CHAPTER 5

NORTH DAKOTA STATE UNIVERSITY
COLLEGE OF ENGINEERING & ARCHITECTURE
DEPARTMENT OF ELECTRICAL & ELECTRONICS ENGINEERING
FARGO, NORTH DAKOTA 58105

Principal Investigators:

Daniel J. Krause (701) 237-7616

John D. Enderle (701) 237-7689

Emergency Telephoning Given Minimal Finger Strength and Dexterity

Designer: Megan Everett
Disabled Coordinator: Dr. S.F. Everett, M.D.
Supervising Professor: Dr. Daniel Krause
Electrical & Electronics Engineering Department
North Dakota State University
Fargo, ND 58105

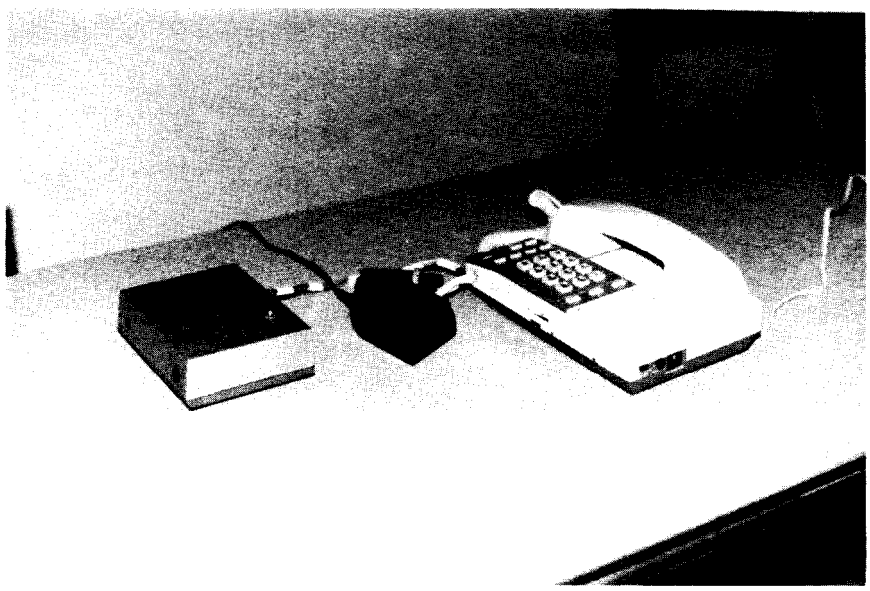
INTRODUCTION

There are many types and degrees of disabilities, such as severe arthritis, which make operating even a Touch-Tone phone difficult. In the extreme of an emergency a person may be completely unable to dial or go for help. This emergency dialing system design modifies a speaker phone, allowing the person to communicate the nature of the emergency even at a distance and even if unable to grasp the receiver or to dial. Three stored numbers can be called, each at the touch of a single large button. The 911 emergency number can also be accessed by a device small enough to fit easily in the palm of the hand. The 911 service would automatically direct help to the correct address. However, the real achievement of the system is that the person can explain the situation and be assured that the appropriate type of assistance is on its way. This is a vast improvement on the best system available now, which lets an operator know someone is in difficulty but not the nature of the problem.

SUMMARY OF IMPACT

The emergency dialing system was developed to respond to critical situations where the ill person was physically unable to move to the telephone. This prototype has been installed, tested and used in a home for nearly three months. The disabled person has been confined to a wheel chair for eleven years due to severe arthritis and weakness. The device has worked flawlessly.

Thus far there have been no crises requiring she call 911. She finds it very helpful in calling frequently used telephone numbers, far superior to her previous telephones. She has been more confident and able to be more active, free from the fear of being unable to reach help shold she need it, due to the emergency telephone dialing system. This system has greatly improved the quality of her life, as it could those who are similarly handicapped.

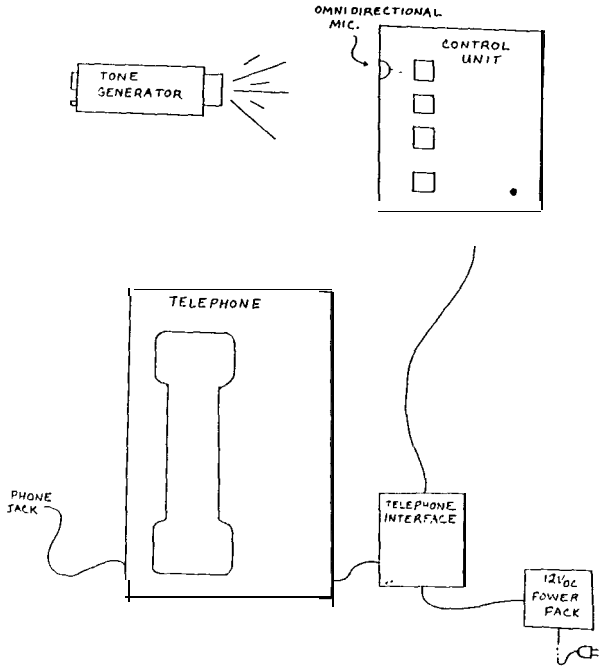


TECHNICAL DESCRIPTION

The remote activation utilizes a tone generator and a monostable. It functions as long as the telephone is within "hearing distance," which is a farther distance than that over which the person's voice will carry due to the piercing nature of the tone. Were several of these devices installed the person would always be within speaking distance of help. A microphone channels the tone through a decoder. When it is recognized, a series of monostables signal the telephone to be taken off-hook and the number to be dialed. The switching automatically places it in speaker-phone mode though the telephone can be set for private operation during normal dialing.

This emergency dialing system is modular in design; making it very adaptable to variations, easy to understand and easy to fix should some part of it fail. It consists of five main parts: (1) the speaker phone, (2) the telephone interface, (3) the tone generator, (4) the power supply, and (5) the control unit -- which, in turn consists of: (a) the tone decoder, and (b) the dialing controls. The speaker phone originally has an alternate action switch, which is actually comprised of 4 switches. They are responsible for taking the telephone off-hook, and switching the microphone and speaker in the receiver to those in the body of the telephone. The battery-powered memory is already included in the telephone, making storing and accessing numbers easy and according to the instructions in the owner's manual. The design's I-pole double-throw relay replaces the manual speaker switch, allowing the switches to be thrown electronically. Reed relays are directly connected to the priority call buttons for the same reason. The remote tone generator consists of a piezo buzzer, a transistor to drive it, a monostable multivibrator and 2 normally open momentary single-pole single-throw switches -- one to activate the device and one to reset it. It is important that this device is easily handheld, easy to activate but not to accidentally activate, and that is has a reset to Prevent the call from being placed if it is accidentally triggered.

The total cost of the project including the telephone is $210.



