CHAPTER 9
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PATIENT-NURSE SUPPLEMENTAL CALL SYSTEM

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Client Coordinators: Margot Ballina, Denise Chetta
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INTRODUCTION

Current commercially available nurse call devices have limitations when used by patients with various disabilities. Call and control buttons are typically small and difficult to read, rendering them prone to incorrect selection, particularly for the elderly or for patients with motor impairment. Further, call systems typically require a verbal response from the patient, which can slow care for those with speech impairment, either pathologic or iatrogenic as with patients experiencing tracheotomy. The purpose of this project is to develop a supplemental communication system to augment the ability of patients to communicate with nursing staff. The device consists of a sealed plastic housing with eight large buttons on the display panel, each associated with a specific audible request (Figure 9.1). Easily visible icons and large text fonts are printed on the button faces. The assembly includes a caddy for the existing hand-held call control, and is rigidly mounted to a fully adjustable bedside stand.

SUMMARY OF IMPACT

The Patient-Nurse Supplemental Call System enables patients with a reduced ability to talk over typical hospital room intercoms to communicate effectively with nursing staff by selecting custom, pre-recorded responses and requests. It works seamlessly with the existing call system. Assessment by the clients is positive. They believe that the device will facilitate more effective care, and further evaluation is currently underway to develop this device, with the goal of producing a number of units for delivery.

TECHNICAL DESCRIPTION

The Patient-Nurse Supplemental Call System consists of a "voice box" made of a 14" x 6" x 3" plastic case with eight large push buttons and a speaker. The buttons are labeled with large-type words or symbols representing customized pre-recorded audible responses. In the current

Fig. 9.1. The front view of the patient-nurse supplemental call system showing the large button display and hand-held call control caddy.

configuration, the responses are: Food/Water, Need Medication, Pain, Breathing Problems, Emergency, Bathroom, Yes, and No. The buttons consist of a single custom-molded silicone elastomer sheet mounted under the front panel of the case with eight 1.5" diameter disks (overlying eight momentary contact switches) protruding through the box. Each button/switch circuit plays a separate phrase. An aluminum caddy is fixed to the side of the voice box and serves as a holder for a standard commercial Executone nurse call device. The entire assembly is attached to a bedside stand modified to enhance stability in order to minimize motion of the assembly when the response buttons are pressed.

All electronics are powered by a 9VDC wall adaptor power supply, internally regulated to 5VDC. The voice box contains an Arduino Diecimila microcontroller board connected to a vinculum VMusic2 player (Figure 9.2). The Arduino board is programmed in C, via a USB connection, to permit the VMusic2 module to locate and play a MP3 file when one of the momentary switches fixed to a response button is closed. Each switch activates one of the pre-recorded tracks stored as separate files on a USB flash drive that is inserted into the VMusic2 module. An audio cable connects the VMusic player to a RadioShack speaker located in close proximity to the microphone of the Executone nurse call device placed in the caddy.

A two-way switch is mounted on the side of the voice box and is connected to the Arduino input to permit selection of the gender of the pre-recorded voice. A nurse can reset the device using a momentary switch that is mounted into the back of the box. A cover protects the switch and seals everything but the Executone device. Two hinges hold an acrylic bar in place above the Executone nurse call button and the voice box on/off switch so that both systems activate simultaneously when the patient presses the bar.

Total project cost: $698.00.

