CHAPTER 21
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Object Communication Display

Designer: Hiroyuki Maruyama
Client Coordinator: Gorman Public School
Supervising Professor: Dr. Thomas N. Hangartner
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INTRODUCTION

The subject for this project is a seven-year-old girl from Gorman Public School in Dayton, Ohio. Her disability is cerebral palsy. The subject's muscle tone is mildly hypertonic in the upper extremity and trunk muscle tone is low. She has limited head control that affects her eye control. Although she can move her legs, the subject is confined to a wheelchair, as her legs are unable to sufficiently support her weight. The girl has a learning disability that causes her to experience problems making connections between what she sees, what she thinks, and what she does. Therefore, a device is desired that can help to improve her ability to match or memorize shapes, interpret pictures, or distinguish a figure from a background. The goal of this project is to develop a device for this subject that could be applied to other students who have similar learning disabilities or problems with visual perception.

It is believed that an object communication display that gives positive reinforcement for correctly choosing a particular item from the display would accomplish this task. An object communication display may take the form of identification of objects, comparison of size or shapes, identification of letters or words, comparison of likes or opposites, or teaching of left-right and up-down directions. The device can be used for training language skills. The system should provide a method for displaying the objects on the communication board in any geometry desired by the teacher. In addition, it should allow the student to visually choose the item displayed and be positively reinforced with a "happy" audible signal for correct answers and a negative stimulus sound for incorrect choices. The activation switches the student uses to make a choice should be adaptable to other switches to accommodate persons with other levels of physical limitations.

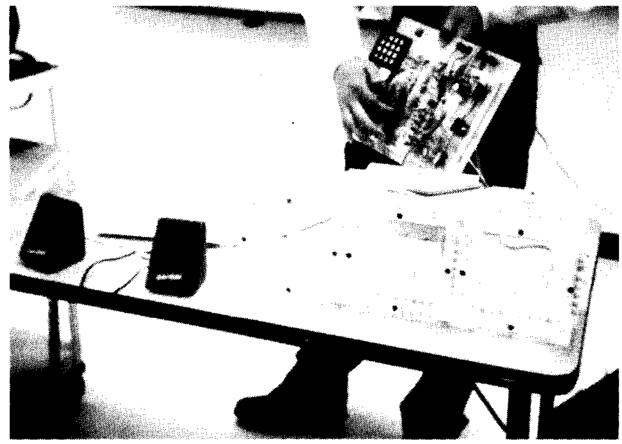

Figure 21.1. Photograph of Object Communication Display.

SUMMARY OF IMPACT

After testing the object communication display on the girl at Gorman School, the device proved quite useful. Since the switch to activate the display choice could be changed and replaced with other switches, the device was capable of being used by other students with similar learning disabilities.

TECHNICAL DESCRIPTION

The solution to the problem is directed to a communication device that can be used as a basic learning tool. The object communication display consists of a series of boxes, each bearing a physical object, that are connected in side-by-side or top-bottom relation (Fig. 21.1). The object can be commonly known objects or needs, such as a pencil, glass of water, etc.

A group of lights is located on the front face of each box. The lights are connected in an electrical circuit that is arranged so that a group of lights is illuminated in sequential progression. By manually actuating the student-switch, the light progression is stopped at the selected item that expresses the stu-

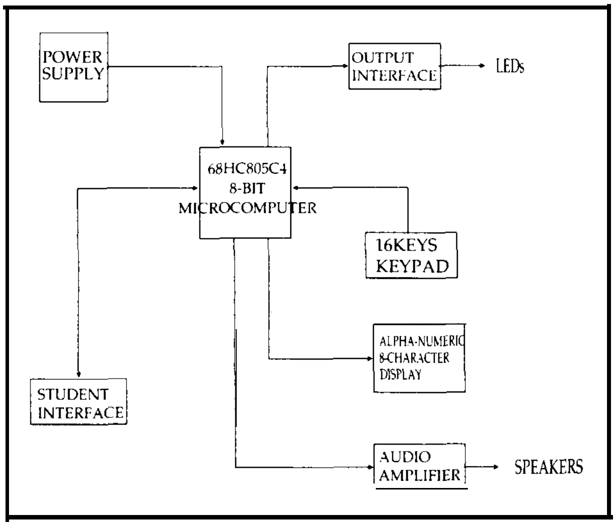

Figure 21.2. System Block Diagram.

dent's answer. If the student selects the correct object, a positive tone will be activated. A negative tone will be given if the student selects incorrectly. The light progression can then be re-established by activating the "GO" key on the keypad.