"Light Talker"
A Sequential Visual Communication Device for the Speech Impaired

Designer: Andrew Beauchamp
Disabled Coordinator: Becky Walters, Fargo Public Schools
Supervising Professor : Dr. Daniel Krause
Electrical & Electronics Engineering Department
North Dakota State University
Fargo, ND 58105

INTRODUCTION

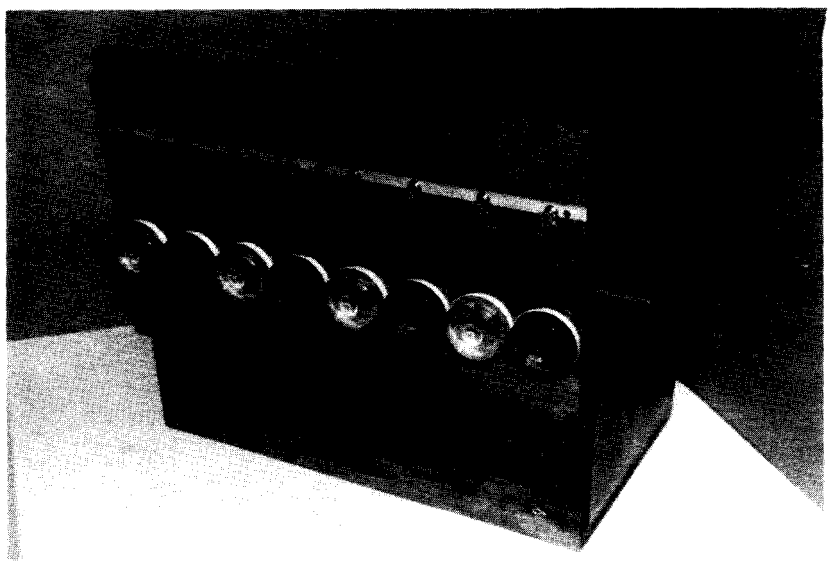
The Light Talker is a communication tool that can be used by speech impaired people to convey eight simple messages. Each message is located above a light. These eight lights form a horizontal line, with only one light on at a time. The lights are controlled using one of two modes. The primary mode "advances" one light with one press of the switch. The secondary mode "advances" continually at a variable rate with a single press of the switch. A second press of the switch stops the "advance".

The device will be used by a speech therapist to communicate with a speech impaired student. Commercially available communicating boards did not prove effective for this student.

SUMMARY OF IMPACT

A linear scanner was designed to facilitate expressive communication in a nonverbal child with severe handicaps. The child is nonambulatory, exhibiting limited mobility in the upper extremities. Visual acuity appears to be good, but visual functioning is inconsistent with difficulty controlling eye gaze and fixating for long periods of time. The child has a few meaningful vocalizations and uses an eye gaze board to make simple requests. Due to difficulty sustaining eye gaze, it is often difficult to judge which request the child is making.

The linear scanner gives the child another means of communicating basic needs and desires. The device is a stepping-stone to teach basic skills that will be needed in learning to operate a more sophisticated system. We no longer need to make a judgement as to what picture the child is gazing at since the light will indicate the child's choice. But most importantly, the student thoroughly enjoys using the equipment and is self-motivated to learn to use it efficiently.



TECHNICAL DESCRIPTION

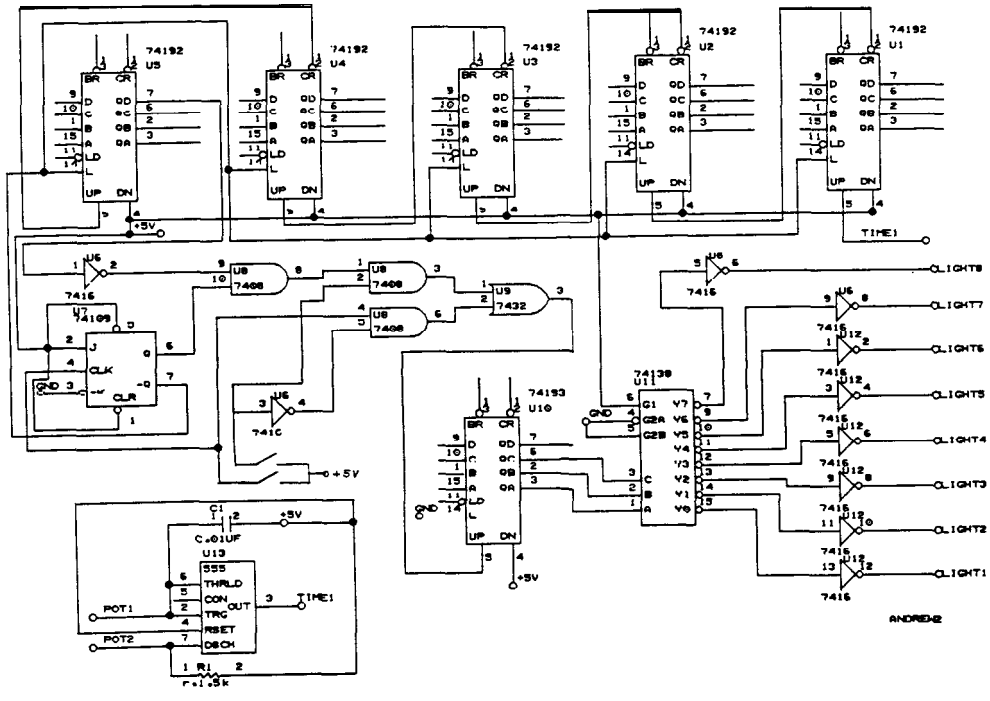
The box which contains the components is seven inches tall, eleven inches deep, and twenty inches long. The lights and pictures are located on the cover which can be secured at different angles. Since the school for the disabled students has a variety of custom switches that have a male 1/8" phono plug output, there is a female jack on the front of the Light Talker. The electronics, on/off switch, mode switch, and speed dial are located inside the box. A connector is located on the back of the box to attach to an external power supply which provides +5 volts and +12 volts.

The primary mode of this device is relatively simple to design. The switch which connects to the front of the box is debounced with a one shot that is set for 1/4 second pulse time. When the switch is pressed, it generates a leading edge to the input of divide-by-eight counter. The three low bits of the counter are then connected to a 3 x 8 decoder. Each of the lines from the decoder is connected to an inverter which drives a transistor. The transistor is either cutoff or saturated. Since there is an emitter resistor on the output of the inverter, no additional biasing resistors are used. The +12V line connects through a light to the collector of each transistor.

