CHAPTER 9
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MODIFIED HOME ENTRY

Designers: Robert Karpowicz (team leader), Brian Long, Joshua Ribbick, and Jeffrey Webb
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INTRODUCTION

Two residents of an assisted living residence were unable to enter their home without assistance. These individuals use wheelchairs and could not unlock and open their front door. The goal of this project was to create a modified home entry system that would allow them to enter and exit their home independently. A key project requirement was that the front door should still function normally for other residents and employees entering and exiting the home, as everyone there is encouraged to do as much for themselves as possible.

SUMMARY OF IMPACT

The final design provides two individuals increased independence without affecting the way the front door opens for other residents and employees. The system is activated by garage door opener-style remotes that allow the two individuals to operate

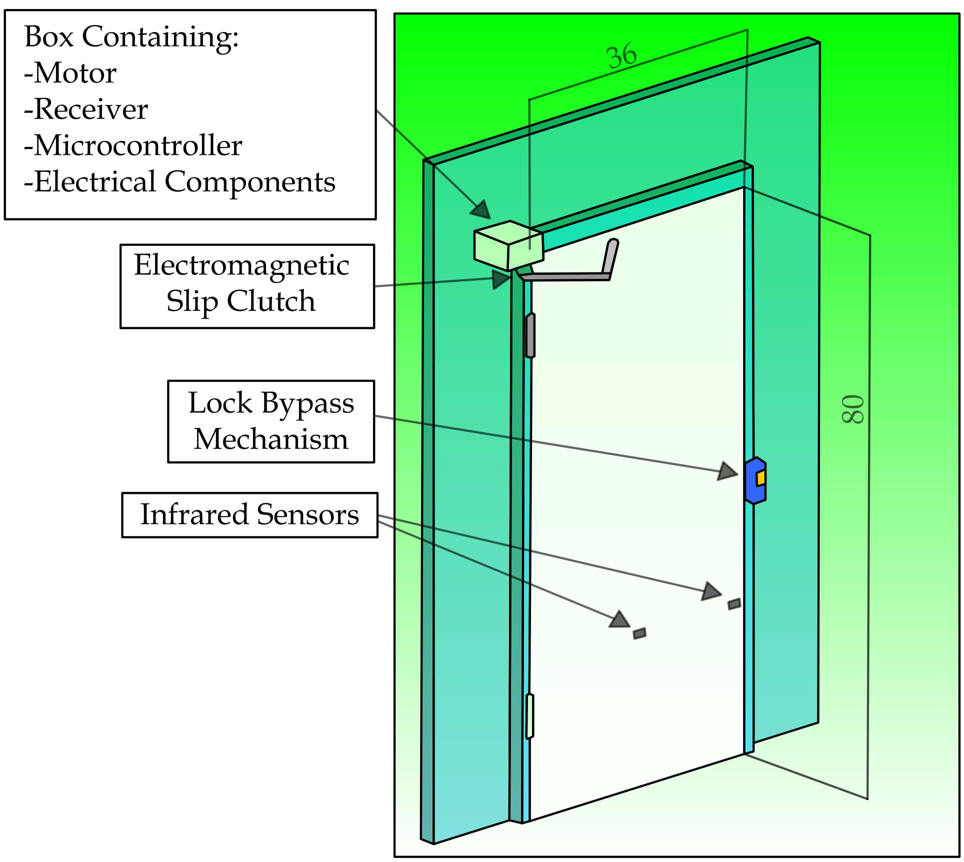

Fig. 9.1. Schematic of the Modified Home Entry System.

the entry. Part of the door's strike plate around the latch was replaced with a lock bypass that moves out of the way, allowing the door to swing freely without having the doorknob turned. Depressing the remote causes the lock bypass to slide clear of the door latch, and it also activates the motor that swings the door open and closed. The door is equipped with sensors that detect objects or people in its path. Fig. 9.1 shows a system schematic. The individuals using the new system say they "love the door and love showing it off."

TECHNICAL DESCRIPTION

The home entry system is composed of four subsystems: 1) electronic control; 2) door motion; 3) lock bypass; and 4) sensors. The key physical structure modifications are shown in Fig. 9.2.

For the electronic control, a garage door transmitter and receiver were used for the user input to the system. In order to coordinate the individual components of the system, an electronic logic controller is needed. A Parallax BASIC Stamp™ microcontroller was selected. The controller is used in conjunction with relays, a transformer, a voltage regulator, and other electronic components. A program was written for the microcontroller to control the operation of the door, allowing for easy programming changes and incorporating adjustability into the system.

A 90 VDC motor that provides 250 in-lbf of torque and moves at 3.2 RPM was used to move the door. In order to preserve the manual operation of the door, an electromagnetic slip clutch is used so that the motor can be disengaged when not in use. This clutch serves two purposes. First, it produces negligible friction when disengaged. Second, it slips when 250 in-lbf of torque is applied. This slipping allows the system to be manually stopped or moved during operation. It was found that a large amount of force was needed to overcome the weather seal of the door being used. This force only needs to be overcome for the initial motion of the door from the closed position, so a linear push solenoid is used in conjunction with the motor to overcome the seal.

The lock bypass is the mechanism that allows the door to swing open without requiring the doorknob to be turned. A portion of the strike plate has been replaced with a sliding steel gate, actuated by a linear pull solenoid. When the system is activated, the slide is lifted by the solenoid, allowing the door to open without handle rotation. This system allows the door to lock and unlock as it always has, while also bypassing the lock when the remote control button is pressed.

Infrared ranging sensors were selected for object detection. They are easy to use, are designed for operation within a large temperature range, and are very cost effective. Five sensors are used in conjunction with analog-to-digital converters. The sensors are mounted approximately 2 ft off the ground with even spacing. They will detect any object appearing in the door's path. When a sensor is activated, the door stops moving and returns to its prior position.

The total cost of the project was approximately $1500.

Fig. 9.2. Box Containing the Motor and Clutch (Left) and Replacement Strike Plate with Sliding Latch Mechanism (Right).

ADAPTED COMPUTER KEYBOARD

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Electrical Engineering Designer: Fabian Fernander
Computer Engineering Designer: Jacob Erlich
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INTRODUCTION

A consumer wishes to use a computer to send e-mail and write letters. This individual has experience typing, but has not used a computer, and has several disabilities that prevent use of a standard keyboard. This particular individual is legally blind, is unable to isolate one finger to type with, and does not have sufficient reflexes to depress and release a key quickly enough to type only one letter at a time. In addition, there were some ergonomic concerns that would require the keyboard to be elevated higher than a normal keyboard.

SUMMARY OF IMPACT

The team performed two visual and two motor skills tests to determine the individual's abilities so the keyboard would meet all specified needs. The final design included keys that were large enough and spaced so that the consumer would be able to identify and depress only one key at a time. The size of the lettering on the keys was also increased to accommodate the consumer's visual impairment. The total number of keys was reduced to 49 from the standard 104: the numbers 0-9, letters A-Z, six punctuation keys, Return, Space, Backspace, Shift, Caps-lock, a key to start the e-mail application, and a key to start an internet browser. The consumer requested that the keys be arranged in alphabetical order.

