CHAPTER 8
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A Device For Teaching Manual Wheelchair Propulsion

Designers: John Lemons and Allister Chang
Client Coordinator: Greta Cherry, United Cerebral Palsy of Greater Houston
Supervising Professor: W.A. Hyman
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INTRODUCTION

A device has been designed to facilitate the training of young children in the use of a wheelchair. When the wheels of this device are turned, a remote controlled vehicle will respond to the movement of the wheels in accordance with the way that a wheelchair would respond. Turning both wheels of the chair forward causes the remote controlled vehicle to move forward. Similarly, turning both wheels backward causes the vehicle to move backward. Moving only the right wheel moves the vehicle left and either forward or backward. Rotating only the left wheel moves the vehicle to the right and forward or backward.

SUMMARY OF IMPACT

In conjunction with other forms of training, the wheelchair trainer helps to teach the concept of moving a wheelchair in a particular direction by moving its wheels. The device was designed for preschool-age developmentally delayed children who have physical limitations that require them to become wheelchair users. The chair is stationary, allowing the therapist to work closely with the user.

Another potential population that may benefit from this design is children that have strong dominance for one hand. Since the device requires the use of both hands to make a toy or other output device operate, its use by this group will encourage bilateral development. The training device will remain in the therapy center for use by a number of chil-

Figure 7.1. Wheelchair Trainer II.

Table 8.1. Remote Controlled Vehicle Response to Wheelchair Trainer Movement

Wheelchair Action	Truck Response
Both wheels turned forward	Moves forward
Both wheels turned backwards	Moves backward
Right wheel turned forwards	Moves forward and to the left
Right wheel turned backwards	Moves backward and to the left
Left wheel turned forwards	Moves forward and to the right
Left wheel turned backwards	Moves backward and to the right
Right wheel turned forward and Left wheel turned backwards	Steering wheels turn left but the truck does not move
Left wheel turned forward and Right wheel turned backwards	Steering wheels turn right but the truck does not move

dren undergoing similar therapy programs.

TECHNICAL DESCRIPTION

The frame of the wheelchair trainer is constructed of PVC pipes. A seat cushion is provided for comfort. Nylon straps connected to the frame of the trainer support the cushion. The wheel axles are mounted through the wood framing and are independent of one another.

An optical encoder (Hewlett-Packard HEDS 5500) is mounted on the end of each axle. The encoders produce two pulsatile outputs (square waves) that vary according to the direction of each wheel rotated. When a wheel spins in a particular direction, one output will lead the other by a certain phase. For example, when the wheel is spinning forward, output A will lead output B; when the wheels are spinning backward, output A will lag behind output B.

The wheelchair trainer circuitry is implemented on a printed circuit board (PCB). The advantages

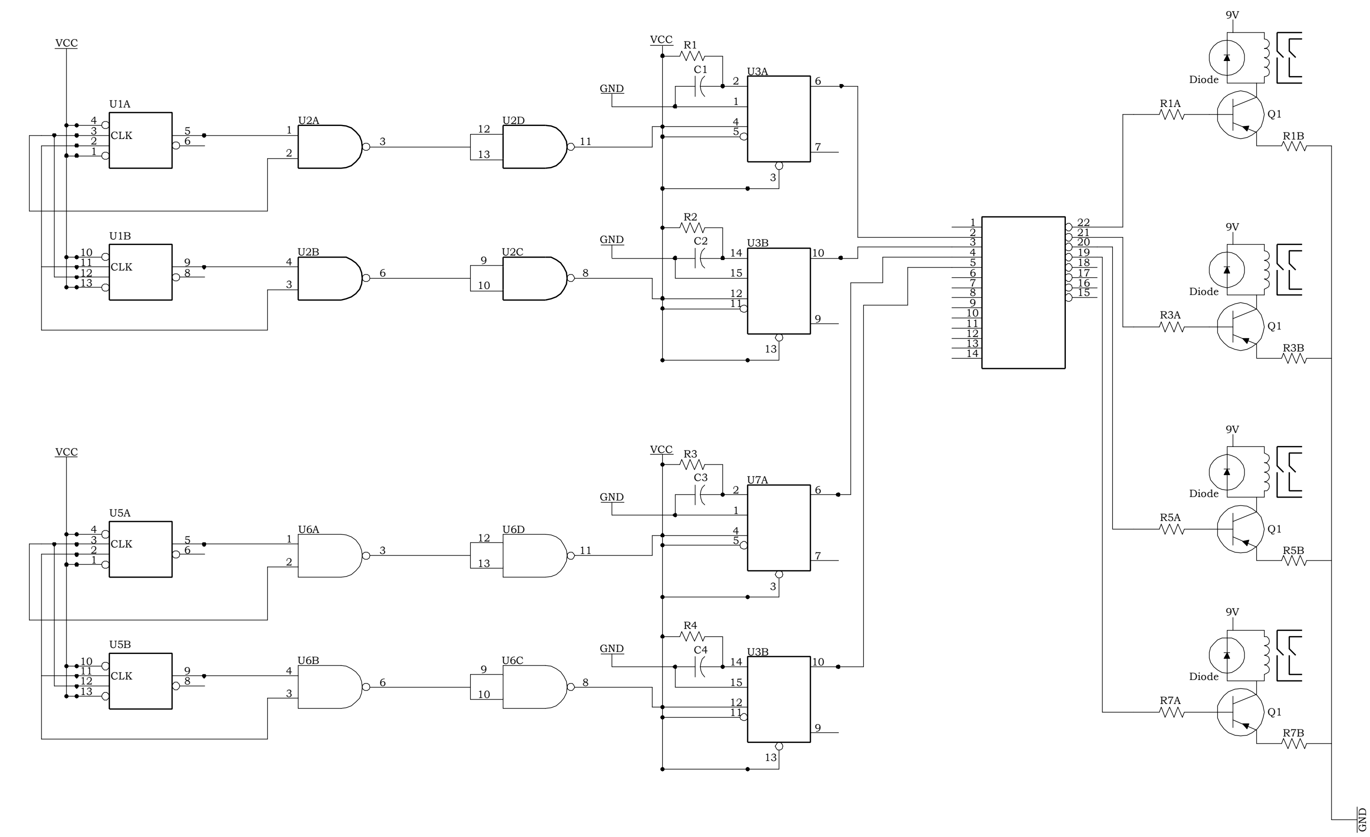

Figure 72. Wheelchair Trainer Circuit

achieved by using a PCB include easier replacement of integrated chips, better performance consistency, and a cleaner layout.

The output of the optical encoders is received by D flip-flops (74LS74). The output of the flip-flops is then input into a series of NAND (74LS00) gates in conjunction with the encoder outputs. The NAND gates output is input into dual precision monostable multivibrator integrated circuits (74HC4538). The circuit contains two 74HC4538 chips, and each chip contains two monostable multivibrators. One output on each chip outputs high when its corresponding wheel rotates forward, and the other output is high when its corresponding wheel is rotated backward. These four outputs are connected to an AMD PAL (PALCE20V8). A PAL was used instead of traditional logic because individual gates would have occupied more space on the PCB than the PAL would. Furthermore, using a PAL allows one to modify the behavior of the wheelchair trainer more easily by simply reprogramming the chip.

The PAL performs the logic required to convert the output of the monostable vibrators to the remote control. The outputs of the PAL are input into the base of a BJT NPN (2N2222) transistor. The transistor is used as a switch; when its base is high it is switched on, allowing current to flow from the collector to the emitter. When current flows through the transistor, it triggers the reed relay to the closed position. This connects the appropriate pads of the remote transmitter and causes the car to respond accordingly.

The circuit is powered by a nine-volt DC input provided by a store-bought transformer, which runs on conventional 120 V AC. Because TTL logic and the optical encoders require five-volt power, a voltage regulator (LM 7805) was used to lower the voltage power from nine to five volts.

The total project cost was $475.

PARTS LIST

Hewlett Packard HEDS 5500 Encoders (2)
Terminal Strip Jacks (6)
Terminal Strip Plugs (6)
Reed Relays (4)
24 Pin DIP Sockets (1)
Encoder Plugs (2)
Encoder Plug Connector Pins (10)
Printed Circuit Board
10"x8"x3" Aluminum Chassis
Box Lid
4.9 μF Electrolytic Capacitors (4)
Silicon Diodes (4)
N2222 Transistors (4)
Resistors (8)
Spacers (4)
Heat Sink
AMD PALCE20V8H
Remote Controlled Vehicle
NiCad Rechargeable Battery Pack
Battery Charger
AC/DC Converter
Rocker Switch
Power Socket
25' Roll of 24 Gauge Wire (4)
1/2"x2'x8' Plywood Board
1/2"x2'x4' Pine Board
Epoxy
5/16 Hex Nuts (4)
1/4 Zinc Washers (4)
Electrical Tape
Corner Brace
1/2"x3' Pipe
3/8" Fender Washers (4)
3/8" Threaded Steel Rod (2)
1"x6' PVC Pipe (3)
1" PVC Pipe Connectors (14)
1/2"x1' PVC Pipe (2)
Spray Paint
Pillows (2)
9' 1/2" Nylon Strapping
7.5' 1/4" Nylon Strapping
Pillow Blocks (4)