The system consists of an MC68HC805C4 (HCMOS) 8-bit microcontroller unit (MCU), which is used as a controller device, an instructor keypad, an AC power supply, an output box interface, an alphanumeric 8 character display, a student interface, and an audio-amplifier for feedback tones (Fig. 21.2). A schematic diagram of the system is given in Fig. 20.3. The student interface consists of a switch that can be replaced by any kind of switch without any additional wiring by simply inserting another switch into the phono jack.

This system allows the instructor to input the selection he or she wishes the student to recognize along with the speed of light progression. A counter keeps track of the correct number of answers. When a predetermined number of correct answers are achieved, a song plays which is chosen from seven available tunes programmed into the system. This offers the student additional positive reinforcement for accomplishing the tasks presented.

The total 2 year cost of the final model is $1500.

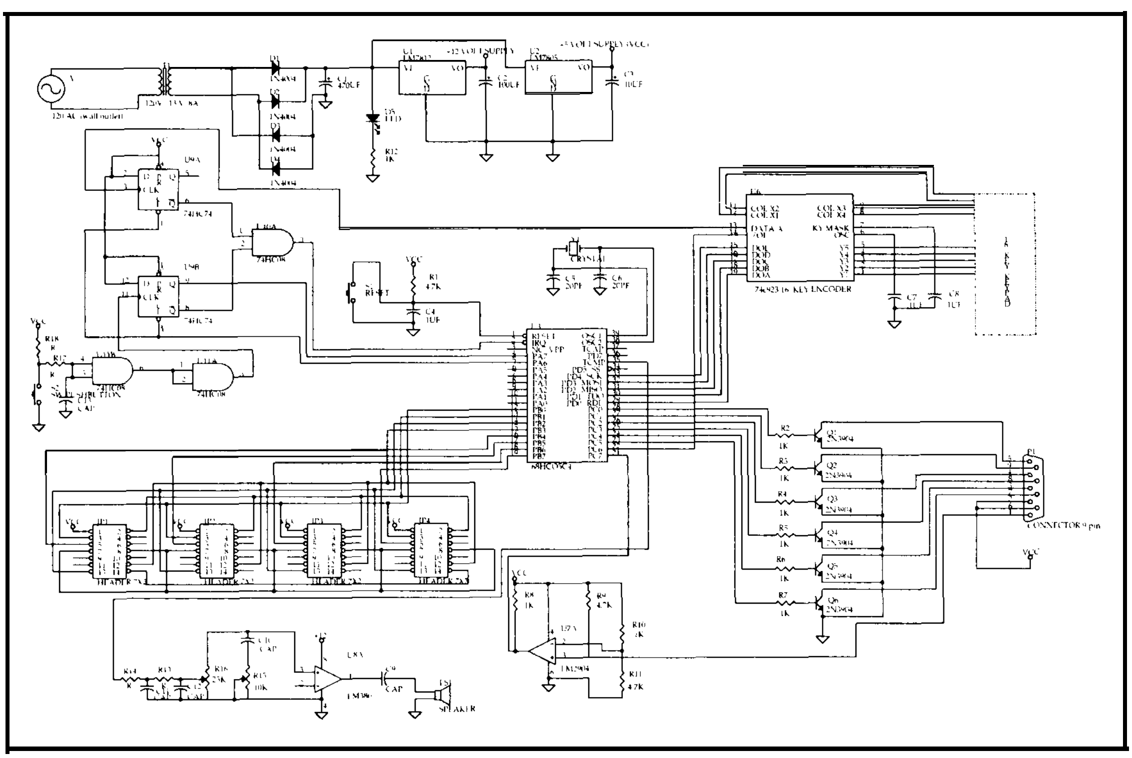

Figure 21.3. Schematic Diagram of the Object Communication Display.

Lighted Communication Board

Designer:Yaser Almadi
Client Coordinator: Gorman Public School
Supervising Professor: Dr. Blair A. Rowley
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INTRODUCTION

Speech problems and learning disabilities are major obstacles to children with cerebral palsy. Teaching non-vocal children is a challenge for the special education teacher. This project involves designing a communication device for seven students with cerebral palsy at Gorman School in Dayton, Ohio. Most of the students are non-vocal, all have poor vision, and all are mentally retarded. A lighted communication board would enhance the effectiveness of teaching these children by allowing them to communicate with their teacher.

SUMMARY OF IMPACT

The lighted communication board worked well to meet the needs of the seven students at Gorman School. It allowed them to communicate more effectively with their teachers. Any of these students can utilize the device because the switch can be changed to accommodate each child's ability.

