CHAPTER 19

UNIVERSITY OF ILLINOIS AT URBANA-CHAMPAIGN

College of Applied Life Studies
Division of Rehabilitation Education
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Champaign, IL 61820

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Collapsible Mounting System for a Communication Device

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Disability Coordinator: John Lansing
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Division of Rehabilitation Education and Department of General Engineering
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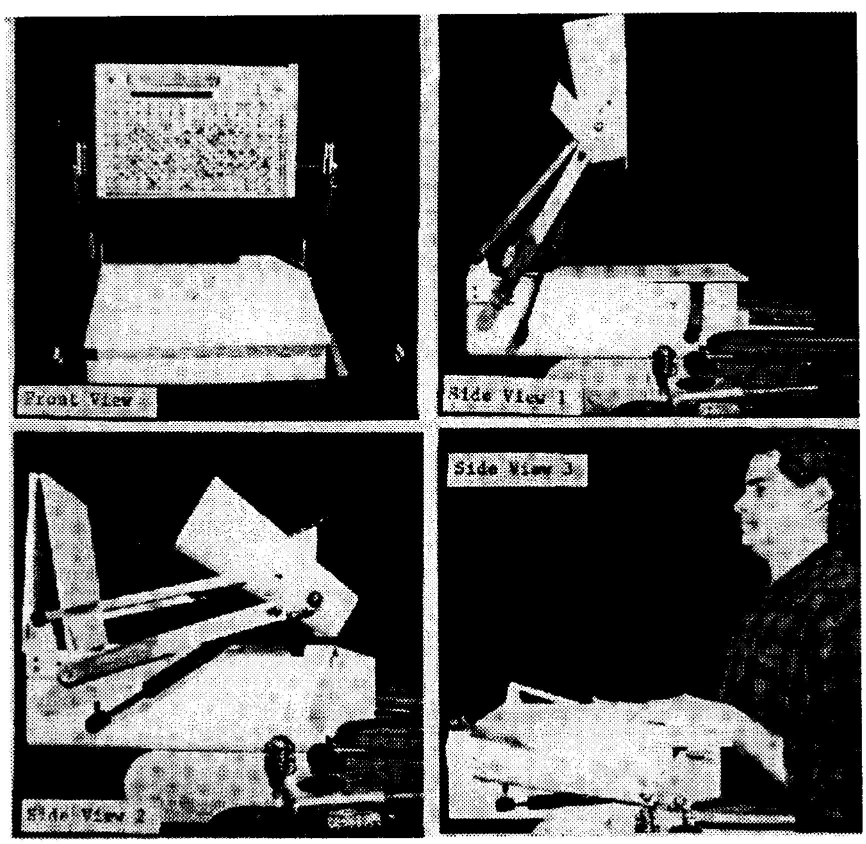
Champaign, IL 61820

INTRODUCTION

This project involved a wheelchair user unable to speak due to cerebral palsy. He needed a mounting system for his Prentke Romich Touch Talker (a communication device) that would allow the device to be stored in his wheelchair mounted lap desk, and then be raised to a vertical position for use. The need for this mechanism was two-fold. First, the previous design required the user to slouch over when using the Touch Talker to see the keys more clearly. In this position the client's posture was suffering. Second, the previous design did not allow the use of the Touch Talker and the desk top simultaneously because when the Touch Talker was in use the desk top needed to be open.

SUMMARY OF IMPACT

"My son has multiple handicaps and uses a motorized wheelchair for mobility and a Touch Talker for communication. Two University of Illinois engineering students designed a customized tray/box mounting system for my son's Touch Talker. They designed the system so it allows my son to position the Touch Talker at eye level to communicate. This position improves his posture tremendously, as well as minimizing his visual impairment. The system also allows him to use his tray for eating, writing, and working while the Touch Talker is either in or out of the box. This feature allows him to talk while eating, writing or working, which in itself has had an enormous impact in his life.



We are extremely appreciative of the time and effort spent creating this important adaptation for my son. It has greatly enhanced the quality of his life."

TECHNICAL DESCRIPTION

Due to the client's inability to use his right arm and limited use of his left arm, the Touch Talker had to be raised and lowered with minimal effort. At the initial consultation with the user, the necessary measurements were taken and his desires for the new mechanism were discussed. Given these constraints, possible designs were then formulated and refined. Finally, the feasibility of the various designs was considered and used as criteria for choosing the final design concept. The design concept involved the use of inert gas springs (Part 1, Fig. 1) to assist the user in raising and lowering the Touch Talker. These cylinders were mounted to rotating links (Part 2, Fig. 1) that controlled the vertical position of the Touch Talker. Using this linkage system, the user had a large unobstructed desk top area because the fixed ends of the links were at the far end of the desk. When the Touch Talker is in the stowed position, the desk top is free for use. If the person wishes to use the Touch Talker, he opens the hinged desk top and may either use the Touch Talker in the down position or raise it to the more easily seen vertical position. To raise the Touch Talker the user lifts a handle with his left hand and the Touch Talker flips up into position. The rotation of the Touch Talker moving to its upright position is controlled by a second link which happens to form a four bar linkage system.

A design problem that was encountered involved locating the correct position for the fixed ends of the rotating links and their corresponding lengths which would then yield the proper initial and final position for the Touch Talker. The first attempt to solve this problem was with Autocad and an accompanying program called FourBar. The FourBar program proved to be unsuccessful in determining the necessary data with trial and error methods. It was then decided to build a full scale, two-dimensional cardboard model of the design that provided a visual aid when using the trial

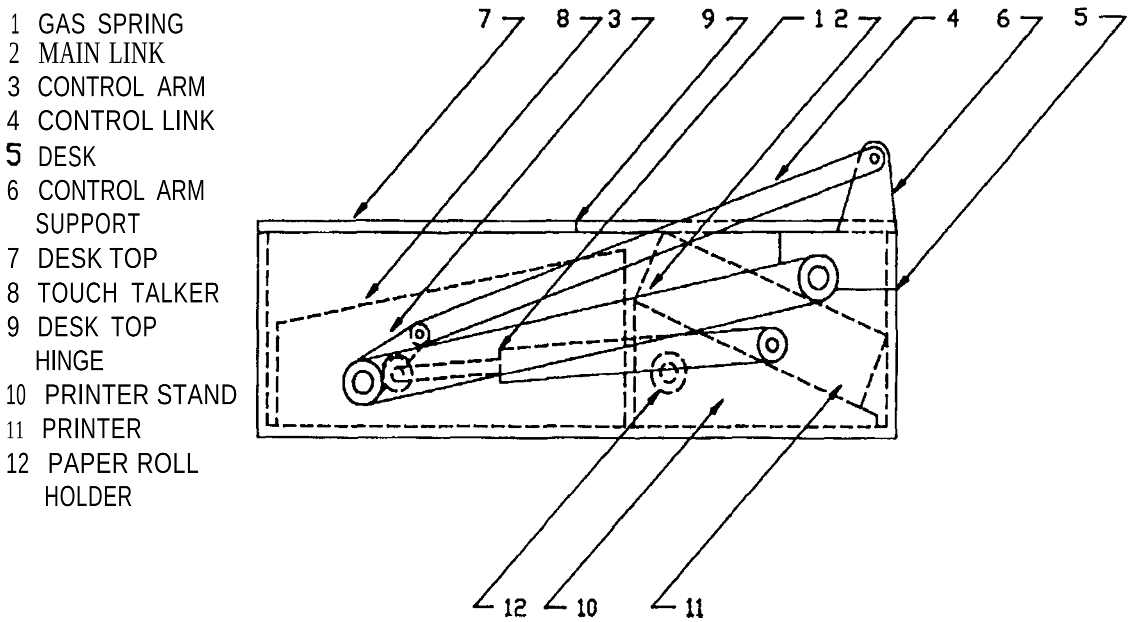
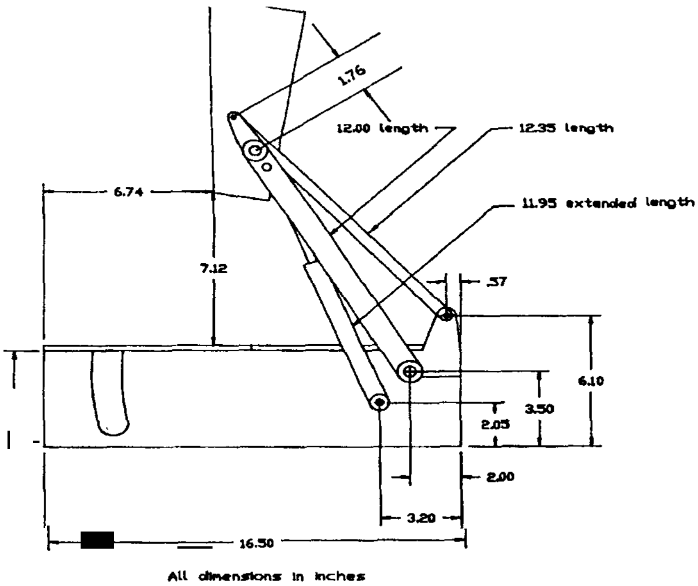