The secondary mode of operation is a little more complex. In order to accomplish the variable time delay, a 555 timer was used. Since the delay needed to vary between one and eight seconds, a variable feedback resistor and "divide-by 100,000" counter are implemented. The output of this system is a leading edge that can be used to trigger the primary system. In order to turn the secondary system on and off, a flip-flop that changes with every user switch input was added at the front end. If the flip-flop has a low logic level, Y. Then the inverted Y is connected to the reset lines of the "divide-by-100,000" counter. When the user switch triggers the change to a high logic level, the counter begins counting and the flip-flop generates the first leading edge. When the high bit of the last counter becomes high (it has reached 100,000), it drops the output to low for one count. When it resets (one pulse after 100,000), it generates a second leading edge. This process repeats itself until the user switch changes the flip-flop to a low logic level. this changes the output to low and resets the "divide by 100,000" counter.

A logic level from the "mode switch" is used to determine which mode is being used. The logic level is added with the user switch output; it is also inverted and added with the secondary system output. These two and-gates are connected, via an or-gate to the primary system input. This way, the primary system is protected from receiving two independently generated inputs.

The Light Talker cost one-hundred fifty dollars ($150) to build. Since there are a number of customized switches that use 1/8" plug, the Light Talker's mode of operation can be easily varied. The device can be used to help many different speech impaired people to communicate.



"Pneumatic Sewing Machine Speed Control"

Designer: Darin Westley
Disabled Coordinator: Susan McMahan, Fargo Public Schools
Supervising Professor: Dr. Daniel Krause
Electrical & Electronics Engineering Department
North Dakota State University
Fargo, ND 58105

INTRODUCTION

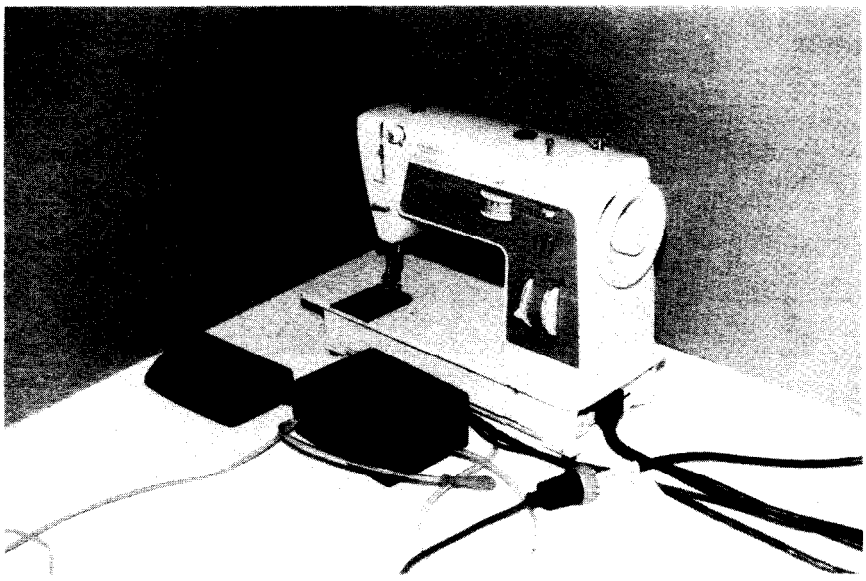
The purpose of this particular project was to develop an adaptation to a sewing machine speed control system to enable a handicapped individual to operate the machine with greater ease. The individual involved had cerebral palsy and was confined to a wheelchair. In order for her to operate the machine before the project was implemented, she had to place the foot pedal on the table and control it with her hand, which only freed one hand to sew with.

The basic idea behind this adaption was to utilize pressure to adjust the speed of the machine. This was done by using an air-filled tube, in which the operator could either bite down on, or place between her fingers and squeeze, to transmit pressure to a transducer. The varying input pressure would create varying voltage output levels from the transducer, which were used to supply a pulse-width modulating chip, which supplied the current drive for the sewing machine motor.

SUMMARY OF IMPACT

The sewing machine switch adaptation designed for a physically handicapped secondary student will be utilized to enhance her ability to participate in a recreational/leisure activity.

The student this adaptation was designed for, is considered educable mentally handicapped with cerebral palsy. The CP involves her upper and lower extremities which hinders her use of either a foot or thigh control when using a sewing machine. Due to her high interest in sewing, this adaptation allows her to be independent. This activity also helps her develop her eye/hand coordination and with practice will enhance her self concept and creativity.



TECHNICAL DESCRIPTION

The approach employed for this project was one which used pneumatic pressure to vary motor speed. An air filled tube was used to transmit pressure to a transducer, which in turn varied the output voltage. The circuit used was one which was modified from a MOTOROLA off-line motor control. The MOTOROLA circuit used a full wave rectified voltage dropped through a resistor to supply a plus width modulating chip that generated a variable voltage to control the motor's speed. The original circuit was designed to drive a 1/2 horsepower motor. For this reason it used a MOTOROLA SENSE FET which employed current mirroring techniques to prevent overdriving the fet.

For the particular application in this project, the motor drew at most one amp. Therefore mirroring was not needed. Instead, the pulse width modulating chip was used to drive the gate of a triac, with main terminal one connected to one leg of the motor, and main terminal two connected to common. The PWM IC (Motorola MC34060) furnished dead time control, soft start, error amplifiers, and double-pulse suppression. The soft start and overcurrent protection limit motor start up currents, which could otherwise be three to ten times the running current. The IC also suited switching-regulator systems with two error amplifiers. A 200 mA output transistor, and adjustable dead time control. Soft start was achieved through the dead time feature, while overcurrent protection used the error amplifiers.

Pulse-width control in the original circuit was achieved by applying a dc control from the potentiometer to the IC's comparator input (pin 3). With no resistance into pin 3 the full control voltage of 3.7 volts was applied, resulting in zero pulse-width and no motor rotation. With full resistance into pin 3, 1.6 volts gave maximum pulse-width and full motor speed. For the project's application, the HONEYWELL MICROSWITCH 164PC01D37 pressure transducer replaced the potentiometercircuit into pin 3. Since the circuit was designed to increase motor speed with a decrease in voltage applied to pin 3, the vacuum side of the transducer was used. The characteristics of the transducer, when using the vaccum side, were such that an increase in the input voltage would result in a decrease in output voltage. The supply voltage for the transducer was realized by a 7 K-ohm, 10 watt resistor and an 8.2 volt, 1 watt zener diode. A similar drive was used for the IC, with the exception of a 15 volt zener instead of 8.2 volts.