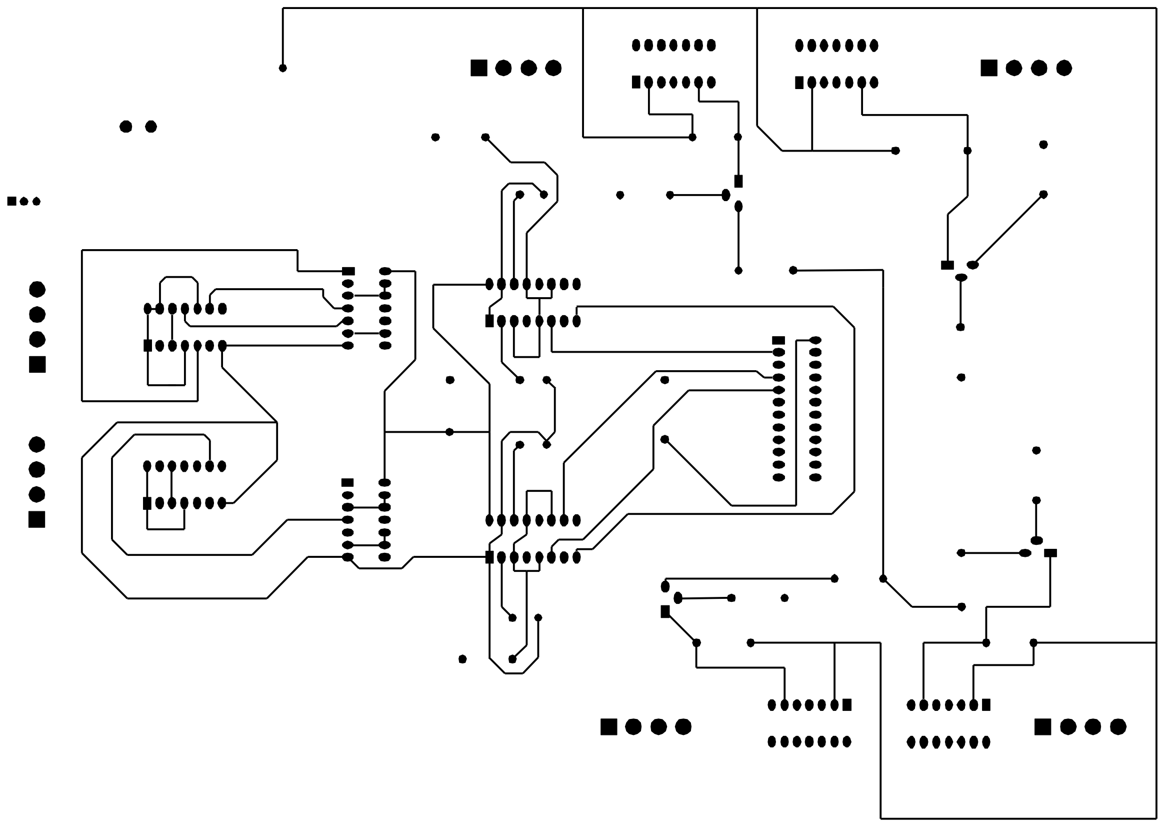

Figure 7.3. PC Board Configuration.

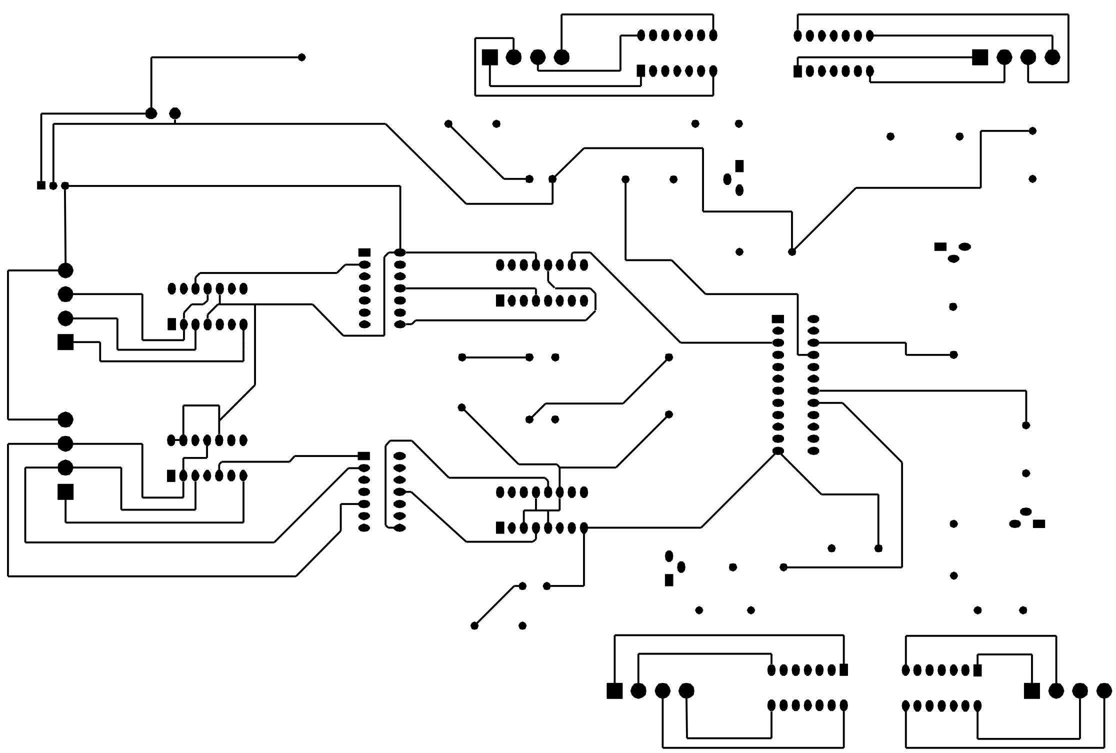

Figure 7.4. PC Board Configuration.

Aggie Inclinometer II

Designers: Wendy Blair, Coreen Vallance
Client: EQUEST Hippotherapy, Dallas
Supervising Professor: W.A. Hyman
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INTRODUCTION

Patients who suffer from motor disorders such as cerebral palsy often undergo hippotherapy, a treatment that involves horseback riding. Young patients are securely positioned on horseback, and a therapist leads the horse. It is often difficult for the patient to hold his or her head in an upright position while riding; the activity thus stimulates muscular and cognitive exercise that may enable the patient to more easily hold his or her head upright during normal daily activity.

An inclinometer was designed to monitor progress in maintaining an upright position during therapeutic horseback riding. Placed upon the patient's head, it measures the angle at which the patient's head deviates from the horizontal.

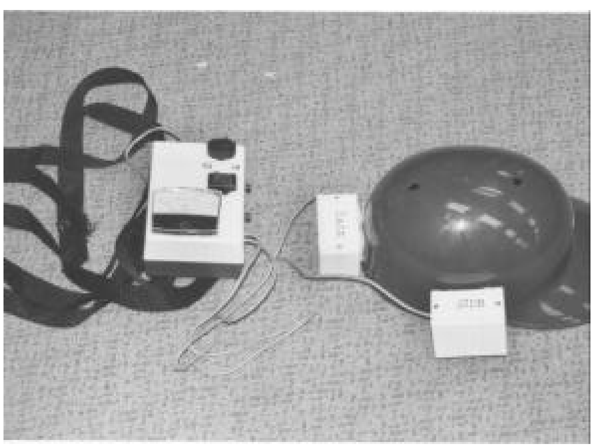

Figure 7.5. Aggie Inclinometer II.

SUMMARY OF IMPACT

It is often difficult for a therapist to determine rates of patient improvement during hippotherapy. Ideally, the patient's head will gradually stay in a more upright position and will experience a lesser degree of bouncing as therapy progresses. By providing a measurement of the angle that the patient's head bounces, the inclinometer data helps the therapist to accurately judge the patient's rate of improvement. An earlier inclinometer design measured only the forward or backward head bouncing for the patient, while the inclinometer II design measures forward, backward, and side-to-side motion to provide a more complete data set for the therapist.

TECHNICAL DESCRIPTION

Operation of the inclinometer II is based on a pendulum mechanism. A fishing weight is attached to a 100kΩ potentiometer that is located on the headgear. The fishing weight circuit located on the right side of the headgear measures forward and backward motion, while that located on the back of the headgear measures side to side motion. When the patient's head moves, the weight remains perpendicular to the ground as a result of gravity. The resistance of the potentiometer, which is originally centered at 50kΩ, will change with respect to the direction of motion. This change in resistance will change the output voltage that is read on the attached voltmeter.

In order to allow easy calibration, the design uses a whetstone bridge with two potentiometers. The top potentiometer is the fishing weight circuit located in the headgear. The bottom potentiometer is a dial centered at 50kΩ that the therapist must adjust until the voltmeter reads 2.5 volts. Since the amplified output of the whetstone bridge is calibrated such that it is balanced at 2.5 volts, the output voltage will remain in the 0 to 5-volt range.

The voltage across the dial potentiometer is inverted and then summed with the voltage across the second 10kΩ resistor. The output voltage of the summer is 0.05 volts. The sum is then amplified with a gain of 50. Thus, the output voltage when the circuit is calibrated is designed to be 2.5 volts.

The op-amps utilized are eight-pin 741 dips. The fourteen op-amps are responsible for inverting, buffering, summing, and amplifying the output sig-

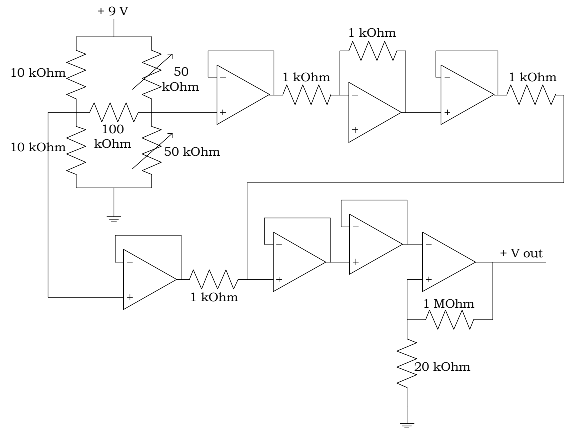

Figure 7.6. Wheatstone Bridge Schematic.

nal from both headgear circuits. Two 9-volt batteries are used to power the op-amps. There are two switches in the circuit: an on-off switch for both batteries, and a DPDT switch that alternates the headgear output monitored on the voltmeter.

