CHAPTER 16
UNIVERSITY OF TENNESSEE AT CHATTANOOGA

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Cause and Effect Table

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INTRODUCTION

The original problem statement was given as follows; a lightweight, portable, tabletop device is needed to motivate and provide a reinforcing stimulation. This approach helps to teach cause/ effect concepts to a person with mental retardation and multiple disabilities. This device should have variable input and output modalities. Several activities are incorporated into the tabletop device to meet the design objectives: 1). squeezing the bulb blows air out of the nozzle located to the left of the bulb, 2). Strumming the guitar strings provide auditory and vibratory stimulus, 3). pushing the textured button provides visual and tactile stimulation by turning on **the** four red lights surrounding the button, 4). pushing the troll doll toward the front or back of the panel provides auditory stimulus in the form of a buzzing sound, and 5). Pushing the yellow gel pad activates a laughing sound providing auditory stimulus. The device is secured to the table top with a Velcro strap.

SUMMARY OF IMPACT

The client has mental retardation and multiple disabilities. The project objective is to design a device to meet the needs specified for the client and construct the device for delivery to the client. The combination of activities presented in the device are accessible to the client and provide him with the desired stimuli.

TECHNICAL DESCRIPTION

The plastic casing, made of PVC plastic, is available from Robar, Inc. and requires one to two days fabricating time. The casing base is 14"×19". The top is slanted and adjustable.

The power is from 4 rechargeable D cells. The system includes a 1 20VAC to 12 VDC converter and battery charger circuit. The battery charger circuit consists of an LM317T regulator and two fixed resistors and one variable resistor to adjust the charger output to 8VDC.

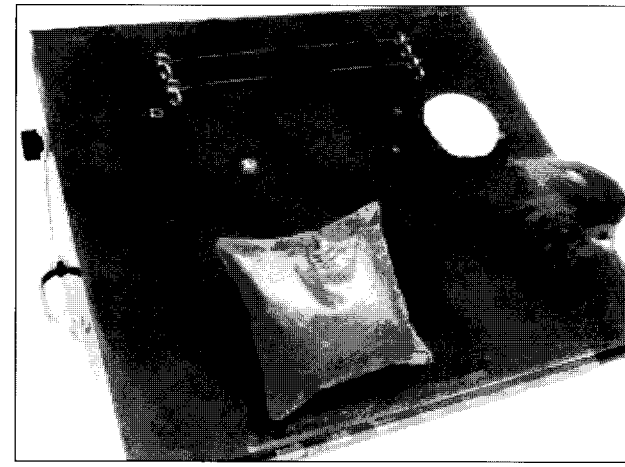

Figure 16.1. Cause and Effect Table.

Squeezing the bulb blows air out of the nozzle located to **the** left of the bulb. The guitar strings provide auditory as well as vibratory stimulus. Pushing the textured button provides tactile stimulus as well as visual stimulus by turning on the four red lights surrounding the button. Pushing the troll doll toward the back of the panel or pulling it toward the front of the panel activates an auditory stimulus in the form of a buzzing sound. When the troll doll is released the switch will return to its center position, turning off the buzzer. Pushing the yellow gel pad button activates a laughing sound which continues for three "cycles" of the laughing sound. Tactile and auditory stimulus are provided by the small guitar.

The bulb for the air nozzle is a high quality squeeze bulb of the type used for blood pressure cuffs. The push button switch is the large mushroom head, normally opened, emergency stop type. The button is covered with a Velcro material. The button closes the 6VDC circuit to operate 4 high-intensity LED's.

The troll doll switch is in the lower right-hand corner, and the speaker hole is in the center of the panel. The troll doll switch operates like a joystick and operates a 6V DC buzzer. The jelly switch is also a momentary contact with a large mushroom head. The head is covered with a jell pack attached with cloth to the mushroom head. This switch operates a laughing device which contains its own batteries. The laughing device is mounted directly to the push-button switch and operates independently of the other circuitry. The guitar strings and guitar mounting hardware are used to provide the final stimulus. The "guitar" is adjustable by lifting the adjustable casing front panel.

The cost for the device was $51.

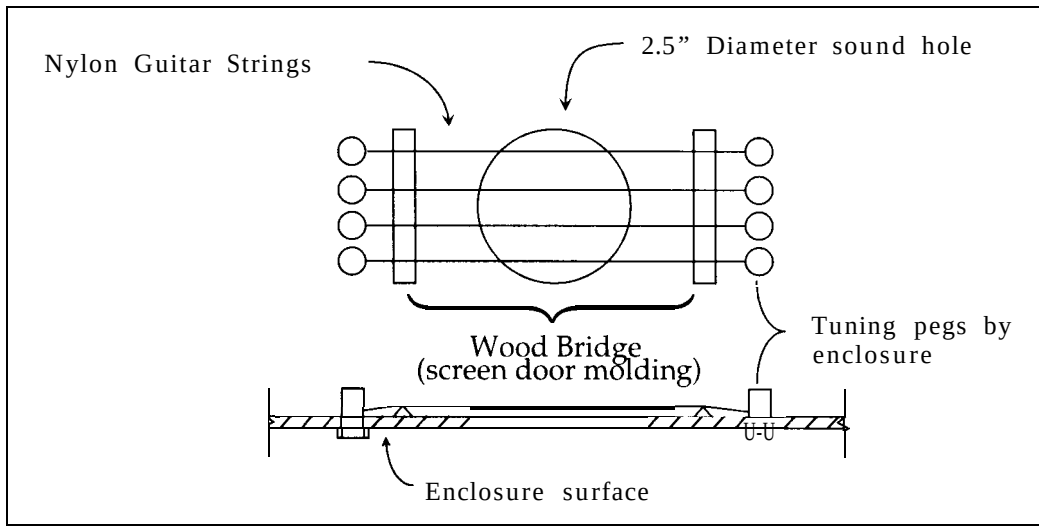

Figure 16.2. Guitar Detail.

