and from her storage shed. This "gun rack" mount is

created using PVC tubing, which connects to the wheelchair using a custom mounting bracket developed for a previous project.

The cost to develop the device is $296, including the cost of the Worx string trimmer.

Fig. 7.16. Client using the lawn mower while sitting in her manual wheelchair.

WALK IT OUT

Designers: Ellie Hwang, Soo Choi, Laura Ferraro
Client Coordinators: Kyle Covington, PT
Supervising Professors: Kevin Caves and Richard Goldberg
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INTRODUCTION

Regina is a 21 year old female who sustained a traumatic brain injury at a young age. She has trouble coordinating her muscles and she has significant spasticity in her movements. As a result, Regina uses a manual wheelchair for mobility, but she is currently working with a therapist to use a walker. She has several types of walkers but they all are difficult to use because as she leans onto the walker for support, it moves away from her, putting her at risk of falling. In addition, Regina has several postural problems that make using a walker difficult. In therapy sessions, two individuals are required to help Regina walk, one to spot her to prevent a backward fall, the other to apply a stopping force to the walker if it lunges forward.

The goal of this project is to modify a walker for Regina to provide her with safe and independent use. The modified walker incorporates a new handlebar, a ski brake for resistance, a reminder bar for her posture and a walking bar for inhibiting crossing of her legs. When the client uses the modified walker, she holds a handle bar directly facing her, similar to that of a shopping cart. As she walks forward and applies downward force on the bar, the braking system activates and increases the stopping resistance on the walker. This successfully slows the client down, prevents her from falling forward, and allows her to walk independently. Meanwhile, the posture bar corrects the client's posture by preventing her hips from moving too far forward. Overall these changes help her use the walker independently.

SUMMARY OF IMPACT

The client commented "I can't wait to use my new and improved walker. It will be so nice to walk around without someone (Mom) hanging on to my walker so it doesn't go crashing into something because I can't control it. I am hoping that I will be able to get up and walk across the room with no help. I like how you made the walker slow down so it doesn't go out-of-control fast. I like that I can just stand there so I don't always have to sit down. It will make my legs stronger. I really want to thank you for putting so much work into it, and not giving up when it didn't work at first."

Fig. 7.17. Modified Walker

TECHNICAL DESCRIPTION

The client's commercially available U-Step walker is used, which employs a handlebar cable braking system. The brakes work in a manner similar to bicycle brakes. The client activates a brake lever, which pulls on a cable and causes a brake pad to press against the rear wheels on the walker, which slows it down. The brake cables on the U-step meet at the front of the walker at a joint called the junction bar. When she activates either hand brake, the cable pulls the junction bar which rotates and activates

both brake pads. The client can also activate the brakes by pushing down on a curved bar across the front of the walker. This existing bar has a gentle curve which does not allow Regina to spread her hands widely on the bar. Therefore, a new braking bar that is ergonomically more suitable for the client is included, providing a wider grip for Regina to give her more stability. The bar is padded using foam and bike grip tape.

When the client presses either the brake lever or the braking bar, brakes will be applied to both rear wheels. However, the braking force is not enough to prevent the lunging of the walker for our client. As a result, a ski brake is included to apply additional braking force. This is made of wood with cushion on the bottom to provide more friction. It rests on the floor and is attached to the front of the walker. A new junction bar is fabricated with an additional metal lever that runs to the top of the ski brake. When the client engages the brakes, the junction bar rotates and the lever presses down on the top of the ski brake, increasing the downward force on the ski, thus increasing the braking force to the walker.

Two postural bars are incorporated into the modified walker. A pelvic reminder bar is attached to the walker in front of Regina facing her hips. During walking, Regina tends to arch her back and push her hips forward, making her prone to falls. The reminder bar is positioned so that if Regina's hips move forward, the contact with the bar will remind her to correct her posture. Similarly, the walking bar is positioned horizontally at knee level, connected to the back of the walker, passing between her knees and continuing about two feet past her. The walking bar provides a tactile reminder to Regina to not internally rotate her legs.

The modified walker has greatly improved the client's ability to walk independently. The new braking system successfully slows down the walker before it slides forward, and it is easy for the client to use effectively. The posture bars improve Regina's walking postures leading to a noticeable improvement in the client's balance and ability to steer the walker.