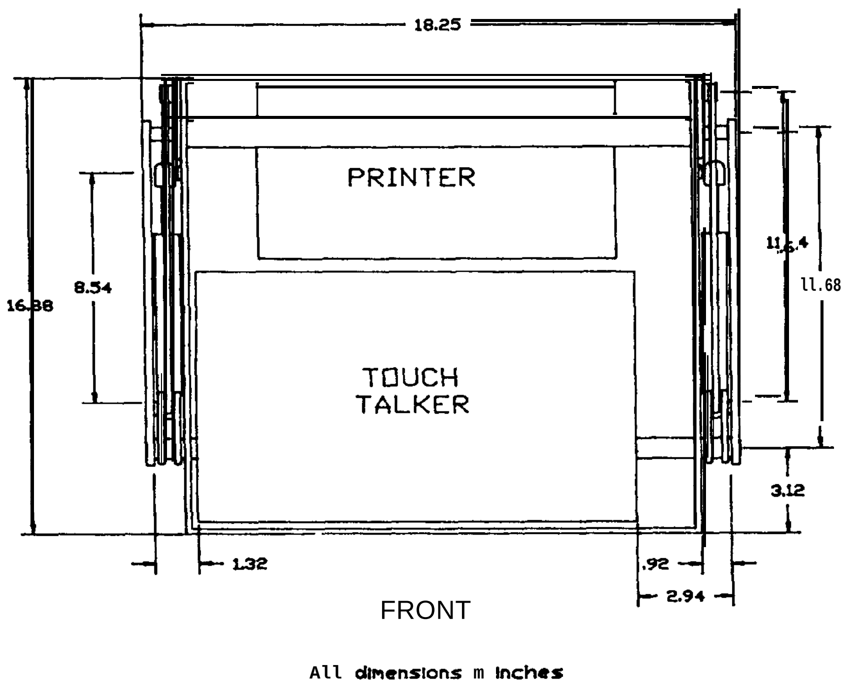
Fig. 1

and error method a second time. This method turned out to be very successful in determining the location of the fixed points and lengths of the links. The two different links were found to be 12" and 12.5” in length with their fixed ends as shown in figure 1, parts 2 and 4, respectively. With this information known, the rest of the design was then completed.

First to be constructed was a case that would hold the Touch Talker. This would allow mounting of the links anywhere on the periphery of the Touch Talker without any modifications to the Touch Talker itself. The material for both the Touch Talker case and the desk was chosen to be 3/16" PVC plastic. This material seemed to have good rigidity, which was needed to prevent any excessive wobble during operation. The dimensions of the desk and case were given to a plastic working shop and both were bent and plastically welded to the desired specifications as shown in figure 1 (parts 5 and 8, respectively). Next, the links were constructed from aluminum bar stock measuring 1"x1/4" and 1/2"x3/16" for parts 2 and 4, respectively. Choosing the proper gas cylinders entailed contacting Service Plus Distributors in Pennsylvania. This company determined that the necessary cylinders would be two 30 pound nitrogen gas springs. They further informed the designers of the proper mounting location of the cylinders to give the desired handle force when lifting the Touch Talker from its initial to final position. It was decided that lifting the Touch Talker should require two pounds of force at the beginning of the raising sequence and then at about 30 degrees from the horizontal the cylinders would take all the weight load and raise the Touch Talker to its final position. To tie these parts together, spacers and bushings were machined from solid PVC plastic rod. The cost of the project is approximately $440.00.



TOUCH TALKER IN UP POSITION



TOP VIEW

Wheelchair Desktop

Designer: David Shupe, Tammy Athas
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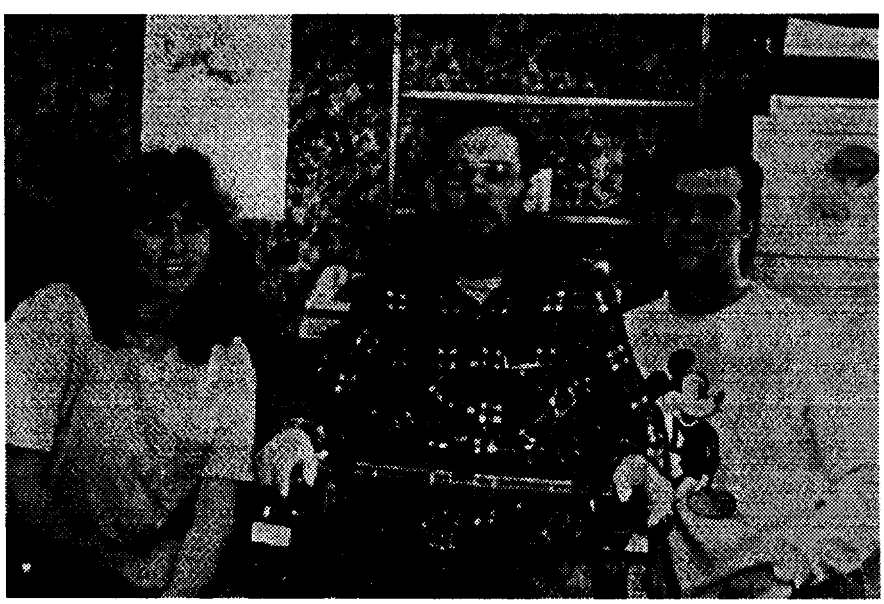
INTRODUCTION

The purpose of this project was to design and build a functional wheelchair laptray for a specific individual's needs. A commercially available laptray did not exist that satisfied his requirements. The laptray is for a person who has diabetes, is legally blind, and is a below knee double amputee who uses an Invacare Power Rolls Arrow XT wheelchair. Our client does have full range of motion and full upper body strength. We met with our client to discuss his needs and limitations. We then determined his physical constraints and set up the following parameters for a laptray:

1. Overall width must not exceed 24" so he can board the bus with the tray in place.
2. Laptray surface must tilt upwards to accommodate his limited vision by placing reading material within 8 inches of his eyes.
3. Laptray must be easily removable and lightweight.
4. Laptray should be able to be stored on the chair when not in use.
5. Laptray should not interfere with his field of vision, especially during wheelchair locomotion.
6. Laptray must not interfere with normal chair operation.

SUMMARY OF IMPACT

"In the fall of 1989 I began classes at the University of Illinois. Being in a wheelchair, I quickly learned that I would not have access to any type of writing surface. I started thinking about some kind of lap top table or a small table that might be adapted to the arm rests of my wheelchair, *only* to discover that there are no commercial wheelchair tables that could be attached to my particular wheelchair seat, so I applied to the University of Illinois Rehabilitation Education Center for help. The University of Illinois Rehabilitation Education Center and the College of Engineering designed and built a table for me that was very easily attached to my chair using a clear plexiglass-type material. The table is portable, very easily stored, compact and easy to put on or take off. This has been and will continue to be a big help to me both in school and



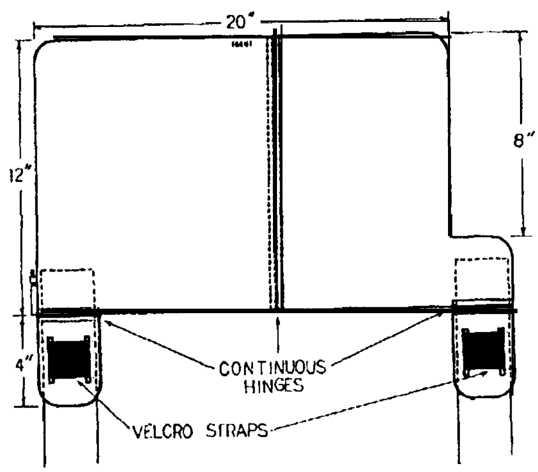
out. In school I now have an effective writing surface when I need it and when traveling the table is no way hinders my movement due to the fact that it is made of a clear transparent material. I can maneuver in tight areas such as on the MTD bus or in crowded classrooms with ease." (From the design recipient.)

TECHNICAL DESCRIPTION

To provide for an unobstructed view at all times, the material that was chosen was clear plastic. The laptray has overall dimensions of 24" x 16" (see figure 1). To allow the laptray to be stored in the wheelchair, the tray was cut down the middle for the attachment of a continuous hinge. This hinge allows the laptray to be folded in half to reduce storage size. The continuous hinge is mounted along the underside of the laptray to provide a smooth writing surface. The laptray is attached to the wheelchair by a 2" wide Velcro strap on each arm support (see figures 1 and 2). The Velcro straps are sufficient for attaching the laptray to the wheelchair since the laptray should never have more than 20 lb.. on it. The laptray has two slits in each arm support, allowing the Velcro to be wrapped through it. This prevents sliding of the laptray and keeps the Velcro straps from being lost.