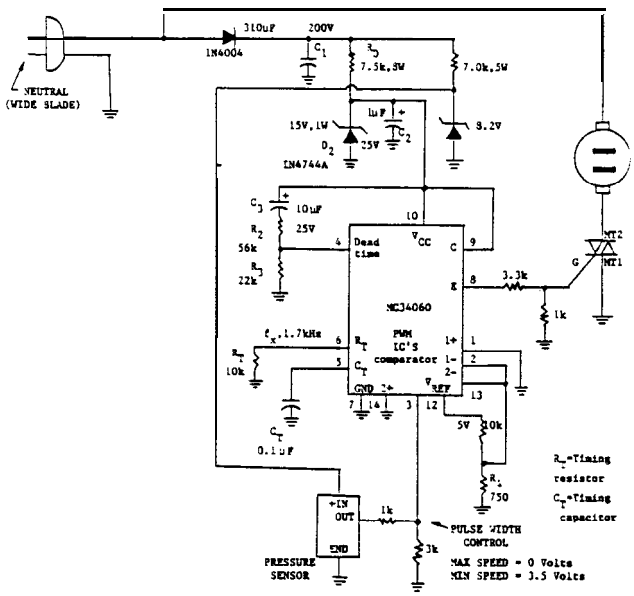
Another modification involved the input. Since a triac was used, the full wave bridge was removed, and a 400 volt diode was placed in series with the input line to the positive lead of the 200 volt capacitor.

The last change in the project circuit was due to the fact that mirroring techniques were not employed. The original circuit called for a mosfet which was a four terminal device. The fourth terminal was used for mirroring and was connected to an error amplifier (pin 1) in the comparator portion of the IC. Since mirroring was not used in the project, pin 1 was connected to common.

A female plug was used to connect to the existing foot pedal so that the pneumatic control could be disconnected and the sewing machine could be operated in its normal mode. When using the control, the foot pedal could be clamped down, effectively bypassing its control.

The air tube connected to the transducer has a rubber bladder on the one end which is the control. It can either be controlled using the operator's mouth to apply pressure, or it could be placed between two fingers and squeezed while sewing.

The cost of the components was $220. The pressure transducer, costing $160, was the most expensive component.



The Quad-Response Teaching Aid

Designer: Steve Vorderbruggen
Disabled Coordinator: Arloine Mithum, Fargo Public Schools
Supervising Professor: Dr. Daniel Krause
Electrical & Electronics Engineering Department
North Dakota State University
Fargo, ND 58105

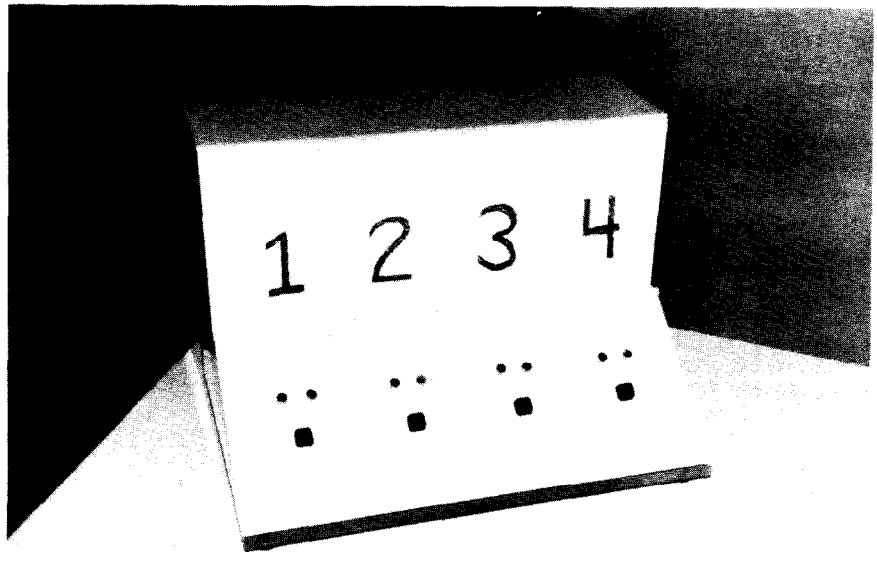
INTRODUCTION

This project was developed to aid in the education of young, mentally handicapped children. It is designed primarily to help students develop basic learning skills. It will be used by students to respond to a teachers verbal questions, using a multiple choice format. The device holds four pictures on a backboard, and four objects may be placed on a shelf above them. The student then makes his response by pressing the button in front of the item he chooses to be correct. When a button is pressed, the machine responds with audio and visual feedback consisting of a buzzer and colored light. Separate types of reinforcement are given for a correct or incorrect answer. This machine can be a powerful reinforcing aid, when combined with an instructor's encouragement.

SUMMARY OF IMPACT

The project was designed for one child who is subject to seizures, has a very short attention span and a developmental delay of over two years. He is able to sit up but needs a teacher or aide to work with him.

Using the machine, we could use 2 ***or*** 3 picture cards and the child was able to choose the correct picture bi pressing a button. He was interested in the green light for a correct response or red if he needed to try again. All of the children enjoyed using this project and it was very helpful for 2 of the children.

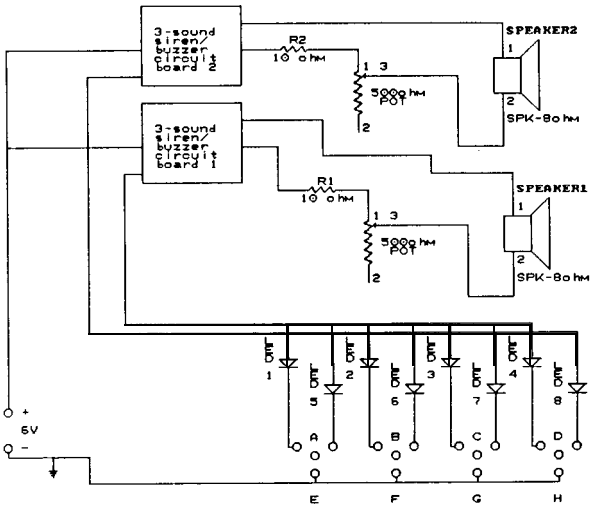


TECHNICAL DESCRIPTION

The Quad-Response Teaching Aid is a small console approximately 17" L x 12" H x 11" w. The backboard holds four 3" x 5" picture cards, while a small object may be placed on the shelf above each one. An answer button, red LED, and green LED, are located on a slight incline in front of each card. On the backside of the device are four switches which are used by the teacher to set the correct answer into the machine. The setting of each switch determines whether the picture or object it is behind is a correct or incorrect answer. Two sirens are located inside the backboard. One siren responds to a correct answer, while the other one responds to an incorrect answer. Each siren is controlled by a separate volume knob. This provides greater control over each buzzer's strength as a positive or negative reinforce. This device is powered by for "D" size batteries in series for a total of 6V. These are placed in the bottom of the machine, and are conserved because power is only used when an answer button is pressed. The machine should give well over seventy hours of use when operated with "D" cells rated for 1.1 Amp hours. The unit is designed for desk top use with the teacher close by. However, it is portable so that it may be used anywhere in a classroom. Although it is not weatherproof, it may be used outside on a table or bench. It should not be used in direct sunlight, as this makes it difficult to see the LED's.