TECHNICAL DESCRIPTION

The final design is shown in Fig. 9.3. Key size, spacing, and layout were determined based on tests of the consumer's mobility and reach, ability to depress keys of certain sizes and spacing, and ability to read letters of different sizes, stroke widths, and color patterns. The team also determined that the consumer typically depresses a key for approximately three seconds for a keystroke and requires a concave key surface to prevent fingers

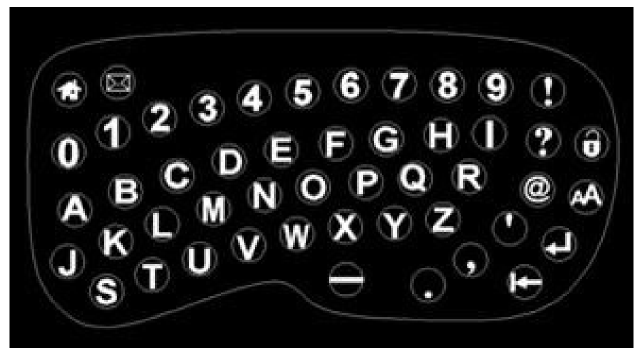

Fig. 9.3. Final Keyboard Layout.

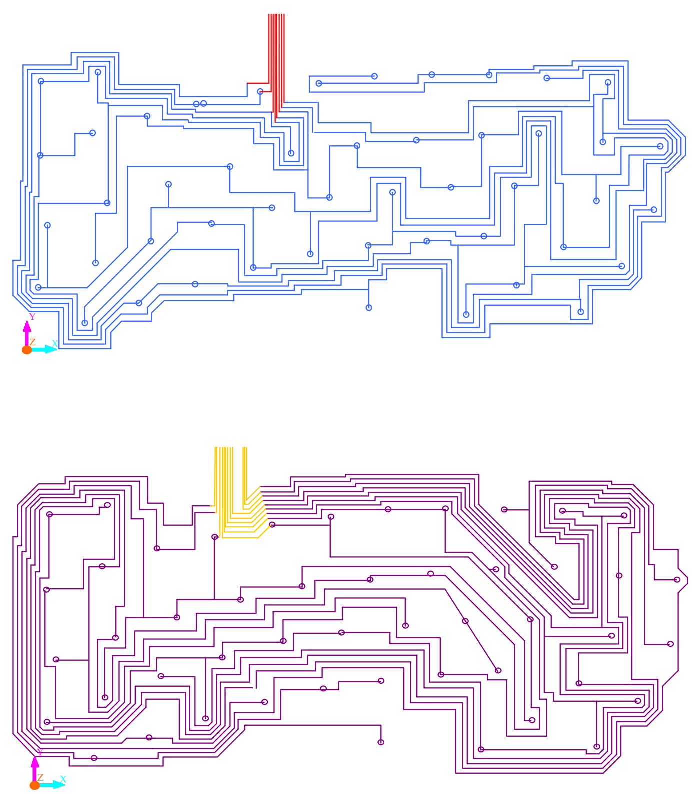

Fig. 9.4. Left (Top) and Right (Bottom) PCB Layouts for New Keyboard Design.

from sliding off the keys. The curvature of the keyboard was modified to match the consumer's reach patterns.

The switching mechanism used in the keyboard design is a flexible printed circuit board (PCB). This mechanism uses three Mylar or Kapton sheets. The bottom sheet is connected to the short slot in the encoder, and the top sheet is connected to the long slot in the encoder. The middle sheet is used as a spacer sheet with strategically placed holes. When a key is depressed it pushes down a rubber dome, which then makes contact with a particular node on the first sheet, and finally makes contact with another node through the spacer sheet, thus closing the circuit. The flexible PCB design was done in AutoCAD to ensure the nodes lined up exactly with the locations of the centers of each key. The PCB layouts for the top and bottom sheets are shown in Fig. 9.4. An existing fully-functional keyboard encoder was used and the new keyboard layout was programmed using Microsoft's Keyboard Layout Creator.

The keys and keyboard frame were manufactured from delrin, chosen for its high strength to resist frame deflection and its low coefficient of friction to resist key binding. The keyboard frame was made with extra internal supports to stiffen the structure in case the consumer hits the frame instead of the keys. The keys were made using a CNC machine, and were designed with a flat surface to prevent them from spinning in place. The keyboard frame and keys are shown in Fig. 9.5.

The user has been given a detailed user's manual that includes installation instructions as well as key identification for keys with non-alphanumeric symbols.

Fig. 9.5. Keyboard Frame (Top) and Key (Bottom) Designs.

The total cost of the project was approximately $550.

PRESSURE SORE ALLEVIATION DEVICE

Mechanical Engineering Designers: Scott Keppel (team leader), Adam Hagerty, Brian Phillips
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INTRODUCTION

Pressure sores are common in individuals who are required to remain seated or lying down for long periods of time without being able to shift their weight. Constant contact on pressure points causes restricted blood flow and may eventually lead to sores that can penetrate into the bone and cause systemic infection. Therefore, it is important to