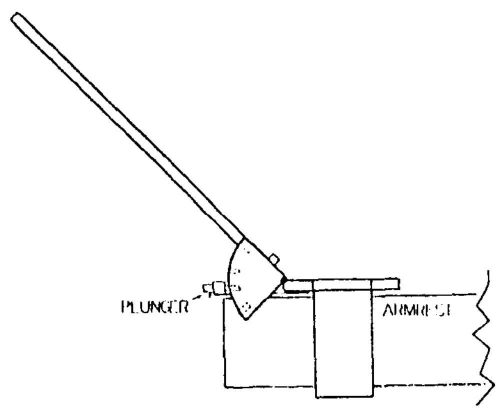
After further investigation of the design, it was determined that a non-brittle, tough plastic was needed. This was required because of possible stress concentrations in the plastic along the continuous hinges. The tensile strength of polycarbonate is 900 psi at room temperature. This is approximately 20 times the tensile strength of Plexiglass. The weight of 1/2" polycarbonate is 3.4 lb/ft^2 compared to the weight of 1/2" Plexiglass, which is 3.1 lb/ft^2

For these reasons, polycarbonate was selected as the material from which the laptray was constructed. Once the material was selected, 1/2" thickness was selected for the following reasons. Since only 2 sq. ft. were required for the design of the laptray, the weight difference between 3/8" and 1/2" was only 1.6 lb. This was acceptable because 1/2" polycarbonate gave greater strength and the client had full upper torso strength. Also, since all screws were to be countersunk, 1/2" polycarbonate would allow longer screws to be used in construction. The task of tilting the laptray toward the client's eyes required the use of continuous hinges and the design and machining of a multi-position locking mechanism. A continuous hinge was installed along each armrest support (see figure 1). These hinges were countersunk into the surface of the laptray to provide a smooth surface at each armrest support. The multi-position locking mechanism was designed around a hand retracted spring plunger #FR-250P from McMaster-Carr. The mechanism consists of two stainless steel



TOP VIEW

Fig. 1.

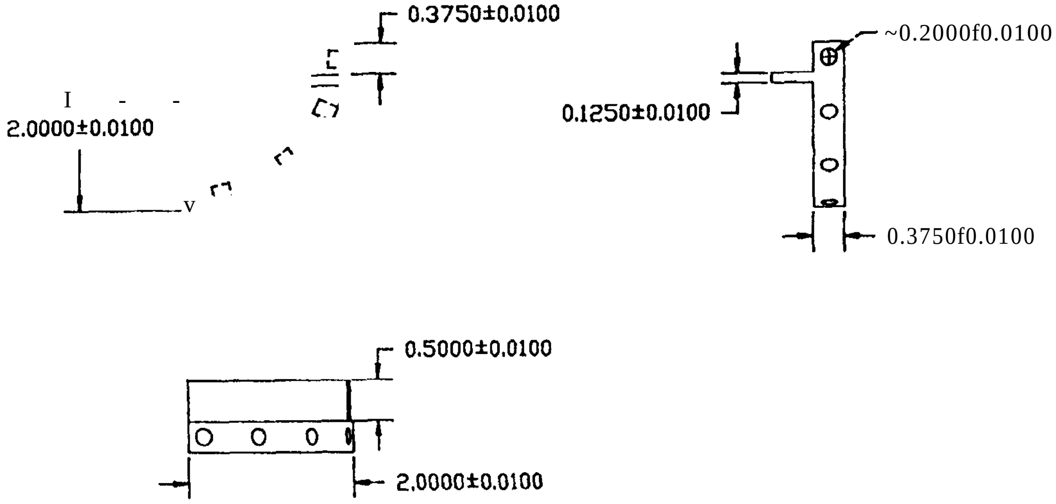


SIDE VIEW

Fig. 2

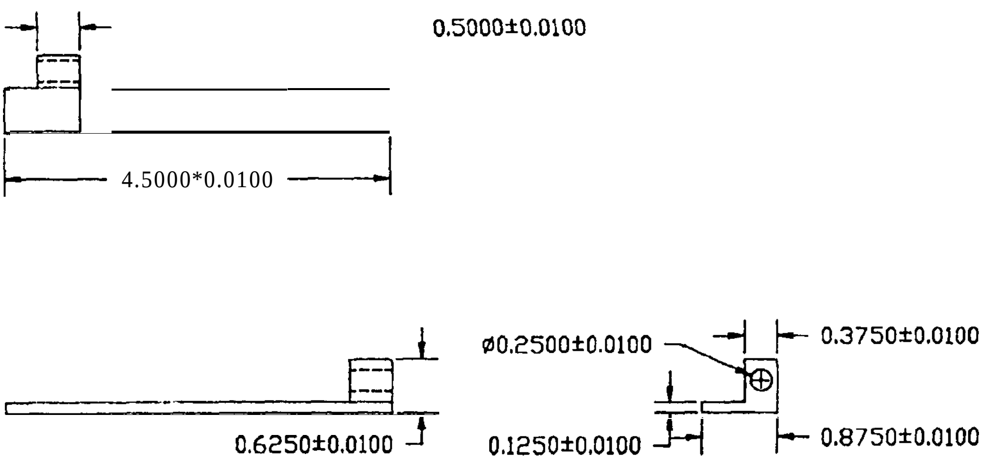
components. A quarter-circle piece 3/8" thick, mounted to the left edge of the laptray, has four holes in the curved edge to allow the spring plunger to hold the laptray at different angles with respect to horizontal. This component is mounted to the laptray by a 1/2" flange extending from the back of the quarter-circle. This flange is flush mounted to the underside of the tilting section of the laptray to allow the support bracket to work properly (see figure 3). The support bracket holds the spring plunger parallel to the left edge of the laptray. This component is attached to the underside of the left arm support (see figure 4). This also provides support for the laptray. These components are both made from stainless steel. Stainless steel was chosen for the strength it would provide and because the laptray would be exposed to different weather conditions and stainless steel would not rust. The multi-position locking mechanism works by the laptray being rotated, which also rotates the quarter-circle, and the spring plunger being inserted into the appropriate hole for the desired angle of rotation. As mentioned previously, the laptray would be exposed to all elements of weather. For this reason, all screws and continuous hinges were aluminum. The screws used were 3/8" 10-24 slotted flat head screws. All screws and hinges on the top surface of the laptray were countersunk to provide a smooth and finished appearance. All holes for the screws were drilled with a 5/32" bit and then tapped with a 10-24 tap.

In retrospect, it would be beneficial to make design adjustments in the multi-position locking mechanism to reduce the cost of machining. The cost of the project is $557.83.



QUARTER-MOON POSITIONING DEVICE

Fig. 3.



PLUNGER POSITIONING DEVICE

Fig. 4

Electronic Communication Board Modification

Designer: Alan Novak
Disability Coordinator: Shirley Green
Taylorville Community Unit Schools, Illinois
Supervising Professor: Dr. Mark Strauss
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INTRODUCTION

A home built electronic communications board was submitted for modification. This specific board had a white translucent surface with a ten segment grid underneath it. When the board was turned on, one of these segments would light up. Pressing a switch would advance the light to the next segment. In this way, by affixing different pictures to each grid, a person with limited speaking ability could communicate with others by lighting the appropriate picture. The owner of the board complained of several problems that needed to be corrected.

(1) After the cycle, there was a period during which no lights would be lit, i.e., the switch had to be pushed seven times before the first segment would light after the tenth segment turned off.

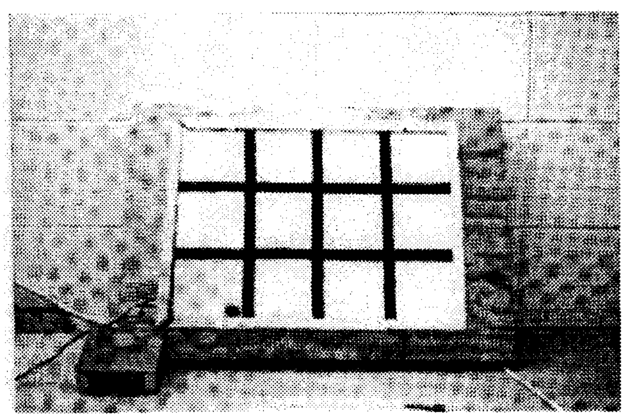
(2) As an option to using all ten segments of the board, the user should be able to select whether all ten segments or only the first five light sequentially.

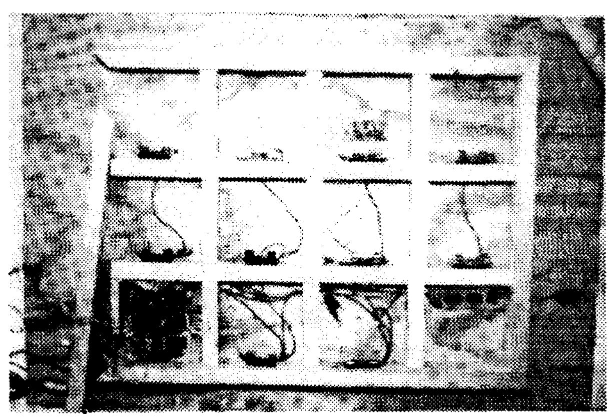
(3) The board should be able to work with a variety of commercially available switches. Originally the board was wired with a three wire switch (normally open and normally closed contacts) for switch debouncing purposes. All switches to be used are of the 2 contact type.

(4) When pictures were placed on the board's surface, they obscured the light in that segment. It was desired to change the lighting arrangement to eliminate this problem.