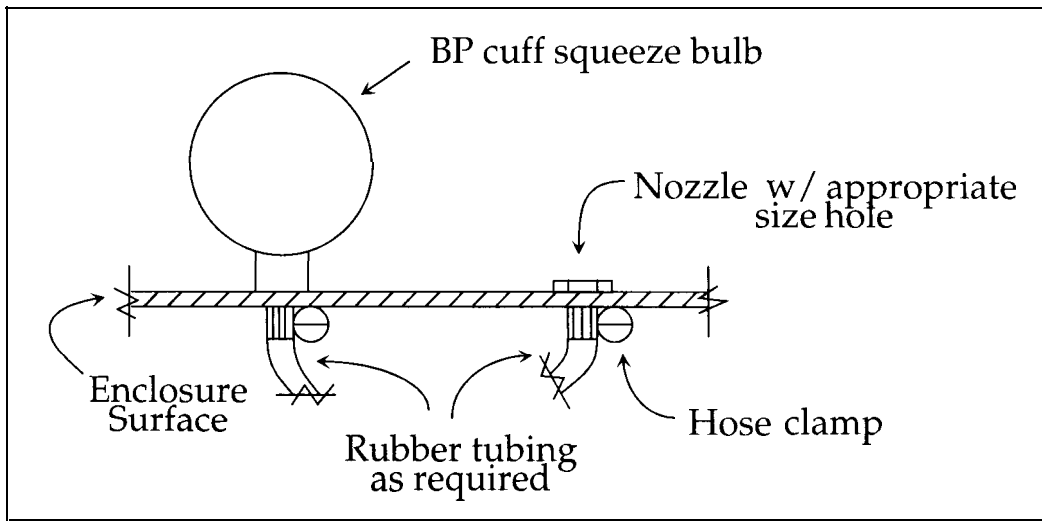

Figure 16.3. Squeeze Bulb Detail

Visual and Auditory Stimulation Device

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Client Coordinator: Debbie Sneed- Orange Grove Center
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INTRODUCTION

The objective of the design was to teach a cause and effect relationship by stimulating the senses. The alternative chosen is a triangular-table top podium as illustrated in Figure 16.4. The podium has push buttons to cause lights to flash. Having the client push the button and then see the lights flash, reinforces the cause and effect relationship. In addition, various tones are also heard through a pair of headphones.

The device works as follows. The person caring for the client turns the main power switch on (rocker switch). This switch is located on the back panel. The podium is placed on the a table or on the floor in front of the client who wears the headphones. The client then operates the device using the push button switches, located in the middle of **the** front panel. The lights begin to flash on and off in the **same** rows where **the** client pushes the button; if the client pushes on the button next to it, a different tone is activated. There are three rows of lights and three different tones.

SUMMARY OF IMPACT

The client is a six year old autistic individual with Down's Syndrome. The most important consideration is that the client does not yet understand the cause and effect relationship. The design group was given the objective of designing a simple device which would use lights and sound to teach this concept. The client responds to sound and lights; headphones are particularly attractive since the clients hearing is not strong and the tones do not disturb other individuals in his vicinity.

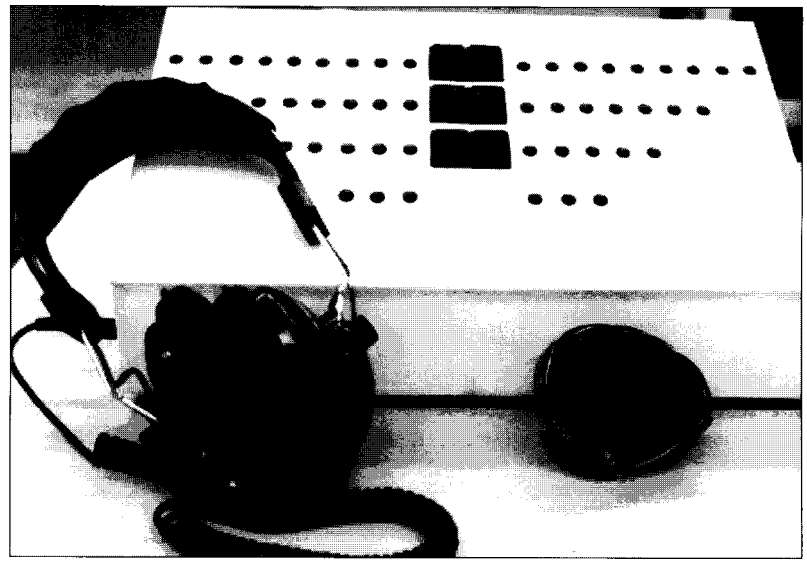

Figure 16.4. Visual and Auditory Stimulation Device.

TECHNICAL DESCRIPTION

This podium is constructed from a $\frac{1}{4}$" sheet of plastic. The overall size is 8"×16", and the front face of the podium is be tilted back at 45".

The LED's are located around the sides of the switches. The distance between each two LED's is two inches vertically, and 1 inch horizontally. There are four LED's on the first row (two in each side), six LED's on the second row (three on each side), eight LED's on the third row, and 10 LED's in the fourth row, with five on each side for a total of twenty-eight LED's. A small door on the back panel hinges inward for battery access. A small lock is used to keep the door locked. A speaker for the audio isolator is located in the top left side of the face and a jack is provided for the headphones.

The device is powered by one rechargeable D-cell battery located inside the podium. The battery requires one D-cell battery holder. The holder is wired to a socket in the back panel. An external battery charger can be plugged into this socket to recharge the battery. The circuitry requires an LED flasher chip, twenty-eight LED's, twenty-eight plastic sockets for the LED's, six throw momentary switches, a rocker switch, 18 and 22 gauge wire, a small breadboard to hold the circuitry, capacitors, resistors, relays, and audio isolator.

The cost for the device was $520.