The circuit for the Quad-Response Teaching Aid is mainly a series siren and LED combination powered by a six volt DC source. A volume control consisting of 500 ohm potentiometer in series with a ten ohm resistor are placed in series with the siren. The tri-sound siren, purchased from Radio Shack, contains a circuit board and speaker enclosed in a small case. This case was cracked open, and potentiometer and resistor combination were soldered in series with the speaker. It was found necessary to employ the ten ohm resistor to prevent the siren's malfunctioning at the highest volume setting. There are eight possible siren and led combinations, one correct and incorrect setting for each answer button. Depending on the setting of the switches in the back of the device, positive or negative reinforcement is received when an answer button is pressed. If the correct answer is chosen, for example, a pleasant siren sound will be heard and the green LED will light. However, if an incorrect answer is chosen, a slightly annoying siren is encountered, as well as a red LED. The unique case design of the Quad-Response Teaching Aid is what makes it so versatile and useful. It was constructed to specifications using white, 1/4" plexiglass. A removable bottom panel of 1/2" thick, clear plexiglass was attached using screws. This thickness adds a little extra weight which helps keep the device stationary during use. It also makes a very sturdy base which protects the device from falls. The bottom part only needs to be removed to replace the batteries in the holder attached to its inner surface. The front face of the case is slanted to allow for viewing of the LEDs and easy use of the answer buttons. The body of the Quad-Responder creates a wall which denies the student access to the setting switches and volume controls. The 1/2" picture shelf, running the length of the machine, is one of its most important features. It holds the 3" x 5" cards that are used to teach the children many useful concepts.

The cost of The Quad-Response Teaching Aid was $125.



Shape Identification and Placement Workshop

Designer: Danial C. Pillar
Disabled Coordinator: Sherry Johnson, Fargo Public Schools
Supervising Professor: Dr. Daniel Krause
Electrical & Electronics Engineering
North Dakota State University
Fargo, ND 58105

INTRODUCTION

The Shape Identification and Placement Workshop is designed to aid those handicapped persons who fall into the classification of "trainably mentally handicapped." (IQ=50) The workshop is composed of eight common geometric shapes that require the person to properly identify each shape and place it into the corresponding recession located on the face of the board. Positioning each shape into the recessions on the board produces a response of either a green light accompanied by a tone for proper placement or a red light accompanied by a different tone for an incorrect placement.

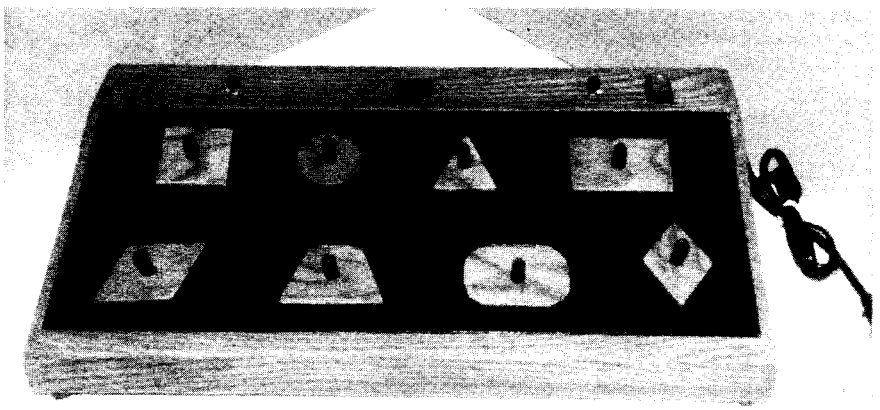
To be able to function in the "real world" the skill of identifying objects and being able to associate them with their proper resting place is a necessity. For the mentally handicapped person, this skill enables them to achieve a sense of self worth in knowing that they are able to perform tasks that are very important to everyday living.

SUMMARY OF IMPACT

The child is trainable mentally handicapped with no physical disabilities and a short attention span. The child needs activities lending themselves to opportunities to work at a task independently.

The shape and size sorter gives the child the opportunity to work with a fine motor task that provides immediate reinforcement either by a red or green light or a tone. The child knows immediately if their response is correct and if not to try another position on the board. The child adapts quickly to get the desired tone and green light which means a correct response. The knob on each shape makes it easier for the child to manipulate the pieces.

The device is a beginning way to give the child a chance to work independently and to operate various types of electronic equipment. The child is motivated to use the equipment because of the positive immediate feedback and the opportunity to work at a task independently.



TECHNICAL DESCRIPTION

The main structure of the electronics involved in the design utilizes TTL logic in determining whether proper placement of each shape has occurred. Within each 3/4 inch deep recession there are placed twosmall single pole double throw (SPDT) momentary lever type switches and one small subminiature push button momentary SPST switch. The lever switches located on the sides of the recession and the push button on the bottom, when all pressed together indicate the correct placement of a shape. Closure of the push button switch with any other combination of lever switch closures will indicate incorrect placement. For simplicity sake the path of logic involved to produce the response indicating correct placement will be presented first and will then be followed by that of an incorrect placement.

To first clarify the operation of the logic gates used within the design it is desirable to know how the logic levels are obtained. To impose the state of logical zero on the chain of logic gates 1 kOhm resistors are tied directly to ground on the 74LS08 side of the switches. When the momentary switches are in the open position the path of the inputs to the logical gates will be directly to ground through the resistors. When the switches are closed, however, a five volt supply from a JE-210 5v DC power supply is applied to the inputs of the 74LS08's imposing a high state of "logical one".

Correct placement occurs when all three switches within a recession are closed. Each set of the two lever switches within the recession connect directly to quad two input AND gates (74LS08) whose outputs connect to one input on each two input NAND gate aboard a quad two input NAND gate (74LSOO). At the 74LSOO, the push button switch joins the operation as the second input corresponding directly with the output of the two lever switches it shares a recession with. Eight such NAND gates referring to the eight shapes are then tied into a dual four input AND gate (74LS21) and continue by connecting as the inputs to a two input AND gate contained on a 74LS08 chip. It is at this point in the logic chain that indication of correct placement may be seen. Correct placement will close the two side lever switches as well as the push button switch sending five volt signals to both the 74LS08 and the 74LSO0 chips. The 74LSO0 being a NAND function will then send logical zero signals to the 74LS21 chip which in turn will produce logical zeros as outputs. These logical zero outputs invoke a zero output from the last set of 74LS08s causing a drop from an original condition of high (approximately 5v) that occurs in the preplacement state. Because the push button switch is momentary and spring controlled the original state of high is returned to once the shape has been placed. The dip in the output signal is what then controls the remainder of the circuit. A complete explanation of that operation will follow that of the incorrect placement discussion.