TECHNICAL DESCRIPTION

The design involves a redesign of the "STEEP" communication board that was previously used at the Gorman School. It utilizes 16 lighted pictures. In this board, a switch begins the scan successively from picture to picture. Compressing the switch a second time stops the scan so that the picture displayed is the "chosen" object that the user wishes to relay to the teacher.

The "STEEP" device tends to be "busy" for the students to use effectively. There are too many pictures displayed and the time delay for the scan between pictures is too fast. The physical size of each picture was also small, prohibiting the visually impaired students from clearly noting the picture during the scan. Finally, the device lacked the option of changing the 16 pictures. Therefore, once the student learned the 16 pictures, the device lost some of its appeal.

In order to address these problems, the basic "STEEP" system was redesigned to accommodate the limitations of the students in the class. Since several of the students were visually impaired, the device is situated at a 30" angle in front of the user. In addition, high Intensity LED's are used to indicate the student "choice."

The new design consists of four main parts: the circuit enclosure which houses the circuitry (12" x 20" x 4") (and on top of which the pictures are placed), the circuit board (4.5" x 6"), a portable switch, and an AC/DC transformer to supply the device with 12 Volts (Fig. 21.4).

The housing for holding the circuit board and the pictures was custom-fabricated from plastic. Eight 4" x 4" picture slots are available on the unit. The pictures can be changed as desired. The eight pictures are scanned under the control of the user. That is, if the student presses the switch once the first light will turn on and remain at that position until the student presses the switch again. At that time, the second lamp turns on, etc., until the Student's desired choice is illuminated.

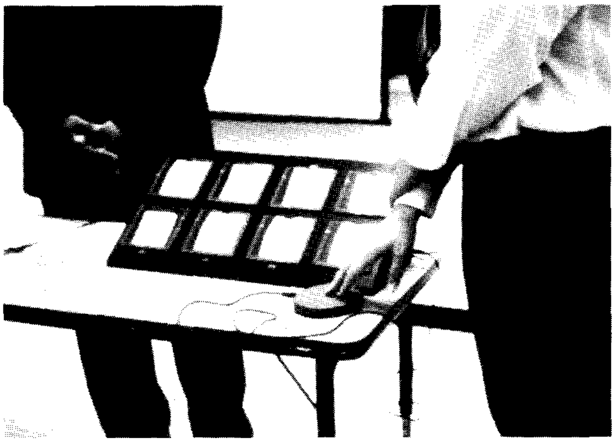

Figure 21.4. Photograph of Lighted Communication Board.

A Quad Digital Bilateral Switch Chip (CMOS 4016), a counter (CMOS 4017), and a 555 chip are used to control the sequence that the lamps illuminate (Fig. 21.5). The (4017) counter advances one count on the positive edge (ground-to-positive transition) of the clock. On any count, the output goes positive while the others remain at ground. Eight output terminals of the 4017 chip are connected to separate input terminals on two 4016 chips. On any single switch, when the control voltage equals ground, the switch remains “OFF” and behaves as a very high impedance. When the control voltage goes high, the switch turns “ON” and behaves as a nearly linear 300-ohm resistor. This illuminates a light connected across the 4016 chip. Pressing the switch once therefore turns on the first lamp. Pressing the switch a second time causes the 4017 to advance to the next output pin and ground the rest of the output pins. This, in turn, opens the first switch in the 4016 and closes the second switch, turning the first lamp off and the second lamp on. The process continues sequentially with each switch action until the desired picture is illuminated.

The final cost of the lighted communication board was $400.