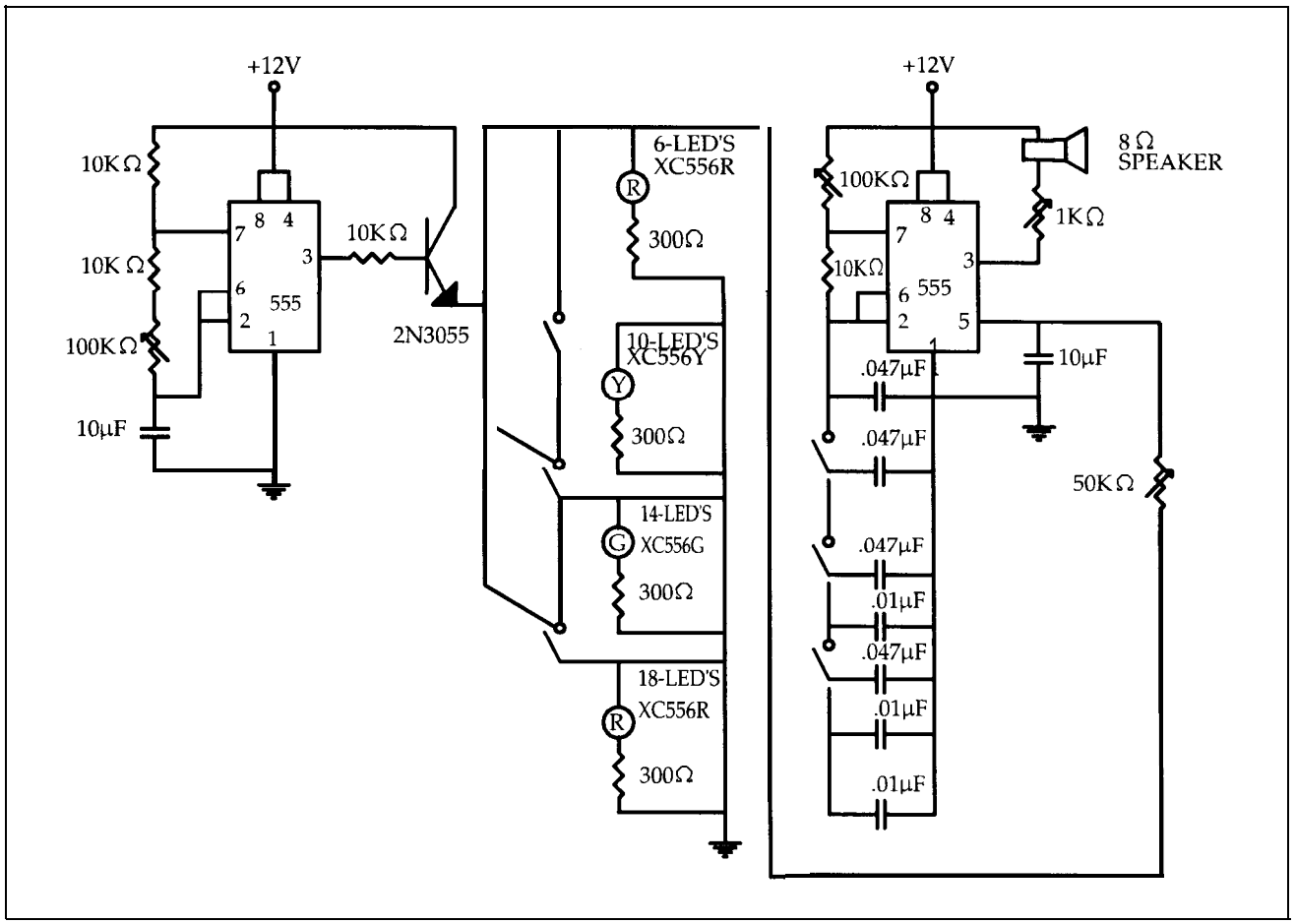

Figure 16.5. Schematic for the Visual and Auditory Stimulation Device.

Coin Dispenser

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Client Coordinator: Nikki McReynolds- Orange Grove Center
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INTRODUCTION

A 22 year old non-ambulatory male working on independence skills can drive a motorized wheelchair with chin-switch to cafeteria, and use a switch to access a computer to order food, but he is not able to pay for his breakfast without assistance. A device designed and constructed to assist the client in paying for his food is the object of this design project.

The light indicating the denomination of the coin to be selected sequences from a quarter to a dime to a nickel to a penny. When the desired denomination of the coin is lighted, the client activates the switch for the desired number of times to select the number of coins for that denomination. This is repeated for each denomination. The coins are dispensed from a standard coin dispenser which has been modified to electronically dispense the coins. The coins fail into a collector which the cashier may remove. The device is shown in Figure 16.6.

SUMMARY OF IMPACT

The device has accomplished the requirements of the design objectives. The client is able to independently pay for his breakfast. The device also allows the client to work on his memory and math skills. The most important aspect of this project is that it boosted the client's self confidence.

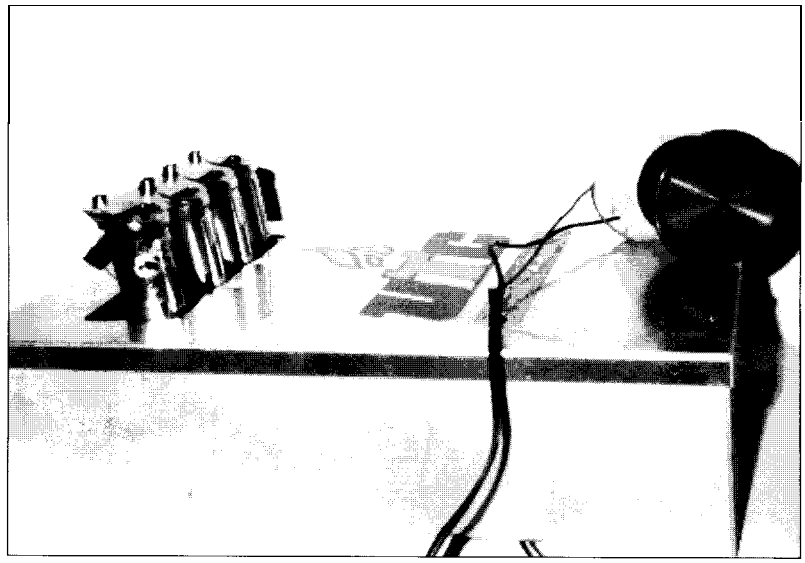

Figure 16.6. Coin Dispenser.

TECHNICAL DESCRIPTION

The control circuit, shown in Figure 16.7, consists of a 555 IC timer that controls the time delay for each coin denomination selected. The time can be easily adjusted to increase or decrease the delay by changing the resistance and capacitance values. The delay operation is in seconds. The output from the 555 timer is inputted to 7490 binary counter, where the square wave pulse is processed. The 7490 looks for a sudden decrease in voltage. Once it encounters such a decrease, it outputs a binary number for the particular pulse counted. Only two outputs of the counter are needed; since the range 1-4 requires only 00, 01, 10, 01, this is accomplished with just two outputs. The third output is connected to the two reset pins on the chip. When a number greater than four is about to be counted, the third pin tries to go high, but since it is tied to the reset, it starts at number 1 again. This method is used to cycle through the numbers. The IC chip is a 7442 binary to decimal decoder. This chip enables us to decode the signal from the counter. A binary input of l-4 is outputted as a low output for the one being decoded and a high on the ones not in use. A series of diodes are connected to the outputs of the decoder by a resistor from the positive voltage. The resistor and the four diodes are connected in parallel. The low signal produces a difference in potential across the diode, causing it to turn on, which informs the client which particular coin is selected.

