CHAPTER 20
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BILATERAL ACOUSTIC TRAINER

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INTRODUCTION

The Bilateral Acoustic Trainer is a keyboard redesigned to teach preschool children proper use of an instrument and to encourage bilateral movement in children who tend to use only one hand. The children become more disciplined since they must properly play with the toy for the keyboard to respond to their actions. Also, children with limited use of one or both arms are more inclined to use the less dominant arm and hopefully increase dexterity in the weaker arm. The instrument is also adaptable for children with hearing impairments to enable them to seek enjoyment from a musical instrument, as well.

SUMMARY OF IMPACT

The keyboard accommodates children who have limited use of only one of arm such that they are required to use their non-dominant arm. It operates only when the child is using both hands with feet properly placed on the activation pad. In addition, it discourages children's abuse of the keyboard. It automatically shuts off if being used improperly or if the child steps off the floor pad.

The keyboard incorporates a switch, which allows the child to use only one hand. The keyboard case and keys were redesigned to withstand environmental stresses. The keyboard is functional for a variety of operators. It includes a visual display for children with hearing impairments. An additional switch, solely for the teacher, allows her to deactivate the bilateral component of the keyboard for children with use of only one arm.

TECHNICAL DESCRIPTION

The floor activation pad acts as a power supply switch for the keyboard. The pad has an upper and lower plate made of plywood. A metal plate is located in the center of the plywood plates, which may be pressed together, causing the metal plates to make contact, thus closing the switch. The no-spring floor pad does not use springs, as it relies on the flexibility of the upper plate to allow the metal plates to make contact.

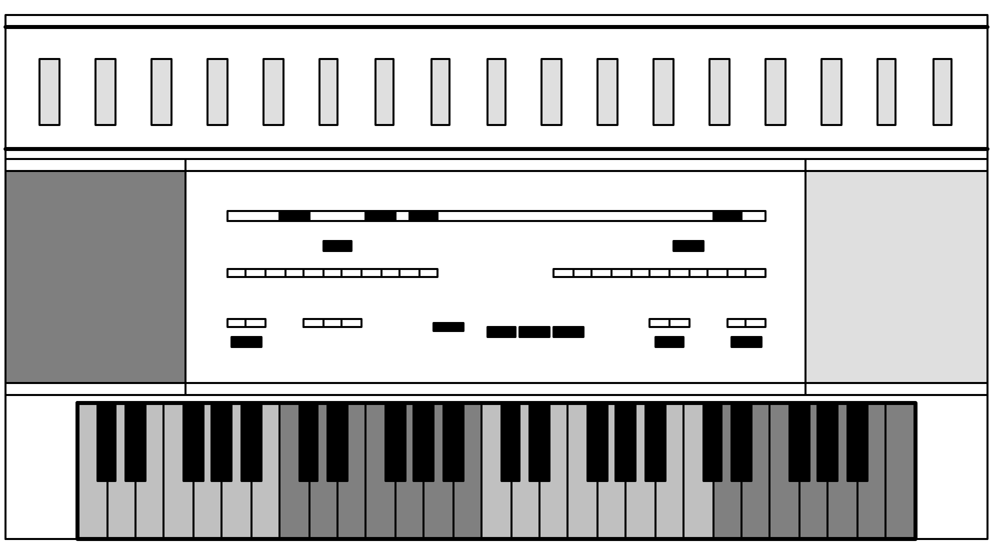

Figure 20.1. Bilateral Acoustic Trainer.

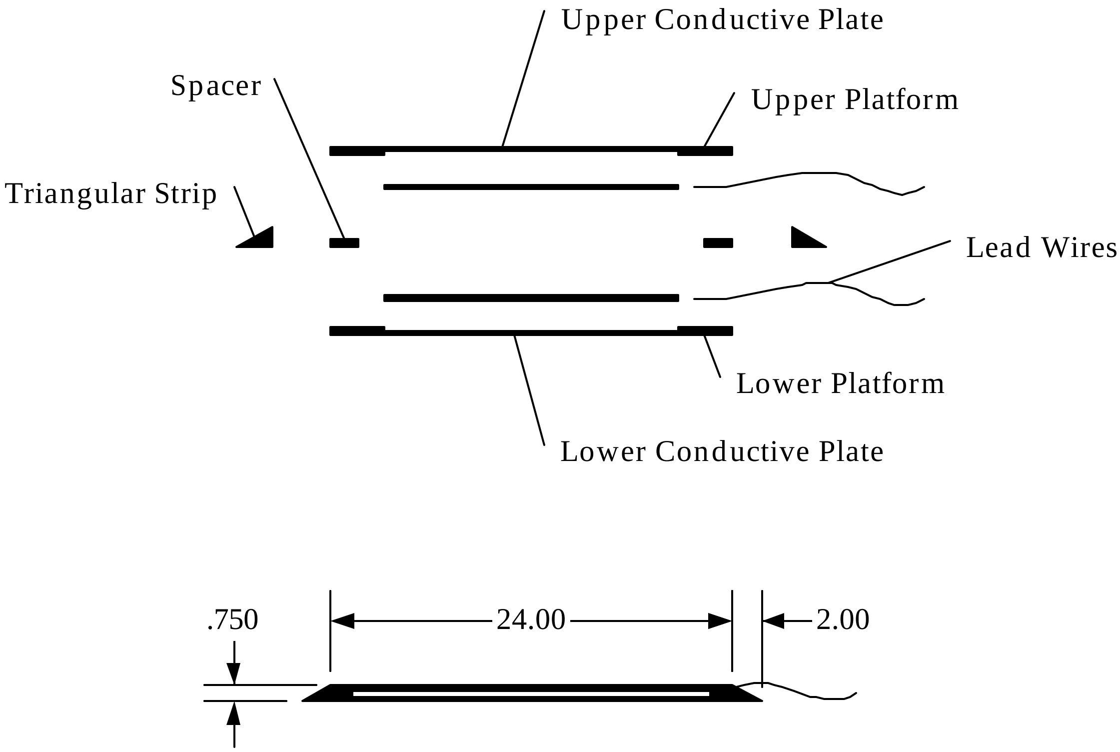

Figure 20.2. The No-Spring Floor Pad.