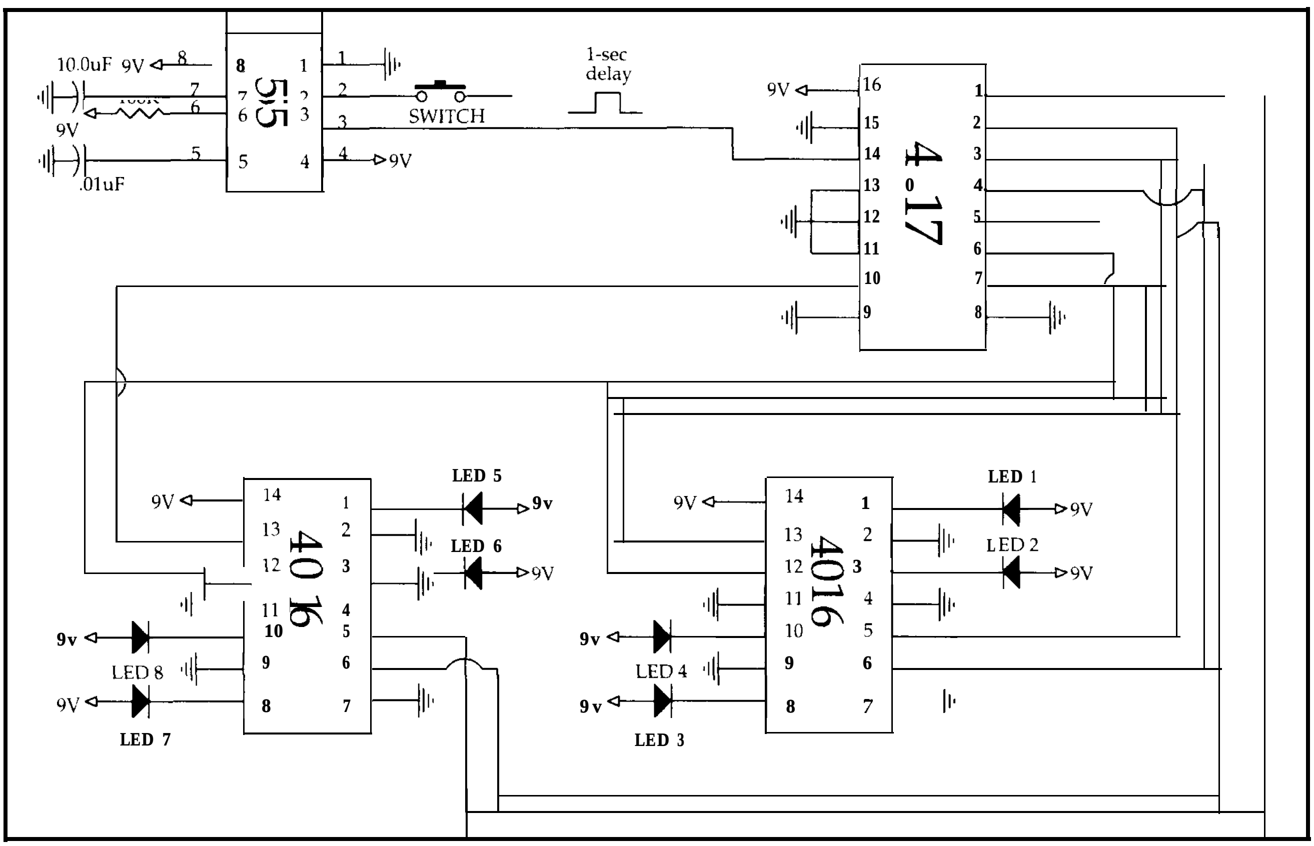

Figure 21.5. Schematic of Lighted Communication Board.

Page Turner

Designer: Adnan J. Al-Muhtaseb
Client Coordinator: Gorman Public School
Supervising Professor: Dr. Ping He
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INTRODUCTION

This project involves Nathan, an eleven-year-old student at Gorman School in Dayton, Ohio. Nathan suffers from spastic cerebral palsy that prevents him from controlling his muscle movement, especially in the hands and arms.

Nathan would benefit from the design of a device that would allow him to turn the pages of a book. He is not capable of using a cuff-and-rod mechanical page turner due to his lack of muscle control. An electric page turner that utilizes a chin switch control would solve the problem. A page turner was supplied by the Gorman school for modification to meet Nathan's needs.

SUMMARY OF IMPACT

Nathan was able to benefit from the modification to the electric page turner. Since Nathan enjoys reading, he is now able to read and turn the pages of a book or magazine independently.

TECHNICAL DESCRIPTION

The operating toggle switch on the available electric page turner was to be redesigned to accommodate a chin switch. The book cover-page holder also required redesign so that it was more lightweight and easier to use. A safety cover was needed for the turning arm so that the user could safely use the page turner.

The chin switch consists of top and bottom switch holders that contain a microswitch. As the user hits the top of the switch with his chin, it activates a motor by momentary action. The motor then supplies power to the arm of the page turner which in turn causes the page to turn. A photo of the page turner in use is shown in Fig. 21.6.

The chin switch is held in place on the user by Velcro. The switch is wide enough to ensure that a simple chin motion will be sufficient for activation.

A clear piece of 9” long Plexiglas is utilized as a holder over the top of the pages to keep the book open. The cover of the book is held open by a metal arm hinged at its base, so that it could swing up or down. With the metal arm in the upward position, the book cover is placed beneath it. When the arm is allowed to swing down, it rests on the inside cover of the book. A screw is then tightened to hold the cover firmly in place.

The final cost of the page turner was $300.

Figure 21.6. Photograph of the Page Turner.