The cost to develop the device is $153.

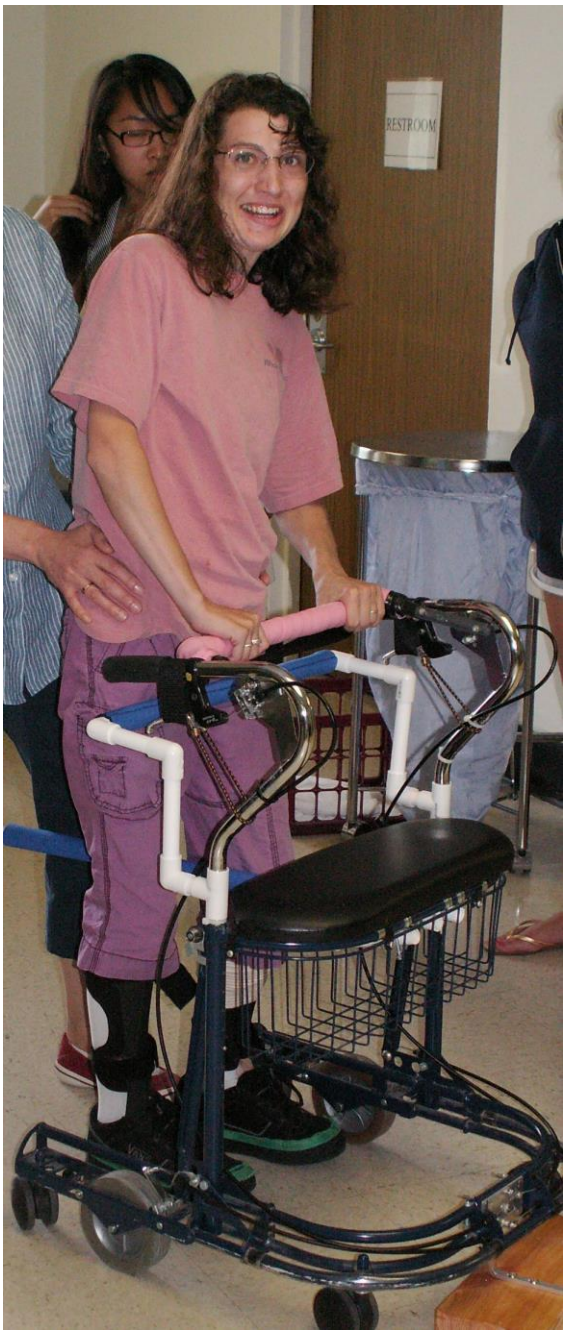

Fig. 7.18. Client using the modified walker.

ROCK'N ROLLER

Designers: Manny Fanarjian, Doug Giannantonio, and Michael Kramarz
Client Coordinators: Nancy Hoopingarner, PT, Lachanda Black
Supervising Professors: Kevin Caves and Richard Goldberg
Department of Biomedical Engineering
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INTRODUCTION

Jill is a high school student with shaken baby syndrome (SBS) that has resulted in severe cognitive, visual and physical disabilities. She is unable to speak and, due to poor muscle coordination, only has voluntary control of her head and right hand. She enjoys both movement and listening to music but cannot currently perform either of these tasks independently. Jill spends most of her day sitting in a manual wheelchair that she cannot propel herself. While the teachers take Jill on walks as often as possible, they simply do not have enough time to dedicate to her, due to the other students in the classroom that also need their attention.

The goal of the Rock'n Roller is to allow our client to experience motion and music as independently as possible. The device consists of a motorized platform onto which Jill's chair is loaded and secured. The platform gently slides back and forth along a drawer slide track for a distance of 10 inches. Jill can access a switch adapted MP3 player loaded with 101 of her favorite songs. The MP3 player and the platform motor are controlled by two separate switches, which can be mounted in our client's reach, using either her head or right hand. The overall design is able to support a large amount of weight, can be stored in the cramped classroom, and is easily transported by one person.

SUMMARY OF IMPACT

The device is designed to make our client's time at school more enjoyable. Our project advisor is "very impressed" with its functionality, our client's teacher said that she is "extremely excited to use this device with [our client]." During the final delivery of the completed device, Jill repeatedly screamed with joy. Her classroom teacher reports that this was a rare display from Jill and that she appeared to be extremely happy while using the device.