Incorrect placement uses the same type of logic as that of correct placement with the addition of an inverting gate (74LS04) on the output of the first bank of quad dual input ANDs. The outputs of the inverters then connect with the push button inputs at a separate set of 74LSO0 NAND gates, 74LS21 AND gates and finally the 74LS08 AND gate. Incorrect placement will cause the correct placement circuit to experience no change on the output. The incorrect circuit, on the other hand, will see the same type of output as shown in the earlier figure.

The outputs indicated above are then both connected to a 556 timer network. Although the 556 is a timer IC, the Workshop utilizes it to produce a monostable output through the use of external connections and components. Working on a trailing edge of the input signal as shown in the previous figure, the 556 produces output pulses, at pins five and nine, whose length is determined by the designer. The outputs of the 556 timer, one being the signal for correct placement and the other incorrect are connected to the base of a 2N222A transistor and the gate of a JFET respectively. The source of the JFET ties to the ground through a current limiting resistor which acts as the driver for the base of the NPN transistor. The NPN then has its emitter tied directly to ground and the collector is connected to the buzzer and light which is in turn connected to a five volt power supply.

The transistor-transistor driver likewise drives the second transistor through a 1 kOhm current limiting resistor connecting to the second transistor in the same fashion as described above. Operation of the light and buzzer occur when the monostable signal is emitted from the 556. That signal turns the JFET and the NPN transistor on which then ties the base of the second NPN to 5 volts which in turn causes the NPN to turn on and complete the circuit for the light and buzzer. The same connections are made for both correct placement as well as for incorrect placement.

The cost of the components was $120.

An Ultrasonic Ranging System for the Visually Impaired

Designer: Eric Durfee
Disabled Contact: Bret Person, NDSU Student
Supervising Professor: Dr. Daniel Krause
Electrical & Electronics Engineering Department
North Dakota State University
Fargo, ND 58105

INTRODUCTION

The Ultrasonic Ranging System is a navigational and obstacle aid for visually impaired people. The device transmits an ultrasonic tone burst and the time it takes for the echo to return is used to generate an audio tone with a frequency proportional to the distance to the object. It has an adjustable tone range, a resolution of .58 feet per tone, and is packaged in a single hand-held box with headphones and a volume control for the audio tone.

The ranging system will detect solid objects, people, and even curbs. Doorways can be easily found.

SUMMARY OF IMPACT

I found the sonic cane to be an excellent device for the blind. It is a far better alternative to the standard long white cane because it is capable of detecting objects that the white cane would miss entirely. Objects which are above the waist of the blind person are not well-detected by the white cane, this can lead to some serious injuries.

The sonic cane performs above and beyond my expectations for the device. There are no readily apparent problems when using it. I like the fact that it detects low-hanging tree branches and objects that could be potentially harmful when in the path of a blind person

The size of the unit should be reduced, and there should probably be some other method besides the constant beeping as a warning signal. The beeping tends to become annoying and distracting after awhile.

Overall, I feel that the cane is an excellent first attempt. A very usable device.

TECHNICAL DESCRIPTION

The ultrasonic ranging system is housed on a box that measures 7.5x4.25x25 inches. It has a pair of mini-headphones and volume control for the audio output and a power switch for the entire system. It is powered by four AA batteries and one 9 volt battery contained within the box.

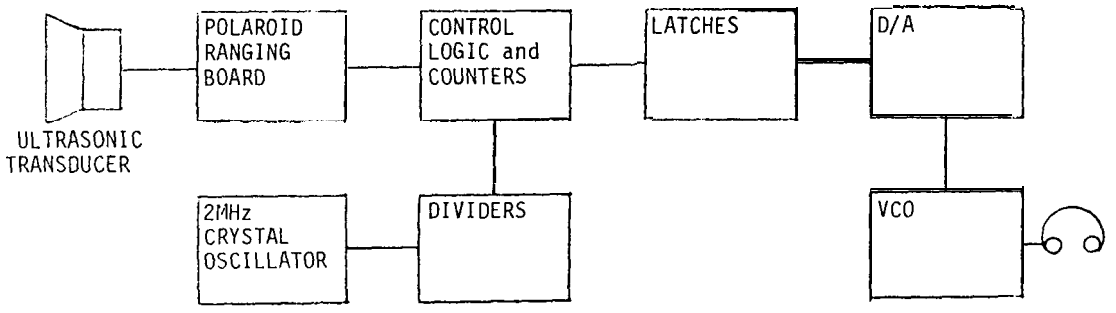
The circuit can be broken down into two major parts. The first is the distance-to-time (D-to-T) converter which measures the distance to an object and has as an output a time between two signals that corresponds to the distance. The second part is a time-to-frequency (T-to-F) converter which measures the time between the signals and converts it to a corresponding audio tone for the user.

The more difficult job of D-to-T conversion is handled by the Polaroid Ranging Board (PRB) and the Polaroid Ultrasonic Transducer (UST). When a start signal, called VSW by Polaroid, is given to the PRB, it generates a lms tone burst at a frequency of 49.41KHz and a signal, XLG, indicating that the transmission has occurred. The UST transmits the tone burst and is then used as the microphone for the returning echo. When the first echo is received, PRB generates a pulse on a line called FLG to indicate it has received an echo. The time between the leading edge of XLG and the leading edge of FLG is the desired output.

The T-to-F conversion, although easier than the D-to-T conversion, was where most of the design time was spent since it does not come as a prefabricated device. The control logic portion of this circuit generates the VSW, then it uses XLG and FLG to generate three signals for the counters and the latches. The dividers generate two signals from the 2MHz crystal oscillator, CLK1 and CKLK2. The counters are used to count pulses from CLK1 during the time interval between XLG and FLg. An object farther away will have a longer time interval and will cause a larger number of pulses to be counted than a nearer object. The latches save this count for use by the tone generation circuit.

The tone generator consists of a digital-to-analog (D/A) converter, a voltage control oscillator (VCO), an op amp and a power amp. The count stored in the latches is fed to the D/A which gives an output voltage that is proportional to the count. This output is level-shifted by an op amp and then used as the control voltage for the VCO. The VCO output frequency is then directly proportional to the distance to the object detected. After power amplification and filtering, this frequency is fed to a pair of headphones for the user.

The cost of components was $145.