The anti-bang device was designed to deactivate the system when the keyboard is struck with excessive force. The teacher must reset it. This feature is controlled by a simple set of switches, which rely on a linear spring to close a switch only when a preset force (determined by the spring coefficient) has been exceeded.

The keyboard is divided into fourths (as shown in Figure 20.1), with two sections being distinguished by green and two sections by orange. To satisfy the circuitry of the bilateral control, a key from each green group has to be played simultaneously, or a key from both orange groups must be depressed simultaneously.

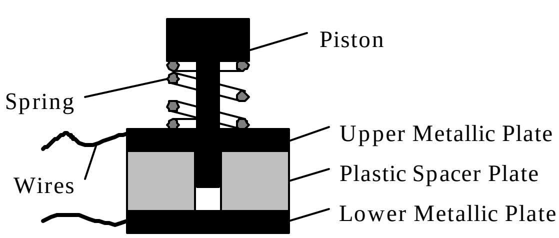

Figure 20.3. The Anti-Bang Switch Acting as a Force Transducer.

The logic behind the Bilateral Acoustic Trainer is shown in Figure 20.4. The decade counter is used as a toggle switch based on a signal being received from the bilateral on / off button. The OR gate closes the relay when two like color keys are pressed, when buttons of different colors are pressed, or if the output of the decade counter is high, indicating the bilateral aspect of the keyboard has been deactivated. Figure 20.6 displays a portion of the existing keyboard, which illustrates the modification of the existing keyboard circuitry necessary to detect when one or more keys in a group is being pressed. This is equivalent for a given color group of keys. The output increases for each progressive key on the keyboard. In essence, the pads, which are closed by a conductive plunger when a key is pressed, are shorted together to ensure current flow if any pad is closed. The diodes enable the distinction between one key in a group being played versus all the keys in the group being played simultaneously.

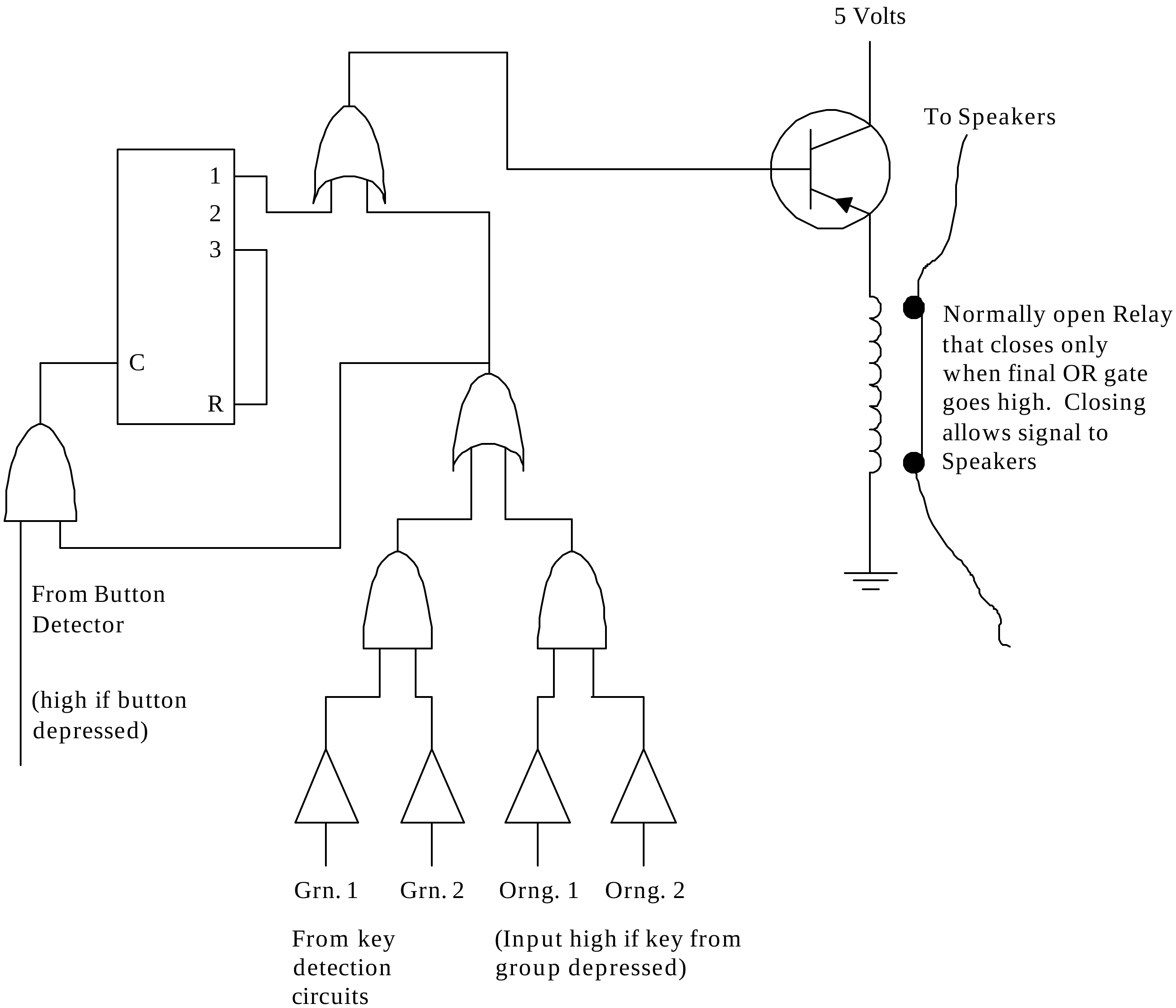

Figure 20.4. Logic of the Bilateral Control.