Each fishing weight circuit is housed in a casing mounted on the headgear. The majority of the main circuit, including op-amps, dials, switches, and the voltmeter, is housed in one casing which is worn like a backpack. In addition, the inclinometer II headgear consists of a plastic baseball-batting helmet with an adjustable chinstrap. The flat surfaces on the sides and back of the helmet ensure that the fishing weights will remain perpendicular to the ground. The two casings are attached to the helmet with Velcro and are marked with the proper placement directions. The helmet is easy to put on and remove.

The therapist must switch between front / back and side to side orientations in order to read both measurements on the voltmeter. Changes in the output voltage after both dials have been calibrated at 2.5V illustrate deviations between the patient's head position (either front to back or side to side) and the horizontal.

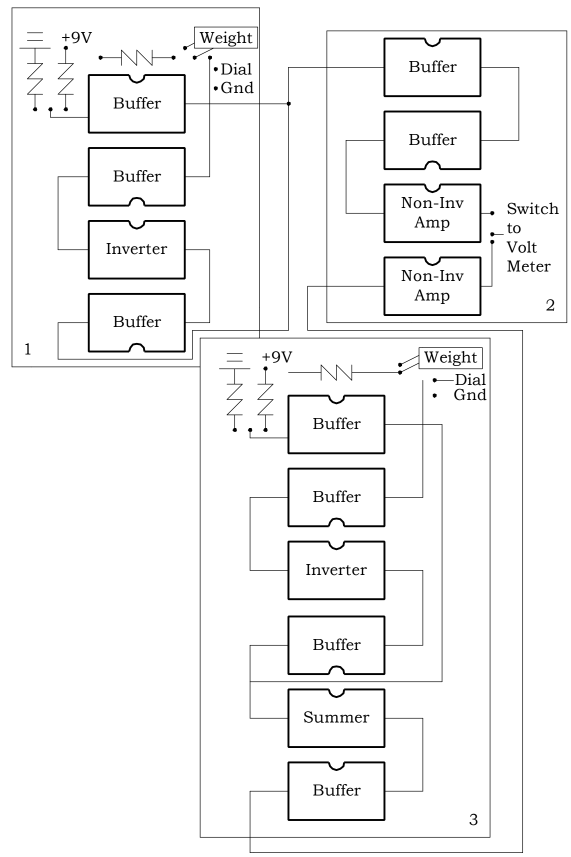

Figure 7.7. Circuit Board Layouts.

Musical Balance Beam

Designers: James Pearce, Bala Sundararajan
Client Coordinator: Greta Cherry
United Cerebral Palsy of Greater Houston
Supervising Professor: W.A. Hyman
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INTRODUCTION

The musical balance beam is used in physical therapy to help teach children how to walk and control their balance while making the task fun and entertaining. It emits musical sounds for each assigned step taken along its length. When the child walks along the beam, he or she is rewarded by tunes from an attached music box.

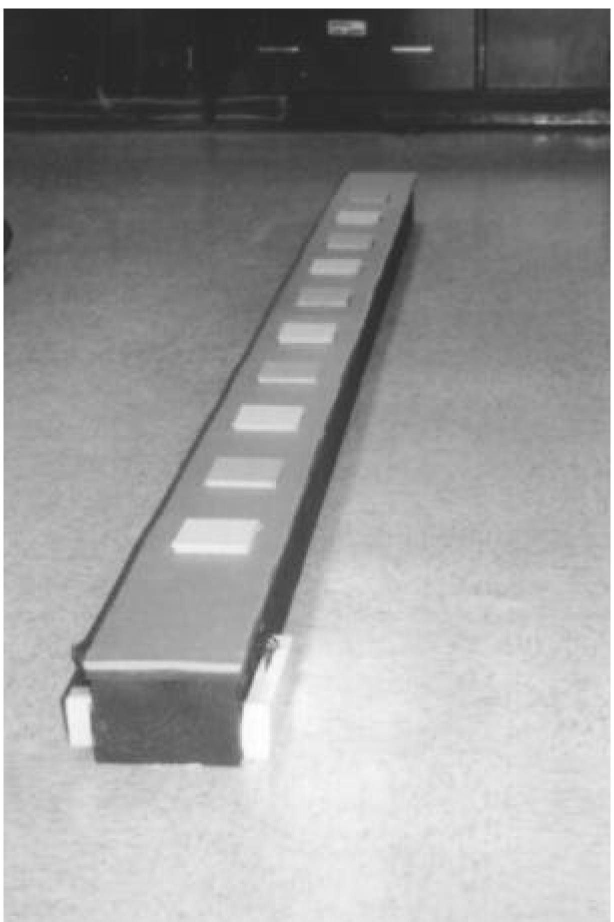

Figure 7.8. Musical Balance Beam.

SUMMARY OF IMPACT

Cerebral palsy is a condition characterized by paralysis, weakness, incoordination, or other motor problems. It is caused by pathology of the motor control centers of the brain. Children with this condition often become dependent on wheelchairs. Their walking and balance skills are greatly reduced through lack of use. This balance beam provides a fun means for children with physical handicaps to practice walking and balancing capabilities. Children who are capable of walking but have balancing difficulties can also utilize the beam. A trained adult should always help patients by guiding them along the path.

TECHNICAL DESCRIPTION

The beam was constructed out of wood. Foam padding was used for cushioning and support. The beam is six inches wide and eight feet long, with a height of only five inches to reduce the risk of injury from falling. The beam has ten assigned steps. Each step is a 3¼-inch wooden square that activates a momentary pushbutton switch located directly under it. Each switch is connected to a sound card. Since each sound device consists of only a few sounds, two sound devices are necessary to complete different musical tunes for each of the ten steps of the beam. The beam does not have assigned step squares at the beginning or end to provide the child with a small practice area before the musical switches are encountered. The top of the beam is padded with foam.

A 4-inch by 6-inch by 8-foot wooden beam acts as the base. Ten holes were drilled in the beam to house the push buttons. In addition, wire paths were routed along either side of the beam, approximately 1 inch from each side, with smaller pathways drilled to connect these to the push button switches. A ½-inch by 6-inch by 8-foot strip of plywood was utilized for the top wooden piece. Ten 3¼-inch squares were cut from this plank, using a jigsaw, to allow access to the underlying pushbutton switches. These squares were later placed in their respective holes to serve as the steps of the beam. Ten corresponding 3¼-inch squares were cut from a 3/8-inch by 6-inch by 8-foot foam padding layer. This foam was glued to the plywood layer, allowing the underlying steps to be depressed and activated.

Each of the momentary pushbuttons is connected to a sound card. The pushbutton has two prongs; each prong is attached to a wire that runs along the drilled pathway to a sound device. A thin groove was drilled in the sound devices to allow the wires to run through the casing and to the sound card. At the sound card, each wire is connected to only one side of the interlocking wire circuit. Therefore, when the button is depressed, the circuit is closed and a particular sound is emitted until the button is released. The sound devices were mounted in pairs on either side of the beam, with the speakers and batteries facing outward for audibility and accessibility. Total project cost was approximately $60.

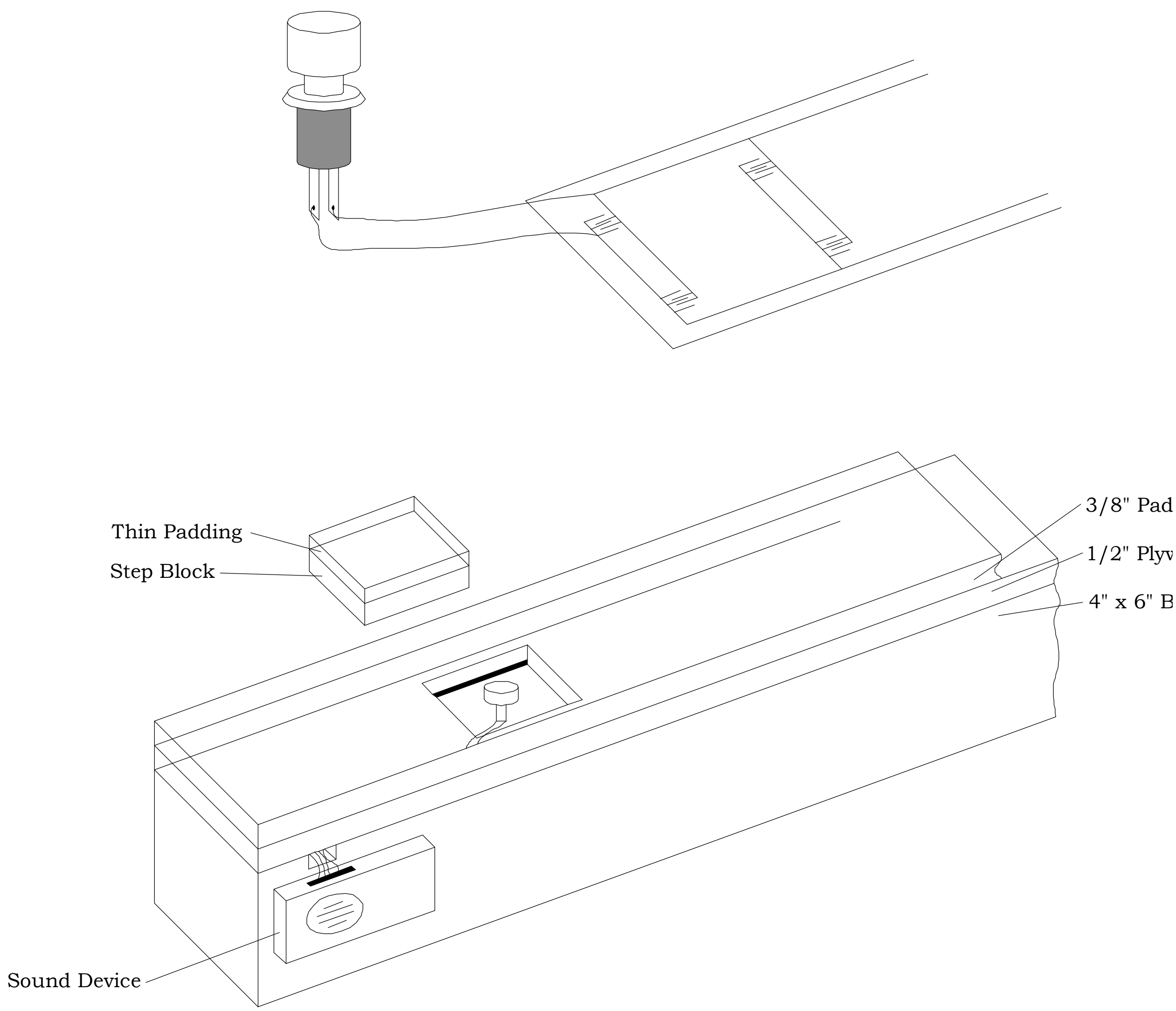

Figure 7.9. (Top) Push Button Connection to a Sound Card. (Bottom) Assembled Musical Balance Beam.