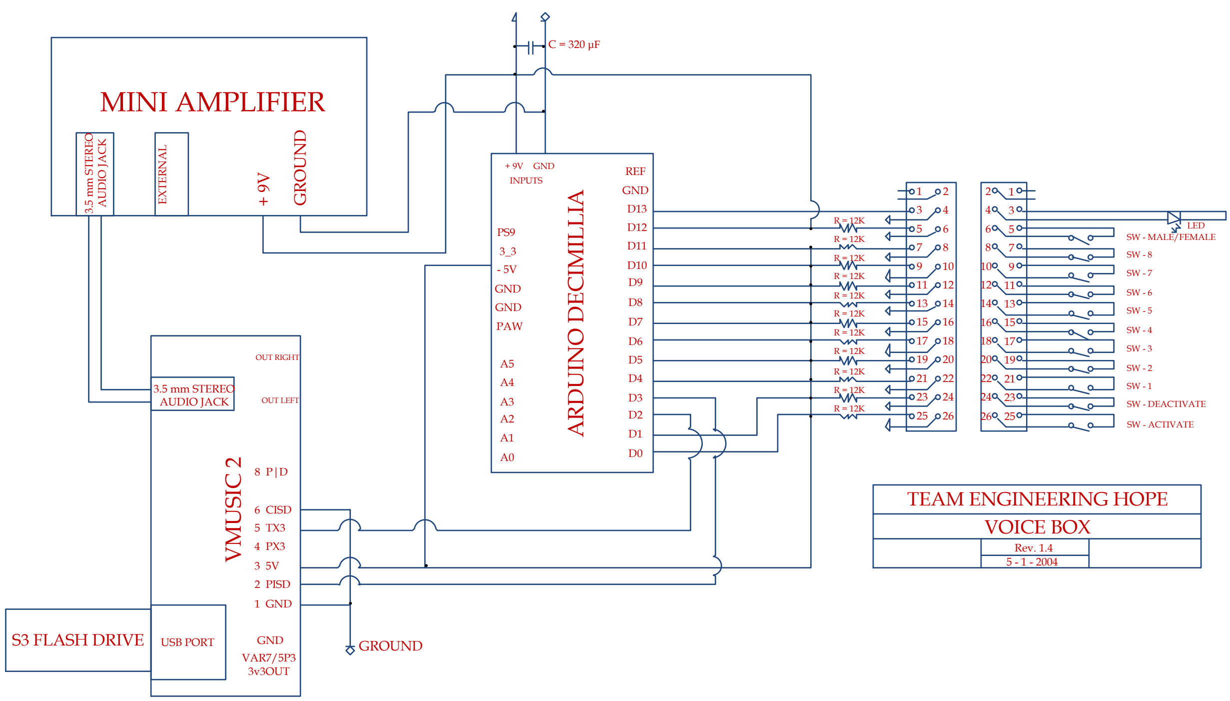

Fig. 9.2. The circuit diagram of the patient-nurse supplemental emergency call system.

CONVERTING GAIT TRAINER

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INTRODUCTION

Our client is a four year old (and his family). He has frequent atonic seizures, reduced muscle tone, and limited spatial perception. He is able to walk unaided only for short distances. His parents prefer to transport him in a standard child's stroller rather than in a wheelchair. In order to encourage independence and to develop ambulatory strength, the goal of this project is to create a gait trainer/walker that can convert to a stroller as needed. It is capable of accommodating our client's growth. The Converting Gait Trainer (Figure 9.3) consists of a commercially available gait trainer to which forearm supports and anti-tipping bars are attached for use as a walker, and to which adjustable head and foot rests, and a fold-away, padded handle bar are attached for use as a stroller.

SUMMARY OF IMPACT

The versatility of the Converting Gait Trainer significantly reduces the difficulties of managing multiple pieces of large equipment associated with the client's day-to-day family activities. The client is able to walk and play independently (Figure 9.4), yet his parents can transport him when necessary. The client's occupational therapist believes this device can significantly improve his ability to maintain balance and posture while learning to walk, and she says the client enjoys using the device and is eager to use it on a regular basis. She also expresses interest in developing similar devices with the other children at the rehabilitation center who could benefit from its design.

TECHNICAL DESCRIPTION

The Converting Gait Trainer is designed with high safety standards and adaptability as primary criteria. The Nurmi Neo child size gait trainer from Otto Bock serves as the base, along with an adjustable sling seat, anti-reverse wheel locks, and friction breaks. It includes the following

Fig. 9.3. The Converting Gait Trainer configured for use as a stroller.

modifications: a headrest, a removable footrest, a fold-down stroller handlebar, walker grips with forearm supports, anti-tip bars, and additional safety features. The headrest, footrest, and stroller handlebar are components that are used during stroller mode. In the walker mode, the main components utilized are the anti-tip bars, forearm supports, and a protective barrier designed to keep the client from falling forward. Each of the modifications is customized for our client and this Nurmi Neo design. These modifications do not compromise the integrity of the original structure.

The headrest consists of two laminated ¼″ sheets of birch plywood creating a rigid curved surface conforming to the frame of the gait trainer. Cushioning is added to the headrest with a ½″ piece of memory foam, upholstered using marine grade vinyl. The headrest is attached to the frame of the gait trainer using U-bolts and acorn nuts that prevent injury from exposed screw threads. This method of attachment permits easy removal for cleaning purposes.

The footrest also consists of laminated ¼″ birch plywood, which is painted and rubberized using Plasti-Dip. A steel piano hinge allows the footrest to fold open to approximately 120 degrees. The footrest is attached to the bottom of the gait trainer using industrial strength hook-and-loop material. When not in use, the footrest is stored along the lower bars of the stroller handlebar. Hook-and-loop is used to mount the footrest in this storage position.

The stroller handlebar is made of ½″ electrical metallic tubing (EMT) formed into a 'U' shape with a pipe bender. Connecting hinges salvaged from a child's stroller create the fold-down mechanism. PVC tee connectors and hose clamps create the lower inserts for the vertical support bars of the handlebar. These support bars, also made of EMT, are secured with epoxy into the hinges and lower braces using EMT pipe connectors. A cross-support made of 1/16″ stainless steel wire rope is secured between each vertical support bar to maintain the structural rigidity of the stroller handlebar assembly. Hose clamps secure the handlebar assembly to the original frame of the gait trainer. The handlebar can be snapped into one of several upright positions, depending on the height of the user. The EMT is covered with polyethylene foam.