The next part of the circuit is the 7402 NOR gate chip. One input comes from the 7442 where the correct output has a low signal, and the others have high signals. The outputs of the 7402 gate chip pass through a 7404 hex inverter that allows the correct signal to go to a switching transistor. The transistor is an NPN TIP 31, a current controlled switch. The collector is connected to the solenoid and the emitter is connected to ground. Whenever the base receives a signal, the transistor is said to be turned on. This completes the path from the solenoid to ground, causing the coil to energize. The solenoids used 12VDC power supply; they have a pull force of 6 ounces at 1" and force of 20 ounces at $\frac{1}{16}$". The solenoids have a pull of 3.75 times more than the weight of the coins. The voltage for the control circuit and the solenoids comes from the wheelchair battery.

The cost to construct the device is $150.

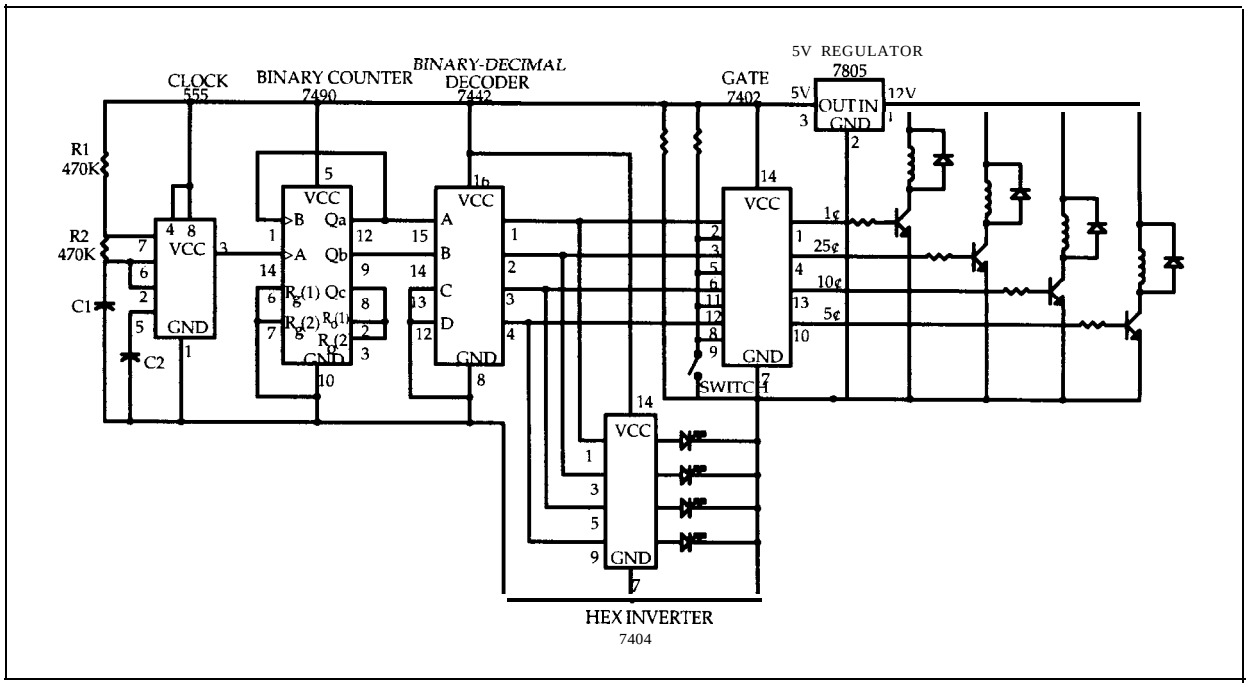

Figure 16.7. Schematic for the Coin Dispenser.

Workstation

Designers: S. Daghlian, L. Holcombe, R. Aplablazo, J. Lambert
Client Coordinator: Marty Davis - UTC
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INTRODUCTION

The goal of this design project is to construct a useful computer workstation for a person confined to a wheelchair with limited mobility. The workstation should provide room for movement and allow easy operation of all functions. The workstation needs to include enough space for a computer, printer, books, notes and supplies, and at the same time, make them more accessible to the student.

The workstation designed and built under this project includes an L-shaped table which provides additional workspace and permits the client to turn in his wheelchair without moving from the table. The disk drive and trackball are made accessible to his left hand. The printer is accessible and pulls out and swivels to provide access to the back of the printer for loading paper. The control switches are readily accessible at the front of the table. The workstation is shown in Figure 16.8.

SUMMARY OF IMPACT

The main concerns of the design project are:

1. Space for the wheelchair to turn
2. An easily accessible power switch on the left side
3. Space for books and supplies
4. Easy access to printer
5. Floppy drives need to be on the left
6. Lowering the trackball
7. A way to move the monitor and adjust the controls

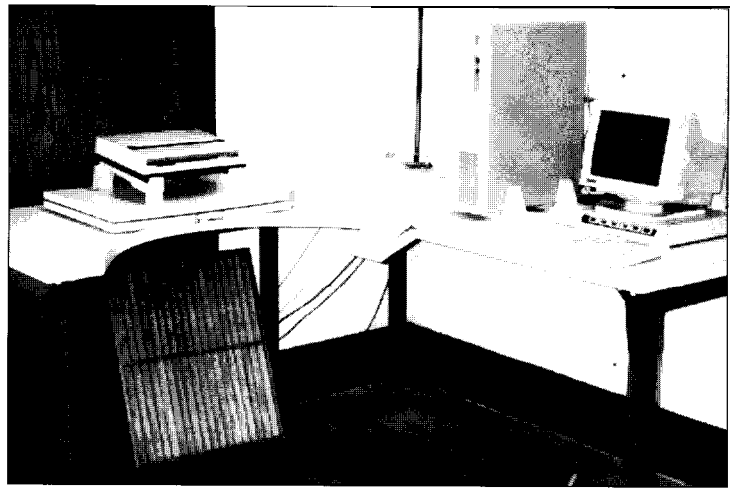

Figure 16.6. Photograph of the Workstation.

Prior to the implementation of the design, **these** specifications were not met with traditional workstations. The completed workstation meets these needs, and enables the student to have easy and complete access to the computer so necessary for his pursuit of his education as a computer science major.