Motion Sensor Switch

Designer: Hoan Le
Client Coordinator: Greta Cherry
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Supervising Professor: W.A. Hyman
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INTRODUCTION

A motion-sensing switch was built to enable children to operate a toy through play and bodily motion. This device emits a passive infrared beam in a path approximately five feet in diameter; any motion within that range will be detected, and the switch will be activated. When there is motion near the device's field of vision, it emits two pulses of activation. Each pulse lasts approximately one second.

Figure 7.10. The Motion Sensor Switch.

SUMMARY OF IMPACT

The learning and developmental processes of children, especially those who have physical disabilities, can be aided by the use of toys. Directed and purposeful play can allow a child to develop cognitively, physically, emotionally, and socially. Play is often conducted with a battery powered switch toy. The action of pushing a switch can be a hindrance, or can distract the child from play. Sometimes a physically challenged child cannot perform the simple function of pushing a switch. Thus, this motion sensor device can greatly aid the child in fully interacting with the toy without having to push any kind of switch. To trigger the toy, the child must simply move around while playing with the toy in the diameter of the motion-sensing device. In addition, several motion detectors can be positioned around a room to activate a certain toy in a particular motion sensor's range. A child ideally learns to associate motion with the reinforcement of activating a toy. If several motion sensors are placed throughout a room with corresponding toys, a child may also develop memory skills by associating the toy's action with its location. Further, the child may benefit from physical exercise obtained by moving to trigger the toy. The child may also enjoy the pleasure and excitement of interaction with the toy because he or she knows that his or her movement can trigger the toy. Lastly, the child can interact with other children during play; children may, for example, take turns activating the toy.

TECHNICAL DESCRIPTION

The detector was built with a 6076-KT Passive Infrared (PIR) Detector kit. This kit utilizes an MPCC chip that controls the passive infrared detector. A sensitivity adjusted 500kΩ potentiometer was soldered from pin 2 to pin 7 on the MPCC chip. This adjusts the detector's sensitivity level, or the amount of motion that must occur before the device triggers the toy via the switch. The relay is then connected to its coil from the output of the detector kit, or the output port on the MPCC chip. As motion is detected, the output will close the circuit on the switch, and consequently switch the toy on for a one-second pulse. A nine-volt power plug with a battery disable or a nine-volt battery source is used to power the MPCC chip. A power switch is connected to the common ground to disconnect power to the MPCC chip. A plastic hood around the sensor dome is used to limit the range of the motion-sensing device to the desired five-foot diameter. The hood may be removed if a larger range is required.

The device will work best if it is placed about seven to ten feet above the highest motion (i.e., above the head of the tallest child). The best sensitivity is achieved when motion is across, rather than in line with, the device's path of projection; a potentiometer that allows sensitivity adjustments was added. When motion stops, the device turns off the switch with little delay. The device can be powered by a nine-volt battery or a nine-volt DC power supply. To save power, the device also contains an on-off switch. In addition, the device has an output port for a 1/8-inch conductor jack.

Additional information can be obtained by consulting an MPCC specification sheet.

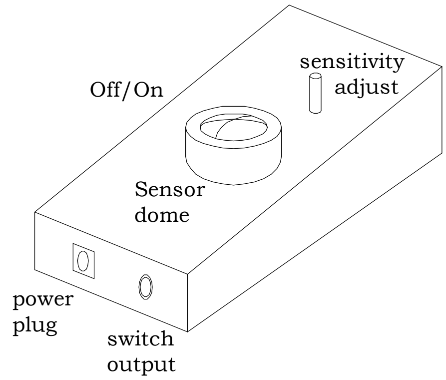

Figure 7.12. Assembled Motion Detector.

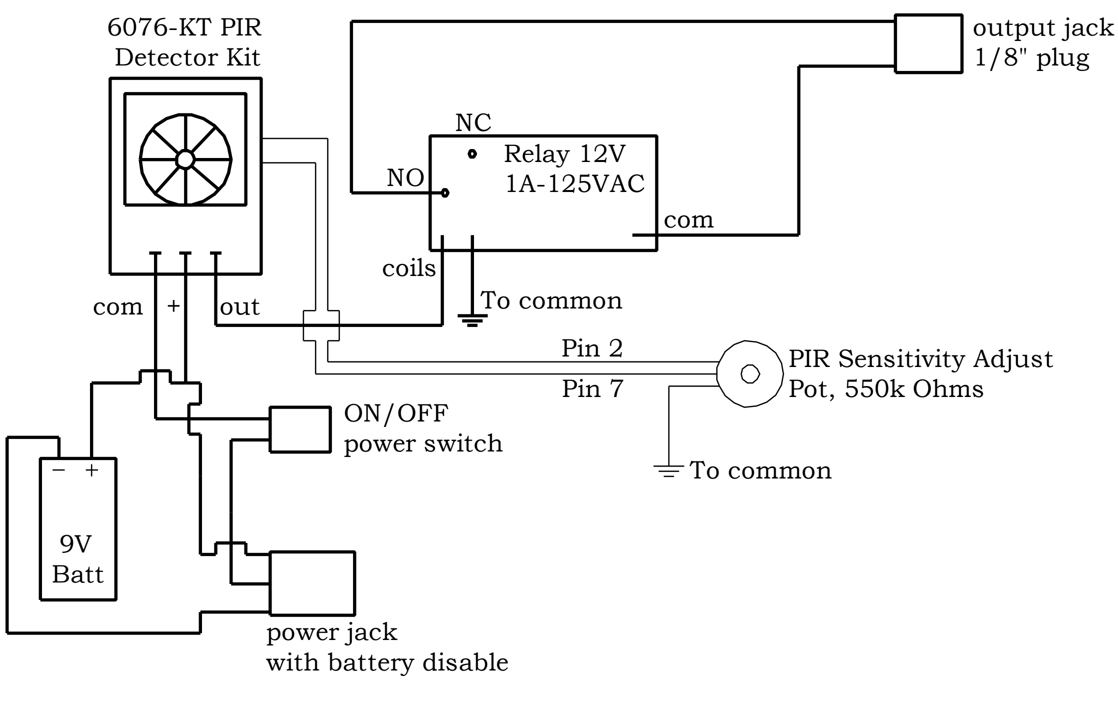

Figure 7.11. Hardware Assembly Drawing of the Motion Detecting Device.

Play Table For Children With Cerebral Palsy

Designers: Lauren Green, Brad Putty
Client Coordinator: Simone Braquet
United Cerebral Palsy of Greater Houston
Supervising Professor: W.A. Hyman
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INTRODUCTION

A play table was designed for one- to three-year-old children at the United Cerebral Palsy Foundation in Houston. The play table consists of three stacked play surfaces supported by adjustable legs. The top surface contains brightly colored, primary shaped indentations for the placement of wooden pieces of corresponding colors and shapes. Electrical circuitry beneath the top surface provides auditory and visual rewards when the wooden pieces are placed in their correct position. The middle surface is a layer of clear Plexiglas for use with markers or "messy" substances such as shaving cream. Beneath the Plexiglas, the bottom surface is attached to the legs of the table and contains an inset bin for the purpose of holding water. The legs of the table can be adjusted to provide table heights of 12, 15, or 18 inches.

Figure 7.13. Play Table.

SUMMARY OF IMPACT

Because young children with cerebral palsy may lack a sense of cause and effect within their environment, it is important that they play with toys that clearly display a cause and effect relationship. Also, tactile interaction provides them with opportunities to learn about their environment. The top surface of the play table provides the child with four different cause and effect games which are brightly colored, making them interesting to the child. The Plexiglas and water bin surfaces allow the child to experience various tactile sensations.

TECHNICAL DESCRIPTION

Although the play table was designed for cerebral palsy patients aged one to three years, it could be stimulating and recreational for children without cerebral palsy as well. The main design requirements of the table were: 1) it had to be safe, i.e., having no sharp surfaces or exposed electrical wiring; 2) it had to be colorful and appealing to a small child; 3) the pieces used with the table had to be specially shaped so the child could handle them successfully.

The top portion of the table was constructed of ¾-inch thick pine, painted red, and shaped as a 16 ½ by 24 by 2-inch hollow rectangular box with a hinged top. Hardboard with a thickness of ¼ inch was used for the bottom of the box; as it might contact water on the Plexiglas surface beneath it, it was primed with an oil-based primer. All electrical wiring for the top surface was placed inside this box. The hinged top of the box allows easy battery and electrical servicing. The top of the box contains six differently colored activities. Three of the activities involve the placement of a green circle, red square, and blue triangle into their appropriate routed spaces on the box. A 7/16-inch diameter peg extending from the bottom surface of each shape fits into countersunk, ½-inch diameter holes in the top of the box and throws a mechanical lever arm switch. When all three of the switches beneath the shapes are thrown, a sound card is activated and a song is played. The fourth activity operates by the same mechanism: when 12 yellow pegs are placed into 12 holes at the points of a yellow star, 12 mechanical lever arm switches are thrown and a red LED inset in the table top is activated. The pegs were created by inserting 7/16-inch wooden dowels into wooden hobby candle cups with hot glue. Wiring is connected to the LED via long gaiter clips to allow easy circuitry/battery servicing when the top is opened on its hinges. The fifth and sixth activities are purchased toys (Fisher-Price® Lights 'n' Sounds Phone and Playskool® Barney Poppin' Pals) which have been set into routed shapes on the top of the box. To secure the top of the box to the rest of the table, ½-inch diameter holes have been drilled in the bottom corners of the box to accommodate 7/16-inch diameter pegs that extend from the base of the table.