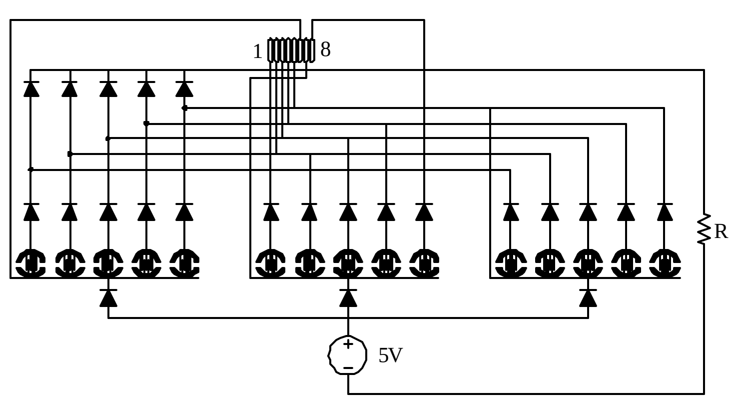

Figure 20.5. Modification of Existing Keyboard.

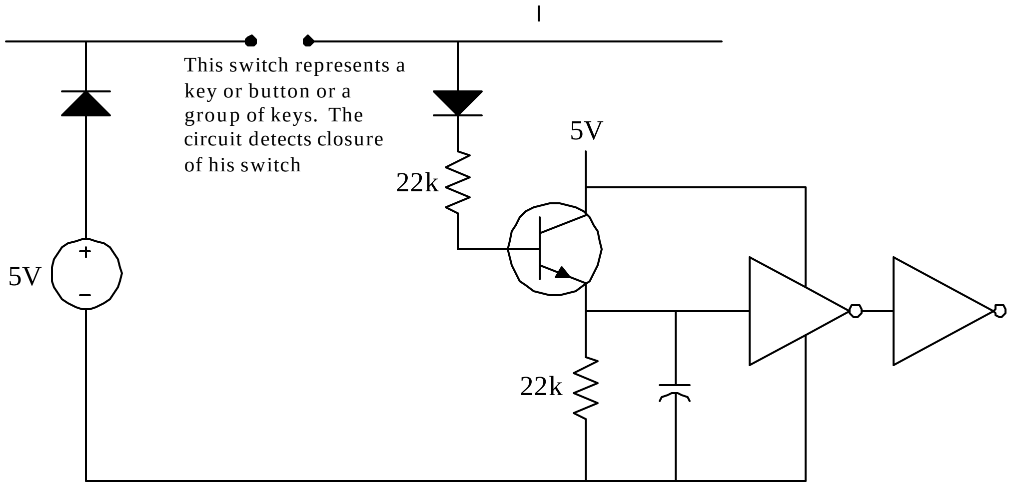

Figure 20.6. Continuity Checking Circuit to Sense when a Key is Pressed.

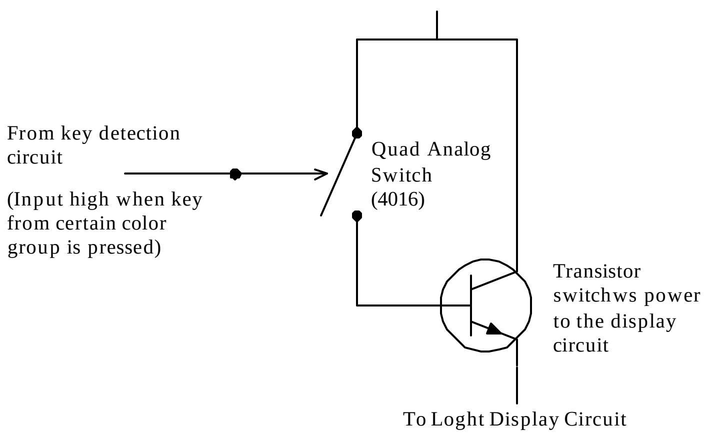

Figure 20.7. Quad Analog Switch Used as a Buffer.

The transistor is necessary because the diodes drop the voltage enough so the Schmidt trigger does not trigger when placed at the high end of the first resistor. The capacitor provides a small amount of debouncing to the circuit. The diodes are necessary to detect if only one key in a group is pressed, as shown in Figure 20.5. Since the Schmidt trigger inverts, the inverter supplies the entire detection circuit its desired output characteristic, namely high when a key is pressed. Conversely, the opposite is true when the desired output characteristic is low.

Figure 20.7 shows the quad analog switch in this circuit used as a buffer, as the hex inverters could not provide sufficient current to completely activate the switch. There are four of these circuits, one for each group of keys. Since the input is high when a key is pressed, the output is five volts to the circuitry controlling the visual display unit. The visual light display shown in Figure 20.1 consists of four groups of lights corresponding to the four groups of keys. When a key is depressed, the corresponding column of lights is illuminated row by row, upward from the bottom. When the key is released, the lights go out. The cycle begins again when the key is pushed. The circuitry for the light display is controlled by a 555 timer that sets the speed for the LED activation. A decade counter is used in conjunction with the 555 timer to light them sequentially upward from the bottom. Transistors are used at the output of the decade counter to increase the current to the LEDs, thereby increasing their brightness.