TECHNICAL DESCRIPTION

The basic design of the workstation is an L-shaped table. The circular cut out permits him to turn easily without having to back up and realign his chair. The table has three sets of legs shown in Figure 16.9. The CPU is placed upon a stand which allows it to be set on end, and moved to the left side of the monitor for easy access to the disk drives. A support is made for the track ball. The support is connected to the table top by hinges to allow the support to flip down to a lower level than the table top, or to be left on the table. The printer is set on a plat form which allows the printer to be pulled out, and swiveled to allow easy access to the rear for paper loading.

The "L" shaped table is designed so the user will be able to turn from facing **the** computer to the printer with out having to pull away from the table and reposition in front of the printer. This means that a set of legs cannot be placed in the inside comer of the table. This plan allows the client to simply swing his chair around.

Additional support in the form of square beams are attached as shown in the figure below to provide additional support for the computer and supplies. The beams are attached to the legs and the primary beam supporting the computer is 15" from the front of the table. Both 2"× 2" and 2"×3" 11 gauge beams were evaluated. While the 2"×2" beam proved satisfactory, the 2"×3" beam is used to provide an additional margin of safety.

The final cost of the device was found to be $551.

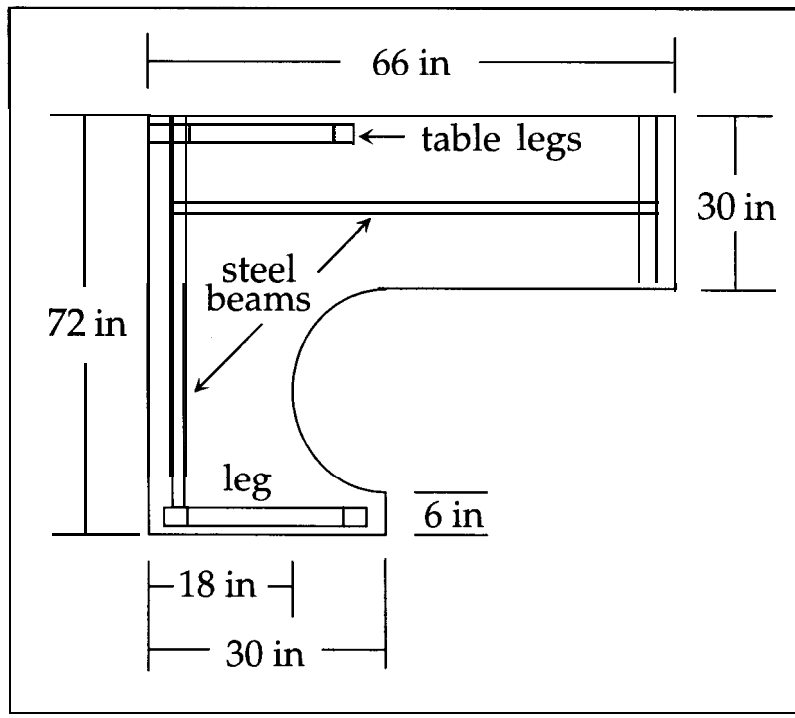

Figure 16.9. Diagram of the Workstation.

Time Teacher

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INTRODUCTION

The client needed tools to allow her to learn the concept and use of time. The client is able to read numbers, but has had difficulty with an analog clock. A device was built in this design project that coordinates the digital and analog clocks. The device also incorporates a timing device to enhance the client's knowledge of her daily schedule. By turning the knobs located below the analog clock, the digital counter displays the time in one minute intervals. This second clock is actually a remote control timer. This timer is used to control the event board using four alarm settings. The four alarm settings are connected to four lights located behind the event windows. The event windows contain transparent cards (7.5"×16") with a picture of an event and the event word. These cards are removable through a slot cut in the top of the wooden case. When the clock reaches a set alarm time, a light is illuminated behind the designated event window. The purpose of the event windows is to help the client recognize times when she must perform a particular task. All of the above devices are mounted on a single sheet of black engraving board.

SUMMARY OF IMPACT

The purpose of this report is to outline and describe the design process for a device to **meet the** needs and objectives of the client. The client is a fourteen year old, spastic, quadriplegic with cerebral palsy. She is non-ambulatory and has functional use of her left hand. She is very verbal and willing to learn. She uses a motorized wheelchair.

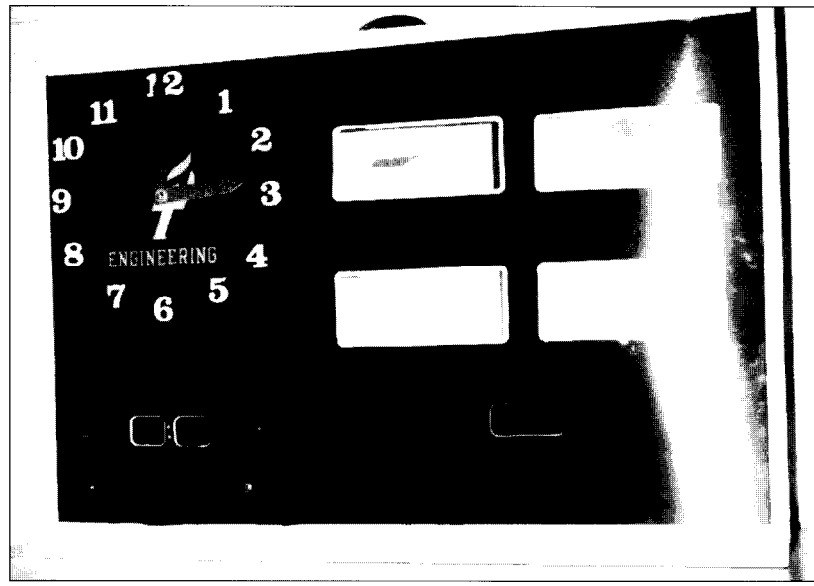

Figure 16.10. Photograph of the Time Teacher.

The goals of this design project are to allow her to improve her functional skills and to learn the concept and use of time. Her reading skills are limited, but she can recognize twenty words and/or signs. She can also recognize numerals to thirty-five(35). One of the client's primary goals is to follow a simple schedule. Each day she is given a minimum of three activities to complete before lunch. Before each activity she is shown her schedule and asked to pick the next activity. The device is teaching her how to tell time and to recognize the time to perform various activities on clock.

TECHNICAL DESCRIPTION

The digital clock, analog clock, and activity pictures are mounted on a single sheet of black engraving board. The engraving board is $\frac{1}{8}$" thick, 30" wide and $19\frac{1}{2}$" tall. A wooden case is attached to the engraving board. The case provides support and encloses the back of the device. Pine boards ($\frac{3}{4}$ "x5") are used to build the frame. The circuit needed to convert the analog time to digital time is illustrated in Figure 16.11. The components needed for the hour conversion are as follows: one reset switch, one on/off switch, one encoder, three BCD-up down decade counters, two decoder drivers and two LED displays. The components needed for the minute conversion are the same as above, except that the three counters are replaced with three binary counters.