The anti-tip bars are made of ½″ aluminum tubing formed at a 90° angle and capped with rubber stoppers. The tubing fastens above the rear wheels of the device, and can be pinned in an upward or downward orientation. When in the downward position, the anti-tip bars prevent the device from tipping backwards while the client is walking.

Forearm supports allow the client to walk comfortably without having to hold himself upright. The forearm supports are made of 4″ ABS pipe cut in half, covered with ¼″ foam, and upholstered with marine grade vinyl. Half-inch PVC tubing connects the forearm supports to the base of the gait trainer.

Fig. 9.4. Model showing gait trainer configuration. Safety equipment is not shown.

The grips on the forearm supports are rubberized for maximum comfort.

The client frequently fell forward while walking, so a protective barrier is added as a safety precaution. Strips of 90% polyester stretch material are sewn into a 35% polyester- 55% cotton blend poplin to create a fabric barrier that holds the client upright, permitting only minimal forward motion and thereby preventing injury. The protective barrier snaps onto the frame of the gait trainer.

Additional safety features on the Converting Gait Trainer include rubber coating on all metal parts that the client may contact. This is an important addition to the design because the client has frequent seizures.

The device is lightweight and folds for storage.

Total project cost: $950.00.

THE REMOTE SNAKE

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INTRODUCTION

Our client is an adult with muscular dystrophy. He has limited hand strength and motor control. He has difficulty grasping and manipulating the multiple remote controls required to operate his home entertainment system, and often needs his attendant to intercede. The objective of this project is to develop a bedside station to hold and position a universal remote control such that the force required to press the buttons is minimized, while the need to handle the control is eliminated. The Remote Snake (Figure 9.5) consists of a universal remote control selected for ease-of-use and the ability to control multiple devices with one unit. This remote is mounted on a flexible conduit extension (the "snake") mounted to a plywood base, providing continuously adjustable positioning while maintaining rigid support.

SUMMARY OF IMPACT

Muscular Dystrophy is a genetic, hereditary family of diseases that cause progressive muscle weakness and degeneration. Due to reduced muscular capacity, our client has difficulty controlling his home entertainment system and often relies on his attendant to change settings for him. He also has difficulty alternating the use of various other electronic devices. The Remote Snake satisfies the client's stated performance criteria. It gives him independence and the ability to consolidate and fully control his home entertainment electronics. Additional field test results indicate that the simplicity, ease-of-use, and convenience of this design make it an effective solution for a large range of clientele.

TECHNICAL DESCRIPTION

The primary design criteria developed in concert with the client are that the device must be: controllable with one finger, compatible with most home-entertainment systems, useable in bed, inexpensive, and easy to maintain.

The Remote Snake consists of three main components: the base, a flexible mounting extension, and the remote control. The base is made of cabinet grade ½″ plywood. The bottom portion of the 1′ x 2′ base fits between the client's mattress and box spring. No fasteners are required to fix the platform to any bed frame. Corner brackets fasten a mounting shelf to the base. A universally adjustable flexible steel conduit is adapted to act as an extension arm and is attached to the shelf portion of the base. It serves to permit the remote control to be rigidly positioned in any orientation, while resisting the applied force necessary to operate the controls. A ¼″ acrylic plate supports the remote control. Its dimensions are just undersized relative to the "footprint" of the remote in order to maximize stability and strength of attachment. The remote control is secured to the plate using hook-and-loop material. The entire apparatus is coated with Plasti-Dip to prevent the client's exposure to any bare metal protrusions.

The remote control chosen for our client is the One-For-All Kameleon URC-9964 Remote Control. It is capable of controlling all of the client's home entertainment components. Additionally, the remote has a motion sensitive back-lit screen which dims when not being used. This reduces annoyance, while prolonging battery life. The remote control operates at the low force levels the client can easily generate.

Total project cost: $200.00.

Fig. 9.5. The Remote Snake showing the basic configuration of remote, flexible extension, mounting, and base.

EXERCISE INCENTIVE MACHINE FOR CHILDREN WITH AUTISM

Designers: Brooke Lovett, David Ladd, Gina Sequeira, Samantha Warren
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INTRODUCTION

Our clients are four students with autism. As a group, they have a wide range of verbal communication, attention, and physical ability. Their teacher believes that including a component of independent physical exercise in their classroom will promote their developmental progression. However, their classroom has space limitations. The goal of this project is to design a space-saving exercise apparatus that encourages self-motivated usage by providing visual and auditory incentives coupled to the amount and quality of exercise. The Exercise Incentive Machine (Figure 9.6) is a modified exercise bicycle fitted with an adjustable, conforming seat with safety harnessing, and equipped with a stoplight visual cue and a CD-player incentive function (children with autism often enjoy music) activated by threshold peddle motion. It is capable of being programmed to prescribe and monitor simple exercise regimens.