The total cost of the project was $790.

ENVIRONMENTAL CONTROL UNIT

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INTRODUCTION

An environmental control unit was needed to allow a person with severe cerebral palsy to control his surrounding environment. The user is a twenty-four-year-old male with severe spastic cerebral palsy. He uses a wheelchair. He is completely paralyzed, with the exception of the ability to blink both eyes and rotate his head about .25 inches to either side. The client is unable to manually change the channel on his television with a conventional remote due to his paralysis. The client is nonverbal. Consequently, the opportunity to choose or to express his desires has never been available. This project design enables the client to control his television set and two additional electrical devices through the use of a cheek button.

SUMMARY OF IMPACT

This environmental control unit allows the operator to actively participate in the surrounding environment and make his own choices, by controlling the television as well as other electrical appliances. This form of interaction with the environment increases the communication level in his home. Having a choice of the four options available to the user at a particular time allows different items to be disabled by the caregivers in case the device is used incorrectly by the client. These options also allow the device to meet the user's needs in controlling only the options desired or the options that may be handled by the simple turning of a switch. With the built-in variable sequencing rate, the product accommodates different user reaction times. As the user becomes familiar with the device, the rate may be increased. Likewise if the condition of the user becomes more severe, the rate may be decreased.

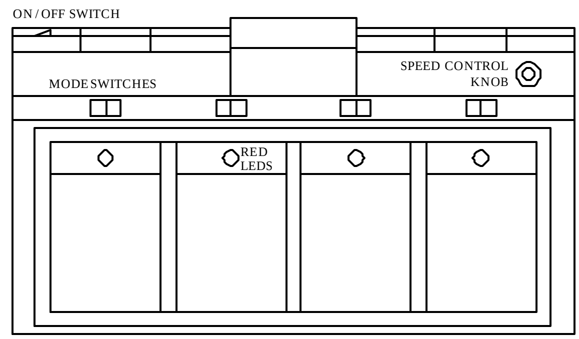

Figure 20.8. Front view of the Environmental Control Unit

TECHNICAL DESCRIPTION

The unit consists of the following eight components: display case, user button, AC/DC adapter, X-10 modules, X-10 remote, remote extender receiver, universal TV remote, and microprocessor. To operate the unit, the user button and power must be placed into the appropriate jacks; the remote extender receiver must be directed at the TV; and the electrical appliances to be operated with the X-10 controls must be turned on and plugged into the modules. The user then determines one of 15 option modes by activating the appropriate switches located above each of the four pictured options. If the switch for a pictured option is activated, then that option is included in the sequencing pattern for selection by the user. Next, the unit is activated with the power switch located in the upper left corner of the display case. The unit then continuously cycles through the selected options, and the operator depresses the button when the desired option is available. The selected option is signaled by the momentary lighting of an LED positioned above each pictured option on the display case. When a choice is activated, the cycle continues until another option is selected.

A microprocessor is used for the basic control of this project, specifically the BASIC Stamp II, which has 16 input/output pins. The first four input/output pins, pins zero through three, are used as inputs to control the modes option.

Any of the four possible options can be switched on at any time. Each of the first four pins is connected to a switch that connects the input pin to a high source when switched to the on position.

The microprocessor program notices which of the four switches are thrown or any combination of those switches and activates output pins four through seven, which are connected to LEDs on the display menu, indicating a particular option to be available. For instance, if switches A and C are thrown, the LEDs above options A and C will toggle on and off until a choice is made or until a different mode is activated, thus allowing the user to expand options. If the user can handle only one option at a time, one switch can be placed in the on position making only that particular option available.

Pin eight is an input pin for an RC circuit. The resistance is varied by a potentiometer to form different RC time constants measured by the microprocessor. This potentiometer allows the user or the user's caregivers to vary the rate at which the options are being scrolled through the menu display, thereby eliminating the problem of having a fixed rate. The potentiometer is available on the front of the display case, and the rate can be adjusted by simply turning a knob. The variability of rates is such that the slowest is appropriate for first time users, while the fastest is quick enough for an advanced user.

Pins nine through 12 are used to activate the TV channel up, TV power, turn the first X-10 device on, and activate the second X-10 device, respectively. Pin 13 is used to continuously monitor the user button input. The remaining two pins, 14 and 15, are used to deactivate the first and second X-10 devices.

The total cost of the project is $630.