A Continually Adjustable Tray With 0 to 60 Degrees Tilt Angles

Designer: Heather Herrmann
Client Coordinator: Gorman Public School
Supervising Professor: Dr. Chandler A. Phillips
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INTRODUCTION

Most children confined to electric wheelchairs utilize some sort of worktable or tray since their chairs do not fit underneath school desks. However, some children can not even utilize a standard wheelchair tray since their disabilities leave often them with reduced strength or range of motion. The trays on the market today that address this need have either a fixed angle of incline or a mechanically adjustable angle of incline. Most persons with Spastic quadriplegic cerebral palsy do not have the ability to operate these mechanically adjustable trays.

A continually adjustable tray with tilt angles of zero to 60 degrees was built to aid Mark, an eight-year-old boy who suffers from spastic quadriplegic cerebral palsy. This tray allows him to perform his school work in a more suitable working environment while encouraging correct posture for writing, typing, or reading.

SUMMARY OF IMPACT

The adjustable tray was able to help Mark to bring object closer to his body and encourage better posture. The fact that the tray is entirely operable by Mark also encourages his independence.

TECHNICAL DESCRIPTION

The (14” x 23”) tray top is fabricated from LEXAN and is supported from below by two 1" x 1" aluminum angle bars. This is a clear material, so Mark's view is not obstructed if the tray is in the 60 degree position. The edges were rounded for safety purposes. A small portion of the tray near the wheelchair joystick is removed to permit access to wheelchair operation. A photo of the adjustable tray is given in Fig. 21.7. Velcro added to portions of the tray top can hold a typewriter etc., in place when the tray is tilted. The framework that holds the actuator is also constructed from LEXAN.

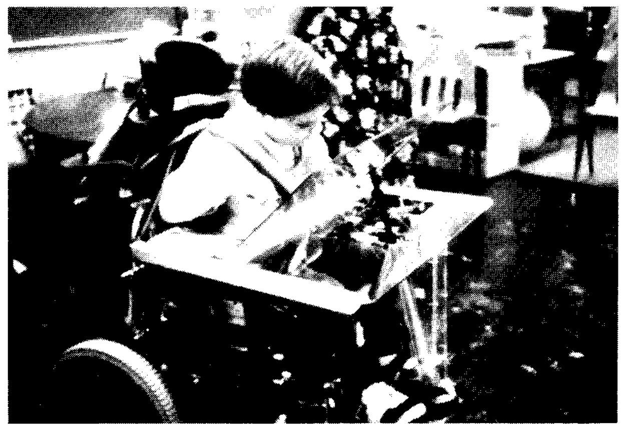

Figure 21.7. Photograph of Continually Adjustable Tray With 0 to 60 Degrees Tilt Angles.

The adjustable tray is completely operable by the user. It is powered by a 12 volt rechargeable battery. A linear actuator mounted in an angular position to produce up to 60” of tilt with a 10 inch stroke limit will accomplish the task of adjusting the table. A momentary rocker switch is wired in order to produce the up/down movement of the tray. Momentary action acts as a safety precaution since the tray will stop when Mark's hand is removed from the switch.

Two cut-off switches help to maintain the normal life span of the actuator's motor. Since it is not advisable to keep the motor running if its stroke limit is no longer changing, the switches automatically shut off all power to the motor when the tray reaches the minimum (0 degrees) or the maximum

(60 degrees) position. The circuit diagram for these switches is shown in Fig. 21.8.

The final cost of the adjustable tray was approximately $600.