SUMMARY OF IMPACT

Students with autism demonstrate a wide range in development of their levels of independence, attention and communication ability. They also have a variety of physical activity requirements that include the need to release built-up energy and strengthen muscle groups in the leg. The Exercise Incentive Machine provides the capability to incorporate physical and mental activity in a relatively small space suitable for a classroom. It permits safe, independent operation by students in a way that encourages their desire to exercise while maintaining their attention. Teachers are able to customize an exercise regime for each student. They are also able to indirectly monitor progress, freeing them to conduct simultaneous classroom activities.

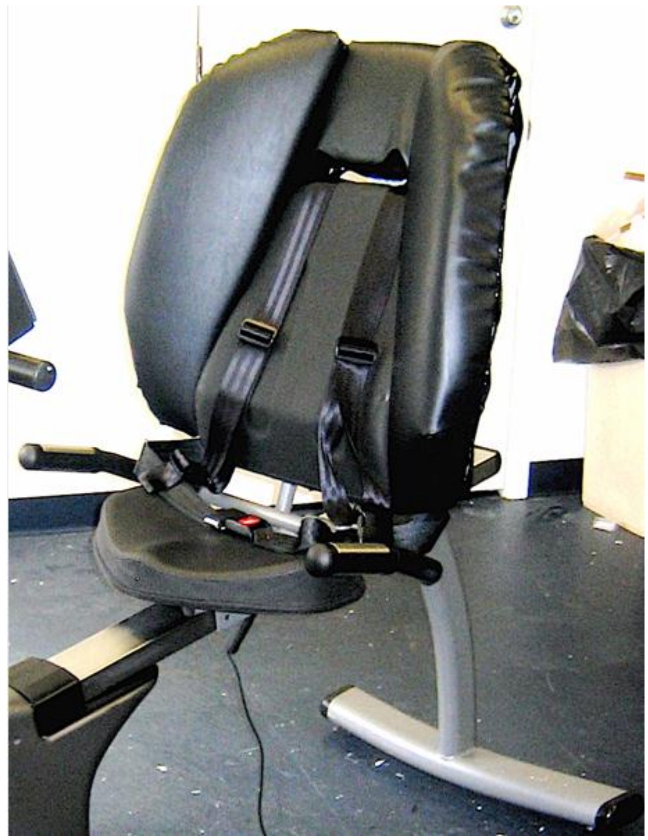

Fig. 9.6. The exercise incentive machine seating system.

TECHNICAL DESCRIPTION

The Exercise Incentive Machine is a modified version of a Vision Fitness R2000 recumbent exercise bicycle. It was chosen for its robustness and its quietness, since its use must not distract other students in the classroom. Two side supports (27″ x 8″) are fixed to the original seat back with steel brackets angled to give a 135° lateral contour. A vertical in-line headrest (approximately 10″ x 10″) is also bracketed to the original seat to provide additional support. All seating additions consist of a plywood base under 2″ –3″ foam padding upholstered with marine grade vinyl. Polyester seat and seat back slip covers fit over the entire seat assembly to facilitate cleaning. A storage pouch for a CD player and CDs is added to the back of the seat. A lap belt and adjustable harness, made of automotive grade 2″ nylon seatbelt material, are securely mounted to the seat to provide augmented support if necessary. The harness is designed to be optional, whereby 2″ buckles can be detached from permanently mounted tongue slides. The Exercise Incentive Machine weighs approximately 130 pounds and fits in a 62″ x 30″ x 50″ space.

A 18.25′′x 6.25′′ x 3.75′′ plastic stoplight replaces the original LCD console (Figure 9.7). The stoplight circuitry is powered by a 10V, 1.2A AC/DC transformer. A 2A fuse is used to limit current. The stoplight contains three holiday lights inserted into a piece of ¼′′ plywood (18′′ x 6′′) within the console. They are situated directly behind each of the three red, yellow, and green translucent plastic plates. An 18.25′′ x 6.25′′ mount for the console is made of 3/16′′ plywood. Two 2′′ brass brackets and two pieces of ¼′′ aluminum secure the stoplight to the wood console back.

A parallax BASIC stamp is used as the main controller of the device. A lighted ON/OFF switch enables the operator to monitor status. A 1 kΩ potentiometer and an onboard analog-to-digital converter allow the operator to enter the desired workout time. A momentary contact switch allows the user to start the programmed exercise regimen. During exercise, 5 LEDs, corresponding to 20% increments of regimen, allow teachers in the room to determine the student's progress in the set program. The LEDs, potentiometer, and start switch are located in the middle of the left panel of the console, above the ON/OFF switch.

A 12V relay is located beneath the user's seat and is used to control whether or not music is played for the user based on peddling activity. The CD player provides audio input that passes through the relay and into the user's headphones.