OBJECT RECOGNIZER

Designer: George O'Connor
Disabled Coordinator: Jean Sanner, Fargo Public Schools
Supervising Professor: Dr. Daniel Krause
Electrical & Electronics Engineering Department
North Dakota State Universitv
Fargo, ND 58105

INTRODUCTION

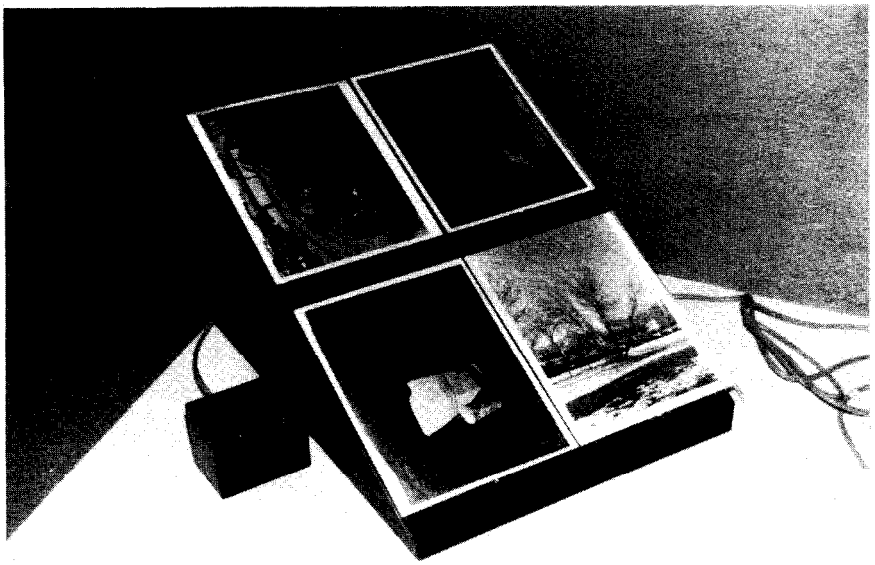
The "Object Recognizer" was designed to assist the instructors at an elementary school for teaching the learning disabled. The idea came directly form an instructor. The device is quite versatile since it can hold up to and including 4 8" x10" pictures or cards. The teacher chooses which slot contains the correct picture by pressing the corresponding button on the control box. The child makes his/her choice by pressing the button directly beneath the picture. Reinforcement is both visual and auditory for both positive and negative cases.

SUMMARY OF IMPACT

The device constructed was designed to reinforce a student for correctly identifying a specific picture. It could also be used for making a desired choice between 4 pictures. As designed, a picture could be inserted in each of the 4 openings from the schools language stimulation kits.

The idea of being able to alternate reinforcement between 4 locations is very important and this aspect of the project was excellent. The size of the picture slots was also very practical. The use of both visual and auditory reinforcement was potentially very helpful.

There were a number of problems in the finished product. The sounds produced for both "correct" and "incorrect" choices would be difficult for children to distinguish. The use of only a "correct" response sound would be better. Since the switches and reinforcing lights are below each picture, the child might not understand whether the switches between the pictures refer to the pictures above or below them.



TECHNICAL DESCRIPTION

The "Object Recognizer" consists of four clear slots each of which can house a picture as large as 8" x 10". The four slots are situated in a stacked manner, that is, two slots on top and two slots on the bottom. These slots will set at an angle to the table top. The openings to the slots will overlap the main unit by 1/2 inch. This will allow easy installation and removal of the pictures. Beneath each slot is a push-button switch to allow the student to choose which picture he/she believes to be correct. Along the middle are 8 indicator lights to act as visual reinforcement, both positive and negative. It should be noted that this device utilizes pictures of objects that the school has on hand (the largest cards that the school uses are 8" x 10").

The "Object Recognizer" also has a control box. The control box is connected to the main unit by a 6' cable. The control box will be hand held by the instructor. It consists of five buttons labeled 1, 2, 3, 4, and Reset respectively. This allows the instructor to choose which slot contains the correct picture. Once the student makes his/her choice the teacher resets the unit and starts over. The control box can be held so that the teacher can choose the picture without the students knowledge.

When the device is powered up and the red LEDs will flash and the negative siren will sound indicating that the device is ready for operation. The instructor must first load the slots with the pictures or flash cards of his/her choice. As mentioned earlier the unit can handle a maximum of four pictures or cards at any one time. Using the control box supplied with the unit the instructor chooses which slot contains the correct picture by pressing the button on the control box corresponding to that slot. The student then trys to choose the correct picture by pressing the large button directly beneath that picture. If the student's choice is incorrect, he/she will receive negative reinforcement through flashing red LEDs and a negative siren. The student can still try to choose the correct picture and can continue to do so until the correct picture is chosen or the teacher resets the device. If the student's choice is correct he/she will receive positive reinforcement through alternatelyflashing amber and green LEDs and a positive siren. The device is reset by pressing the "Reset" button on the control box. Once the device is rest the instructor can again choose which slot contains the correct picture.

For the teacher to choose the correct picture, there are four switches on the control box that correspond to the four pictures on the main unit. The control box is connected to the main unit via a six foot conductor cable. These switches are single-pole single-throw. One side of the switch is tied to ground, the other side goes to an invertor and is pulled high through a 1k ohm resistor. The other side of the invertor goes directly to a D-type flip-flop which is set up as a latch by typing the compliment output to the preset. This allows the teacher to only have to push the button once for his/her choice. The student's button that corresponds to the teacher's button is ANDed directly with the output of the latch to determine if the student chose the same picture as the teacher. The student presses the button directly beneath the picture of his/her choice. These switches are also single-pole double-throw switches and like wise have the one side grounded and the other tied high through a 1k ohm resistor and also connected to an input of an invertor. The output of the invertor is connected to an AND gate with the output of the latch of the corresponding button as the other input. It is also connected to a NOR gate with all the other student buttons which are used to trigger the 555 timer. The outputs of the 4 AND gates are NORed and then inverted. The output of the invertor is the input to a D-type flip-flop which is set up like a latch.

The output of this latch is connected to 4 NAND gates and 1 AND gate. The other input of the AND gate comes from a Decade counter used to divide the base frequency (1MHz) to approximately 2Hz. The output of the AND gate is connected to D-Type Flip-flop. This causes the output to toggle high and low at a frequency of 2Hz when a correct response is given. The output and the compliment are then connected to the 4NAND gates alternately which are in turn connected to the yellow and green LEDs respectively. This causes the green and yellow LEDs to alternate being on and off.

The compliment of this latch is used to control one of the relays that controls the siren, giving the positive sire. It is also ANDed with the output of another AND gate whose inputs consist of the output of the 555 timer and the output of the NOR gate. The output of the AND gate is inverted and is connected to the ground pin of the 4 LM3909 LED flashers which are used to flash the red LEDs for the negative reinforcement. The output of the 555 time is connected to an AND gate whose other input is the OR of all the latch output from the control box. The output of this AND gate is connected to the reset of the latch enables the yellow and green LEDs. The 555 timer output is also inverted and used to control the relay that enables the siren.

The components, including the fabrication of the case cost $135.