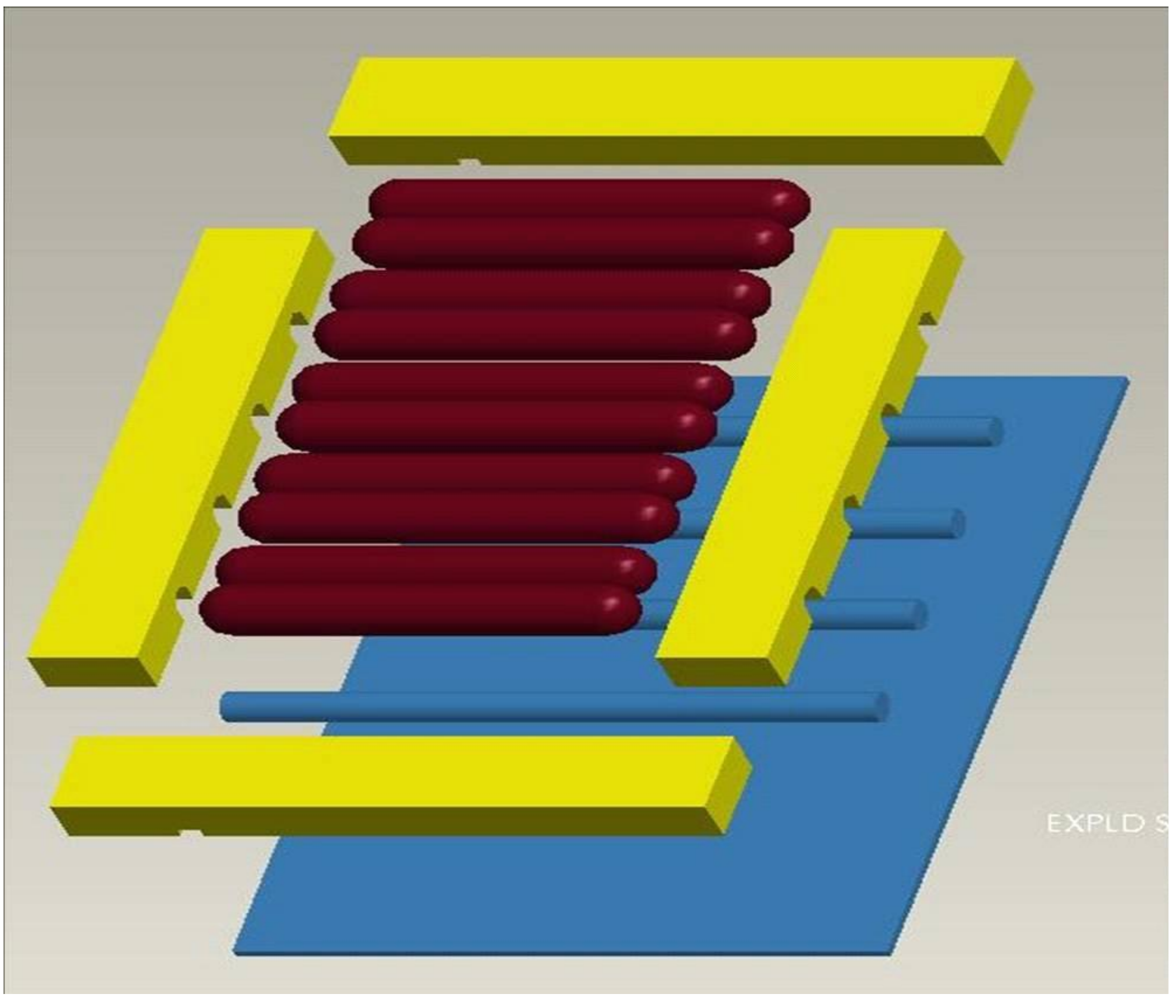

Fig. 9.6. Air Bladders, Non-Inflatable Firm Foam Cylinders, and Bedding Grade Foam that Forms a Full-Sized Frame around the Twin-Sized Air Bladders.

provide a means to vary pressure points for individuals who are not able to move independently. The focus of this project was to develop a bed that will automatically vary pressure points during the night for a consumer who has pressure sores. Typically, aides would come in several times during the night and manually move the individual. This was causing severe sleep disturbances, so a key goal was to provide a system that would allow the individual to sleep undisturbed while still varying pressure points.

SUMMARY OF IMPACT

The final product is an air bladder system with three different cycles of support that can be set to change in 30-, 45-, or 60-minute intervals. The design also has a "full inflate" option that provides a uniformly inflated surface. All controls are located outside the consumer's room, so aides do not need to enter during the night to vary cycle times. The consumer is now sleeping through the night regularly, and is relaxed enough to move her own legs slightly while sleeping.

TECHNICAL DESCRIPTION

The pressure sore alleviation system is a device that fits on top of the consumer's existing full-sized bed. The system consists of a series of air bladders and firm foam cylinders enclosed in a bedding-grade foam frame. Since the individual only moves minimally during the night, a twin-sized air bladder system is used, and bedding grade foam surrounds the bladders and makes the system fit a full-sized bed. A pump is located near the bed and a control box, that allows aides to control the inflation cycles, is located outside the consumer's room.

The cycle variation over the ten air bladders is:

1. Inflate bladders 1-3-5-7-9; weight is supported on these bladders only.

2. Inflate bladders 2-4-6-8-10; weight is supported on these bladders only.

3. Deflate all bladders; weight is supported on firm foam cylinders.

4. Inflate all bladders; weight is supported on all bladders.

The pump is controlled using a BASIC stamp microcontroller connected to a four-button user control box. The four switches on the control box are linked into I/O ports 10, 11, 12, and 13. Port 10 is set up for 30 minute cycles, port 11 for 45 minute cycles, port 12 for 60 minute cycles, and port 13 for full inflate. The initial control is to determine when one of the switches is turned to the "ON" position, which creates a voltage to the port to signal the controller to switch that port to high. Once that port is set to high (>1.5 V), the program switches to the proper subroutine to begin the alleviation cycle. If no switch is selected, the program is set up to automatically fully inflate the mattress until a cycle switch is chosen, and if multiple switches are chosen, the program will only use the first switch selected. A pressure sensor monitors each set of air bladders (1-3-5-7-9 and 2-4-6-8-10).

Once in the switch subroutine, the program cycles continuously through the routine until either the switch is turned off or the power to the controller is lost. While in the individual switch subroutine, the ports that the pressure sensors are connected to (0 and 1) are continuously checked to see if they are switched to high due to the voltage reading from the pressure sensors. Since the ports only switch from low to high at 1.5 volts, a resistor was necessary to make the appropriate pressure switch to high to signal the sensors to activate the valves. The resistor was chosen to be 18 ohms after testing was completed for comfort. When the pressure sensor port is switched to high, the valve ports, either 3 or 4, depending on which pressure sensor is switched, also switch to high. This high signal opens the valve for five seconds to release some of the pressure in the air cells, and this entire routine is looped continuously for either 30-, 45-, or 60-minute cycles based on counters in the program. The first cycle leaves the one valve on high for the entire routine and only controls the other valve. The second cycle does the opposite of the first and the third cycle leaves both valves open to utilize the foam layer of alleviation. A 3-cycle rotation takes approximately 90, 135, or 180 minutes to complete depending on the whether the 30, 45, or 60 minute interval is chosen.

The total cost of the project was approximately $840.

STANDING TABLE

Mechanical Engineering Designers: Craig Hudson (team leader), Matthew Bell, Kahamala Morgan, Maria Spagnola
Industrial Engineering Designer: Jeffrey Matusik
Electrical Engineering Designer: Aditya Srinivas
Client Coordinator: Kristen Quinlan, Arc of Monroe County
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INTRODUCTION

The goal for this project was to design and build a standing table, a device used to lift individuals with disabilities out of a wheelchair and support them in an upright standing position. Ideally, the table would be able to lift and support a person weighing up to 275 pounds in a standing position, while providing a stable work surface.

SUMMARY OF IMPACT

The final product is a collapsible, rolling standing table that can support users of varying heights and weights up to 300 pounds. The table legs extend out to allow the table to fit around an easy chair and back in to allow the table to fit through doorways. The lifting mechanism is controlled by a corded remote, and the actuator is sized so that it would not be able to lift individuals who are too heavy for the table's structure to support. The adjustable-height work surface is transparent, allowing the consumer using it to see the ground ahead of him or her when the table is being moved. The standing table is shown in Fig. 9.7.

TECHNICAL DESCRIPTION

Design of the standing table was divided into three areas: 1) power and lifting, 2) frame, and 3) ergonomics. Individual components are identified in Fig. 9.8.