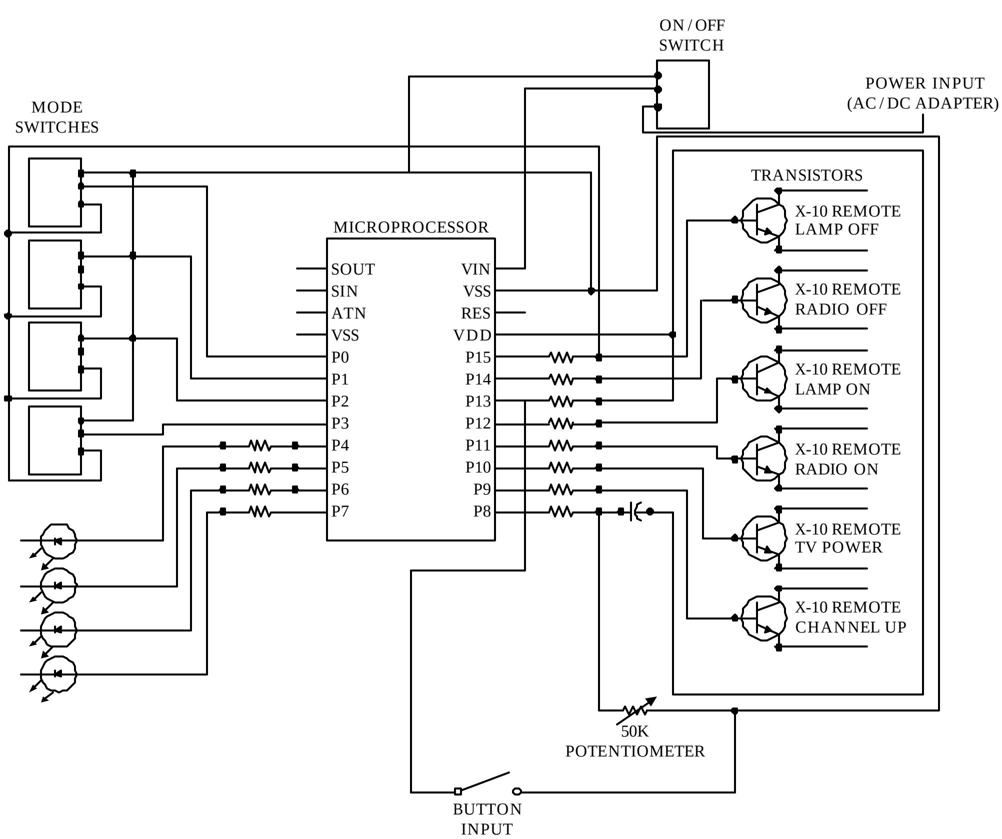

Figure 20.9. Wiring Diagram.

ADJUSTABLE CHAIR HEIGHT

Designers: James Marks, Kevin Spicer
Client Coordinator: Debbie Accurso
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Supervising Professor: Dr. Ping He
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INTRODUCTION

This adjustable chair height project was developed to modify an existing wheelchair for a five-year-old child with Arthrogryposis Multiplex Congenita, involving fibrous stiffness of one or more joints. The client remains in his wheelchair during the day. Previously, because of the fixed height of his wheelchair, the child had to be transferred to another chair when he wanted to work or play at various stations positioned throughout his classroom.

SUMMARY OF IMPACT

The adjustable chair lift raises and lowers the client's chair to variable heights to accommodate different workstations throughout his classroom. The adjustable chair height project allows the child to interact in a variety of situations with other children in the class.

TECHNICAL SUPPORT

The client's wheelchair sits approximately 13 inches off the ground. Some of the classroom workstations, a sandbox and workbench, are at a height of 25 inches off the ground, placing them out of the child's reach when he is in his wheelchair.

The adjustable height chair involves lifting the chair manually with a screw jack, using a hand crank placed on the back of the chair. The chair is mounted to the top plate of the jack by two steel plates. The base of the screw jack is mounted onto a steel plate. The cylindrical base rails of the chair are replaced with rectangular steel rails of the same length. The steel base plate is then mounted on these new base rails. The 90° drill attachment (RAD) is attached to the base of the chair by a bracket. A steel adapter attaches the 90° drill attachment to the jack. Another steel adapter attaches a universal joint to the opposite end of the drill attachment. The universal joint is used to compensate for the drift experienced by the jack. One end of a steel rod is attached to this universal joint. Another universal joint drill attachment system is then attached to the opposite end of the steel rod. A steel adapter attaches the hand crank to the 90° drill attachment. This system, along with the hand crank, is the gear mechanism used to rotate the screw, resulting in a change of chair height.

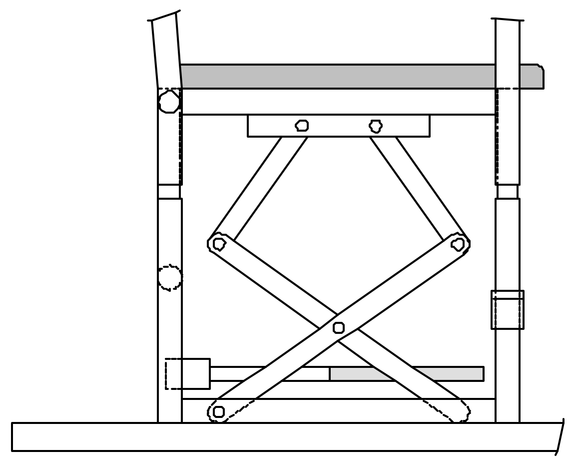

Figure 20.10. Scissor Jack Design.

The hand crank mechanism is attached to the back of the chair by a slide-guide rail system. This system allows the position of the hand crank to remain constant as the chair moves vertically. The 90° attachment, RAD, is attached to the slide-rail system by a bracket. Another steel plate is attached to the lower part of the slide-rail system to add stability. The slide-guide system is attached to the back of the chair by a block made of ¾-inch plywood.

Two struts are used to help reduce the torque needed to raise the chair and provide stability, reducing the side-to-side motion of the chair. The struts are also used as a safety measure to control the rate at which the chair is lowered. These struts are attached to the back legs of the chair and rail base by means of a ball-and-socket system.

Two steel rods serve as leg guides at the front of the chair. One end of the rod is placed inside the leg. The opposite end of the rod is attached to the rail base of the chair by a nylon block. This block is designed to allow lateral movement of the rod, compensating for the drift experienced by the jack.

For mobility, four casters are placed at the ends of the base rails. The two front casters are rigid, while the back casters swivel to allow chair rotation. The back casters have a lock system that is implemented when the chair is raised or lowered.