The following is an operational description of the analog-to-digital conversion for the hour hand. The encoder provides 120 pulses/revolution which are sent to the BCD-up down-decade counter, which then divides the 120 pulses/revolution by 10 to give 12 pulses/revolution for each hour on the analog clock. Theses pulses are then sent to two more BCD decade counters one for least significant digit (LSD), and another for most significant digit (MSD). Reset takes place when LSD=3 and MSD=1. The analog-to-digital conversion is the same for the minute hand except for the following two details. The first difference is the binary counter that divides the 120 pulses/revolution is 2 rather than 10, which yields 60 pulses/revolution. Secondly, the system is programmed to reset when the LSD=9 and the MSD=5. The output is displayed on the LED displays.

The appliance modules are basic AC modules which are used to turn on and off household appliances with the use of the Remote Controller/Timer. The four modules are connected to four lights located behind the event windows. The event windows are located in the upper right comer of the device. The event windows contain transparent cards ($7\frac{1}{2}$"×16") with a picture of an event and the event word. These cards are removable through a slot cut in the top of the wooden case. When the clock reaches a set alarm time, a light is illuminated behind the designated event window. The cost for the device is $350.

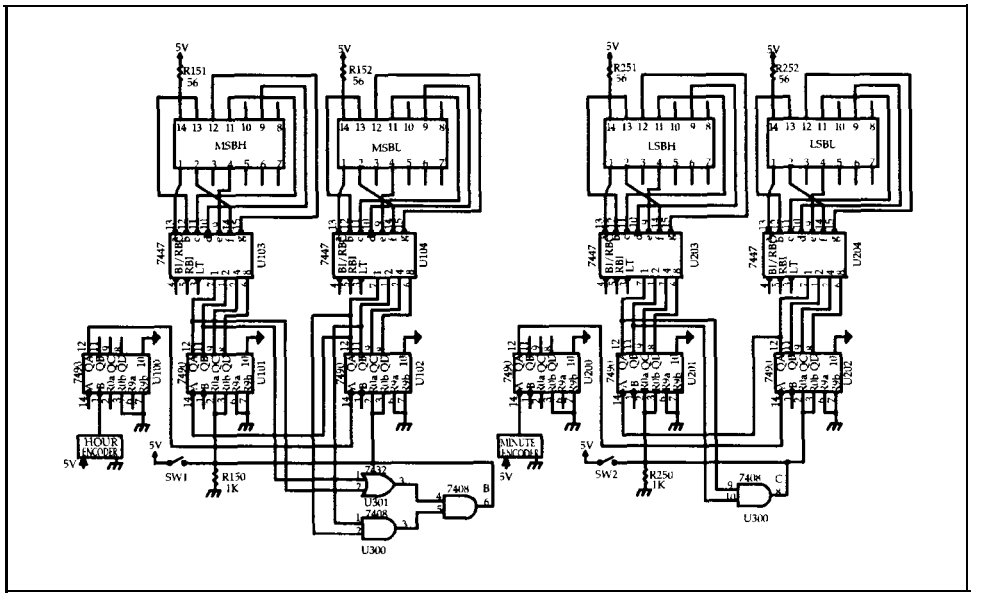

Figure 16.11. Schematic for the Time Teacher

Message Board

Designers: Eric Hammer, Stephen Carpentert
Client Coordinator: Dennis Wilkes- Orange Grove Center
Supervising Professor: Dr. Edward H. McMahon
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INTRODUCTION

The goal of this project is to provide the client with a mechanism to increase communication capabilities and adaptive behaviors to improve the client's self worth and quality of life. The message board is very simple and easy to use. The message board system consists of a transmitter case and a receiver case. The transmitter case contains four transmitters related to four different pictures displayed across the top of the case. By pressing one of the four buttons located on the top panel, the client is able to display a corresponding message on the receiver case. The receiver case displays four printed messages related to the four pictures on the transmitter case. Therefore, when a button on the transmitter case is pressed, a light is illuminated on the receiver case, lighting and displaying a corresponding printed message. Once the signal is activated, the message is displayed for approximately three to four seconds. The time display can be set for any time ranging from 0.1 second to 1000 seconds. At the same time the button is pressed, a buzzer sounds alerting the teacher. The teacher is then able to look at the receiver case, and understand the client needs exactly.

SUMMARY OF IMPACT

The client is a ten year old girl who was born with cerebral palsy and scoliosis (curvature of the spine). Her legs and left arm are deformed and she has limited movement in these limbs. She has good control of her right arm **that** is a little shaky but is otherwise normal in appearance. Her speech is very difficult to understand. She cannot read or write, but she understands pictures and shapes. She wears glasses and a hearing aid.

The design is very simple but also very useful for both the client and her teacher. The client uses this product to enhance her communication skills and interaction with others. The project does satisfy the specifications and also helps in the clients interaction with others.

TECHNICAL DESCRIPTION

The circuit developed for the transmitter case is four Stanley remote transmitters mounted in a wood cabinet. Each remote transmitter board is coded for a specific receiver and operates only one receiver. Each transmitter is powered by a 9-V battery which can be changed when it runs low on power by removing three screws on the back panel. By using battery powered transmitters, the cabinet is totally portable and requires no power switch. The transmitters operate on a ground connection scheme, so no power is lost when they are not in use. Each transmitter is labeled 1 to 4 for trouble shooting.

The circuit developed for the receiver is the heart of the project. This circuit is powered by 120-VAC and a transformer which reduces the 120VAC to 24-VAC for operation of the four receivers and the control relays. A 120-V 6 amp fuse is in-line with the incoming 120VAC line to protect all components from malfunction and fire. It also should save the rest of the components from damage in case a component malfunctions or a power spike occurs.

This circuit works by 4 receivers, 4 control relays, 4 timed relays, a 9-V buzzer & buzzer on/off switch, a power on/off switch and four 60 watt household bulbs. When a transmitter is activated, the receiver coded for that transmitter sends a 24-VAC signal to the control relay. The control relay then closes both sets of contacts. One set of contacts control the timed relay, causing it to activate. The other set of contacts operate the buzzer circuit. When the timed relay is activated, it turns on the corresponding 60 watt light bulb for approximately 4 seconds, and then resets. If the switch is pushed before the cycle is finished, **the** buzzer sounds and the light stays on for four more seconds from the time the button is

activated. If the transmitter button is held down the buzzer continues to sound until the button is released.