To secure its position, the Plexiglas layer of the table also has ½-inch diameter holes drilled in its corners to accommodate the pegs extending from the base of the table. Strips of 1/16-inch thick foam were glued on top of the corners of the Plexiglas to prevent damage to the Plexiglas by the top box. The bottom of the Plexiglas was primed with water-based primer and painted white so the surface beneath the Plexiglas would not be visible to the child.

When the red top box and Plexiglas are removed, the yellow ½-inch thick plywood surface containing a water bin is visible. The bin used was a 14 ½ by 10 ½ by 2-inch Baker's Secret® lasagna pan. A 14 ½ by 10 ½-inch rectangle was cut from the center of the plywood, and a slightly larger rectangle was routed ¼ inch deep surrounding the cut, allowing the pan to be completely inset in the plywood. The plywood was nailed to a 1 by 2-inch pinewood frame and painted with yellow oil based paint.

Beneath the plywood, the blue painted PVC pipe legs of the table were anchored to the corners of the pine wood frame with pieces from a table leg anchoring kit. The legs were capped with PVC caps to add stability. Additional information concerning the table's adjustable PVC pipe legs can be obtained from the designer.

Total project cost was about $200.

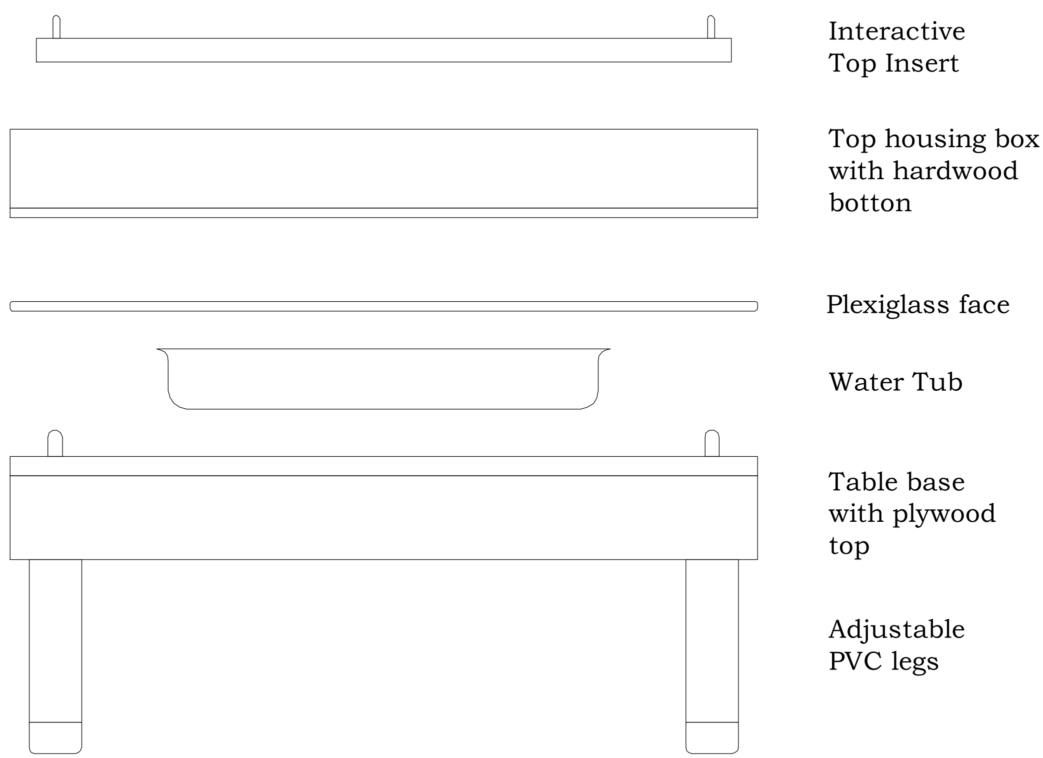

Figure 7.14. Disassembled Table, Side View.

A Speech Therapy Aid For Developmentally Impaired Children

Designers: Shannon Dunphy, Marisa Medrano, Karl Schneider
Client Coordinator: Janette Hughes, Speech-Language Pathologist
United Cerebral Palsy of Greater Houston
Supervising Professor: W.A. Hyman
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INTRODUCTION

A four compartment opaque box has been constructed for use in speech therapy. An object is placed inside each of its four compartments. A one-way opaque mirror conceals each object. Four switches control a light source for each individual compartment. When a switch is activated, the light turns on inside its corresponding compartment, and the toy inside is revealed. When the switch is no longer depressed, the light turns off and the mirror again becomes opaque, concealing the object inside the compartment.

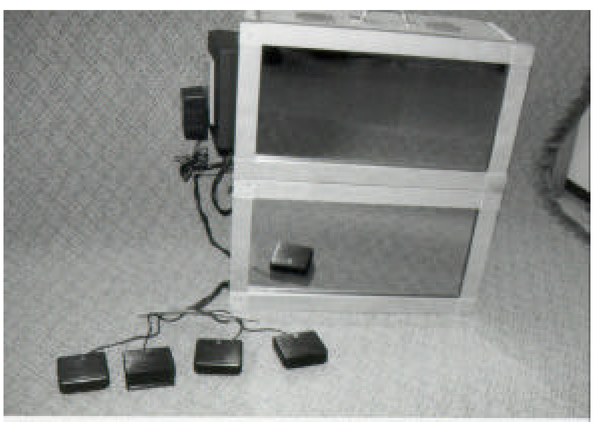

Figure 7.15. Multi-Station Opaque Box.

SUMMARY OF IMPACT

This multi-station opaque box will be used to teach children who are developmental handicaps, such as those associated with cerebral palsy or spina bifida. Children may learn picture-object association by matching a two-dimensional photo with the corresponding three-dimensional object. The development of these skills is crucial to the language development of a child.

In addition, this box can be used to stimulate development of learning disabled students. Some people with learning disabilities are incapable of matching a three-dimensional object with a two-dimensional picture; if such a person is given a picture of an object, he or she may be unable to select that object from a group of objects. Visual stimulation may improve matching capabilities. The teacher or therapist will show a picture of an object to the student and then reveal the corresponding three-dimensional object within the opaque box. This sequence is repeated to stimulate the individual's ability to relate two-dimensional pictures to three-dimensional objects.

TECHNICAL DESCRIPTION

The opaque box is built with four compartments; its size is 32 by 16 inches. Tinted (one-way) glass is placed in front of each compartment so that the interior of each compartment will be visible when the compartment is illuminated. The compartment will become visible when there is more light inside the compartment than outside of it. When the light inside the compartment is turned off, the glass will appear opaque, so that the object is hidden. The one-way glass was coated with silicon to prevent breakage.

The structure of the box is made entirely of wood. The compartments are enclosed by wood on all sides except the front, which is covered by tinted glass. Each compartment has a separate light source, a 6 by 2.5-inch fluorescent bulb, providing ample illumination to allow visibility from the outside. All surfaces of the box were painted shiny metallic silver to scatter of the light. The light sources require 110 volts AC; for operator safety, the 110 volts AC must be isolated from the control switches. This is accomplished by using a 12-volt DC system to activate the lights. Relays are used to interface the 110-volt AC with the 12-volt DC.

Four individual pushbutton switches activate the lights in each of the compartments. Different objects are placed in each compartment. The switches are placed next to the pictures that correspond to the objects in the compartments. The child may look at the picture, press the switch, and view the three-dimensional object seen in the picture. The approximate cost of the multi-station opaque box was $275.

Object Association Window

Designers: Joe Richter and Lauren Heitmann
Client Coordinator: Janette Hughes, Speech-Language Pathologist
United Cerebral Palsy of Greater Houston
Supervising Professor: W.A. Hyman
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INTRODUCTION

An object association box has been designed for children with learning disabilities. The front surface of the hollow box consists of an opaque, voltage-activated LED screen. Upon activation, the screen instantly becomes transparent. Three-dimensional objects can be placed inside the box behind the opaque screen and can be revealed to the viewer by moving a toggle switch to the 'on' position.

Figure 7.16. Object Association Window.

SUMMARY OF IMPACT

Children with learning disabilities often have difficulty associating two-dimensional representations of objects with their three-dimensional counterparts. Correct formation of these associations is crucial to optimal cognitive development. An object association box aids learning for children with association difficulties because it allows for hands-on, instant feedback in a game atmosphere. Consider the following scenario: a teacher uses multiple boxes and places different toys in each box. After showing the child the toys in the boxes by making the screen transparent, the teacher returns the screen to its opaque resting state. At this point, the teacher shows the child a picture of one of the toys. If the child correctly identifies the box containing the toy, the instructor can instantly reward him or her by allowing him or her to play with the toy. If the child's attempt is incorrect, the teacher can make the screen transparent again to refresh the child's memory and then resume the game.

TECHNICAL DESCRIPTION

The construction of the object box association is fairly simple. The 12.5 by 7.5 by 11-inch rectangular box consists of pieces of 0.25-inch hardboard nailed together. The LCD screen is the front surface of the box. Two pieces of 0.125-inch transparent plastic, which are the same size as the screen, cover the front and back surfaces of the screen. Rims of 0.5-inch molding nailed to the hardboard both in front of and behind the screen and plastics hold them securely in place. To facilitate the placement of objects, the box was left open in back. A 20-watt fluorescent lamp is attached to the inside top surface of the box with heavy duty Velcro. The cord powering the lamp is stapled to the inside surface of the box to prevent interference with objects placed inside.