A new footrest was made of ¾" plywood so the child's feet would not be left suspended from the chair. Nylon bellows are attached to the front legs of the chair, as well as around the shaft and universal joints used in the hand crank mechanism, to prevent children from getting pinched between the guides and the legs of the chair as the chair is raised and lowered.

Execution of the lift is basic. Once the chair is wheeled to the desired table, pushing the tab at the side of the back wheel to the down position locks the back casters, making the chair ready to be raised. Then the person places one hand on the back of the chair to stabilize the person operating the crank and then turning the crank clockwise until the chair is at the desired height. The chair will remain in that position until the hand crank is used again.

To lower the chair to the original position, one hand is placed on the back of the chair, once again for stabilization of the operator, and the crank is turned counterclockwise with the other hand. The crank is turned until the chair stops moving. The chair is able to raise and lower within a specified range. It has a minimum height of 13 inches, measured from the floor to the bottom of the chair, allowing the chair to be used for the lowest table in the room. The maximum height attainable is 19 3/4 inches, again measured from the floor to the bottom of the chair, allowing the chair to be used with the highest table in the room, 25 inches.

The total cost of the project, excluding the donated manufacturing costs, is $710.

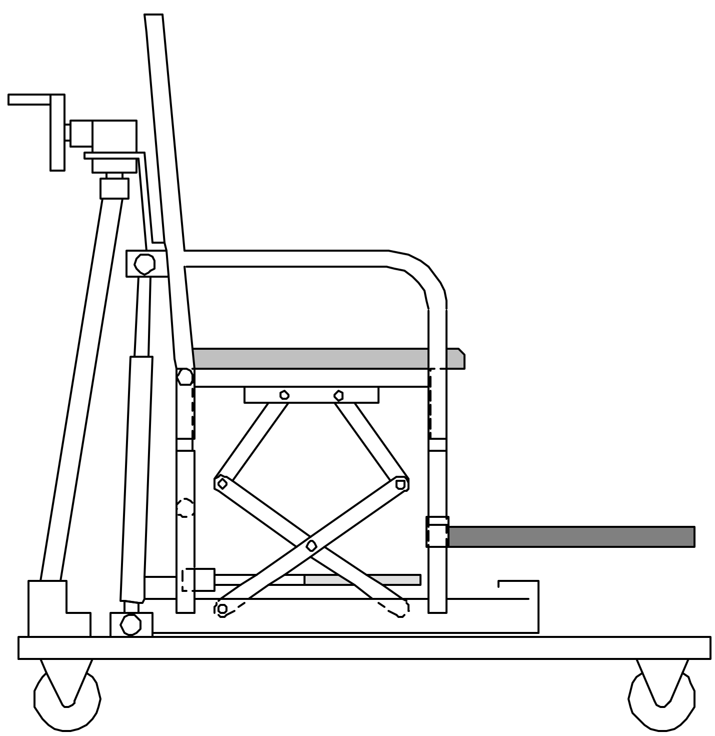

Figure 20.11. Adjustable Height Chair.

MULTI-FUNCTION SPEECH THERAPY APPARATUS

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Client Coordinator:
Supervising Professor: Dr. Ping He
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INTRODUCTION

A multipurpose device was needed to aid speech-language pathologists (SLPs) in the treatment of patients with a variety of speech disorders. Speech therapists often use Devices used by SLPs include metronomes, tape recorders, volume indicators, and delayed auditory feedback (DAF) systems. Tape recorders are used to record a sample of the patient's speech to examine and store for future use variables, such as breathing rate and articulation. Although standard tape recorders adequately serve this purpose, they require constant user interface to control the record and playback of the sample, requiring the therapist to expend therapy time rewinding and locating the sample on the tape. Solid-state recorders such as those used in some answering machines address these problems, but can only record and playback finite read-write cycles.

Although there are commercially available devices that measure volume levels, research revealed no prior single self-contained device designed specifically for speech therapy that clearly displayed relative volume levels. Metronomes are commonplace devices that produce a pulsatile sound at a variable constant frequency. There are many types of metronomes on the market, but few, if any are designed specifically for speech therapy.

SUMMARY OF IMPACT

This multipurpose device will assist SLPs in the treatment of patients with speech disorders.

TECHNICAL DESCRIPTION

The Multi-function Speech Therapy Apparatus utilizes a microprocessor to ensure no degradation in the sound quality regardless of the storage time. The metronome used in this project is a simple 555 timer allowing for simple on/off switching and simple control rate. The microphone pre-amp in this design is a simple transistor amp, which has the benefits of a single power supply, few components, low power consumption, and a desired built-in +2.5 volt offset. A TDA7052 headphone driver chip is also included in this design since it has the required bandwidth, the power output ability needed, and a single potentiometer to control the volume. A LM3914 chip is specifically designed for driving a string of LED's in the desired manner. This chip takes a voltage input, processes it with a comparator stack, and lights a corresponding LED based on the input voltage.

This device offers several functions including the metronome, short delay, long delay, and visual feedback. The metronome function is controlled with the metronome on/off switch and the metronome rate knob. The purpose of the metronome is to help generate a fluid speech rate. The metronome is generated from an audible pulse occurring at an interval set by the delay control knob. The patient will usually say one syllable per beat. Therefore, the delay ranges from one to five beats per second.

The short delay function is controlled with the toggle switch (short delay on/off) and rotary switch (short delay length). The purpose of the short delay is to delay the speech of a person from 50 to 250 milliseconds. This delay period can reduce stuttering. The delays are utilized therapeutically by starting the patient on the long delay and then gradually decreasing the delay as speech improves.