The transmitter case contains photographic displays of activities for selection. There are four photographs corresponding to the four buttons on the transmitter case. This allows for four possible selections to be made.

The photographic displays are simple to create, thus, new displays can easily be developed. The displays consist of two pieces of Plexiglas (3 inches by 19 inches) and four photographs of activities, and glue or epoxy. The four photographs are glued to one of the pieces of Plexiglas, aligned with the display slots of the top panel, which serves as the bottom layer. The second piece of Plexiglas, or top layer, is then glued to the bottom layer, sandwiching the photographs in between the two pieces of Plexiglas. Now four new selections are created and may be used to develop communication. In order to use these new selections, corresponding messages must be developed for the receiver case, which correspond to the four photographic activities of the transmitter case. The printed messages are simple to create.

The message board consist of one sheet of Plexiglas (31 inches by 14 inches), stencil lettering that will stick to the Plexiglas (2 inch tall lettering), and one can of black heat paint. To create the message board, first divide one of the sheets of Plexiglas into the four message slots (approximately 6 inches by 15 inches). Carefully apply the lettering. It is suggested that the lettering be applied, such that, the final message is centered top to bottom and then to the far left. By placing the printed messages in this position, there shouldn't be any glare from the light bulbs. After applying the lettering, spray paint the sheet of Plexiglas with the black heat paint. Once dry, be sure there isn't any light able to shine through the Plexiglas sheet. After the paint has dried, remove the lettering. With the new photographic displays created earlier, there is now another interchangeable display selection available. The **message** selections created should help improve communication and also serve as a learning tool.

The cost to construct the device is $530.

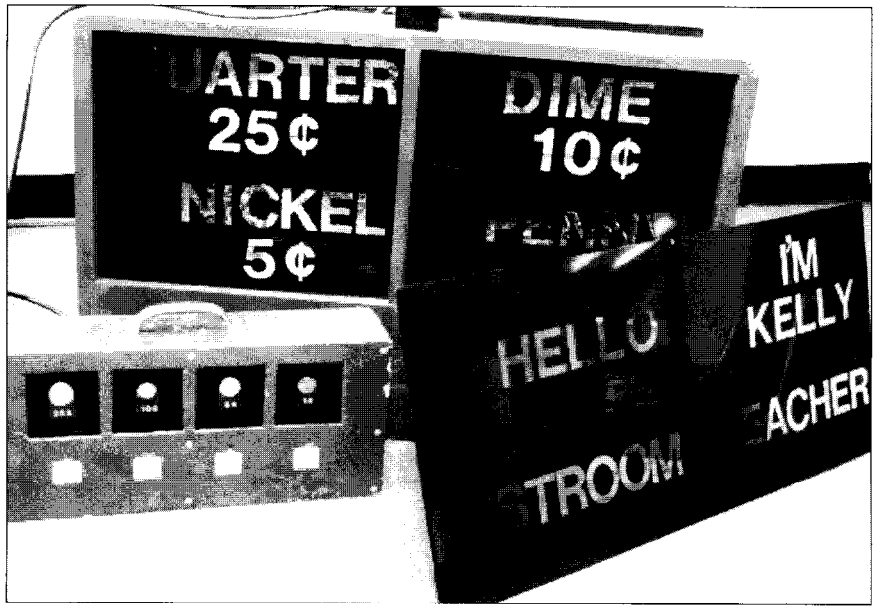

Figure 16.12. Photograph of the Message Board

Computer Desk

Designers: Mark Powell, Chris Miller, Michael Hamm
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INTRODUCTION

A specially designed desk was constructed to handle both the physical requirements and the activity requirements of the client. The client is confined to a wheelchair with her legs in a horizontal position. She cannot use a normal desk because of this restriction. The physical dimensions of the desk are designed with these limitations in mind. The desk is to be used as the clients primary workspace, and also as a resource so that she may assist others in the use of a computer.

The storage space, three drawers and a cabinet are designed to be accessible within the limits of her reach. The cabinet door has a special pull designed to enable her to reach the door to close it.

The computer is accessible from the wheelchair to load floppy disks, and the keyboard is on a special designed keyboard holder. The keyboard slides out over the side of the desk so that another student can position his or her wheelchair next to the desk, and use the keyboard. As the keyboard is pushed to the side, the computer monitor is automatically positioned to face the student being assisted.

SUMMARY OF IMPACT

The client is a nineteen year old female student of Orange Grove. She suffers from spina bifida and does not have the use of her lower extremities. She does, however, have normal use of her arms and hands. The client can maneuver her wheelchair without assistance. Her legs are in a horizontal position which makes it impossible to maneuver to a normal desk.

The client can put in a disc and boot the programs. She enjoys working on the computer and has a positive attitude toward the learning of new materials and seems to thrive on self gratification from completing a task. The workstation meets the criteria of increasing her responsibility, building her self-esteem, increasing her independence, building vocational skills of an office-like atmosphere, and her ability to work with peers.

TECHNICAL DESCRIPTION

The desk is constructed in three sections. On the right side is the drawer section which houses three drawers. On the left is a cabinet with sliding storage trays. The third section is the desktop which consists of the writing surface, the sliding keyboard/book holder, and the swiveling monitor stand.

The drawer section and the cabinet sections are standard construction other than the dimensions and special device necessary to make the areas accessible from the wheelchair. The cabinet has two trays. The top tray is for storage of small items and pulls out for access. The bottom tray is for storage of larger articles such as a purse or jacket. The tray also slides out. A vertical handle is attached to the tray to assist access to this tray. In addition the door to the cabinet, which opens 90°, has an extension handle on the inside to assist in closing the door from the wheelchair.

The most challenging aspect of the design is the sliding keyboard/book tray and the rotating monitor base. At one point, these were considered separately but the decision was made to combine the two devices since it was desirable that the monitor rotates when the keyboard support is moved to the position over the edge of the desk.

The keyboard support is 47" long and is at an angle of 20" with the horizontal. The keyboard can be moved to either the left side of the support or the right side of the support. In the left side the keyboard is out of the way, and the slanted surface is available for books or papers to assist in reading, or the keyboard support can be moved to the left and extend over the end of the desk where it is available

to a second user in a wheelchair who will be assisted by the client. When the client wants to use the computer, she moves the keyboard to the right of the support.