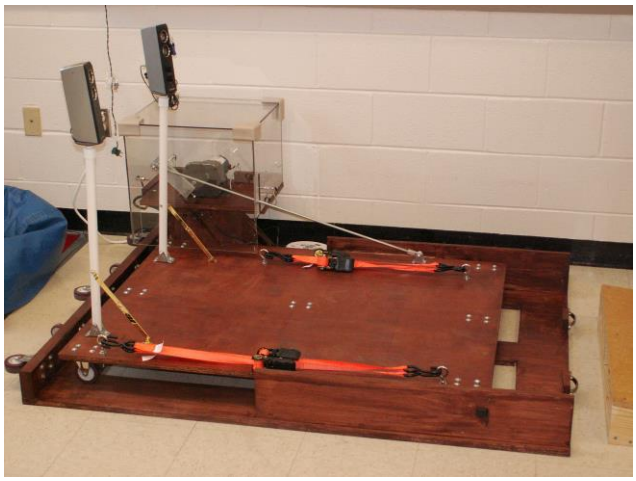

Fig. 7.19. Wheelchair Rock'n Roller.

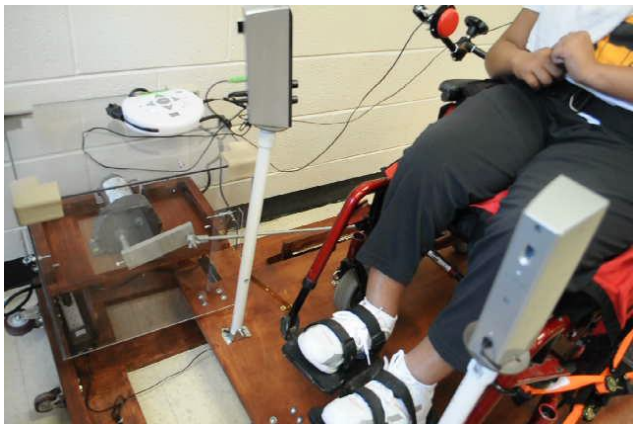

Fig. 7.20. Close up of the platform and motor.

TECHNICAL DESCRIPTION

The Rock'n Roller has three major components. The platform and base are made from a sheet of 3/4" birch veneer plywood, chosen for its strength and appearance. The top platform rolls on a set of nine two inch castors. The platform is guided via two 24 inch full extension drawer slides that also serve to keep the platform in place while transporting it. The

motor is a 12V, 6.5 amp gear motor capable of generating 45 ft-lbs of torque. A custom motor shaft attachment is included and a three foot rod connects the motor shaft to the top of the platform. As the motor turns at 6 rpm, the shaft attachment makes a 10 inch diameter rotation, which the rod translates into ten inches of linear movement of the top platform. The motor and shaft attachment are covered with a clear acrylic box to prevent injury but to still allow observation by other students. Biscuit jointing is used throughout to provide a professional appearance and durable connection. An Ablenet Powerlink controller enables Jill to control the device operation through switch activation.

The platform comes with a three foot loading ramp, so that teachers and aides can easily transfer Jill's wheelchair on and off the platform. Once in place, the chair is secured using four commercially available cargo tie downs connected to each of fouir eyelets bolted to the platform surface. All materials and attachments methods are engineered with significant factors of safety.

The system employs a switch adapted MP3 player that allows Jill to advance to the next song when she presses a switch. The MP3 player is connected to amplified speakers attached to custom folding mounts. These mounts position the speakers in front of Jill so that she can hear her music without disrupting the other students in the class.

The cost to develop the device is $487.

Fig. 7.21. Client using the Rock'n Roller device.

PICASSO'S ASSISTANT: ADJUSTABLE EASEL AND MARKER HOLDER

Designers: Doug Helferich, Nissar Ahmed, and Sushma Reddy
Client Coordinator: Nancy Hoopingarner, PT
Supervising Professor: Kevin Caves and Richard Goldberg
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INTRODUCTION

Our client is an artistic high school student with cerebral palsy (CP), who enjoys drawing with markers. However she has severe contractures in her fingers, which makes it difficult for her to grasp and release marker pens when desired. Every time she needs a new marker, a teacher or aide manually opens her fingers and places a marker in her hand. Also, her range of motion is limited, and as a result, she can only access a portion of the drawing surface.