SUMMARY OF IMPACT

"The communication board is being used on a daily basis by several students enrolled in my special education class. The modifications to the communication board have allowed the students access to a device which previously had not been available to them. I believe that this device will serve as a precursor to a commercially available communication system for at least one of my

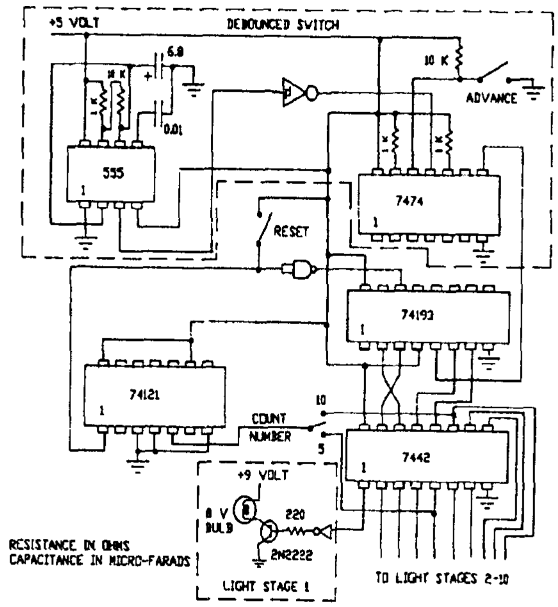




students. Therefore it is increasing the student's ability and as a result increasing the student's overall level of independence.
On behalf of my students, thank you again for involvement in this project."

TECHNICAL DESCRIPTION

The first step in correcting the problems was to determine how this communication board worked. After careful examination, the reason behind the dead period became obvious. The 74193 4-bit counter is used to count the number of times the switch has been pressed. If that it starts at 0000 binary (0 decimal) it will count to 1111 binary (15 decimal) before "wrapping around" to 0000 binary. However, the 7442 decoder only recognizes the first 10 binary numbers 0000 through 1010. Hence, the 7442 outputs a 10-bit decimal (thermometer code) corresponding to the first ten inputs from the counter, and outputs nothing during the final five inputs from the counter. The solution to this problem was relatively easy. In examining what happens when a light turns off, it is not difficult to see that the corresponding pin on the decoder goes through a low to high transition. By



using a 74121 monostable multivibrator to catch this rising edge, a pulse can be generated and used to reset the counter back to 0000 binary. The use of a single pole double throw switch allows the user to select whether the counter is reset after the tenth light turns off (10 light cycle, no dead zone) or after the fifth light turns off (5 light cycle).

The last problem on the list was also easily addressed. The lights were originally placed in the center of each grid and lit the entire square from behind. By moving the lights to the bottom of the squares and by marking the cover with the grid pattern, the lights were readily visible directly below each of the pictures. To satisfy the desire to use different types of switches, a new switch debouncing circuit had to be developed. A fairly simple switch debouncer was developed that uses a type D flip flop in a clocked circuit. The new circuit works in the following manner:

(1) The 555 timer generates a clock signal.
(2) The 7414 Schmitt trigger inverter is used to "clean up" and sharpen the edges of the clock signal.
(3) Every clock cycle the 7474 type D flip flop (rising edge triggered) checks what signal level is on the D input and transfers the inverse of this to the $\bar{Q}$ input.
(4) As the switch is pressed, input D is drawn low, $\bar{Q}$, is pulled high at the next clock cycle, and the counter adds a single pulse.

Note:

(1) The addition of extra filtering at the 5V line of the power supply. This was to counteract the ripple that the flip flop tended to produce on the supply voltage.
(2) The only time that this circuit will fail to debounce the switch properly is if the switch bounces at the exact instant as a clock pulse, which is very highly unlikely.

As a final change to the board, the wall mount power supply was replaced with one of larger current capacity. The original supply was running at just below maximum rating and tended to get very hot. The final cost of duplicating this board is approximately $71.20. The schematic (left) shows the final circuit design.

Camera Holder

Designers: Lori Gold, Sharon Lake and Wayne Van Lerberghe
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University of Illinois at Urbana-Champaign
Champaign, IL 61820

INTRODUCTION

In his mid-twenties, an avid photographer suffered a stroke that paralyzed his left side. For the past ten years he has improvised his photographic technique and adapted to using only his right hand. To take a picture, he holds his 35 mm camera by the lens to focus, places the camera in his lap to readjust his grip, and finally grasps the camera by the body to depress the shutter release. This process significantly encumbered him. A camera holder has been designed to support the weight of the camera at eye-level to enable him to freely focus and shoot.

The overriding objective through the design process was to allow the disabled individual to be independent. The harness design is lightweight and easily slides onto the photographer's shoulders. The camera holder provides the photographer with the ability to catch action shots and candid photos. Because the weight of the camera is supported by the torso rather than the right arm, fatigue is reduced.

SUMMARY OF IMPACT

"This camera support device will alleviate the difficulties I faced when using my 35 mm SLR semi-automatic camera due to left arm paralysis that I incurred as a result of a stroke.

The camera support device conforms to all the requirements I requested, i.e., lightweight, not cumbersome, and sturdy as possible, while still allowing me some degree of versatility. The device easily supports my camera at eye level so that I can focus with my good hand, glance over or around the camera to make sure my subject is ready to be photographed, then move my finger to the shutter release to take the picture.

It also makes loading and unloading of the camera much easier. I simply bend the camera down and away from my face so that gravity holds the film cassette in place while I "thread" the film into the takeup spool, and prevents the cassette from falling out when I pop open the back of the camera to unload.

I sincerely hope that you and your students will continue to share your skills and resources with the needs of other disabled people. You do indeed provide an invaluable service."

TECHNICAL DESCRIPTION

The camera holder design consists of three main components: a universal rotating head upon which the camera rests, flexible gooseneck tubing that provides a flexible link between the camera and the body harness, and a body harness made of PVC plastic.

The universal rotating head is merely a camera tripod head adapted for the purpose. It allows motion in almost a full 360°. Additionally, it includes a quick release mechanism that allows the individual to quickly and easily dismount the camera from the apparatus to change the film or lenses. The head is connected to the flexible tubing by a short threaded rod.

The flexible gooseneck tubing consists of a 10" section with female threaded couplings on both ends. The threads used are UNC 1/4"- 20. The flexible tubing allows the individual freedom to position the camera wherever decided, and supports the camera independently to allow focusing and film advance with one hand.

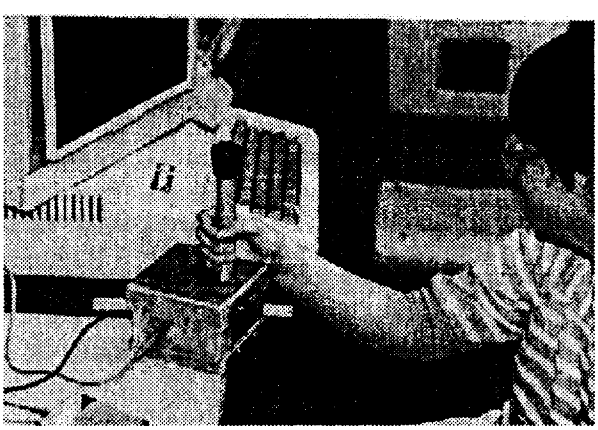
The body harness is made of 1/4" thick PVC plastic. A 7"x15" plate lies on the chest, and molded straps wrap over the shoulders in a cane fashion to maintain the position of the harness and support the load of the camera. 3M open- cell foam cushions the shoulder surfaces for comfort. To provide stability and strength in the design, the back of the PVC plate is partially covered by a centered 5-3/4"x5" aluminum plate that is 1/8" thick. A 1/8" aluminum plate of dimensions 5-1/2"x4-1/2" is on the front of the PVC plate and is in line with the rear plate. On this front plate, an aluminum block of dimensions 2-1/2"x1"x1" is centered. A 1/4"-20 screen is embedded in the block vertically, and the screw threads into the bottom of the gooseneck. To fasten the PVC, the two aluminum plates and the aluminum block together, 2-1/4"-20 screws are placed in the assembly from the back. The screws are threaded through the rear plate, the PVC, the front plate, and finally penetrate about 1/2" into the block. The final cost of the project is estimated to be $175.

Indestructible Joystick for a Child with Cerebral Palsy

Designers: Heidi Blaumueller, Charles Shih
Disability Coordinator: Dianne Tennant
Urbana Middle School, Urbana, IL
Supervising Professor: Dr. Mark Strauss
Division of Rehabilitation Education and Department of General Engineering
University of Illinois at Urbana-Champaign
Champaign, IL 61820

INTRODUCTION

A young student with cerebral palsy and arthrogryposis needed to interact with an Apple IIe computer. The joystick being used by other students was not suitable for him because his rapid, semi-controlled arm movements would have broken it. Also, because the boy's hand is unsteady, the joystick handle moves when he initially grasps it. A stronger, more durable input device was needed. A design was needed to allow a small amount of movement of the joystick handle before the circuitry was activated. A secure housing was designed to encompass a commercial joystick for strengthening and durability purposes. The interface between the joystick and the operator will not allow small, unintentional spastic movements to activate the joystick. This design will allow the student the use of an Apple IIe Computer and the educational software that is run on it.