Total project cost: $850.00.

Fig. 9.7. The stoplight feedback unit. The five LEDs and the timer controller for the teacher is located above the left hand.

AN AUTOMATED SMART MEDICATION DISPENSER

Designers: Ben Wheatley, Will Sprott, Peter Navarro, Jesse Compo
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INTRODUCTION

A large client population comprised of patients disabled by chronic pain requires strong medication. Treatment is often compromised by patient non-compliance and drug overuse. The client coordinator of this project hopes to implement in-home technologies that regulate and monitor the medications prescribed for pain management. This project aims to develop a prototype dispenser that accomplishes these goals (Figure 9.8). The current design consists of a keyed, tamper-resistant housing containing a programmable motor controller capable of providing timed dispensing of medication. The multi-compartmented foil punch-out disc is filled in the pharmacy according to a physician's prescription. The disk rotates one compartment for each programmed dispensing event. The digital display shows timing and other information for the user. The operational history of the dispenser is stored in on-board memory, and can be recalled as a means of monitoring compliance. The prototype provides a proof of concept for further development of the product.

SUMMARY OF IMPACT

Approximately one in five Americans lives with chronic pain. The treatment for chronic pain is an area of significant interest in the medical field due to the propensity for non-compliance or abuse by these patients. The design goals of this project that have been achieved are to develop a prototype medication dispenser demonstrating portability, tamper-resistance, and prescriptive dispensing. The client coordinators are now able to demonstrate how such a dispenser will work and are able to provide input for second-generation designs. The prototype shows the need to incorporate new technologies, such as medication packaging in accordance with prescription. This design demonstrates that the administration of pain medication can be controlled on an hourly, daily, or weekly rather than monthly basis, thereby potentially reducing many of the ancillary problems associated with narcotics used to treat chronic pain.

Fig. 9.8. Dispensing unit prototype showing carrying handle, pill punch control, output chute, and digital display.

TECHICNAL DESCRIPTION

The housing consists of a 9" x 9" x 9" box made of half-inch cabinet grade plywood to which a carrying handle is attached. The top access panel is key-locked to permit loading medications by only qualified personnel. A "gumball-type" dispensing chute delivers pills through the front panel. A spring-loaded plunger passes through the top panel and is used to manually punch-out individual pills through a customized foil "blister-pack." An LCD display indicating dispensing cycle timing and is mounted in the front panel.

The principal component of the design consists of two circular metal plates, approximately 8" in diameter, between which a blister-pack of individual pills is sandwiched (Figure 9.9). The plates and foil blister-pack are intended to be specific to a given prescription. These would be loaded in the pharmacy. Each plate has a central hole that fits on a drive shaft. Twenty-four, ¾" diameter holes are arranged along the perimeter, each capturing a foil blister containing one or more pills or capsules. Just interior to each of the 24 holes is a small alignment hole that allows an infrared sensor to determine when a new compartment is in the correct position following plate rotation. The central hole is coupled to a 200:1 gearhead DC motor, resulting in a nominal disc rotation speed of 10 rpm. The rotation of the plate-blister-pack assembly is controlled by a programmable motor controller. When the internal timer countdown reaches zero, the motor switches on until the infrared sensor detects the LED at the next alignment hole, at which time the motor is switched off. Once the motor has rotated, the current dose is in line with the manual plunger that is then depressed through the foil blister-pack to drop its contents into the dispensing chute. Simultaneously, the LCD timer is reset to indicate the time remaining until the next pill is to be dispensed. The device is battery powered, with a battery charger access port through the back panel. The next phase of this project includes adding reporting and reprogramming access through telephone dialup data exchange.

Total project cost to date: $150.00.

Fig. 9.9. Pill wheel showing 24 compartments and optical indexing holes.

A WHEELCHAIR-ACCESSIBLE SINK FOR A SPECIAL NEEDS CLASSROOM

Designers: Elaine Horn, Raeanna Poplus, Jesse Ranney, and Brent Smith
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INTRODUCTION

Our clients are students in the special education program at a local high school. Many use wheelchairs. Their teacher uses a sink in her classroom to teach hygiene and other skills. Access to the existing sink and faucet was limited. Many students couldn't get their wheelchair close enough. Some couldn't reach far enough to operate the faucet. Splashing was a problem. The goal of this project is to select and install a sink and fixtures that permit wheelchair accessibility and independent operation by the students. Project goals are accomplished by redesigning the counter space and height, the sink location, under-sink plumbing, and faucet position, as well as by selecting a more easily operated faucet with an aerator and a basin shape that minimizes splashing (Figure 9.10).