An adjustable easel that fits on her lap tray is designed in this project. The drawing surface rotates and has an adjustable tilt angle. The client can rotate the surface independently. A teacher or aide can adjust the tilt angle, although once the optimal angle is set, adjustments will be rare. The device also includes a marker holder so that she can access up to eight different markers. She can slide the marker holder out of the way when desired.

SUMMARY OF IMPACT

The client tested prototypes and provided feedback throughout the project development to insure that the device would meet her needs. Her teacher said that "the device has allowed [the client] to be more independent with her drawing" and that she is "really excited when she gets to use it."

TECHNICAL DESCRIPTION

The easel consists of a stable base and an adjustable drawing surface, both of which are made of furniture grade plywood. The top surface is mounted to a backing using a lazy Susan, which allows the surface to rotate relative to the backing. The plywood backing is connected to the base with a hinge along the front edge. Several adjustments are possible. The drawing surface is 14" x 20" and the client can access about half of this area at any one time. By rotating the top surface, the client can position any part of the paper within her range for drawing. By tilting the easel surface, the teacher or aide can adjust it to the ideal drawing angle for the client. There is a latching mechanism to hold it at an appropriate angle. This consists of a wooden post that is hinged to the center of the backing, and it fits into one of six slots on the base, allowing for six different angle adjustments.

Fig. 7.22. The client with her adjustable easel resting on her lap tray.

The drawing surface has two large clips on the left and right sides to hold the paper, notebook, or pad in place.

The marker holder allows the client to independently access any one of eight markers. Initially, the teacher or aide loads the markers, with the caps removed. The client can remove and replace the markers at any time. The holder is an enclosed box made of acrylic. The top plate has eight holes, spaced one inch apart and in a single row. On the inside of the box, the bottom plate is covered with a layer of Spenco (Spenco Medical Corporation, Waco, TX) to keep the marker tips from drying out.

When placing a marker in the holder, the client has a difficult time letting go of the marker. As a result, some resistance is needed to keep the marker in place as she tries to release it from her hand. This is accomplished by putting a layer of foam material underneath the top plate of the holder. The foam has holes that are slightly smaller than those of the acrylic, providing a snug fit for the markers. This resistance is great enough to help her let go of the markers when replacing them, but not so great that it is difficult for her to remove them from the holder when desired.

For the client to access the marker holder, the ideal location is directly in front of the easel. However, it is then in the way of her drawing. Therefore, a mechanism is included that assists the client in sliding it out of the way. The marker holder connects to custom wood mount in the shape of an elongated letter "C". This attaches to a drawer slide that is connected to the base of the easel. There is a handle on the end of the wood mount, and the client can grab this handle and move the marker holder left and right as necessary.

The total cost of the device is $83.

Fig. 7.23. The client drawing, using her easel and marker holder

ADAPTED GARDEN TOOLS FOR A CHILD WITH TAR SYNDROME

Designers: Christopher Kobe, Matthew Baron, and Kalen Riley
Client Coordinator: Anne Stanton, OT
Supervising Professor: Kevin Caves and Richard Goldberg
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INTRODUCTION

Our client is an active, resourceful, intelligent twelve year old boy. He was born with a rare genetic condition called TAR (thrombocytopenia with absent radius) Syndrome. In addition to missing a radius bone in his forearm, our client has a shortened humerus and an immobilized right knee and left ankle joint. As a result, he has restricted movement of his extremities, resulting in limited grip, reach, strength, and mobility. In addition, our client quickly fatigues after standing up for a short period.

Our client is interested in gardening, but it is difficult for him to independently maintain a garden due to his physical limitations. Our goal is to develop custom tools and equipment that enable him to perform all of the desired gardening tasks. Conventional and ergonomic tools available on the market do not adequately satisfy our client's needs. In his past gardening experiences with store-bought tools, he was not able to generate enough force to manipulate the soil. As a result, he requires custom tools to accomplish tasks needed for gardening.