SUMMARY OF IMPACT

The project involved a middle school student with cerebral palsy and arthrogyrposis enrolled in a public school program for students with severe multiple disabilities in Urbana, IL. This student was learning to maneuver an electric wheelchair with a modified joystick but was unable to use a standard joystick with joystick training computer programs. Severe motor coordination and strength deficits limited the effectiveness of the joystick. Motor deficits included limitations in shoulder range of motion above 90°, elbow extension limited by 30°, and bone deformities in the hand allowing for no hand grasp. The back of the flexed wrist and fingers was used for joystick manipulation. The student also exhibited decreased strength and difficulty grading muscle movements. Training using a standard joystick with an Apple computer was attempted without success. It was evident that a joystick that could endure a greater force and was less responsive to ungraded movements until end range was needed. The final design provided a joystick that withstands physical abuse. A wrist cuff made from splint material enables the student to proceed with joystick training programs. It is hoped that this training will carry over to improved electric wheelchair maneuvering abilities. The joystick also will allow other students with physical and behavioral deficits to utilize the joystick computer programs. These programs can be of benefit for developing eye-hand coordination, developing directionality concepts, and establishing cause-effect relationships. The programs themselves can be very motivating. We thank the engineering design program and students for the excellent project they have accomplished.

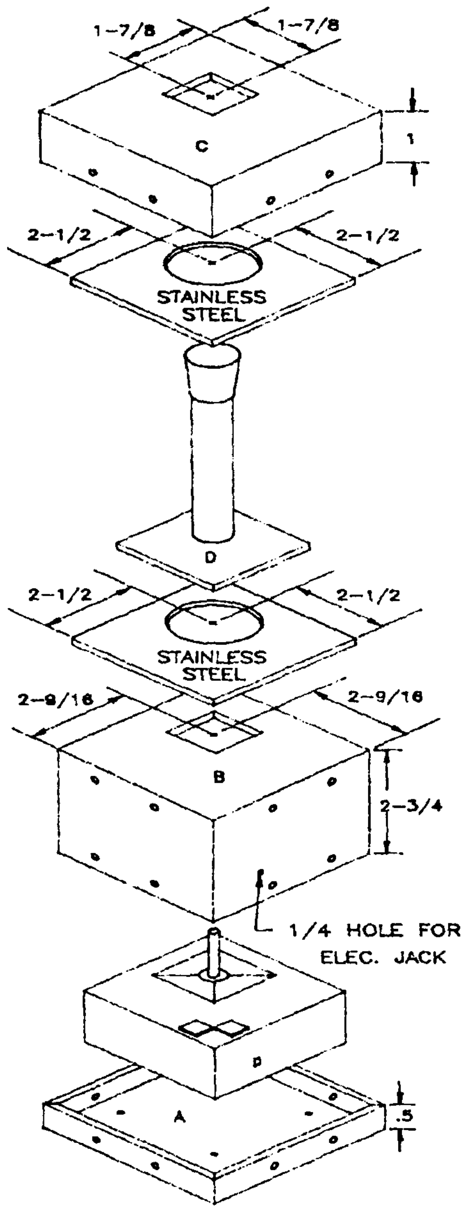
TECHNICAL DESCRIPTION

One criteria of the design solution, as specified by the teacher, was that the student access the computer via his upper extremities. This eliminated any head activated control mechanisms. Heavy duty commercially available industrial joysticks were pursued as a possible alternative until it was found that the cost would make the solution prohibitively expensive. It was decided that any solution would have to be based on modifying the common Apple IIe compatible joystick. Replacing the components of joysticks used with Apple IIe's with more durable components, i.e., bearings, shafts, etc., was not feasible because it was found that the entire assembly is fragile. The final design was based on the principle of providing a protective exoskeleton for a common joystick used for an Apple IIe. The most critical part of the design was to determine the correct geometry of the moving components of the exoskeleton that would provide for protected but normal functionality of the joystick.

A Mach II joystick from CH Products was purchased and an aluminum housing was designed and built around it. This housing was constructed by cutting and bending three 1/8" thick 6061 aluminum plates into box shapes. Plate A (see figure right) was used as the bottom of the housing, plate B as the body and "false top" of the housing, and plate C as the top cover. The unbent plates were 5-1/4" x 5-1/4", 9-1/4" x 9-1/4", and 6-1/2" x 6-1/2", respectively. A square 2-1/16" hole was machined through each of plates B and C. A sturdy interface between the user and the joystick was designed as follows. A 7" aluminum tube, with an outside diameter of 7/8" and a wall thickness of 3/16" was used to cover the joystick handle. The top knob of the handle was removed to allow a smooth sliding surface. The dimensions of the hollow tube provided the desired dead zone. A fourth aluminum plate (plate D) with dimensions of 2-9/16" x 2-9/16" had a 7/8" hole drilled into it. The tubing was pressed through this hole and welded into place. Plate D was sandwiched between plates B and C, and to provide a hard bearing surface between these plates, sheets of stainless steel were placed between the aluminum plates. This design prevented the travel of the joystick handle from exceeding the normal operating range and thus breaking.

Since the original joystick was now encased in aluminum, the pushbuttons could not be accessed. A 1/8" phone jack was installed into the side of the aluminum casing and wired in parallel with the existing firing button. This allowed any switch with a 1/8" plug to be interfaced with the joystick. Sixteen #30 holes were drilled and tapped (6-32), and 1/8" machine bolts were placed in these holes to hold the entire assembly together.

A recommendation for replicating this design would be to use a softer aluminum, such as a 303 aluminum alloy. This would prevent the hairline cracks from occurring when the aluminum was bent into box shapes. Approximate cost for the project is $96.00



ALL DIMENSIONS IN INCHES

ALL SEAMS WELDED

A Tactile Map of a Shopping Mall for the Blind

Designers: John Connelly
Disability Coordinator: Zoe Hood, PACE, Urbana, IL
Supervising Professor: Dr. Mark Strauss
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University of Illinois at Urbana-Champaign
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INTRODUCTION

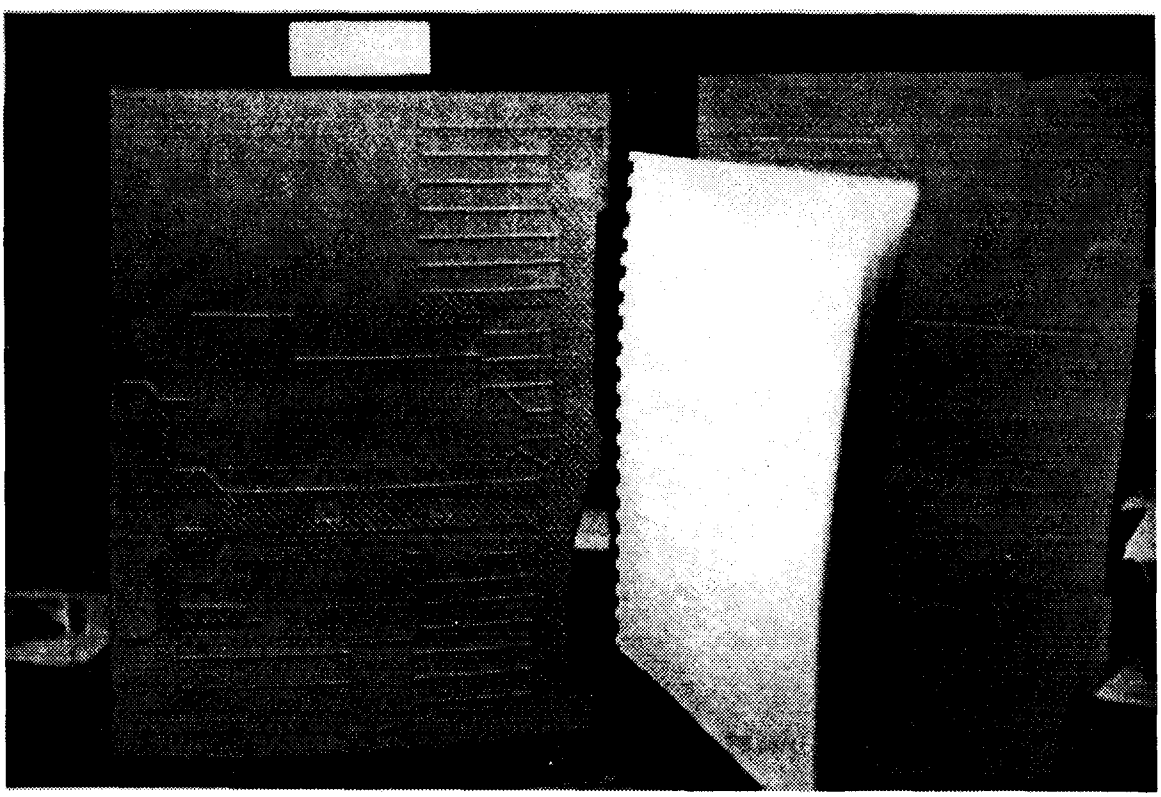
The purpose of this project was to enable visually impaired individuals to locate and move around a local shopping mall with little or no assistance. This was accomplished by first making a drawing of the mall floorplan on a computer. Braille characters were used to represent the different stores, landmarks, and other important information, such as telephones and washrooms. The drawing was then transformed into a raised line map (11" x 17") with the help of an optical lathe. The map was cut from a semi-rigid plastic sheet. The corresponding braille characters on the map are referenced on a braille legend that lists the stores by categories (i.e., men's apparel, jewelry, shoes, etc.). The phone numbers of the stores are also listed on the legend. The legend is made of a plastic-coated paper and is attached in booklet form to the map. The map will either be sold at cost to the visually impaired individuals or will be available to borrow at the information desk in the mall.