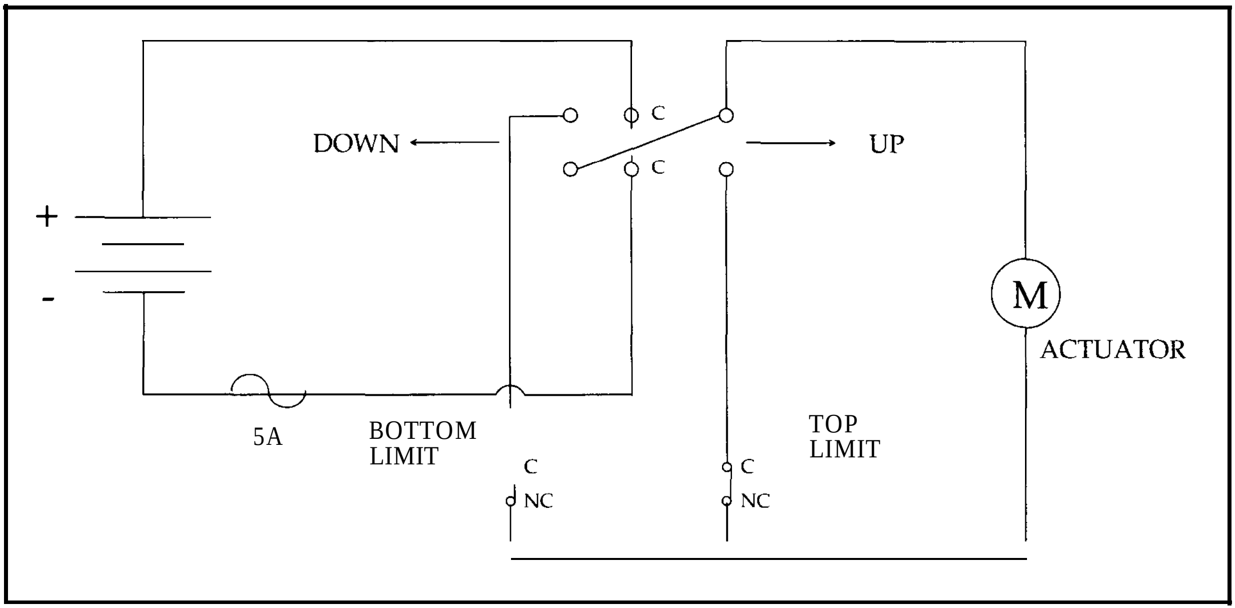

Figure 2 1.8. Circuit Diagram for Tray Switches.

Table Walker

Designer: Samer Al-Taher
Client Coordinator: Gorman Public School
Supervising Professor: Dr. David B. Reynolds
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INTRODUCTION

The subject of this project is a lo-year-old girl named Jessica suffering from spastic palsy with tremors. She has limited proximal control and her movements are poorly graded. Her precession skills are immature due to ataxia and fluctuating muscle tone. Jessica can walk short distances without assistance but normally walks with a Kaye posture control walker or Lofstand crutches. Her pencil skills are not well developed and she would benefit from the use of a typewriter that could be carried from room-to-room on her walker.

A modification of the WINNIE WALKER to accommodate the typewriter would accomplish the objective.

SUMMARY OF IMPACT

Jessica used the table-walker and found that it met her needs. She was able to move about with the typewriter available to her when she desired. The table-walker also gave the student self-confidence and encouraged her social abilities since it also improved her ability to ambulate.

TECHNICAL DESCRIPTION

The table-walker is designed to carry a Cannon (20 lb weight, 10"x13") typewriter (Fig. 21.9). A WINNIE WALKER was used to accomplish this goal. The WINNIE WALKER is intended for teenagers with cerebral palsy. It is designed to require the child to adjust his or her posture upright. The child stands within the base of the walker with hand-grips positioned at the sides to allow for an improved upper extremity position. This walker is a pushing-walker with four 8” pneumatic wheels, a positive braking system, and locking hand brakes. The wheels allow the child to walk with less energy and improved rhythm and timing. In addition, this walker design allows for easy transition from the walker to crutches or independent walking.

The Winnie-Walker was modified with a tray by welding a U-shaped steel arm support on the chair base of the walker. A Lexon plastic tray (13"x15") was secured to the U-shaped tray base. Velcro hook-and-loop fasteners were used between the tray and the typewriter to hold the typewriter firmly in place.

The final cost of the table-walker was $500.

Figure 21.9. Photograph of Table Walker.

Portable Four Light Communication Device

Designer: Ziad A. Sadi
Client Coordinator: Gorman Public School
Supervising Professor: Dr. Blair A. Rowley
Department of Biomedical and Human Factors Engineering
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INTRODUCTION

The subject of this project is an eight-year-old boy from Gorman School with athetoid cerebral palsy. The student is non-verbal and utilizes an electric wheelchair. Since the boy is non-verbal, he has problems communicating his needs with others. A communication device was designed employing a two-by-two matrix of simple selections, so that the student could begin to express his needs in an understandable way to others. The device is activated by a switch system specific to the ability of this particular student.

SUMMARY OF IMPACT

The communication device achieved the purpose intended. The student was able to use the switch well and access the device on his own. His is now able to share his needs with those around him by simply activating the four light communication device when desired.

TECHNICAL DESCRIPTION

The device consists of a two-by-two communication matrix in which four "selections" are visible to the student. A single momentary switch lights four lamps corresponding to each selection sequentially with a time delay between each light controlled by switch activation. The student controls the light sequence using the switch until the desired selection is illuminated. In addition, an audible signal sounds when the switch is activated in case the user wishes to get the attention of someone who is located across the room, for example. A photo of the device is shown in Fig. 21.10.