Lifting is driven by an actuator with a 1000-pound limit, 12 inches of travel, a 15 percent duty cycle, a ball screw for quiet operation, and a clutch to prevent overloading. The actuator is mounted so that it will be perpendicular to the lifting arms at the start of lifting, when the most force is required. It is nearly parallel to the lifting arms near the standing phase, when the least force is required. The actuator is powered by a 12V 24A sealed and rechargeable medical battery. A power switch on the frame controls power to the system, and a second power switch on the corded remote controls power to the remote only.

Fig. 9.7. Student Designers Demonstrate Procedure for Lifting.

The standing table frame is primarily made from steel with welded construction and was painted to reduce rust. All static and fatigue factors of safety meet or exceed the required 1.5, and static analysis was done to demonstrate that the table will not tip, even with unusual loads applied. The base is made from 8020 aluminum that slides over UHMWPE linear bearings. The base width can be adjusted through the use of two water cylinders, one for expanding the width and one for compressing.

Ergonomic analysis ensured that the table would be suitable for all body sizes from the 5th percentile female to the 95th percentile male. Chest and kneepad locations were determined accordingly, as were attachment points for the lifting harness. An anti-fatigue mat is included on the footplate

The new owners have been provided with a user's manual that includes maintenance and troubleshooting guides.

The total cost of the project was $1292.

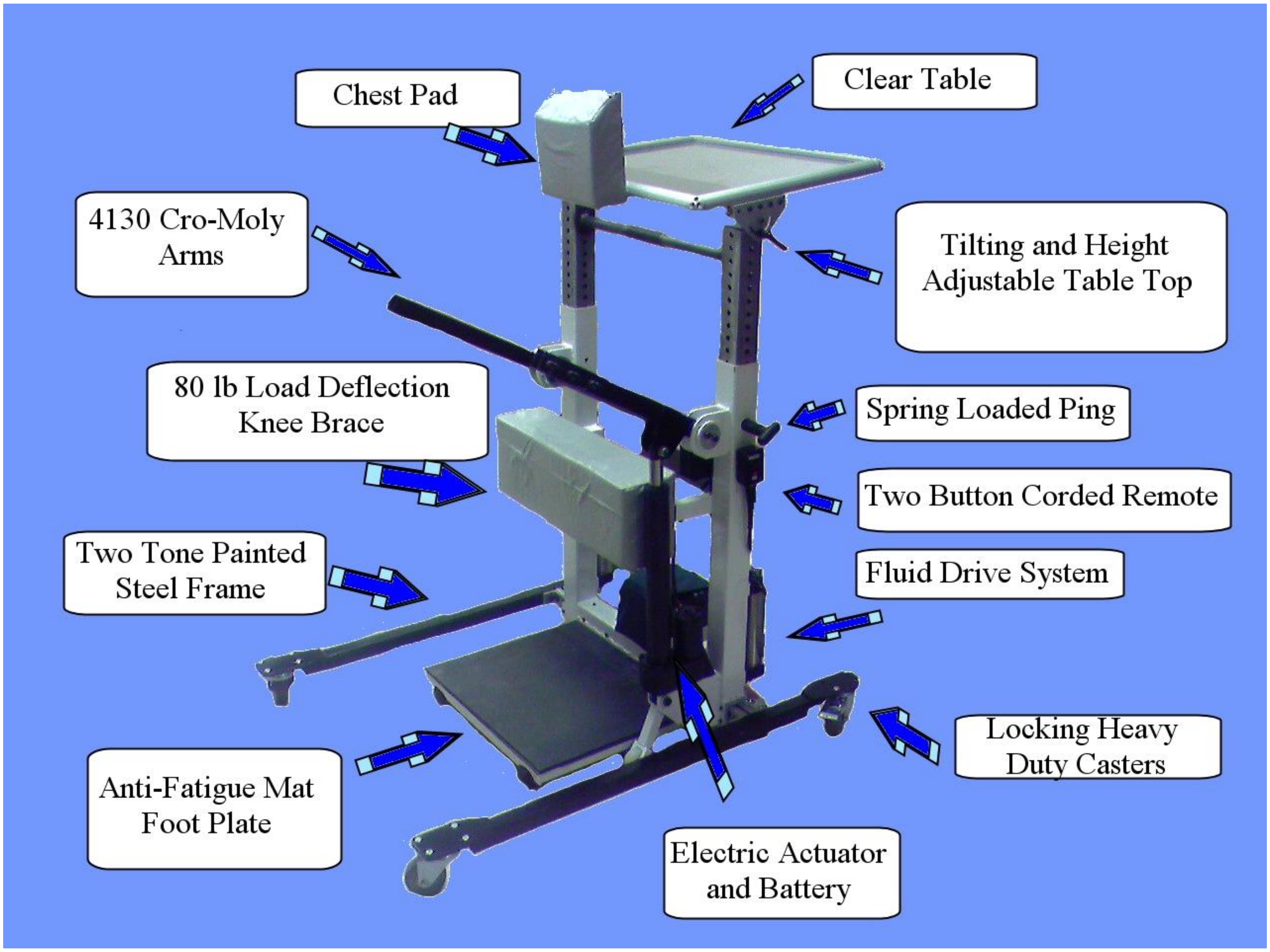

Fig. 9.8. Standing Table Key Components.

CUSTOM WHEELCHAIR TRAY

Designers: Caseyann Sarli (team leader), Jaclyn Capeci, Owen Dublin
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INTRODUCTION

The object of this project was to design and fabricate a custom quick-release wheelchair tray for the Quickie S-626 Power Wheelchair with Power Tilt. Prototypes were made for two consumers who desired a tray that could be used not only as an eating area, but also as a workstation. The consumers also requested a storage compartment and cup holder. Existing trays are not rigidly attached to the wheelchairs, causing the individuals some distress if the tray slides back and hits either of them in the abdomen.

SUMMARY OF IMPACT

The final products are two transparent wheelchair trays with several unique features. Each prototype includes an under-tray compartment that can be used for storing writing utensils or eyeglasses, a collapsible cup holder, and a protected space for each consumer to display a photograph. The rigidly attached trays have a rimmed edge to prevent liquid spills from rolling off the surface, and they can be attached and removed quickly. Unfortunately, due to an unforeseen modification in the supplemental support devices required by the consumers, the trays no longer fit on the wheelchairs; however, they are available if other individuals would like to use them.

TECHNICAL DESCRIPTION

The tray surface (Fig. 9.9) is made out of ¼-inch Lexan MR10, which is a polycarbonate material that provides sufficient clarity, allowing the consumer to see through it to the floor in front of his or wheelchair. The Lexan has an abrasion and ultra violet (UV) resistant coating on both sides. The high mar-resistant surface prevents paint, adhesives, and other materials from adhering to its surface. These characteristics aid in preserving the clarity of the tray surface. An ANSYS model was run to ensure that a typical load (textbooks, notebook, weight of individual leaning, etc.) would not cause dangerous deflection or failure. Both trays also feature a 3" x 7" storage compartment with a closable lid. The storage compartment is removable and can slide on and off by way of channels mounted on the underside of the tray surface. These channels are secured using polycarbonate silicon sealant and four screws. The compartment lid is attached to the tray by means of a rod that runs through the length of the lid.