SUMMARY OF IMPACT

This tactile map of a mall is the first of its kind to be used in this area offering much of the same information provided by the mall's map for sighted shoppers. The map uses different textures to indicate whether a specified area is a store, service area, mall walkway, or an obstacle on the walkway. Braille abbreviations on each specified area of the map are classified according to the type of merchandise or service offered and referenced in a Braille legend. Visually impaired individuals will be able to use this map to independently locate appropriate stores for their shopping needs.

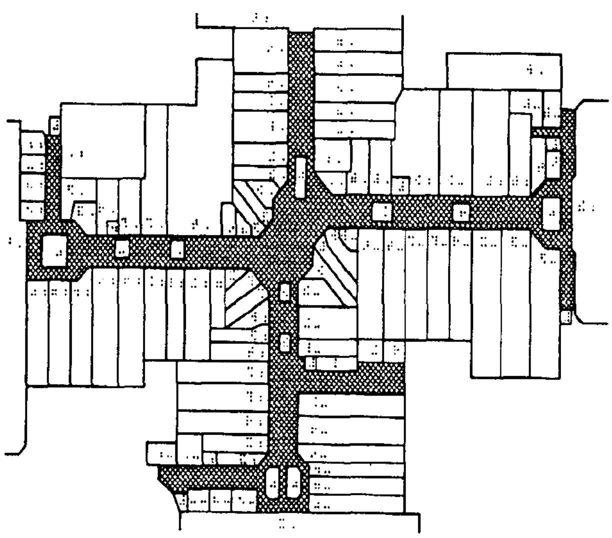
TECHNICAL DESCRIPTION

Many hours of research were necessary to develop a tactile map that will properly suit the visually impaired individuals who will be using it. There are no set guidelines as of yet that deal with the information that should be given or how a tactile



map should be made. Some information about tactile maps can be found by referencing the Journal of Visual Impairment and Blindness. The American Foundation of the Blind also has a bibliography listing various references dealing with the topic of tactile maps. The best source of information is that gathered first hand from the visually impaired individuals who would be using the map. See references for more details. When designing a braille floor plan, such details that have to be considered are the thickness of lines, symbols for the different locations, and different textures to represent the various floor areas (surfaces). Before the map is produced, one should talk with the potential users and find out their preferences concerning the map's details.

The map produced of the mall was generated with Autocad, a mechanical drawing program. A font file for the braille symbols had to be created to place them on the map. This was necessary since Autocad does not have a braille converter or a braille font file available. The font file was programmed using the Autocad machine language. The commands and their meanings can be found in the appendices of the Autocad manual, version 9.0. The braille characters corresponded to the various letters on the keyboard. Braille symbols were used to indicate different locations. Cross hatching was used to differentiate the main walkway from the stores. The final tactile map was



produced using an optical lathe. An ink drawing of the floor plan, generated by Autocad, and a sheet of plastic 1/32" thick were placed on adjacent drums. Both sheets were 11" x 17". As the drums are rotated simultaneously, an optical eye scans the ink drawing. If the eye senses white on the paper, the lathe cuts into the plastic. If the eye senses ink (a dark line) the lathe does not cut into the plastic. The raised lines were approximately 1/32" (0.7 mm) and 3/64" (1 mm) thick. The braille legend, with the corresponding braille characters, was generated from an ink legend that is given out to the mall's sighted patrons. The written legend was reproduced into a computer ASCII file with special control characters added, then sent through a Ransley Braille Translator that finally outputs to a braille embosser. The braille legend was placed in a press with a plastic coated paper. The press heats up, softens the plastic slightly, enabling it to form a copy of the braille legend. When cooled, the plastic coated paper is more durable than the braille printer paper. The braille legend was placed into a booklet form and attached to the map. The overall size is 11" x 17". The map will either be sold to visually impaired individuals at cost or will be available in the mall to borrow at the information desk. The only cost associated with this project was the plastic sheet used to cut the map ($8.00) and the plastic-coated paper used for the legend (6@ $0.25 = $1.50). Several trial copies were made and refined with the input of a blind volunteer. Total cost: $50.00.

REFERENCES

Lederman, S. J. and L. M. Lambert, An Evaluation of the Legibility and Meaningfulness of Potential Map Symbols, *Journal of Visual Impairment & Blindness,* October 1989, pp. 397-403.

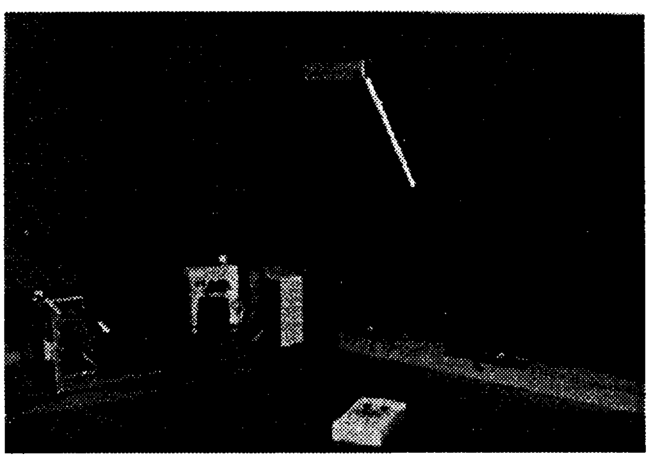
Mobility and Mobility Aids for Visually Handicapped Individuals, *National Library Service for the Blind and Physically Handicapped.* (Available through American Foundation for the Blind, Manhattan, NY.)

An Automatic Door Opener Operable from a Wheelchair

Designer: Carl H. Mayer, Jr.
Disability Coordinator: Suzanne Gewe
Supervising Professor: Dr. Mark Strauss
Division of Rehabilitation Education and Department of General Engineering
University of Illinois at Urbana-Champaign
Champaign, IL 62820

INTRODUCTION

The purpose of this project was to design a door opener for an outside door to an apartment that could be operated by "Open & Close" pushbuttons from a wheelchair, or from a hand-held transmitter. This opener was designed for a quadriplegic whose only motor abilities are his left wrist and finger, and for others who might live with him or care for him. He operates his wheelchair with a joystick and would gain more independence with the ability to open and close the outside door of his apartment. He could escape if he were in his wheelchair, and a fire was to break out in his apartment.



TECHNICAL DESCRIPTION

Design considerations for this door opener were:

1. Using a "linear-actuator" to power the door, for design simplicity.
2. Using DC current for control and power, in case of power failure.
3. Using a l-amp battery-charger to keep the battery charged.
4. Using a timer to operate the battery-charger each day.
5. Providing a mechanism which essentially would lock the door, without the need for a key.
6. Providing a device, with a slip-clutch, to prevent failure with a blocked door.
7. Using an actuator with built-in limit switches at close and open, for ease in installation and control.
8. Using a DC-powered radio-frequency switch.
9. Using plug-in relays for easy replacement.
10. Alternate provision for opening door in case of RF switch failure.

The solutions to these design considerations are respectively as follows:

1. A Warner Electric Electrak-#1 Linear Actuator with 73# force, 5.8" stroke, equipped with limit switches and slip-clutch, and powered by a 12V-DC is used to open and close the door.
2. A 12V motorcycle-battery was chosen for the power unit.
3. A Radio Shack Radio-Frequency activated switch was chosen for the control unit (RS#61-2667). Although this unit was built to operate on AC current, it was converted to be powered by 12V DC. This switch is signaled from an "open" and "close" 2-button transmitter located on the left arm of

a wheelchair. These remote controllers are powered by 9-volt batteries.

4. An AC-powered timer is used to operate a DPDT-relay that closes both the plus and minus connections to the battery from the charger. The required daily charging time can be set on the timer.
5. The linear-actuator is driven by a self-locking acme-screw that eliminates the need for a lock.
6. The "Electrak #2 Actuator" is driven by a slip clutch that allows the drive to slip if the door is blocked.
7. The actuator has built-in limit switches that disconnect the DC current from the actuator when it is extended or retracted.
8. The RF switch, which was designed to supply AC current to house appliances, was converted to operate on 12V DC, to be operable in case of power failure.
9. The two relays used for control of the door are 12V-DC operated, DPDT, and 4PDT, plug-in relays.
10. A key-operated switch is provided to give secondary control to open and close the door from the outside.

The approximate cost for this project is $336.86.