STATEMENT OF IMPACT

Our custom tools take advantage of the client's core and lower body strength as well as the dexterity in his feet. The tools enable him to effectively and easily carry out necessary gardening tasks, such as raking, shoveling, and manipulating the soil, so that he can plant and harvest crops. Perhaps most important, these tools are enjoyable for our client to use and have increased his interested in and passion for gardening. The client said that the tools "will help me grow foods that I like and have given me something to do independently that I enjoy and can have fun doing".

Fig. 7.24. The custom gardening tools. From top to bottom: the working end of the weeding tool, shoe tool for raking, integrated body-rod with hoeing tool.

TECHNICAL DESCRIPTION

The overall design of this project includes three types of devices including a weeding rod, a tool attachment to the client's shoe, and an integrated body-rod with tool. These three tools can be used to collectively fill all roles of maintaining a garden. The client can use the rod for weeding, the shoe attachment for digging and raking, and the integrated body-rod for hoeing.

The weeding rod enables the client to remove weeds from the garden. It consists of a rod that is attached to a conventional, hand-held weeding tool at its working end. The rod is 4.5 feet long, has a 0.625 inch diameter, and is made of aluminum. To attach the rod to the weeding tool, a connector rod of ½ inch diameter and 8 inches in length is included, also made of aluminum. The weeding tool inserts into a bored-out portion of the connector (diameter of ½ inch matches hollow tool rod inner diameter of ½ inch), and two bolts are added for increased strength. The other end of the connector is solid, and it is co-welded to the main rod for a secure fit. To use this tool, the client holds the rod against his body and drives the tool into weed-ridden soil. A foot peg is attached near the working end to help in directing and driving the tool. This peg is a ½ inch diameter aluminum rod that is bolted onto a set screw collar, which is then secured to the rod. The client uses his foot to help move the working end up and down to displace weeds.

The client uses the shoe tool for raking and shoveling soil. The base structure is a commercial bike pedal with a toe clip. This connects to a metal tool, either a small rake or shovel, which is adapted from a conventional store-bought tool and inserted into a metal connecting block under the pedal. The connecting block is made from an aluminum plate and milled into a T shape. The tool inserts into the bottom end of the "T", and the flat end of the connector is bolted to the front of the bike pedal. The toe clip is also bolted onto the pedal and it secures the client's shoe to the device. For securing these connections, there are set screws inserted through the "T" connector and into milled slots on the tool. A fender washer holds the top, flat surface of the toe clip so that it does not flex up when used. To use this tool, the client slips his foot into the attached shoe pedal and performs the task while seated.

Fig. 7.25. The client using the integrated body-rod tool for hoeing.

The integrated body rod combines characteristics of both previous devices.

It incorporates a hoe that is harvested from a store-bought tool, a "J" shaped rod that wraps around the client's back, and a foot peg attached to the rod that enables the client to generate extra force with his foot. A rectangular connection device is inserted into the hoe tool head and screwed on. This is then connected to the rod by two bolts. The opposing end of the rod has a padded brace made by bending the end of the metal rod to mold around the client's back and neck. This allows the client to pull back on the device to assist in action. An arm brace is positioned perpendicular to the rod and angled towards the client's body to allow him to stabilize the device. This is constructed from ½ inch aluminum rod that is bolted onto a set screw collar, which is then secured to the rod. This design allows the body-rod to be free of any deformation from connection devices and maintain its structural integrity. To use this tool, the client sits on a stool, grasps the rod and inserts his foot into the toe clip, and uses his entire body to assist in hoeing.

The overall cost of these devices is $328.

COMBINATION SEED DISPENSER AND PLANTING MECHANISM

Designers: Robert Dodson, Dongwoon Hyun, and Victor Lieu
Client Coordinator: Kimi Dew
Supervising Professor: Kevin Caves and Richard Goldberg
Department of Biomedical Engineering
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INTRODUCTION

Our clients are a number of individuals who require assistance in a greenhouse at Goodwill Industries. They perform a variety of tasks involved in planting and growing crops, and Goodwill donates the resulting produce to the Food Bank of Central and Eastern North Carolina. The clients have either developmental disabilities or traumatic brain injuries, involving both cognitive and physical issues.