Writing Skills Improvement Board

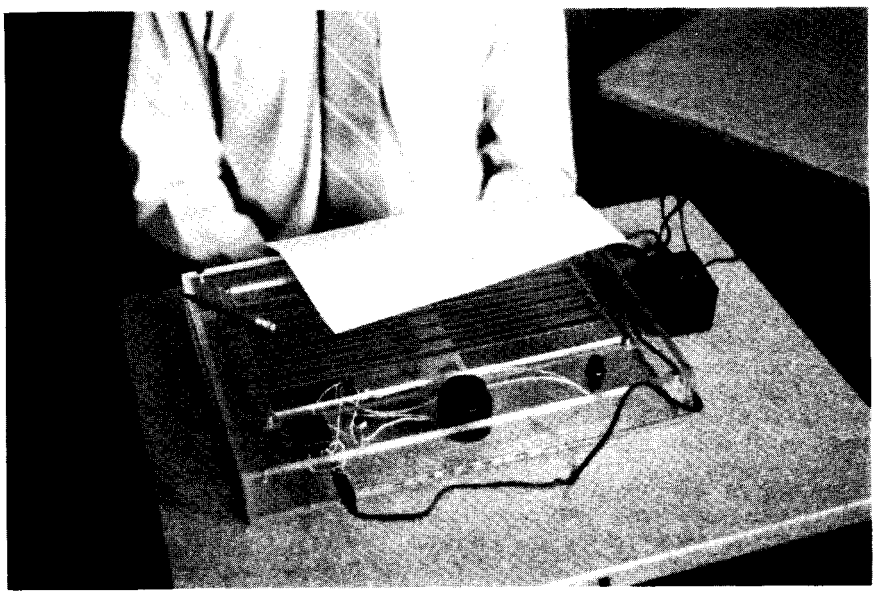
Designer: Charles Breid
Disabled Coordinator: Karen Gertz, Fargo Public Schools
Supervising Professors: Dr. Daniel Krause and Jenny Rawson
Electrical & Electronics Engineering Department
North Dakota State University
Fargo, ND 58105

INTRODUCTION

The Writing Skills Improvement Board is a device that will help handicapped students improve their writing skills. When handicapped children are learning to write, they have a tendency to wander all over the paper. The Writing Skills Improvement Board gives the students a warning when they are writing outside of the lines. The students will learn to write inside of the lines from using this board. The student needs only to place a piece of paper on this device, turn it on, and start writing.

SUMMARY OF IMPACT

This adaptation is designed for students with a sensory motor dysfunction and, visual/perceptual problems. It gives the student automatic feedback when performing a written task. Students with visual planning problems have difficulty perceiving when writing, their word formation is either too large or too small. The buzzer and the light will give the student both a visual and auditory cue. Immediate feedback is the best way to reinforce correct response and motivate the user to continue practice. Eventually it would be anticipated that repeated use of the board would improve the student's eye/hand coordination, gross/fine motor skills, handwriting skills, develop propioceptive memory, and re-education of motor skills.



TECHNICAL DESCRIPTION

The writing board is 15 inches long, 11 inches wide, and 2 1/4 inches tall and is made out of 1/4 inch plexi-glass. The top side contains a 7 inch by 12 inch opening into which the paper is placed. A sheet of plexi-glass is mounted under this opening and the paper is placed on this. Mounted to the top is the on/off switch, a power-on indicator, the warning buzzer and the warning light. Mounted on the back is a power jack that a 9 volt AC to DC adapter plugs into.

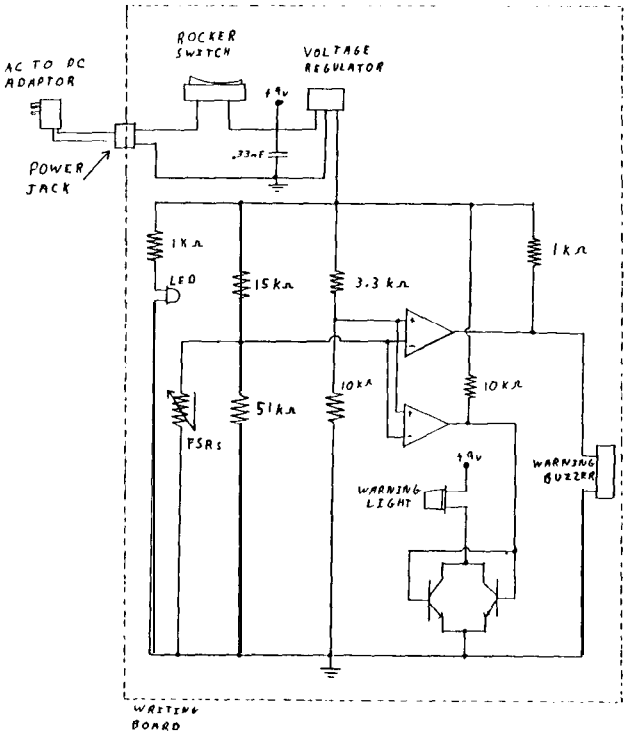
To sense pressure between the lines, Force Sensing Resistors (FSR) are used. The FSR is a device that can sense pressure. When pressure is applied to the FSR, its resistance decreases. This decrease in resistance is then converted to a voltage level by placing the FSRs in parallel with a 51k ohm resistor. This combination is then used in a voltage divider network with a 15k ohm resistor and a +5 volt source that is obtained from a 5 volt voltage regulator.

The voltage across the combination of the FSRs and the 51k ohm resistor is around 3.86 volts when no pressure is being applied. When a pencil is pressing on the FSR, this voltage drops to around 3.60 volts. A constant threshold voltage is compared to this variable voltage to determine if pressure is being applied to the FSRs. A threshold voltage of 3.75 volts is used and it is obtained from a voltage divider using a 3.3k ohm and a 10k ohm resistor and the +5 volt source.

These two voltage levels are compared using a comparator and when the voltage across the FSRs falls below the threshold voltage, the comparator output goes high indicating that pressure is being applied to the FSR and that a warning should be issued. To issue the warning, the buzzer is sounded and the light illuminated. Two comparators are used, one to drive the buzzer and one to drive the light.

The buzzer is connected from the output of the comparator to ground. A 1k ohm resistor is connected from the +5 volt source to the comparator output to provide the current to drive the buzzer. By varying this resistor, the loudness of the buzzer can be adjusted. The light is connected from the +9 volt source to the collectors of two transistors. The bases of these transistors are connected to the comparator output and their emitters are connected to ground. A 10k ohm resistor is connected from the +5 volt source to the comparator output to provide the current to drive the transistors. The transistors act as a switch to turn the light on and off. Two transistors are used in parallel so that enough current flows through the light such that it is illuminated bright enough.

The Writing Skills Improvement Board cost about three-hundred fifty dollars ($350) to build. Since most students will be able to use it, the teacher will find it to be a very useful device in teaching handicapped children to write.




S. VALENTA