The long delay function is controlled with the toggle switch (long delay on/off) and optionally by the manual Play/Record Control. The long delay can record 16 seconds of speech and play the sample back. When the long delay mode is activated, it will check to see if the manual control is attached. If the control is not present, the MFSTA will automatically start recording a 16 second sample. When the buffer is full, the MFSTA will wait approximately four seconds and then play back the sample. Upon conclusion of the playback, the unit will start to record again. If the status of the short delay or long delay modes is changed while the unit is recording or playing back, the mechanism necessitates waiting for the unit to finish the playback before the change occurs.

The visual feedback device (VFD) is activated by the power switch. The VFD has an arc of 10 LEDs, indicating the relative volume of the speaker. The indicator shows the volume of the speech the user is hearing over the headphones. The LEDs are color- and position-coded such that green is ideal, yellow being close and red being in the extreme. The left LEDs indicate "too soft;" center is optimal; and right is "too loud." The threshold knob (calibration) adjusts the sensitivity of the VFD to represent different desired volumes. This device is useful in any case where a second feedback source is desired.

The total cost of this project is $790.

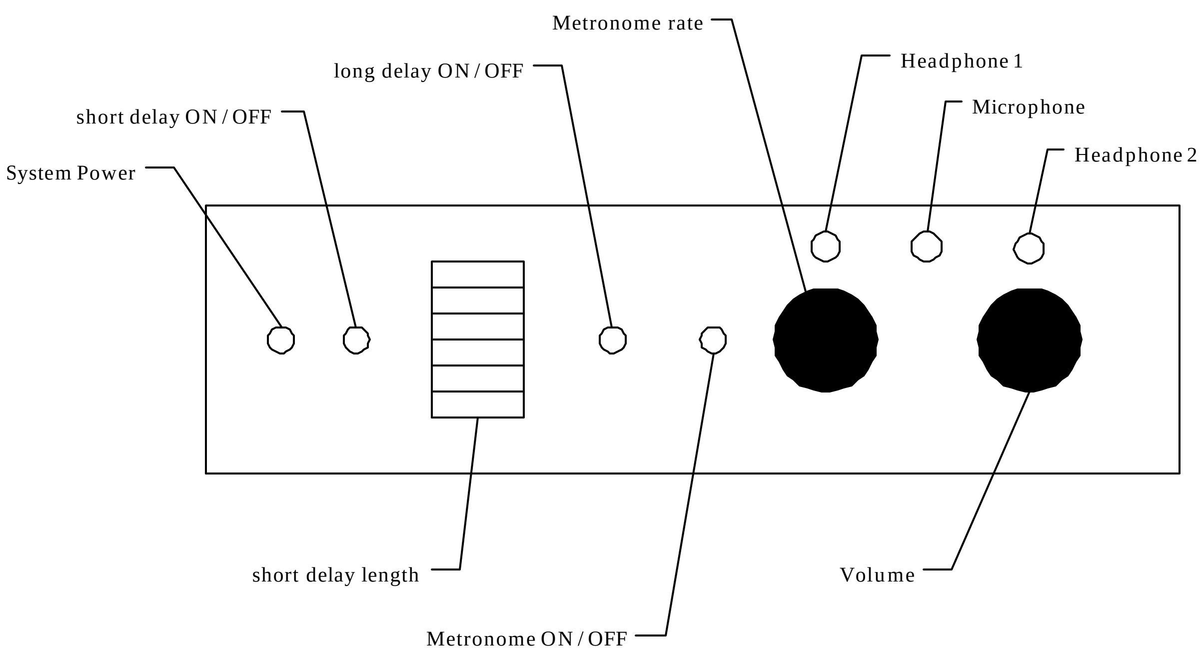

Figure 20.12. Diagram of Controls.

AUTOMATIC JAR OPENER

Designers: Chong Kim, Rob Short
Client Coordinator: Ms. Donna Harlarcher
Fairborn Community Services
Supervising Professor: Dr. David Reynolds
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INTRODUCTION

A device was designed to automatically open jars . It was designed for a client with scleroderma, a form of arthritis, which diminishes physical capabilities such as gripping. In the process of opening a jar, one must be able to stabilize the jar with enough grip strength to counteract the torque necessary to unscrew the lid. The three main objectives of this design include the vertical mount subsystem, the grip/interface subsystem, and the torque input subsystem. The vertical mount subsystem allows for vertical accommodation of various jar sizes. The grip/interface subsystem applies grip to hold various jar materials, provides the necessary counter-torque, and accommodates various jar diameters. Finally, the torque input subsystem applies grip to hold jar lids, provides the required torque, and accommodates various jar lid diameters.

SUMMARY OF IMPACT

Besides aiding those who suffer from scleroderma, an automatic jar opener would be useful for others who physically struggle to open a tightly sealed jar.

TECHNICAL DESCRIPTION

The motorized Open Up Jar Opener manufactured by Appliance Science was the best match for the desired specifications based upon ease of use and manufacturing considerations. This pre-fabricated, readily available, motor-driven unit was a logical choice for use in a comprehensive design. Testing indicates that the device provides ample torque and the device provides ample torque and can accommodate a range of lid sizes. Because the device requires a normal force and a gripping counter-torque, the remaining design considerations focused around adapting this device to the client.

A normal force of at least 50 lbf, but not more than 100 lbf is considered ideal. Also, space specifications are an important factor in the normal force generator. A laboratory scissors jack was used because of space efficiency, fluid motion, and ease of use. The jar gripping system needs to be easily aligned under the cone of the opener and consists of employing a high normal force and a friction-enhanced surface (rubber). This system is integrated with the scissors jack by coupling an adapted handle to the labjack power screw.