When the keyboard is moved to the extended position over the edge of the desk the monitor rotates to face the second user sitting next to the desk. The keyboard support slides 17 inches, resulting in the rotation of the monitor of 75". The geometry to accomplish this is a 9 inch radius monitor support connected to the keyboard support by a solid rod pinned along the circumference of the monitor support and the back of the keyboard support. The length of the arm is 10 inches. The pin support on the keyboard support is 19.17 inches from the left end of the keyboard support, and the support on the monitor support is 8" from the center of the tray.

The cost to construct this device is $475.

Figure 16.13. Computer Desk.

Patient Lifter

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INTRODUCTION

The purpose of the device is to aid in the removal and transportation of students from their wheelchairs to a designated area. The device is compact enough to allow the client to be transported into the bathroom to use the facilities. The device provides enough movement to allow a client to be transported from the wheelchair to the floor or from the wheelchair to the changing table.

The device consists of two arms that will fit underneath the armpits of the student. A nylon strap attached to the arms provide a seat on which the student will ride. The strap is connected to one arm, and when the device is rolled up to the student, the strap is slipped under the students' thighs and then connected to the other arm, thus allowing the strap to act as a sling. Another nylon strap is placed at the end of the arms and is connected in a similar manner to provide a back rest for the student. The strap is connected to one arm and when the device is rolled up to the student, the strap is placed across the back of the student and connected to the other arm.

The device has two legs that are adjustable to fit different width wheelchairs. Once the student is strapped in securely, the operator of the device activates a switch that triggers a 12-V linear actuator to provide lifting power. The actuator is operated using 120-VAC. The range of motion for the device is a three foot vertical rise.

SUMMARY OF IMPACT

The client is very large, and the therapists and aides have trouble maneuvering her from the wheelchair to the other designated locations such as toilet facilities, therapy pads or changing tables. The problem is to minimize time, effort, and manpower required to move the client. The normal sling type device is difficult to position and the size makes it difficult to position the client to the desired range of heights.

TECHNICAL DESCRIPTION

The actuator chosen has the following dimensions: 26.31 in. retracted and 39.81 in. extended. The maximum lifting load for the actuator is 600 lbs. With these constraints, several experiments were conducted to determine the lengths of the members of the frame. There are several critical values that need to be determined. First, the vertical lift of the device must allow for the movement of the client from the floor to the changing table. Second, the members must be connected with the actuator in such a way as to provide the vertical lift, as well as staying within the constraints of the 600 lb. maximum lifting force.

A static analysis was performed on the lifting arm to determine the force on the actuator. The force is dependent on two factors, the total length of the lifting arm and the placement of the actuator along the lifting arm. For this particular design, the total length of the arm needs to be 42", and the actuator is pinned 18" from the vertical member. By summing the moments around the end pinned to the vertical member, the vertical component of the actuator is found. For this particular instance, the vertical force is found to be 233 lbs.

The vertical distance moved by the end of the lifting arm is then 42 x sin 32" or 22.25 in., which allows the student to be placed on the ground. This position also exerts the maximum lifting load on the actuator; the actuator requires 572 lbs. lifting force at this position. The vertical lift is determined to be 10.87", and the required lifting force of the actuator is 517 lbs.

Several additional features were added to aid the user in the operation of the device. The device is painted blue to enhance the overall appearance.

Velcro straps are added in several places to help in the storage of the components. The actuator switch is attached with Velcro to the lifting arms. The hook of the seating strap is also be attached with Velcro to the arms when not in use. The back-straps is attached to the two brackets while a patient is being positioned in place for buckling into the device. Finally, the extension cord of the actuator is stored on the vertical members with the two brackets provided.

The final cost of the device is $551.

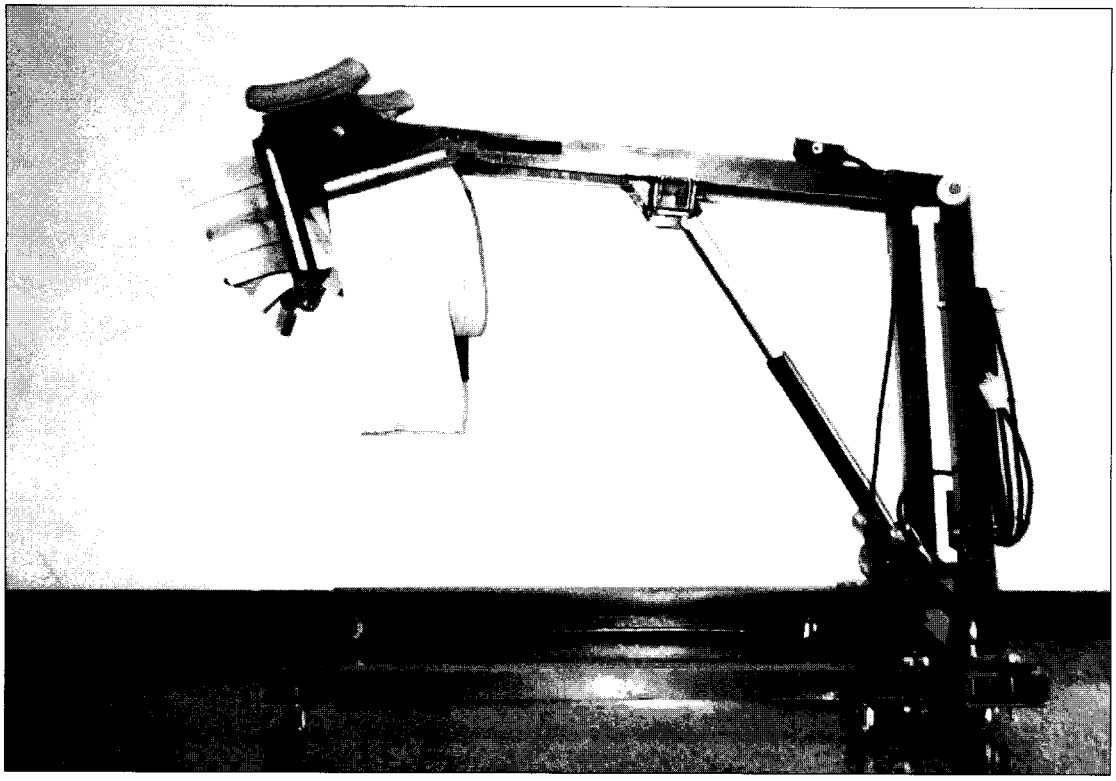

Figure 16.14. Patient Lifter.