A Motorized Adjustable Bulletin Board

Designer: James Lee
Disability Coordinator: Donna Zima
Supervising Professor: Dr. Mark Strauss
Division of Rehabilitation Education and Department of General Engineering
University of Illinois at Urbana-Champaign
Champaign, IL 61820

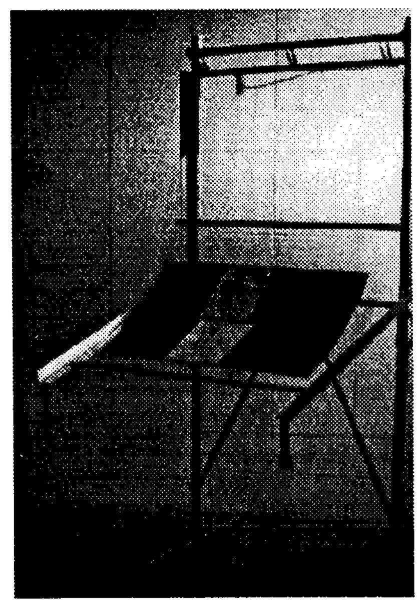
INTRODUCTION

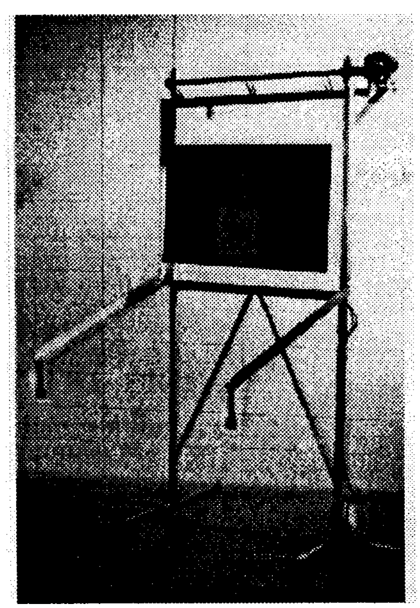
This project was designed for an individual who works as a school administrator in Chicago, IL. This person requested aid in the task of placing and removing items from her bulletin board. The limiting physical constraints of this person were: (1) She had muscular dystrophy and thus required the use of a wheelchair; (2) She could not raise her elbows from the arm rests of her wheelchair; and (3) She did not have the strength enough to lift a load greater than a pound. In addition, she generally uses her left hand for manipulating objects, and her right arm for trunk support.
The solution called for the construction of a motorized bulletin board that would in effect come to her.

This mechanical board was made of Lexan, a plastic polymer, and was thus flexible. It is supported on an aluminum frame structure that stands in front of her desk, thus allowing the board to move toward her on two extending arms. Finally, the surface of the board was lined with two way reusable tape so that she could simply press her papers down onto the board or pull them off with minimal effort.

SUMMARY OF IMPACT

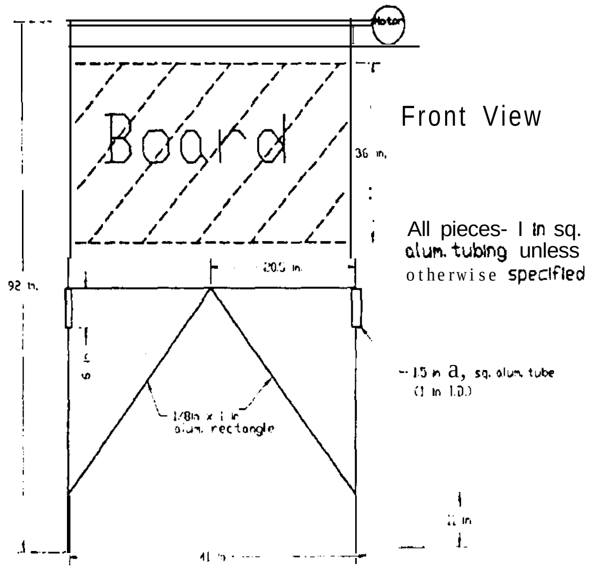
This adaptable bulletin board was designed for a person who passed away before the project was completed. It is currently being used in a school for disabled children to have them post and display their accomplishments.





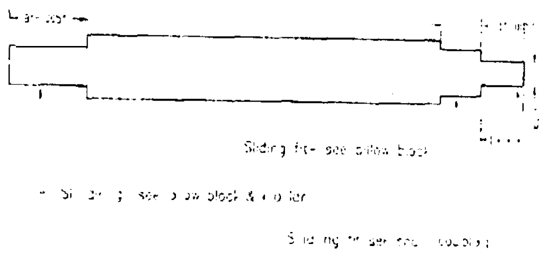
TECHNICAL DESCRIPTION

The frame itself consists of aluminum square tubing (1” O.D., 1/4" wall) and aluminum angle iron (1.5”) welded together. The motor is a double reduction right angle motor from Bodine, model N3RG and has a rated torque of 43 lb-in. This motor rotation is reversible and is controlled by a DPDT switch with momentary center off from American Switch Company. By having a built-in worm gear, this motor was able to hold the board in place when the power was shut off, thus eliminating the need for a brake. The cables attaching the board to the motor shaft (1” aluminum rod) are 1/16th" diameter “aircraft cable” purchased from McMaster Carr in Chicago. The pillow blocks supporting the motor shaft are 1" in dimension as are the shaft collars. The wires were secured to the board and to the motor shaft by drilling holes into them and threading the holes with screws to hold the wires. The arms extend out at an angle of approximately 64 degrees with the vertical and were designed so that the board would cross over the top of her desk by 18” on the far edge and 6” on the near edge.



To insure stability of this device on the floor, certain implements were added to the general structure. Adjustable pads, much like furniture levelers, were drilled into the bottoms of each of the five feet to produce a level contact surface between the floor and the base. In addition, a cross bar was welded between the two main legs at a distance of 49” from the ground. This was done to minimize the rocking and instability caused by the parts in motion.

It was decided that the overall frame should be capable of being disassembled should it not be able to fit through a standard doorway. As a result, the two legs were cut and then reattached by placing a 1.5” O.D aluminum tube (sleeve) over the break lines. Bolts were inserted completely through the legs and sleeves, thus making the structure sturdy and collapsible. The total cost for this project is $664.63.



Part: Shaft
Material: Aluminum

Design of an Electronic Communication Board

Designer: Kathleen A. Olson
Disability Coordinator: Mark Stover
Sunnyside Center, Decatur, IL 61526
Supervising Professor: Dr. Mark Strauss
Division of Rehabilitation Education and Department of General Engineering
University of Illinois at Urbana-Champaign
Champaign, IL 61820

INTRODUCTION

A 16 year old student with cerebral palsy is non-vocal and is unable to control his hands for functional activities. He can tip his head to activate a wobble switch mounted on the right side of his wheelchair. Currently, the wobble switch is connected to an Apple- computer to allow him to make choices while participating in simple computer games at school. His teacher sees a potential for increased communication using this switch and requested a portable electronic communication board that could either be mounted on his wheelchair or be free-standing on a desk or table.

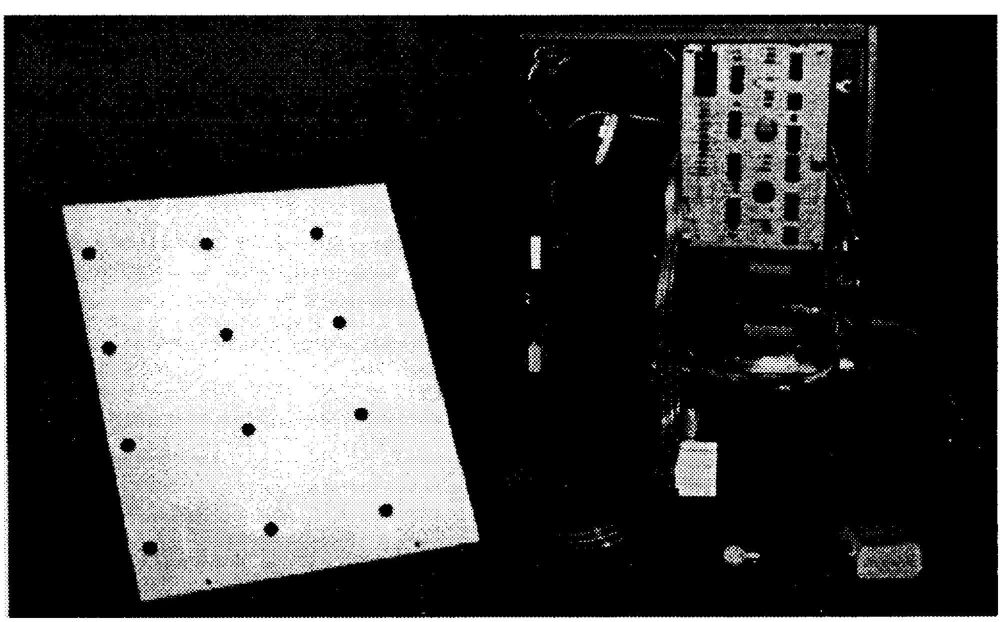
A circuit was designed that will allow the student to activate 12 small red lights mounted on a notebook-sized plastic board using a wobble switch. Each light is positioned next to a 2 x 2" clear plastic pocket containing a picture or small object relevant to his communication needs. The student can activate the light of his choice using one of two scanning modes: single step scanning or continuous scanning. While in the single step scanning mode, each activation of the head switch causes the next light to turn on and stay on until the head switch is activated again.