The wires to and from the screen and lamp enter and exit the inside of the box via a 0.375-inch diameter hole of in the right front surface of the box. Covering this hole, a 4 by 1.5 by 5-inch plastic box is screwed into the outside surface of the hardboard. A toggle switch is embedded in the top of this box. When flipped, the switch allows 120 volts to reach the screen and the lamp. A grounding outlet and cover plate are embedded in the outside vertical surface of the plastic box. A nine-volt adapter is plugged into the outlet. A two-foot, 16-gauge cord exits the bottom of the plastic box and is connected to a 120-volt plug.

When plugged into a 120 volt providing socket, the 16-gauge cord powers the nine-volt adapter. The toggle switch is connected in series with the adapter. When the switch is in the 'on' position, the adapter powers a 120-volt relay with nine volts. When activated, the relay connects the circuit between the 120-volt live wire and the screen and lamp, collectively.

Total project cost was approximately $145.

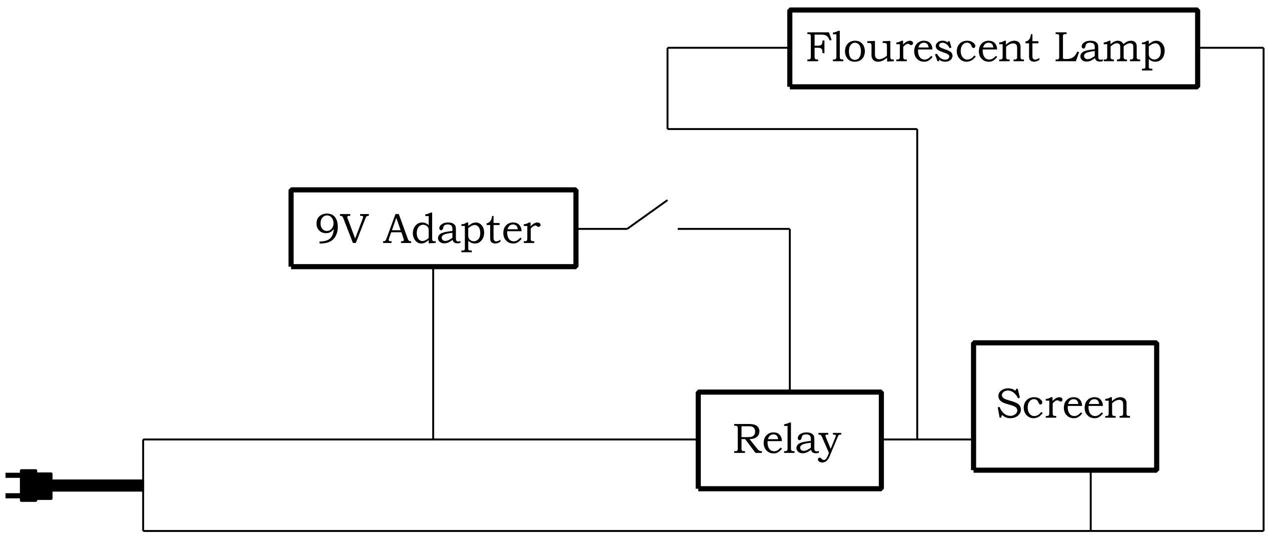

Figure 7.17. Electronic Block Diagram for the Object Association Box.

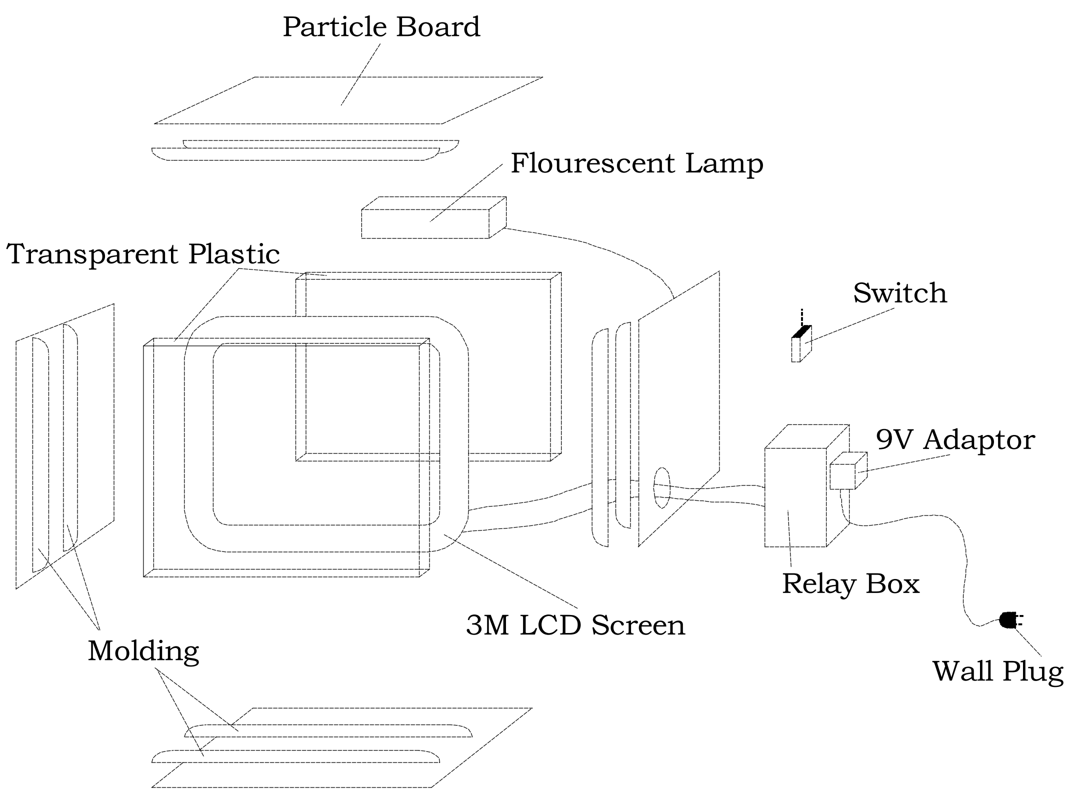

Figure 7.18. Hardware Assembly Diagram.

Multi-Function Switch

Designers: Darren Bell, Robert Nichols
Client Coordinator: Greta Cherry
United Cerebral Palsy of Greater Houston
Supervising Professor: W.A. Hyman
Bioengineering Program
Texas A&M University
College Station, TX 77843

INTRODUCTION

This novel switch is large and easy to operate so that young children will be able to utilize it relatively easily. When activated, the switch lights up, a colorful wheel rotates, and train sounds are produced. There is also an external jack so that additional toys may be operated with the switch.

Figure 7.19. Multi-Function Switch.

SUMMARY OF IMPACT

This switch design allows the child to see the pattern of cause and effect. When the child pushes down upon the large switch, he or she is immediately rewarded with auditory and visual stimulation. This large switch is ideal for children who do not possess fine motor control skills. Depressing any area upon the big switch will result in lights blinking, the wheel rotating, and train whistles sounding.

TECHNICAL DESCRIPTION

The switch has a square Plexiglas top. Four locking single pole switches are found under the flanges of the Plexiglas surface; one is located at each corner. Only one of the four switches must be connected to the circuit to activate it. This alleviates problems that might be produced if all four switches had to be simultaneously activated; many users will not depress the Plexiglas top uniformly, causing fewer than four switches to be activated.

There is a small toy motor, powered by a single AA battery, which spins a colored wheel. Eight blinking LEDs are powered by three additional AA batteries. The batteries must be replaced when the LEDs light up but no longer blink as they should. The eight LEDs are all wired in parallel to each other and to the power source.

The sound is powered by four additional AA batteries. A four-pole six-volt relay is also powered by these four batteries. The relay was added so that the jack, lights, sound, and motor are all contained in separate circuit paths. In this manner, the lights, sound, and motor cannot draw power from any toy that may be connected to the external jack.

A total of eight batteries are used for this switch. All of the batteries are located on the bottom of the switch.