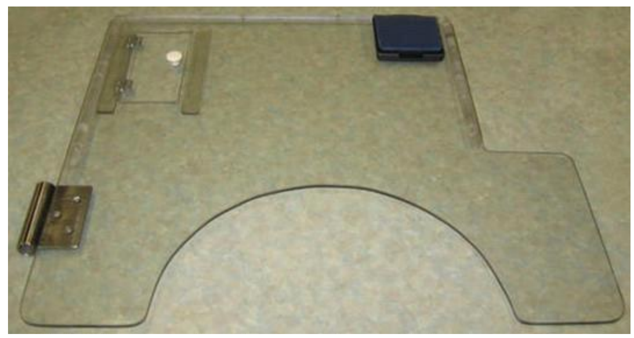

Fig. 9.9. Wheelchair Tray Surface.

Fig. 9.10. Rod and Clamp System for Attaching Tray to Wheelchair.

The trays are attached to the wheelchairs through a system of 304 stainless steel rods and cast iron pipe clamps (Fig. 9.10). These are rigidly attached to the wheelchairs, and a roller catch clip allows the tray to rapidly attach and detach from the rods and clamps.

An additional feature that was designed into the system, but later eliminated by the client coordinator, was the ability to automatically adjust the tray's position. The design consisted of three motor-driven lead screws: one would slide the tray in and out, and the other two would raise and lower the front and rear of the tray separately, providing both height and tilt adjustment (Fig. 9.11).

The total cost of the project was $764.

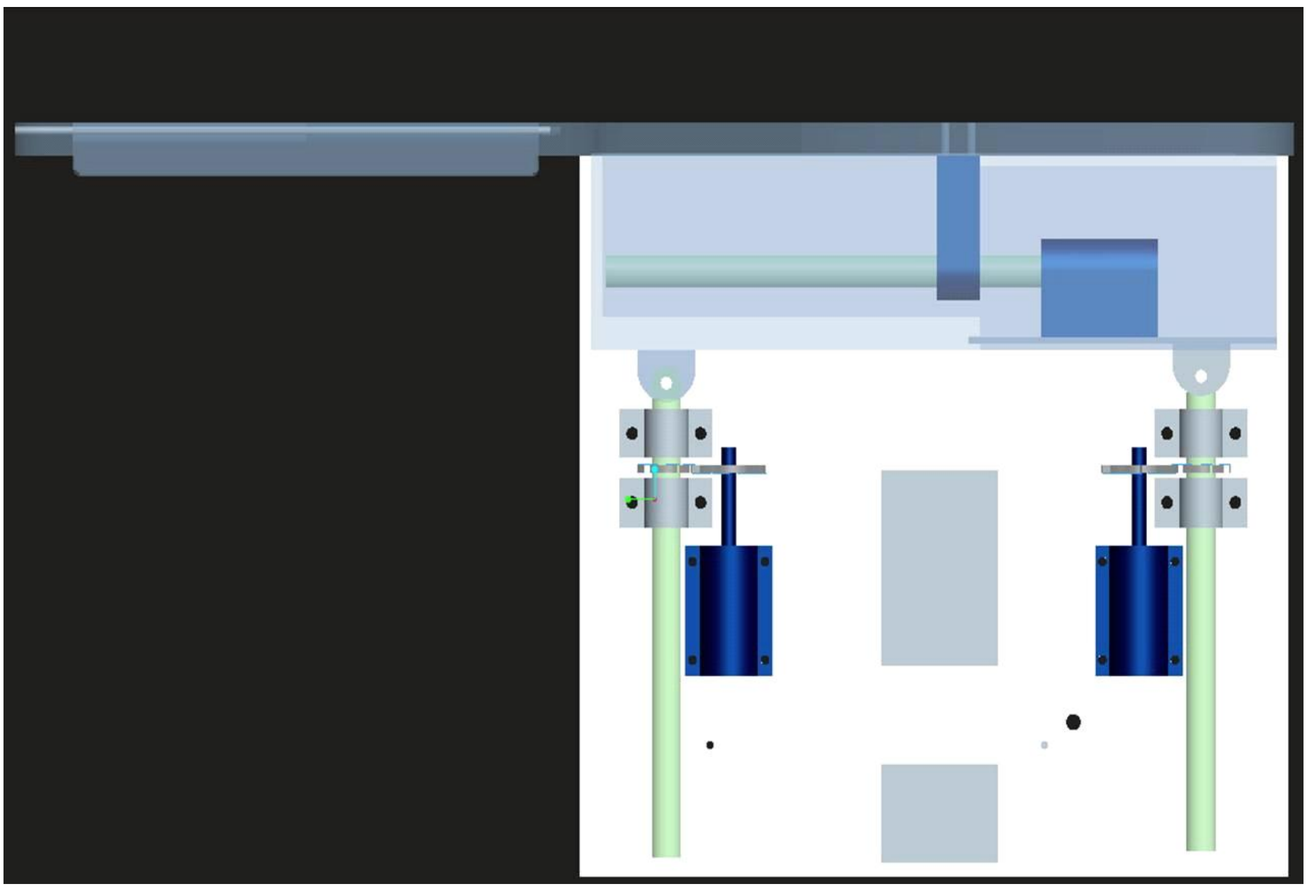

Fig. 9.11. Original Design Showing Motor-Driven Fully Adjustable Tray.

DROP-SHIPMENT AREA MODIFICATION FOR PEOPLE WHO ARE BLIND OR VISUALLY IMPAIRED

Industrial Engineering Designers: Adam Kelchlin (team leader), David Netti, Jeffrey Sweet
Mechanical Engineering Designers: Daniel Braucksieck, Christopher Sinclair
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INTRODUCTION

The client for this project works in an agency that employs individuals who are blind or have visual impairments in various light manufacturing jobs. A drop shipment area, where orders for reusable sticky notes are collected and labeled for shipping, required modification. The products being stored and shipped include pastel and neon pads, and range in size from 1.5″ x 2″ to easel-sized pads. Most of these are packaged into corrugated cardboard boxes of similar sizes, so that distinguishing one product from another is difficult even for sighted employees. Additionally, the process previously used was taxing for the individual working in the area, and was resulting in incorrectly filled orders. The project goals were to reduce the number of shipping errors and make the job easier for employees with visual impairments.

SUMMARY OF IMPACT

The design team redesigned the drop shipment layout and established a standard operating procedure that allowed a visually impaired employee to work more efficiently. Improvements yielded a 28 percent reduction in walking distance and a 13 percent reduction in time spent to complete an order. Employee feedback has been positive and order filling errors have been minimized.

TECHNICAL DESCRIPTION

The team's work was focused on two areas: layout redesign and operating procedure development. The benefits of the new layout (Fig. 9.12) in comparison to the old (Fig. 9.13) are described below.