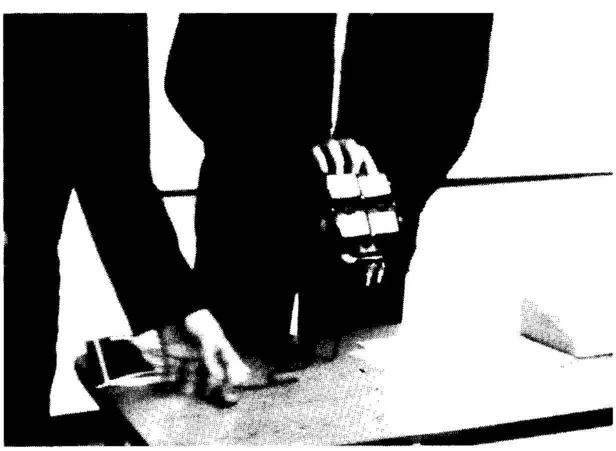

Figure 21 .10. Photograph of Portable Four Light Communication Device.

For this student, the light box was clamped on the right side and the switch on the left side of the wheelchair. The lights were mounted in a box made from PVC measuring 5.5" x 4.5" x 2". Plexiglas slots in the box allow selection cards to be inserted and visible. These cards could be easily changed by the instructor if desired.

A block diagram for this device is given in Fig. 21.11. A single switch controls the four LED's and the alarm via the sequencer, the automatic switch, and the pulse generator. When the switch is activated, the sequencer receives a high pulse from the debouncer. The output sequencer then steps from the stand-by pin to the first output pin that activates both the beeper and the pulse generator. The pulse generator then sends a high pulse to the input of the sequencer that shifts to the second output pin, thus activating the first LED. Any further activation of the switch causes a step to the output of the sequencer that activates the auto-switch to close and light the next LED, and so on. The circuit is powered by a rechargeable battery.

The final cost of the four light communication device was approximately $600.

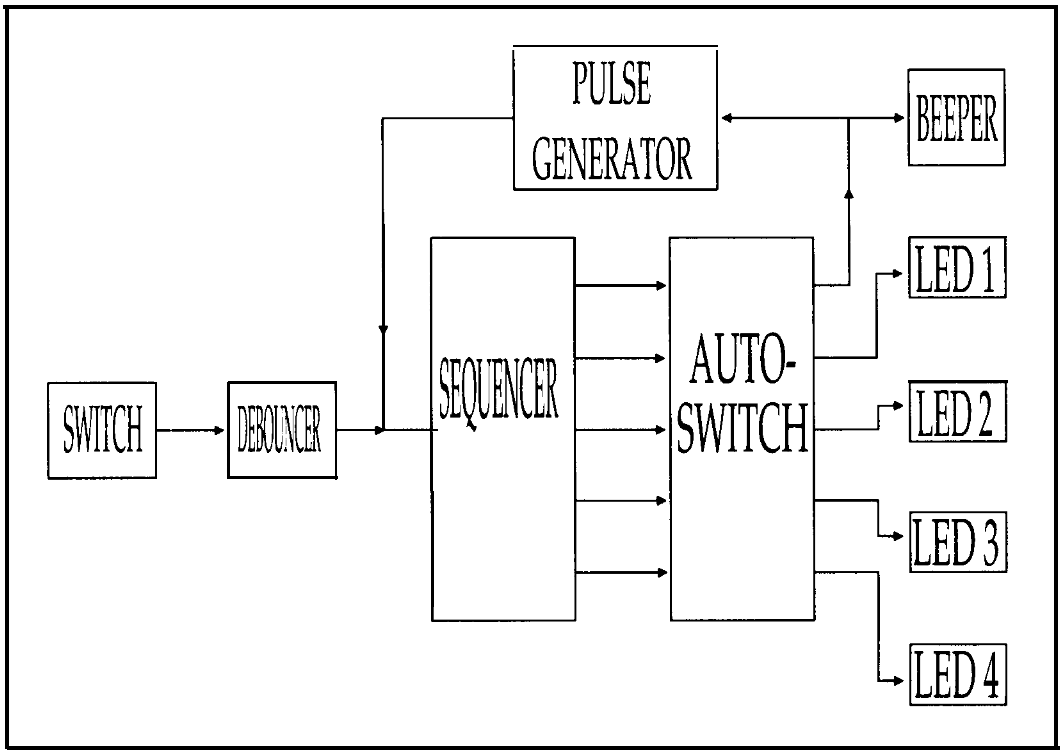

Figure 21 .1 1. Block Diagram for the Portable Four Light Communication Device.