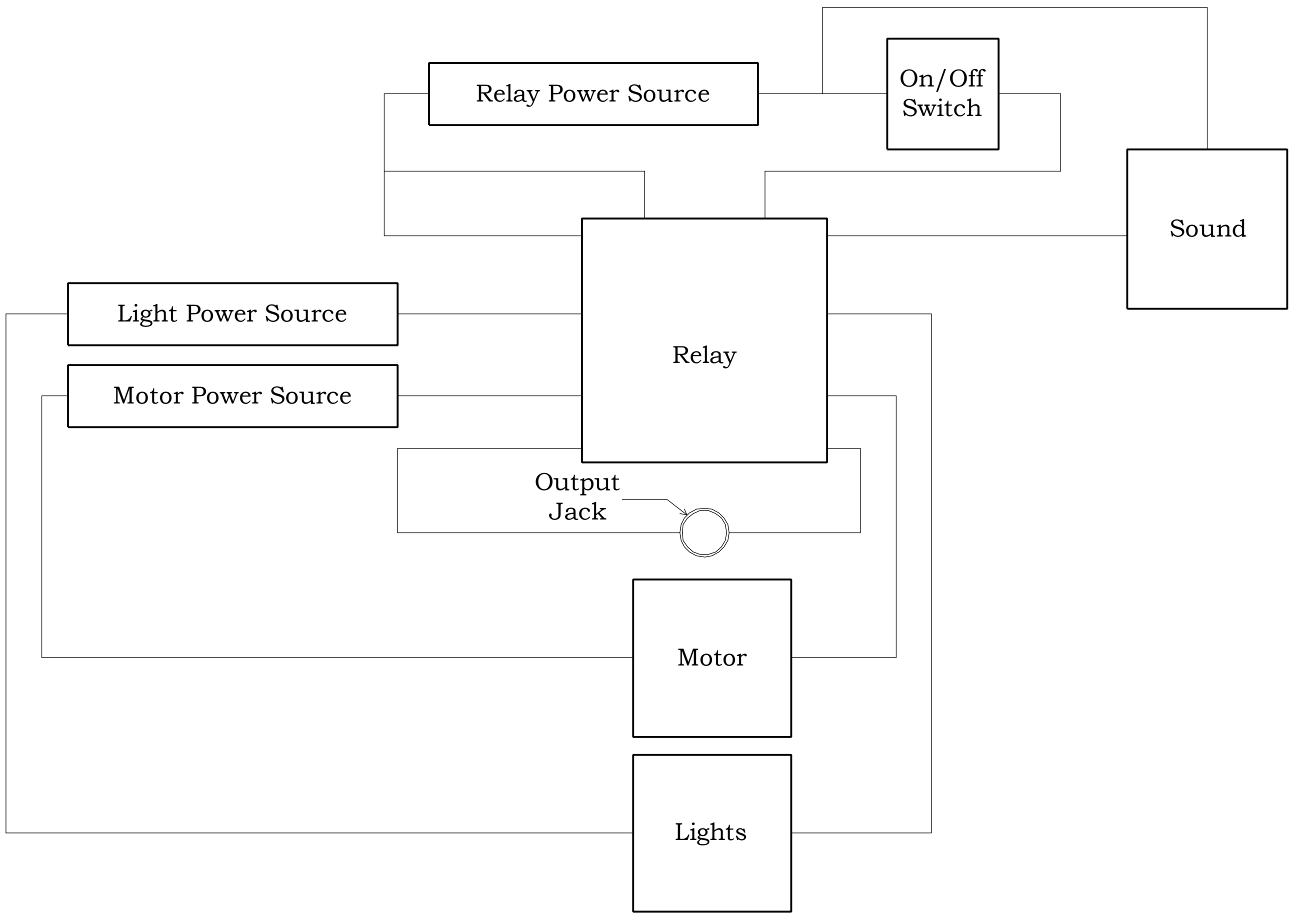

Figure 7.20. Multi-Function Switch Electronic Block Diagram.

Two-Stage Switch

Designers: Darren Bell, Robert Nichols
Client Coordinator: Kathy Moody
United Cerebral Palsy of Greater Houston
Supervising Professor: W.A. Hyman
Bioengineering Program
Texas A&M University
College Station, TX 77843

INTRODUCTION

A two-position switch suitable for mounting on a wheelchair and use as a head switch was designed. There are two external 1/8-inch jacks that provide an interface for the device to be operated by the switch. A television remote control was adapted for use with the switch. There are six functions on the remote control and six corresponding remote control jacks. The user may decide which two functions will be controlled by the switch.

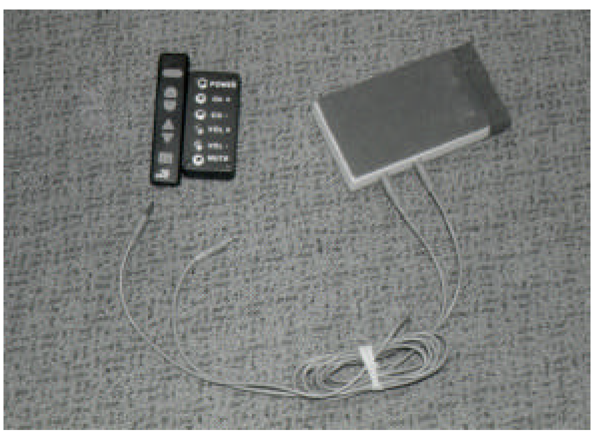

Figure 7.21. Two Stage Switch, Utilized with a Television Remote Control.

SUMMARY OF IMPACT

The two-position switch concept simplifies the use of a head switch for people who do not possess motor control skills that would enable them to activate a switching mechanism with their limbs. Patients with quadriplegia may find this head switch extremely useful since it would enable them to control a device through head movement. The two-position feature enables them to control two separate functions through a single switch. The traditional one position switch would necessitate the presence of two separate head switches for this purpose. The user would be forced to move his or her head from side to side in order to control two functions. The single two-stage head switch is easy to mount and is much less bulky; the user need only activate one switch in order to control two separate functions. For example, the user can use the functions of channel up and channel down through the same switch. This gives the user a much greater degree of control over his or her activities.

TECHNICAL DESCRIPTION

The switch is entirely contained in a small project box. There is a thin metal plate attached to the box, with a hinge that serves as a lever to operate the switch. Three momentary contact switches are located under the plate. As the plate is depressed, these switches are closed sequentially. Each of the three switches controls the operation of a five-volt single-pole double-throw (5V SPDT) relay. The first switch operates the first jack. When the second switch is closed, the power is disconnected from the first relay, thus opening the circuit containing the first jack. The third switch controls the operation of the second jack.

One 220µF capacitor was placed across the terminals of relay three to provide a slight delay in the re-activation of the first function as the switch lever passes from the second function back to "off". This prevents the first function from being activated when the user releases the switch after using the second function.

When the switch is operated, the first click indicates activation of the switch's first function. The second click signals deactivation of the first function, while the third click indicates activation of the second function.

The approximate cost of this two-stage switch was $40.

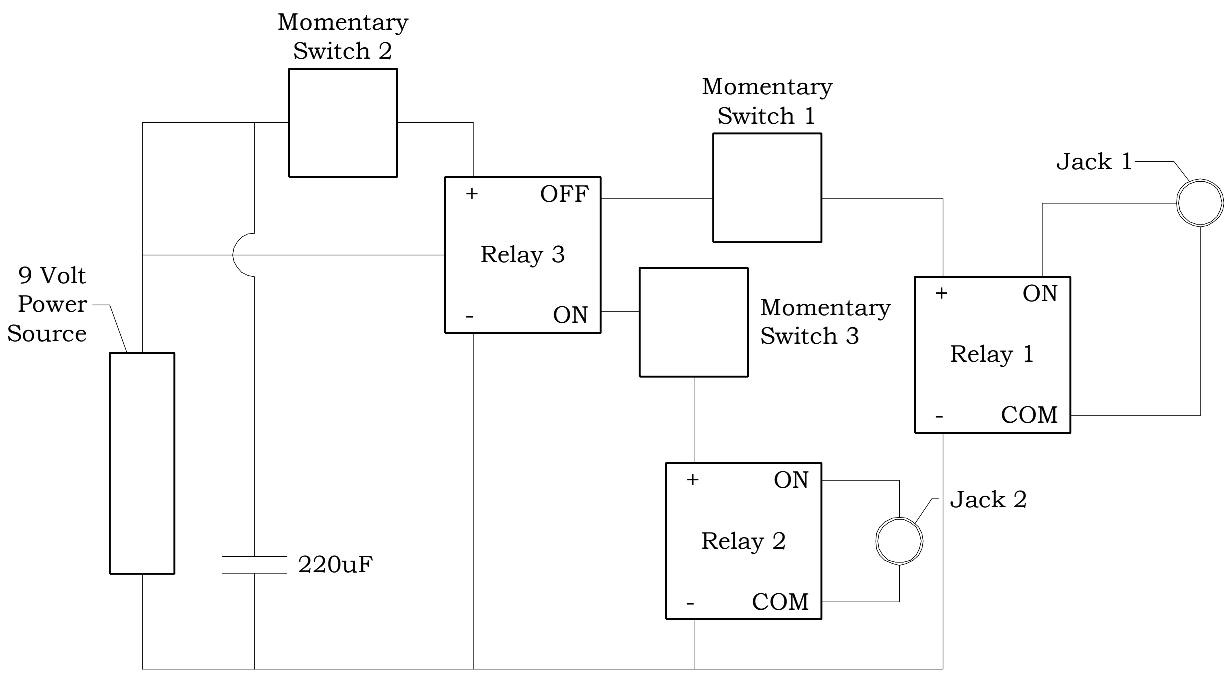

Figure 7.22. Two Stage Switch Electronic Block Diagram.

An Adapted Tape Recorder

Designers: Casey Stevenson, Marisa Medrano
Client Coordinator: Trish Peddicord
Special Education Department, Bryan (Texas) Independent School District
Supervising Professor: W.A. Hyman
Bioengineering Program
Texas A&M University
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INTRODUCTION

An adapted tape recorder with switches has been designed for a student in a special education program in Bryan Independent School District. The client has Rett Syndrome, a severe neurological disorder that primarily affects females and leads to a variety of problems, the most severe being apraxia. These patients exhibit the will to move but have difficulty engaging in movement.

A stock tape recorder was modified to allow the music therapist to choose one of two modes of operation. In the "on" mode, the stop, play, rewind, and fast forward keys are operational. In the "off" mode, only the stop and play keys function.

A standard on-off switch was designed to activate only the play function of the tape recorder. After pushing the play key, the therapist inserts the switch jack into the remote output of the tape recorder. This allows the play function to be activated using the on-off switch.

SUMMARY OF IMPACT

Many children with Rett syndrome become frustrated as a result of their inability to communicate.

Figure 7.23. The Adapted Tape Recorder.

Music has a calming effect and is used as an effective communication tool. Previously, the client fumbled with tape recorder keys during music therapy sessions and at times inadvertently erased her music tapes by accidentally pushing the record key. The adapted recorder allows the therapist to select between two modes of operation when working with the client. In the "on" mode, the recorder can be used with all of the standard functions; in the "off" mode, only the play and stop functions work. Additionally, the eject button was moved to the side of the recorder. The recorder can be used with either the standard on-off switch or the modified on-off switch, both of which allow the play function to be alternately turned on or off when the play key is depressed. The device meets the needs of many clients without full motor control of their upper extremities.

Students with cerebral palsy also work with music therapists. Many of these students are unable to exert the constant pressure needed to activate the tape recorder's existing momentary contact switch. The conversion of the switch to an on-off alternate action switch enables patients to activate and deactivate the play function by alternately pressing the contact area.