SUMMARY OF IMPACT

Accessibility remains a significant problem for people who use wheel chairs, particularly when dated facilities are to be used. The use of an existing sink in the clients' classroom presented such a situation; only one student could use the existing sink on his own, and many students could not fit their wheelchairs under the countertop. A number of students had difficulty reaching the faucet and lacked the arm strength to use the handle. The current design of the sink, faucet, and counter space permits all students to access and use the sink without the assistance of the teacher. The proper selection of the basin shape prevents excessive splashing. Faucet selection and placement facilitates easy operation. The teacher is now much more able to teach hygiene skills as part of her classroom effort and has expressed great satisfaction with this solution.

TECHNICAL DESCRIPTION

The Wheelchair-Accessible Sink is a rectangular, drop-in, self-rimming stainless steel sink. The basin shape and shallow depth reduces splashing, but still permits all wheelchairs to fit beneath. The sink is placed forward in the countertop with the drain to the rear in order to facilitate accessibility. A single-handle, ADA-approved mixing faucet with a swivel spigot is also installed forward and on the right side of the basin to permit access. This side-mounted faucet is easily operated and is within reach of all students including those using wheelchairs. A removable lanyard that snaps onto the surface of the countertop limits the range of motion of the spigot so that the faucet cannot be positioned outside the basin and spill into a student's lap or onto the floor. A flow restricting aerator further controls splashing.

The counter top is raised approximately two inches to meet ADA standards. A new 40" section of Corian countertop replaces a portion of the original countertop. Pressure-treated wooden legs provide mechanical support. The Corian countertop is secured to the original countertop using Corian-specific epoxy. A metal cleat fastened to the wall supports the free end of the new Corian section. The counter is also supported along its length with wooden cross-braces. The new countertop is cut to be flush with the front edge of the original countertop, and a Corian backsplash completes the counter installation.

Total project cost: $700.00.

Fig. 9.10. Illustration of the installed sink configuration. Not shown is the stop that keeps the spout over the basin.

WORLD OUTSIDE MY WINDOW

Designers: DéJeune Antoine, Laurin Buettner, Scott Jennings, Ashok Manepalli
Client Coordinators: Hank Klimitas
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INTRODUCTION

Our client has Type III Osteogenesis Imperfecta, a disease resulting in fragile bones and weakened musculature. Even with the support and safety restraint provided by commercially available car seats, moderate decelerations risk inflicting significant musculoskeletal injury. Consequently, the client cannot sit upright safely in her family's vehicle during car trips. Instead, she lies on the floor behind the driver's seat, which allows her to roll and gently accommodate normal vehicular motion. However, in this position she is unable to see out the windows, which can lead to disorientation and reduce the pleasures of travel. The goal of this project was to design a closed-circuit television system to permit the client to monitor the view outside her vehicle. The Video Window Viewer (VWV) consists of three cameras and monitors providing views through the left, right, and front windows while not obstructing the driver's lines of sight (Figure 9.11). The system is designed for portability and allows the client to easily transfer the system to other vehicles.

SUMMARY OF IMPACT

The VWV uses a closed-circuit television system to provide views from the side windows and through the front windshield. The client is now able to partake of the view as she travels, having real-time images through a 270° field of view from within her family's vehicle. Together, the three perspectives provide her with enhanced navigational abilities and a more enjoyable ride. She comments, "Your device gives me a new outlook on the world around me. I am able to see what is going on outside of my car. I am once again able to see the happenings of the city, the new buildings, and the true culture that surrounds me every day. It may not be looking out the real window, but it is sure close!"

TECHNICAL DESCRIPTION

The main structural component of the system is a folding tray (Axius® auto expressions™ Backseat Travel Tray, part# 142403) that can be secured to the back of any standard car bucket seat with a network of nylon straps. Originally designed for use as a dining and writing surface, this tray provides a horizontal support surface for the monitors and other components of the system. A steel 10" x 15" cookie sheet is secured to the underside of the horizontal surface of the tray using hook-and-loop material and wire bent into staple-like fasteners. The steel sheet extends 10" from the edge of the tray towards the middle of the vehicle, providing a horizontal surface directly over the client's head.

Three liquid crystal display monitors, two Emerson Mobile MT-1564R monitors and one Road Theater RT-500 monitor, are attached to the underside of the steel sheet using machine screws. This allows the client to view all three monitors simultaneously, and allows each monitor to be removed and examined individually if service is required. A thick plastic sheet is used to cover the upper surface of the steel sheet in order to conceal the fasteners while providing a usable horizontal surface.

Each of the three monitors is connected to a PC213XS closed-circuit microvideo color security camera by means of a standard video input connection. One camera is mounted on the dashboard, looking through the windshield, while the other two are mounted on the left and right C-pillars and look through the windows of the left and right sliding doors. These cameras are fixed in position using 3M Command™ mounting adhesive. All monitors and cameras are powered by the vehicle's 12VDC power supply. The power lines for each monitor and camera are separately fused. They all feed from a single cigarette lighter-style 12VDC plug.

Total project cost: $400.00.