1. Reduced Walking Distance: The worker's desk was moved into the inventory area, effectively

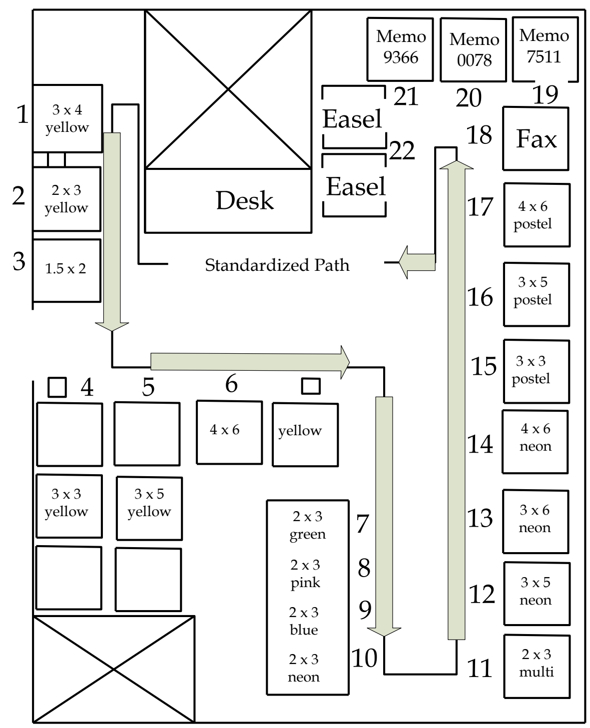

Fig. 9.12. New Layout of ABVI Drop Shipment Area.

reducing the distance walked to collect an order. The most frequently ordered products were moved closer to the worker's desk, while less frequently ordered products were moved away from the desk, reducing walking distance even further.

2. Standardized Layout Orientation: Large signs were put in place in addition to standardized product inventory floor spaces to ensure pallets would always be placed in the correct spot. The standardized floor spaces are the numbers 1 through

22 of inventory labeled in Fig. 9.12. Also, all products were grouped functionally allowing the worker to have familiarity of where products are each time an order is picked.

3. Standardized Pick Order: The team worked with Order Entry personnel to develop order slips to allow the worker to pick orders in a standardized path (Fig. 9.12).

4. Decreased Floor Space: The design team implemented a flow-through rack to decrease the floor space within the Drop Shipment Area. The slowest moving products were placed in this flow-through rack, creating additional floor space that allowed the design team to add new products within the layout.

The new operating procedure includes barcode scanning to generate a packing list and to confirm that the picked order is correct. The benefits of new operating procedure are described below.

1. Reduced time to input order number: It is difficult for the visually impaired worker to type in the ten-digit order number because it is in small print and hard to see on the order slip and on the UPS Software Entry Screen. Scanning the order number makes it easier for the worker, and more accurate.

2. Reduced number of order-picking errors: The pick and scan system allows the worker to verify that the correct notepads were picked. This increases accuracy, and effectively improves customer satisfaction.

3. Reduced time to input weight of packaging: The worker had to enter the weight of each package into the computer manually. Now, these weights will be electronically entered into the computer when the worker scans the boxes picked. Again, this saves time entering this information and reduces the potential for mistakes.

The total cost of the project was $1500.

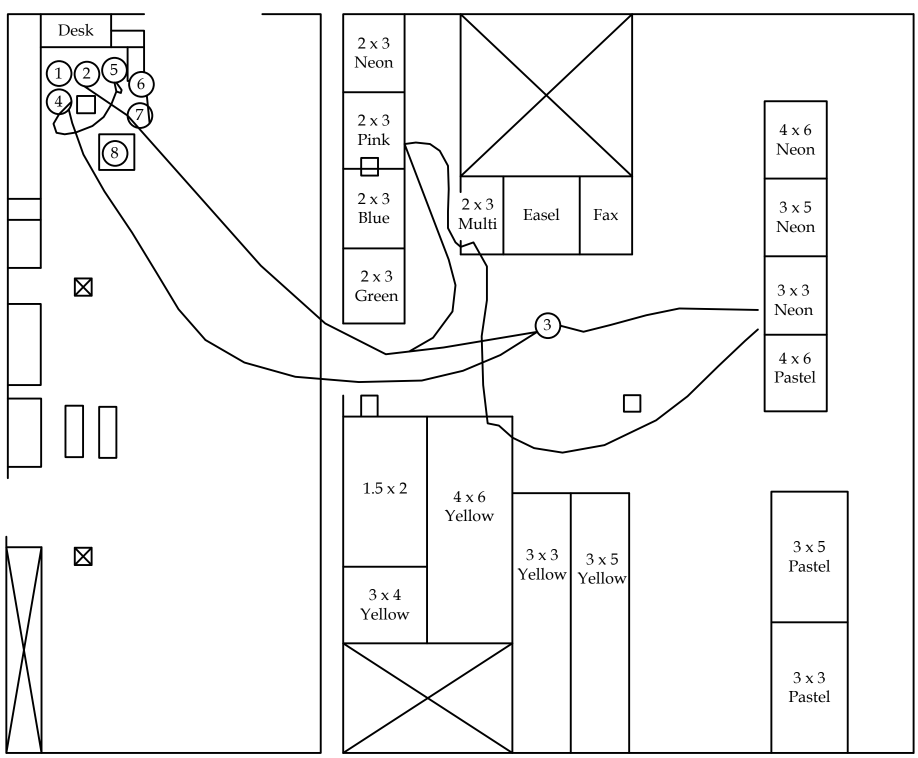

Fig. 9.13. Old Layout of Drop Shipment Area; New Layout Now Situated within One Side of Old Layout.

ARCWORKS SPORTS BOTTLE CLOSURE TUBE ASSEMBLY WORKPLACE ADAPTATION

Industrial Engineering Designers: George Gooch (team leader), Michael Hayden
Mechanical Engineering Designers: Jeffrey Coppola, Christopher Donati, Hui Kim, Michael Levis, William Lucas, Drew Stone-Briggs,
Client Coordinator: John Syrkin, ArcWorks
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INTRODUCTION

An agency employs individuals with developmental disabilities to perform light manufacturing work subcontracted from local companies. Employees are paid based on the number of pieces they produce. One of the products assembled by employees is a closure tube assembly for squeeze-style sports bottles (Fig. 9.14). Existing equipment required individuals to manually fit together the cap and adapter using a press. The subassembly was boxed, and later a different individual attached the straw to the adapter. The design team was asked to help the organization with inventory management and raw material order points.

SUMMARY OF IMPACT

The new design includes a number of improvements. First, the entire closure tube assembly is now done on a single pneumatically driven machine, with automatic counters included to record the number of caps, adapters, and straws each employee assembles. Next, the device is automated, reducing ergonomic strains on the individuals performing the assembly. The new device is also robust enough to work with a range of different sizes of caps and straws, so employees do not need assistance to modify the machine when different-sized units are being assembled. Finally, the warehousing and ordering procedures have been modified so the correct amount of raw materials are always on hand in easily identifiable locations. The completed system is shown in Fig. 9.15.