Adapted Shower Chair

Designer: Dennis R. Welton
Client Coordinator: Gorman Public School
Supervising Professor: Dr. Blair A. Rowley
Department of Biomedical and Human Factors Engineering
Wright State University
Dayton, OH 454350001

INTRODUCTION

The subject of this project, Pat, has a form of muscular dystrophy known as limb-girdle syndrome. The disease has left him with a general weakness in his lower torso and upper leg/thigh muscles. Due to this condition, it is necessary for Pat to use a shower chair designed to meet his particular needs. Most shower chairs are very unstable when placed in a bath tub rather than in a shower. Also, they are bulky and rather difficult to transport. Pat would benefit from a shower chair designed to eliminate these problems. It would also be of value if the chair could rotate for ease of entry and exit from the bath tub/shower.

SUMMARY OF IMPACT

The design goals for this project were achieved to the user's satisfaction. The chair fit well into the bath tub and allowed Pat to maneuver in and out of the tub with ease.

TECHNICAL DESCRIPTION

This shower chair design focuses on accessibility, portability, and durability. It provides easy access for the user to enter or exit the shower. This is accomplished with a swivel mechanism on the seat. The design also takes into account portability, should the user wish to use the chair outside his home, on vacation, for example since the chair can be easily disassembled and reassembled when desired. The materials used in the design are compatible with the wet environment of the bath tub, thus making the chair durable.

The shower chair designed for Pat consists of an off-the-shelf polyurethane shower seat (without the back) mounted on a rotating mechanism. This is supported by a 5" diameter aluminum pole secured to a base. A photo of the shower chair is given in Fig. 21.12. This design allows for stability of the chair while emphasizing accessibility.

The chair is designed to withstand at least 350 pounds of stress. Both the seat and the rotating cylinder are made from polyurethane due to the wet environment. The housing, pole, plunger lock, and chair base are constructed of anodized aluminum.

An integral part of the design consists of a seat with the ability to rotate. The swivel mechanism permits a 45" rotation of the seat, at which time the seat locks into place. This is a "plunger" lock mechanism. This plunger is located below the seat within the rotating mechanism. When it is pulled outward, the lock releases, thus allowing the chair to swivel an additional 45" until it locks into the next "slot." This permits rotation to the desired position in 45" increments.

The final cost of the shower chair was $600.

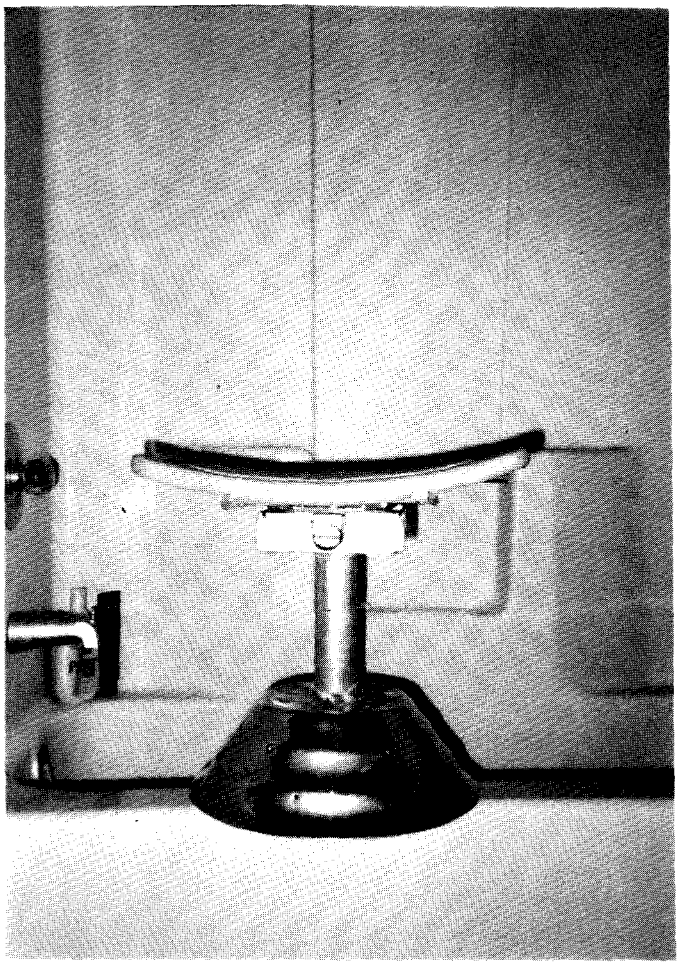

Figure 21 .1 2. Photograph of the Adapted Shower Chair.