Fig. 9.11. The Video Window Viewer as installed in the client's family vehicle. The monitors are attached to the underside of the fold-down tray.

STAND ASSIST WHEELCHAIR

Designers: Shoib Bajaj, Chaitanya Nandipati, Stephanie Roberts, Samantha Weil
Client Coordinators: Salvador Paz
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INTRODUCTION

Our client is paralyzed from the waist down and uses a wheelchair. With full use of his upper body, he used a device that allowed him to transition to a standing position, but this device was lost during Hurricane Katrina. The goal of this project is to restore the client's ability to work in a standing posture, with consequent functional and therapeutic benefit. This is accomplished by modifying a wheelchair to include nitrogen gas struts to actuate a hinged chair frame such that the footrest, seat and seat back align in the standing configuration (Figure 9.12). The client is able to use his body weight and upper body strength to compress the gas struts and return the chair to the wheelchair configuration, thus eliminating the need for an outside active power source.

SUMMARY OF IMPACT

For people who are paralyzed, the use of a standing system has several benefits. Pressure relief reduces the occurrence of skin ulceration, trunk strength and balance are improved, organ alignment improves renal and bowel function, and spasticity is decreased. Prior to Hurricane Katrina, the client used a device that allowed him to transition to a standing position from his wheelchair. The Stand Assist Wheelchair returns this capability to the client in one integrated system. In addition, it makes it easier for him to complete therapeutic stretching exercises. Standing allows him to enjoy typical daily activities. Importantly, the client has a renewed sense of independence.

TECHNICAL DESCRIPTION

The Stand Assist Wheelchair replaces the seat, back, and leg supports with three main plywood sections. These are hinged together and bolted onto a standard wheelchair frame. Throughout the sitting and standing movement, the seat back and leg support maintain a vertical position by following a four-bar linkage mechanism to which the sections

Fig. 9.12. The standing wheelchair. Top: wheelchair configuration. Bottom: standing configuration, rear view showing gas springs and 4-bar mechanism.

are attached. The frame of the linkage consists of 1″ square steel tubes pinned at each end with ¼″ bolts. The leg-support and footplate are fixed to the wheelchair frame with U-bolt fasteners. Two casters are attached to the underside of the footplate to prevent tipping and increase stability.

To operate the chair, the client first removes the armrest of the device and transfers himself from his wheelchair. The client uses his other hand to push on the armrest and relieve some of his weight on the seat. As the load on the seat lessens, two 130 lbs. capacity nitrogen gas spring struts mounted at an angle underneath the seat extend and the chair moves to a standing position. The opposing ends of the struts are fixed with brackets to a plywood support panel. To return to the seated position, the client reaches back and pulls up on the armrest. The additional force on the struts causes them to compress. Once in the seated position, two spring-loaded pins snap-fit into the wheelchair frame and lock the linkage mechanism. Bicycle brake cabling is used to disengage the locking pins when the chair again converts to the standing position.

Four-inch condensed batting is used to cushion the seat, and the rest of the chair is padded with two-inch thick fiber batting. The front and back of the chair are upholstered with 100% cotton fabric. In addition to a knee abduction and restraint system, three safety straps secure the client. One holds his feet in position, and two support his torso. Each is elastic, adjustable, and secured with hook-and-loop fasteners.

Total project cost: $520.00.

THE TOUCHCOM: AN INTEGRATED ENTERTAINMENT AND COMMUNICATION SYSTEM

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Client Coordinators: Scott Songy
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INTRODUCTION

Our client has a spinal cord injury at the cervical level, but retains some use of his right arm. It is difficult for him to operate various audio devices including an MP3 player, cell phone, and voice amplifier, and it is especially difficult for him to alternate using these devices. The goal of this project is to design a single touch-screen interface that permits the facilitated operation of multiple audio devices using minimal applied force. The TouchCom (Figure 9.13) consists of large touch-screen LCD and embedded programmable interface controller housed in a custom fabricated ABS housing mounted to the client's wheelchair with a continuously adjustable ball-joint arm. Additional functionality includes the remote control of a television and an automatic door opener.

SUMMARY OF IMPACT

The design goal of the TouchCom, to facilitate the use and control of multiple peripheral audio devices for a client with restricted use of one arm, was achieved early in the project. The client can now easily switch between his MP3 player, cell phone, and voice amplifier microphone. The further developed final design surpasses his expectations by including the added functionality of TV and automatic door opening control. Touch-screen technologies offer highly effective solutions for applications where the use of multiple devices needs to be simplified, and where device control requires low operating force.