TECHNICAL DESCRIPTION

The system is based around two pneumatic presses that are operated with an anti tie-down switch. The left side of the system (Fig. 9.15) presses an adapter into a cap and the right side presses a straw onto an adapter. A switch on the base allows the user to run both sides simultaneously or each side individually, and a counter on each side tracks the number of components assembled. The new automated system limits the user's motions to those required to press the anti tie-down buttons and eliminates the gross

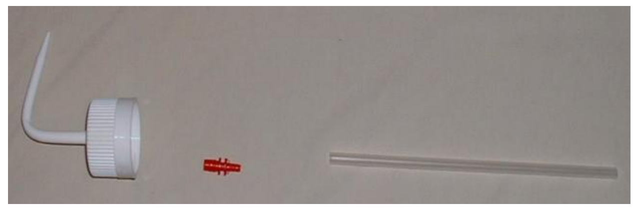


Fig. 9.14. Closure Tube Assembly: Cap (Left), Adapter (Center), and Straw (Right).

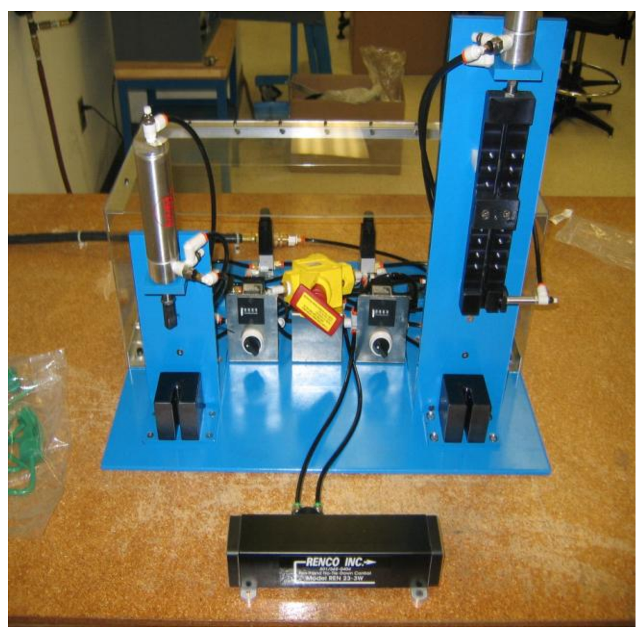
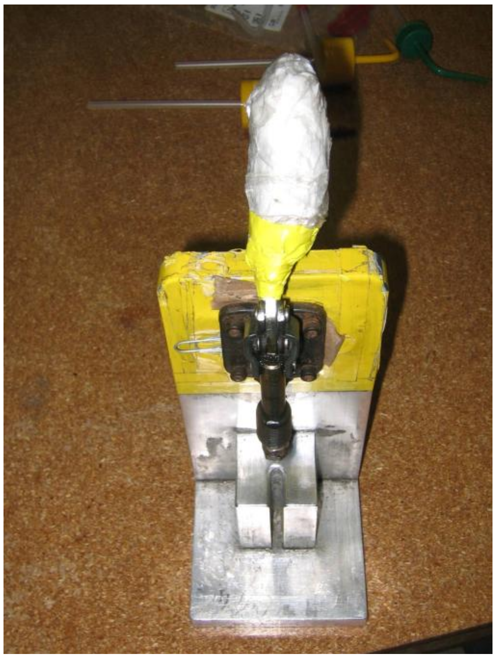


Fig. 9.15. New Closure Tube Assembly System.

motion required to operate the existing manual presses.

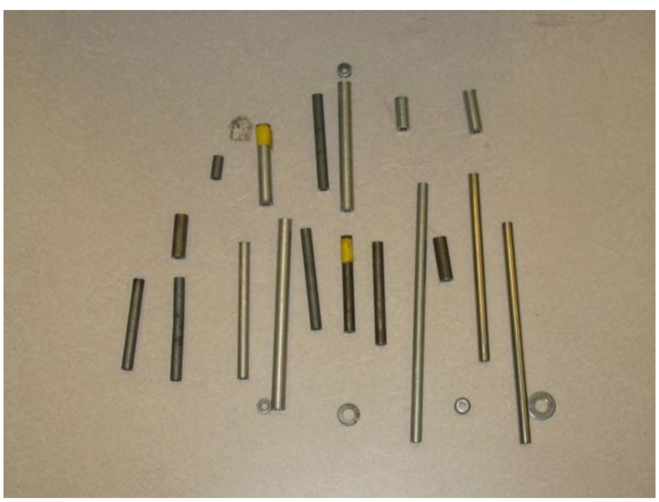
Fig. 9.16 shows some comparisons between the existing and newly designed assembly devices. It is clear that the new designs reduce the manual aspect of assembly as well as the number of parts required for the device to be able to handle all of the products. This increases the independence of the user, who will now be able to assemble any product without requiring assistance to modify the equipment.

The total cost of the project was $1658.



(a)

(b)



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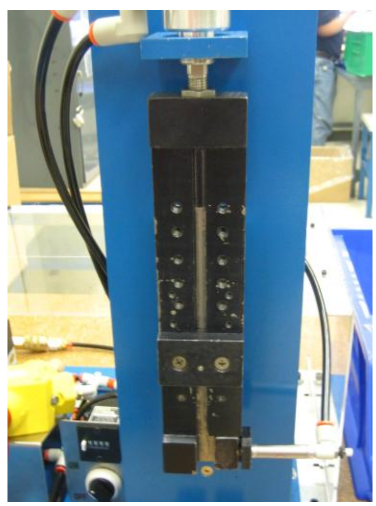

(d)

Fig. 9.16. Top (a and b): Old (Left) and New (Right) Equipment for Pressing Adapter into Cap. Bottom (c and d): Old (Left) and New (Right) Equipment Required for Assembling Straws of Varying Lengths.

SENSORY AWARENESS TRAIL

Mechanical Engineering Designers: Richard Adams (team leader), Brian Luke Hogan, Choi Wong
Electrical Engineering Designers: Chiedu Monu, Timothy Mugwanya
Client Coordinator: Susan Epstein, Everybody Rides
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INTRODUCTION

The object of this project was to create a sensory awareness trail at a therapeutic horseback riding facility that serves individuals with developmental disabilities. Users may be on horseback or on foot. Each station created stimulates one or more of the senses, educates participants on the natural elements surrounding them, and blends in with the natural surroundings as much as possible, all while requiring only renewable energy sources.

SUMMARY OF IMPACT

The team's final designs consisted of a set of bamboo chimes, a solar powered floating fountain, a pinecone bucket game, wooden animal silhouettes, and a series of audio boxes that play informational messages about particular natural features.

TECHNICAL DESCRIPTION

The bamboo chime station (Fig. 9.17) reaches 8 feet above the ground and is 53 inches wide. Trail users on horseback and on foot will take a stick from the basket shown and strike the chimes. The chimes will then project melodic sounds. This station stimulates the user's motor skills, sense of touch, and sense of hearing.

Fig. 9.17. Bamboo Chimes Station.