The continuous scanning mode allows him to activate the head switch once to start an automatic cycle in which each light turns on and off sequentially. When the light next to his choice of pictures is lit, he can activate the head switch again to stop the cycle.

For portable use, the communication board can be mounted to the student's wheelchair and powered from a rechargeable battery pack. For desktop use, the board fits into a square stand and can be plugged into a wall outlet to conserve the batteries.

SUMMARY OF IMPACT

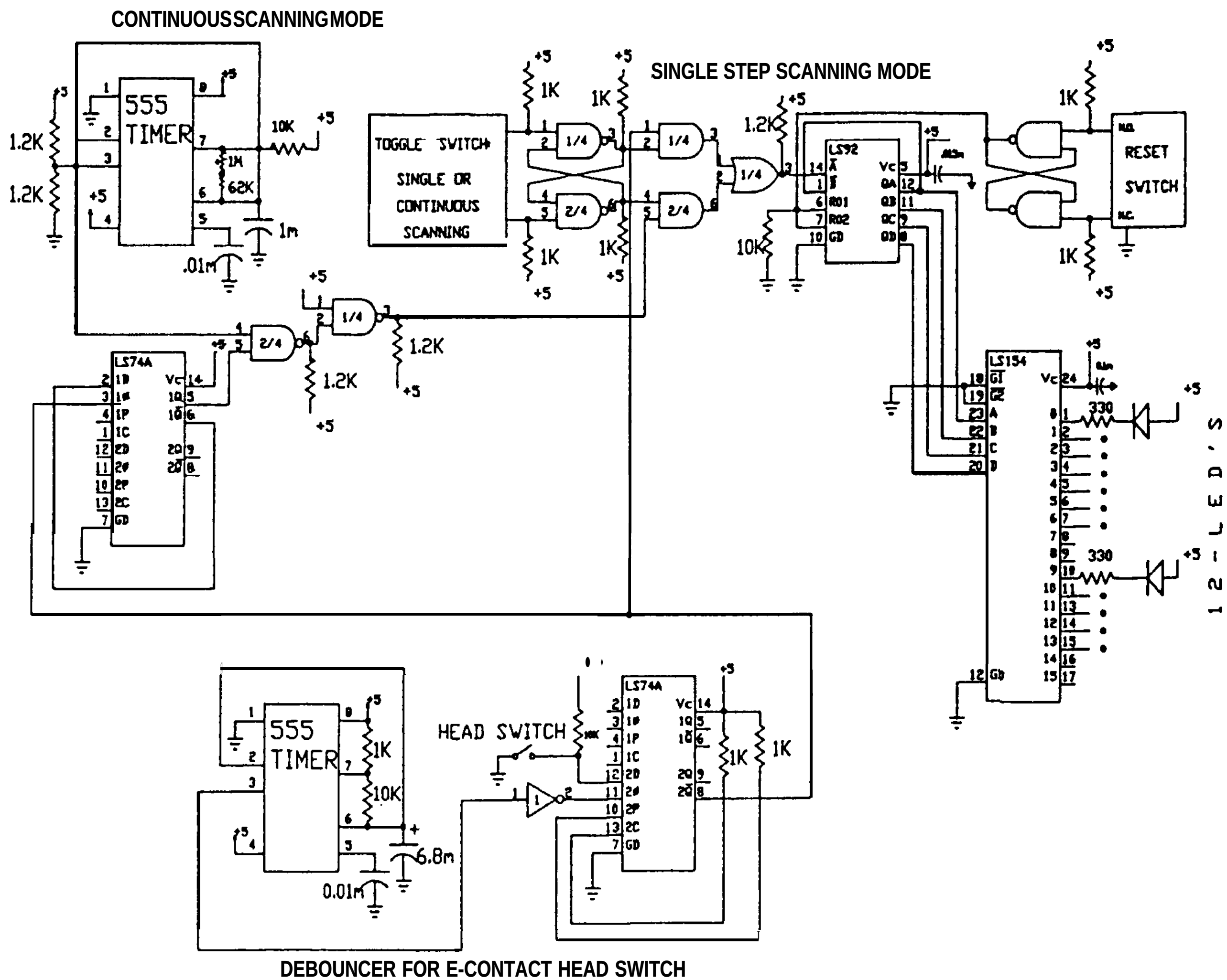
For a nonverbal student with severe physical limitations, an electronic augmentative communication board was designed. It allows the student to communicate with others through step scanning or linear scanning methods. We hope that this device will improve the student's ability to interact not only with the teachers but also with his peers.



TECHNICAL DESCRIPTION

The circuit diagram is shown below, The single step scanning mode receives a debounced signal from the head switch. Note the 3-chip debouncer for the head switch: a 555 timer, hex inverter and flip flop are necessary to "clean up" the output of the 2-contact wobble head switch from Prentke-Ron-rich. Most commercially available switches for use by persons with disabilities use 1/8" plug, 2-contact switches, and must be debounced in this manner. The remainder of the single step scanning mode consist of an AND and an OR gate sending a signal to the divide-by-twelve counter and finally to the 4-16 line decoder that controls the 12 red jumbo LED's, each 10 mm in diameter. A 330 ohm current-limiting resister is in series with each LED. Each LED is rated 20 mA maximum forward current.

The continuous scanning mode likewise receives the debounced signal from the head switch and passes it through a flip flop. This signal is paired with a 555 timer signal into a NAND gate. This output is paired with a high input into another NAND before entering the single step circuitry. It continues on as described above but is now controlled by the timer and the head switch. Speed of continuous scanning can be varied so that the time between successive lights ranges from 1/8 to 2-1/4 seconds and is controlled by a 1 M ohm potentiometer on the timer. A wider range of speeds is available if the 62K ohm resistor is eliminated at the timer. A reset switch can be used in either mode to restart the lights at the first picture in the upper left comer of the board. The total current draw of the circuit is 165 mA. For portability, the circuit can be powered with Radio Shack's 7.2V, 1200 mA "Enercell Turbo Racing Battery Pack." The NiCad rechargeable pack can power the circuit for about 8 hours before charging is required. The battery pack can be fully charged in 4-5 hours using Archer's 7.2V DC 400 mA battery charger. To reduce noise from the battery pack, a 4.7 mF capacitor was introduced directly between the output pin and ground of the 5V regulator. The capacitor acts as a low-pass filter. The circuit also can be powered by an external DC power supply, in this case Archer's 7.2 V, 400 mA battery charger. This unit plugs into the board via a 1/4" jack so that it cannot be mistaken for the 1/8" head switch jack on the other side of the box. A 4 pole triple throw toggle allows the user to choose between the 3 modes of operation of the circuit: charging, power from the charger of power from the battery. Since the battery pack should not be overcharged and there is not an automatic shut-off on the charger, laminated charging instructions were glued to the back of the box for the user's convenience. The batteries should not be charged for more than 5 hours. The 10-5/8" x 12" x 2" box has a 3/16" thick white cast acrylic (Lucite) front with 12-10 mm holes drilled for the LED's. A slightly larger diameter lip at the base of the LED catches on the hole and "Plastic Welder" adhesive secures the LED in the hole. The LED's are connected to the rest of the circuit using 15 conductor ribbon cable that can be unplugged to facilitate front plate removal. The front plate is attached to the box with 4-3/4" threaded bolts along the top and bottom edges. The remainder of the box is gray PVC: 1/2" thick sections at the "floor" and "ceiling" of the box to allow adequate clearance for threading and 3/8" thick sections for the sides and back to minimize weight and bulk. PVC was chosen for its toughness and durability as well as suitability for threading. Lucite was chosen for the front because of its availability in white and for its stiffness. The 2" x 2" clear plastic pockets, commercially available for photographic slides, are bonded to the front of the board with Weld-on cement, which provided the strongest bond of all the plastic adhesives tried. The universal support arm attaches to any tubular metal piece on the wheelchair using a circular clamp with a set screw. The clamp can remain on the chair with the rest of the arm detached when the communication board is not needed. A wide range of positions is available using the rotating, flexing and telescoping joints of the arm. A 1-1/2" diameter section of aluminum rod was machined flat along the top 3" of its length to provide a flat surface of contact between the board and the rod. This semicircular section fits into a semicircular bracket bolted to the back of the board and is secured by a set screw. The bottom 1" of the solid rod section was machined to a 1/2" diameter with a 3/8" diameter channel groove to accept a set screw from the connecting section of the support arm. For desktop use, the communication board rests in a 6" x 6" PVC base onto which is mounted a square aluminum block. The 1/2" diameter bottom section of aluminum rod attached to the communication board fits into a center hole drilled in the aluminum block and is secured with a set screw. The set screw can be loosened to allow for swivel of the board during use. The total cost for this project is $561.44.


CONTINUOUS SCANNING MODE
555 TIMER
SINGLE STEP SCANNING MODE
TOGGLE SWITCH SINGLE OR CONTINUOUS SCANNING
RESET SWITCH
LS92
LS74A
LS154
12 LED'S
DEBOUNCER FOR E-CONTACT HEAD SWITCH
HEAD SWITCH
555 TIMER
LS74A