TECHNICAL DESCRIPTION

The TouchCom housing was custom fabricated using a 3-D printer in order to minimize the size required to contain electronics and support a large touch-screen graphical user interface (GUI). The housing is made of acrylonitrile-butadiene-styrene (ABS) plastic. To meet the design criteria of large screen size, color display, low power consumption, and serial connectivity, we selected the ezDISPLAY 2.0 serial graphic touch-screen LCD module. The GUI consists of menu screens and buttons that send serial x and y-coordinate input to a dzPIC30F4011 embedded microchip programmable integrated controller (PIC). The PIC coordinates the various functions of the device using 5 volt logic to activate latching relays that consume power only while switching. Latching relays are also advantageous because they retain their last switch state when power to the device is turned off. Power at 5 VDC is drawn from the 24 volt wheelchair supply through a DC-DC converter. When fully active, the TouchCom draws approximately 1 A, but when screen sleep mode is initiated after 45 seconds of inactivity, the device draws only 170 mA.

In addition to controlling multiple audio input/output devices, the TouchCom can be configured to amplify voice input. This public address (PA) function permits alerting traffic and hailing friends. An infrared LED is mounted within the housing to permit the PIC and touch-screen GUI to function as a typical TV remote control. Also an in-board radio frequency electronic key fob was incorporated such that the TouchCom can operate the client's automatic door opener control.

The TouchCom is rigidly, but reversibly, mounted to the client's wheelchair using U-bolts.

Total project cost: $725.00.

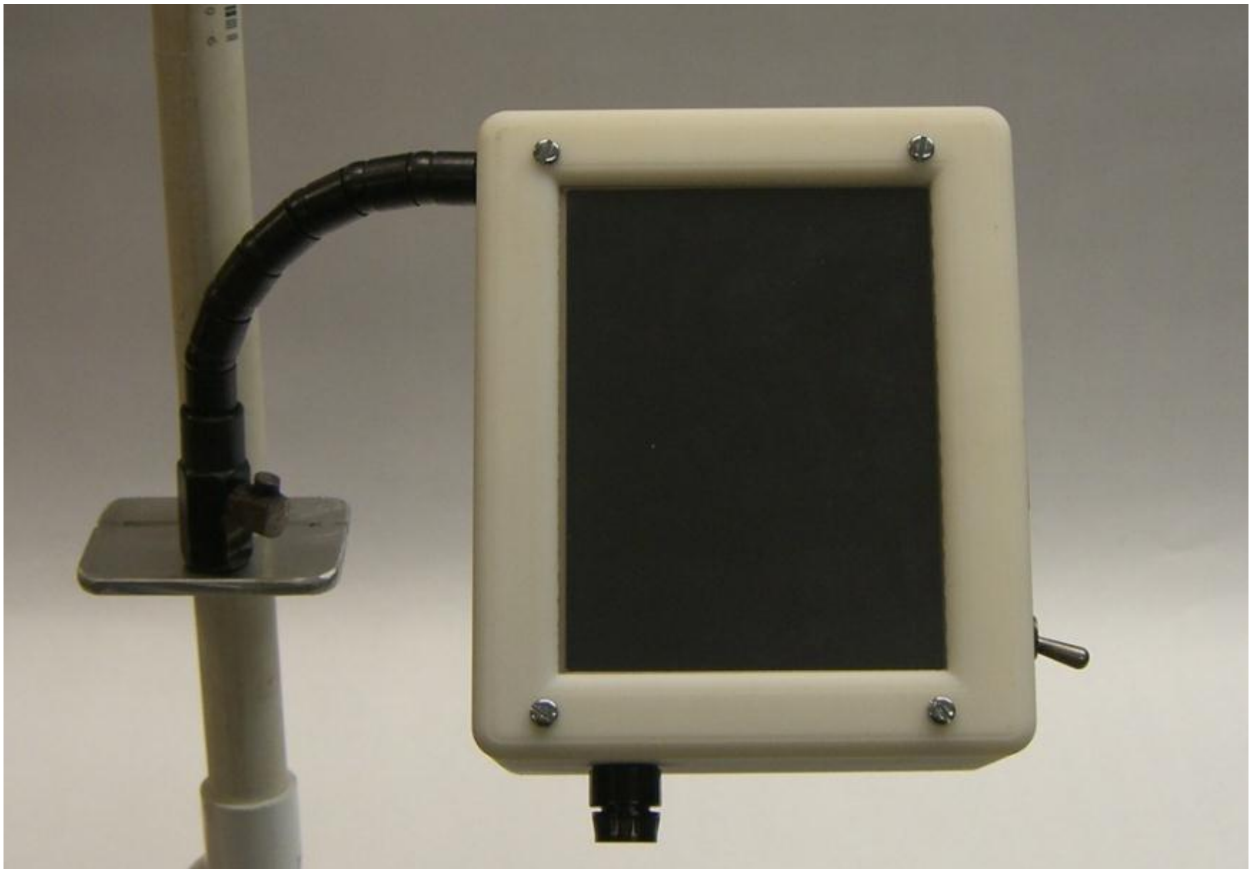

Fig. 9.13. The TouchCom touch-screen interface and flexible mounting arm.