To obtain enough clearance for this handle, the Open Up is mounted to the labjack, which presses down onto the fixed jar when the crank handle is turned. Under the jar, silicone rubber (coupled with the normal force generated by the labjack) acts to secure the jar. The ½-inch thick rubber mat also absorbs the excess normal force generated as a lid is unscrewed. A 1/8-inch-thick aluminum frame with a Plexiglas door encloses the device. For additional safety, a double strain gage force feedback system is implemented to provide user feedback.

The total cost of this project is $890.

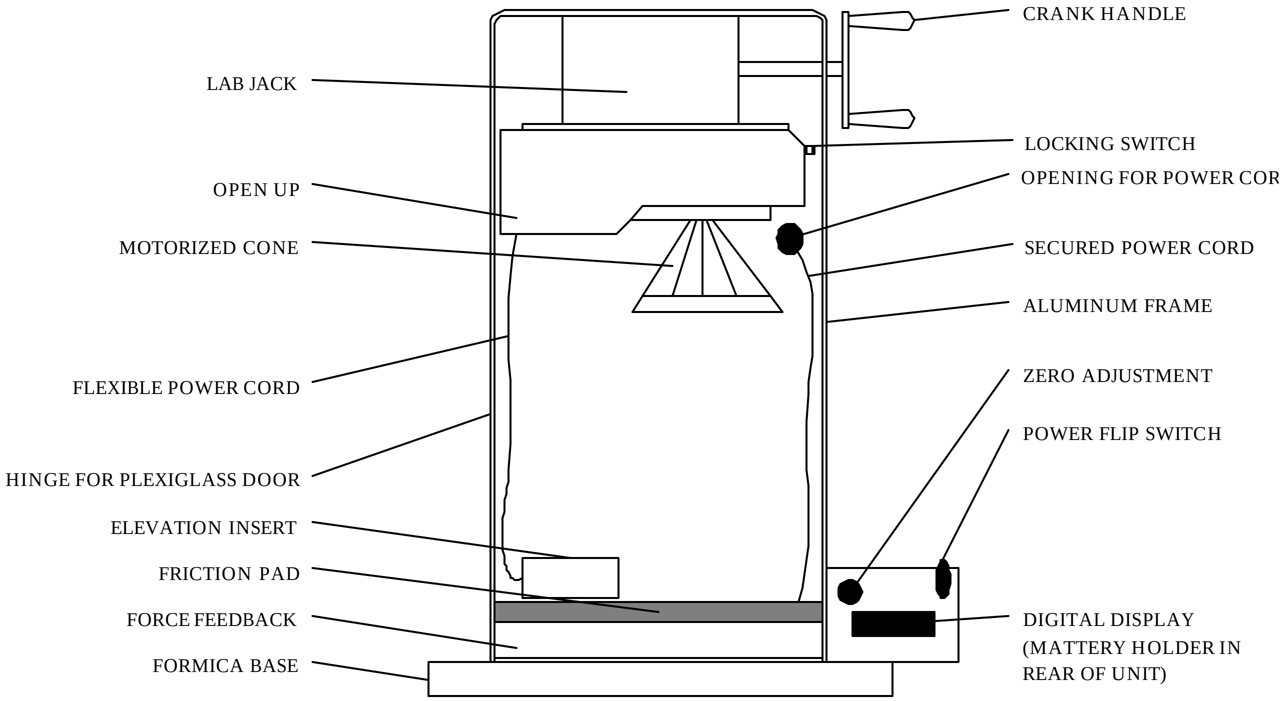

Figure 20.13. Front View of Automatic Jar Opener.

RTA BUS ANNUNCIATOR SYSTEM FOR PERSONS WITH VISUAL IMPAIRMENTS

Designers: Kimberly Clarkston, Bryan Jones, Tariq Sharif
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Supervising Professor: Dr. Thomas Hangartner
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INTRODUCTION

This project was completed in conjunction with a regional transit authority (RTA). The purpose was to increase the accessibility of public transportation for people with visual impairments. These individuals were assumed to be free of hearing impairment, such that detection of audible signals was not a concern. An audio annunciator system was installed in a bus with a speaker located outside the bus near the door. The announcement consists of the route number and final destination of the bus. The system is activated by the opening of the door and requires little effort by the driver.

SUMMARY OF IMPACT

The current RTA buses have front and side signs to display the route number and final destination of each bus. Individuals with visual impairments have a difficult time obtaining this information without assistance. Therefore, the implementation of an audio annunciating system was critical.

TECHNICAL DESCRIPTION

The design of this system involved a microprocessor, in which the voice recordings were stored on EPROM accessed by a QuikVoice sound chip. The information is transferred to an amplifier and out through a speaker. With the product being controlled by the bus driver, the code entered for the signs accesses the necessary information to make the corresponding audio announcement outside of the bus. The announcement is triggered when the door of the bus is opened.

The sound chip is the VP-1606, which allows messages to be recorded at sampling rates from 16K to 128K pbs. Increasing the sampling frequency increases the amount of memory required for a given number of messages. For this project, the desired sampling rate was 32K pbs. This chip also allows direct access to 64 messages recorded onto the EPROM. For this prototype, only 10 messages were recorded. Thus, only a single EPROM chip was required. After the chips were programmed, the QuikVoice sound chip was connected to the external EPROM chip.

The voice chip (VP-1606) was also directly connected to the microprocessor (MC68HC11 E9). The unit was then connected to the existing hardware, specifically to the thumb-wheel/visual display used by the bus driver.

The output of the unit was then connected to the amplifier, which was connected to the speaker. The activation switch for this unit is an internally connected relay, also connected directly to the dome light voltage wire. When the front door opens, the voltage goes high, closing the relay and activating the system.

The total cost of this system was $660.