TECHNICAL DESCRIPTION

The adapted tape recorder was designed to comply with the following specifications: 1) it must be portable and durable; 2) the therapist must be capable of easily switching between the two operation modes; and 3) the function keys must be easily actuated by the patient.

The tape recorder was disassembled, and individual keys were disconnected. Holes were drilled through the record, play, stop, and pause keys approximately 0.4 centimeters from the leading edge. Steel pins were placed through the holes of adjacent keys (record and play, stop and pause). This adjoins the two keys and in effect combines the two keys into a single key. Color-coded keypads were glued to the tops of the pairs of modified keys. Lever arms of the record and pause keys were cut off to disconnect them. This resulted in one functional play key and one functional stop key, each with a large surface area, and unmodified rewind and fast forward keys.

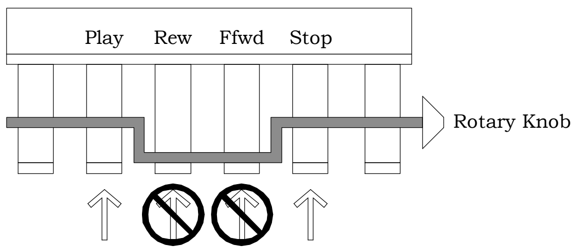

Figure 7.24. Modified Tape Recorder Keys.

A very thin metal rod was pre-bent to the shape shown in Fig. 8.25. Two holes were drilled on each side of the tape recorder, in which the rod is allowed to rotate. In its proper position, the rod extends slightly beyond one side of the recorder to allow the attachment of a rotary knob. In the "off" mode, the knob is rotated such that the flanged section of the rod prohibits the movement of the rewind and fast forward buttons, but allows movement of the play and stop mechanisms. The eject function was originally combined with the stop function on a stop/eject key. The normal ejecting mechanism was disabled and replaced with a slide switch located to the side of the recorder.

The standard on-off switch was easily made by drilling a hole in the top of a plastic electrical box and fitting it with a standard alternate action switch. The switch is wired with a 1/8-inch jack but can be fitted with an adapter if necessary. The modified on-off switch was made from a pre-existing momentary contact switching device with a large contact surface area. A standard alternate action switch was fitted below the plastic contact surface by drilling a hole in the base of the device and connecting it to existing wires. A corresponding hole was made in a plastic electrical box, and the device was secured to the top of the box with screws, thus concealing the protruding portion of the switch.

The approximate cost of the adapted tape recorder was $55.

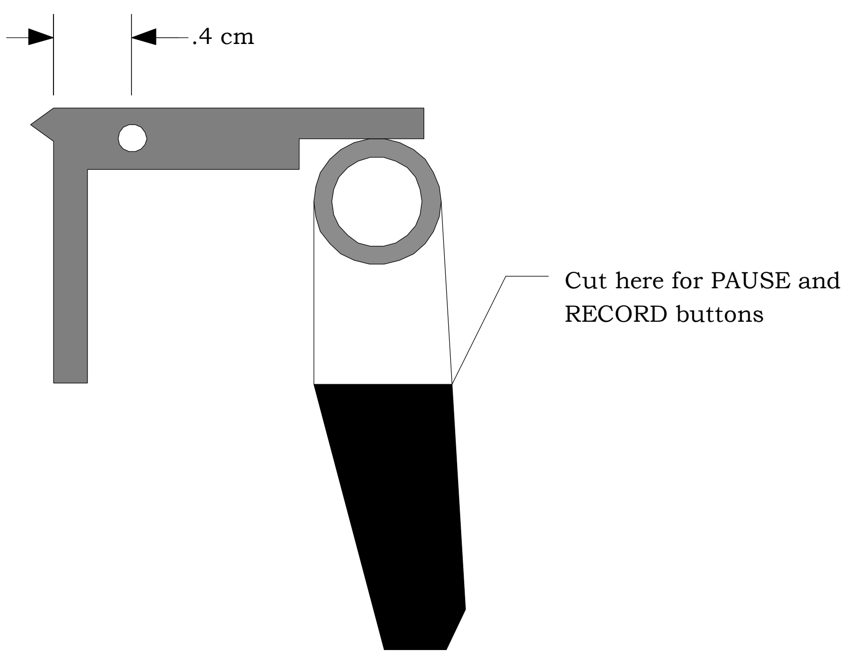

Figure 7.25. Rotary Knob Allowing "On" and 'Off' Mode Alternation.

Touch Sensitive Jack-In-The-Box

Designers: K. Michelle Davis, Shawn Kollatschny
Client Coordinator: Maureen Haggerty
Crockett Elementary, Bryan (Texas) Independent School District
Supervising Professor: W.A. Hyman
Bioengineering Program
Texas A&M University
College Station, TX 77843

INTRODUCTION

Children with limited motor skills often have difficulty operating buttons and switches. Play with toys is important for fostering learning about cause and effect relationships, improving motor skills, and giving children a sense of control. Several types of mechanisms have been designed to help children with disabilities activate toys on their own. Heat sensors, motion detectors, traction pads, and touch sensitive mechanisms have been used for this purpose.

A jack-in-the-box was modified for an eleven-year-old boy with limited motor skills. It was made to eject when he touches a keypad, thereby reinforcing his association of touching the pad with an action. The jack-in-the-box music is not necessary to achieve this objective.

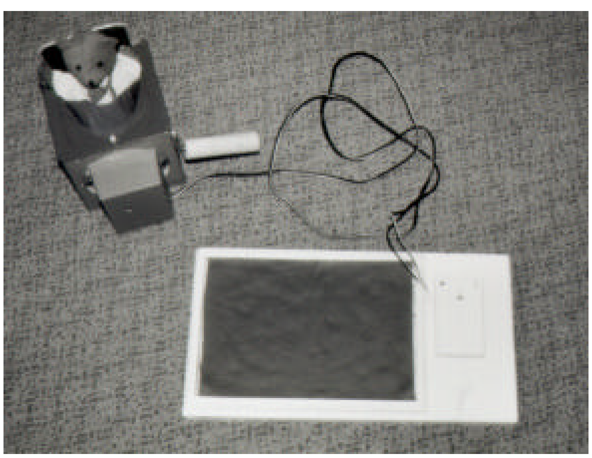

Figure 7.26. Touch Sensitive Jack-In-The-Box.

SUMMARY OF IMPACT

Due to the client's limited motor control, the touch sensitive pad has a large surface area over which to place his hand. In addition, it is activated by even a very light touch.

The client coordinator requested that the jack-in-the-box maintain its usual mode of operation, through the child's turning of the handle. A larger handle was therefore placed on the box so that the child could hold the handle with adult assistance. The jack-in-the-box was specifically chosen for this project because the child reacts positively to its action by smiling and laughing.

The child's learning of cause and effect relationships will be enhanced as he plays with the jack-in-the-box. Turning the box's wooden handle with adult assistance will help to develop motor skills and coordination. The child will be amused by the toy and will feel a sense of achievement and fulfillment upon being able to operate a toy independently, emulating the activities of his classroom peers.

TECHNICAL DESCRIPTION

The jack-in-the-box has a latch that was easily modified. The actual latch contained a center hole that enabled the designers to physically attach a wire to the latch. The wire was then connected to the solenoid pin by running the wire down the inside wall of the box and out of a pre-drilled hole located halfway down the side of the box. The solenoid was mounted to the outside of the box, and a plastic cover was placed over it for safety. A small hole was drilled in the bottom of the plastic cover, which allowed the electrical wires that powered the solenoid to run from the jack-in-the-box to the touch sensitive pad. When the circuit is connected, the solenoid is triggered; this action tightens the wire, pulls the latch open, and activates the jack-in-the-box.

An 8 by 12 by 1-inch wooden board forms the base board for the project. The battery compartment and touch sensitive pad are mounted to this board. A nine-volt battery activates the solenoid and is mounted in a case adjacent to the pad for easy replacement.

The touch sensitive pad was made with two plates covered in electrical conducting tape, and a copper wire coiled underneath. Four small springs hold the plates apart. The slightest pressure on the top plate connects the circuit and controls the jack-in-the-box. Quarter-round molding was placed around the pad to keep children's fingers from touching the electrical tape. A vinyl pad was placed over the top plate to keep children protected from electrical shock.

A large wooden handle with a one-inch diameter was placed over the original handle of the jack-in-the-box. The handle is long, allowing the boy's hand to fit easily around it.

The overall cost of the touch sensitive jack-in-the-box is approximately $40.

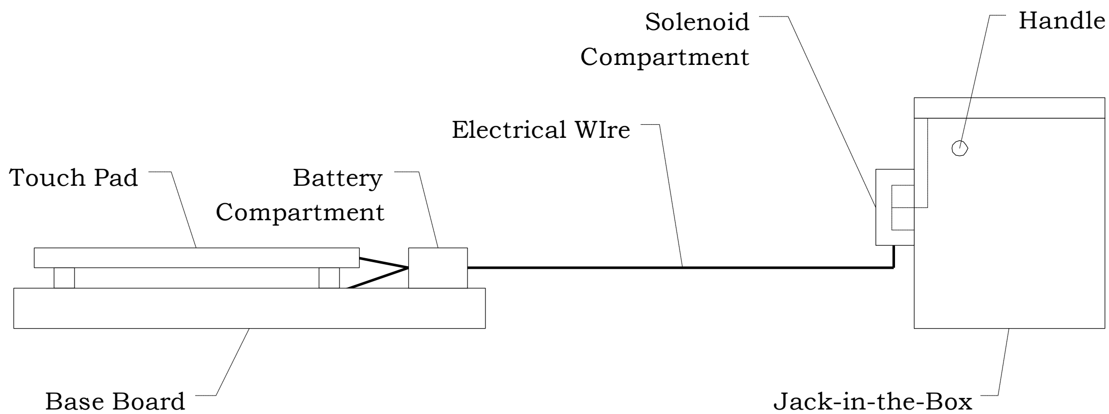

Figure 7.27. Touch Sensitive Jack-In-The-Box Schematic