The staff at Goodwill Industries requires a system to help the clients with planting seeds. The clients plant seeds in flats, consisting of 12 trays of 2x2 cells for a total of 48 cells per flat. Each client seeds two to three flats per day, so the number of seeds planted is quite extensive. The seeds are small and difficult to discern from the soil. The disabilities of our clients result in difficulties with perception, dexterity, and focus. The current method has staff members spreading seeds on a Styrofoam plate. The clients then push the seeds off of the plate, and into the cells. However, this method is imprecise and tedious. Depending on the client, they have trouble with one or more of the following tasks: picking up the seeds, planting only one to two seeds per cell, and keeping track of which cells have already been seeded. No current solution covers the entire breadth of needs for the clients. Handheld seeders are available but often require greater dexterity than is available by our clients. In addition, they fail to guide the clients so they can keep track of which cells they have already seeded. Our system needs to help our clients with the seeding task, while also providing them with a sense of independence.

SUMMARY OF IMPACT

The combination seed dispenser and planting mechanism helps employees at Goodwill Industries to focus on and complete their task of planting seeds, while reducing frustration and fatigue. It makes the experience of planting seeds enjoyable. The Goodwill Nature Center Coordinator, Kimi Dew, was pleased with the outcome of our project, and particularly liked the bright colors of the neoprene, which significantly improved the contrast between the seeds and their background. She stated: "Our participants have developmental and physical disabilities, which limits accuracy when we

Fig. 7.26. Client is using her finger to push the seeds through the valves into the cells below (top); Client is using the seed dispenser to place seeds onto template (bottom).

are seeding. It also makes seeding frustrating for the participant and the facilitator because of overuse of seeds and inaccuracy. The template seeder and dispenser were devised to help the participant partake in a detailed activity with accuracy and success, while allowing them independence. It also works for a variety of seed sizes and a variety of disabilities and is appealing by texture and visual stimulation. I am very happy with the project and the ease of operation and function."

TECHNICAL DESCRIPTION

Our final design is composed of two main components. One is a template that the clients place over the seed flat. It is exchangeable between flats. The second part is the seed dispenser. It requires some setup by the Goodwill staff, and dispenses only a few seeds at a time.

The purpose of the template is to show the client the locations of each seed cell. They load the template with seeds, and then push them through to seed cells below. Each template is composed of two 11"x22" sheets of acrylic, with a sheet of colored neoprene sandwiched in between them. The three layers of the template are connected together using 8 bolts and nuts. The acrylic sheets have a 12x4 pattern of 1" diameter holes that line up over each of the 48 seeding cells. There are also diaphragm valves cut into the neoprene sheets under each hole in the acrylic. The diaphragm valve is an "X" shaped slit, which will hold the seed until it can be recognized by the client, who then pushes it through the valve into the cell. The neoprene then reverts back, closing the valve. Acrylic L-brackets are glued onto the edges of the template so that it stays in the proper position over the flat.

The clients can use the custom seed dispensers to distribute one to two seeds onto each hole in the template. Its operation and appearance is similar to that of a syringe. It is made of a PVC pipe cut lengthwise in half, with a loading hole drilled in on one side. A cut with a length of 0.2" thick acrylic and with width equal to the outer diameter of the PVC, and cut a 0.1" deep groove into one end (called the dispensing end) are made. The PVC is glued to the top of the acrylic strip with the groove sticking out. This is called the loading chamber. A cut with length of 0.1" thick acrylic, called the slide, is then made with width equal to the inner diameter of the PVC pipe. A hole is drilled on one end of the slide, with hole size dependent on the size of the seed to be planted. A small piece of plastic is glued on that same end of the slide to act as a stopper. The other end is slid up through the loading chamber. A semicircle of 0.2" acrylic is glued onto the pipe on the dispensing end so that there is not a gap between the slide and the semicircle. The same is done on the other end. Finally, a small spring and a rubber stop are placed onto the other end of the slide to form the plunger. Seeds are loaded into the loading chamber through the large hole, and a stopper is placed into the hole to prevent seeds from coming out. The client uses the seed dispenser by placing the guide in the hole and pressing down the plunger. After every hole in the template is seeded, the clients poke the seeds through the valves using their fingers.

Fig. 7.27. Three clients using templates, one of them in conjunction with the seed dispenser.