Audio boxes stationed around the trail play pre-recorded 20-second sound clips. These boxes are used in the animal silhouette station and in various parts of the trail. They provide informative clips about different aspects of the trail and in the silhouette station. A 9V rechargeable NiMH Energizer battery is used in each. The circuit draws 58mA from the battery; therefore, the lifecycle of the battery will provide approximately 460 operations.

Silhouettes of deer, squirrel, rabbit, and coyote were constructed (Fig. 9.18). These silhouettes are stationed throughout a clearing alongside the trail. Immediately off the trail, mounted to the top of a post, is a wooden box with a speaker inside. When the black button on the speaker encasement is pushed an audio clip plays. This clip educates the user about the animals that are represented by the silhouettes. Therefore, the user's sense of hearing and sight are stimulated.

A pinecone bucket game was devised to challenge motor skills and aid practice for a similar game in the Special Olympics (Fig. 9.19). The buckets are mounted to trees roughly 30 yards apart along the trail. The user takes a pinecone from one bucket, carries it to the next bucket, and drops the pinecone in that bucket.

Finally, a realistic lily pad fountain was placed in a pond bordering the sensory trail. The fountain contains three heads built into a resin leaf shape. The pump is powered completely by a solar panel and shoots water 18" high. This solar fountain creates a soothing sound and it is visually appealing.

The total cost of the project was $709.

Fig. 9.18. Animal Silhouette.

Fig. 9.19. Pinecone Bucket Game.

SEIZURE MONITOR

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INTRODUCTION

The mother of a teen who has generalized tonic-clonic (GTC), or grand mal, seizures requested a device to detect her teen's seizures during sleeping periods. The mother requested an easy-to-use device that could be attached to her teen during sleeping periods. The device audibly alerts a person located somewhere within the same household to the occurrence of a seizure.

SUMMARY OF IMPACT

Though a device might be developed to detect only GTC seizures, the medical coordinator requested a system that could be used to detect multiple types of seizures, since such a device would be useful in the treatment and care of other patients with seizure disorders. Other seizure types exhibit a combination of movements in the limbs, head, and/or torso and may not involve rhythmic shaking. Therefore, the system designed for this project is capable of collecting data from several different sources attached to different parts of the body. The system consists of wearable motion-monitoring devices, a base unit to collect the motion data, and data analysis software that will determine whether or not a seizure event is occurring.

TECHNICAL DESCRIPTION

After researching the different products that were commercially available, the decision was made to us the M5282ZIGBEE ColdFire MCF5282 ZigBee ready demo kit. The kit, technology used, and design modifications are specified below.

The motion monitoring system:

1. Communicates with the base device using ZigBee protocol based on the IEEE 802.15.4 wireless communication standard;

2. Has a communication range of approximately 50 m from the motion monitoring device to the base device;

3. Has a maximum data transfer rate from the motion monitoring devices to the base of 250 kbps;

4. Uses data transfer rate of 2.197kbps, based on a six monitoring device design, a 100 Hz sampling rate, 10 bit microcontroller, and a 3 axis accelerometer; and

5. Transmits the motion data to a personal computer or laptop via an Ethernet (UDP) connection.

The motion monitoring device:

1. Is padded using PORON, a medical grade cushioning material;

2. Employs a selectable (1.5, 2, 4, 6)-g tri-axial accelerometer;

3. Has a usable bandwidth of 350 Hz for XY motion and 150 Hz for Z axis motion;

4. Is capable of being dropped onto concrete from 1.8 meters onto any axis;

5. Is powered by two AAA batteries, which will provide continuous operation for nine hours; and

6. Has an overall mass of 151.7 grams.

The base device:

1. Can communicate simultaneously with up to 16 motion-monitoring devices; and

2. Can send the data from the motion monitoring devices to a computer via UDP.

The software:

1. Is able to process and write the 16-channels of data streams to a computer via UDP; and

2. Is able to perform FFT, cross-correlation, and signal energy analysis techniques to identify seizure events.

The current design is functional but can still be improved. A key aspect of plans for future work is installing extra safety measures, such as a periodic self-test mode that will warn if the system is not working, a low battery warning, and extended usage time (beyond 9 hours). A modified base unit might store data on a flash memory drive, which would eliminate the need for a laptop as part of the base unit. Finally, data analysis will be improved and geared more specifically at identifying specific types of seizure events.

The total cost of the project was $1109.

Fig. 9.20. A wireless motion monitoring device worn on the wrist of a user.

THERAPY POOL LIFT

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INTRODUCTION

Many of the individuals using the pool at an agency for people who have physical disabilities are unable to walk unassisted down the steps into the pool. They use a pool lift that lowers them into and raises them out of the pool. The lift previously used was unreliable, unsteady, and did not meet ADA/ABA regulations. This project was aimed at designing and constructing a new lift to improve the safety and comfort of consumers using the therapy pool.

SUMMARY OF IMPACT

The new pool lift meets all ADA/ABA regulations, in addition to providing a safer and more comfortable seat for the consumers using it. Consumers and therapists can now be a safe distance from the edge of the pool deck when individuals are helped into and out of the seat. Also, motion from the deck to the pool is smooth. Critical surfaces are padded, and all pinch points have been eliminated. The lift can be completely operated by one person, although it has been designed so that two people can assist the consumer, one on each

Fig. 9.21 Pool Lift in Submerged Position.

side of the seat.

TECHNICAL DESCRIPTION

The final design is shown in Fig. 9.21. This is the submerged position of the lift, where the consumer could exit the seat in the water. The armrests are shown in the lowered position, but they can also be raised to facilitate a person entering or leaving the seat. A linear actuator with a wired remote powers the lift; a therapist can lift an individual out of the pool using the “Raise” button on the actuator remote. The actuator itself is splash resistant, and the actuator control box is waterproof. Power for the actuator comes from a GFCI outlet located below the pool deck, so the power supply is out of splash-range and there are no exposed power cords to pose tripping hazards.

The raised pool lift position is shown in Fig. 9.22. The lift can rotate 360º, but will typically only be rotated 180º, from the submerged position over the pool to the loading position over the pool deck. The horizontal bar at the top of the device is used to rotate the lift. In the loading position, the seat centerline is 36” from the edge of the pool deck, and the seat is accessible by therapists from both sides.

The base of this new pool lift is designed to fit into the hole used for the existing lift with few modifications. The base consists of a stainless steel plate with a thrust bearing set on it. The main post that rotates the consumer in the lift will ride on this thrust bearing. An oil-impregnated bronze bushing is set into place around the main post to provide an additional bearing surface. The bushing is encased in PVC pipe to protect it from the surrounding concrete, and a waterproof gasket under an aluminum top plate protects the entire base assembly.

The structural elements of the pool lift are all made from 6061-T6 aluminum, coated with industrial corrosion resistant paint. Static and fatigue analysis on load bearing components indicate that the lift should operate for at least 20 years. The new owners have been provided with a user’s manual that includes maintenance and troubleshooting guides.

The total cost of the project was $1479, with an additional actuator donation valued at approximately $1000.

Fig. 9.22. Pool Lift in Raised Position.