# CHAPTER 5
# MISSISSIPPI STATE UNIVERSITY


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# Sensory Stimulation Unit for the Severely/Profoundly Disabled

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## INTRODUCTION

Under the mandate of federal law P.L. 94-142, the local public schools of Starkville, MS offers a class for the severely and profoundly disabled. The instructor of this class and the school physical therapist expressed a need for a sensory stimulation unit that could be used to provide visual and auditory stimulation to individual students. An enclosure device, shown in Fig. 5.1, was designed to be rolled over the student when lying on his/her side to provide visual and auditory stimulation in an isolated environment. An array of lights on one wall is lit in different patterns, and a stereo speaker on the other wall allows for music and other recorded sounds to be piped in. "Skylight panels" on the top of the enclosure can be used to display transparencies and to allow the teacher to observe the students' reactions.

## SUMMARY OF IMPACT

Students who are classified as severely or profoundly mentally disabled display a range of mental abilities from the cognizant communicators with limited speech patterns to the unresponsive non-communicators with no speech or other developed forms of communication. Although the stimulation unit will be useful for all of these students, it will be particularly useful for the noncommunicators who may respond only to the simplest sensory input: light/dark, geometric patterns, and silence/music. By providing this opportunity for a student when

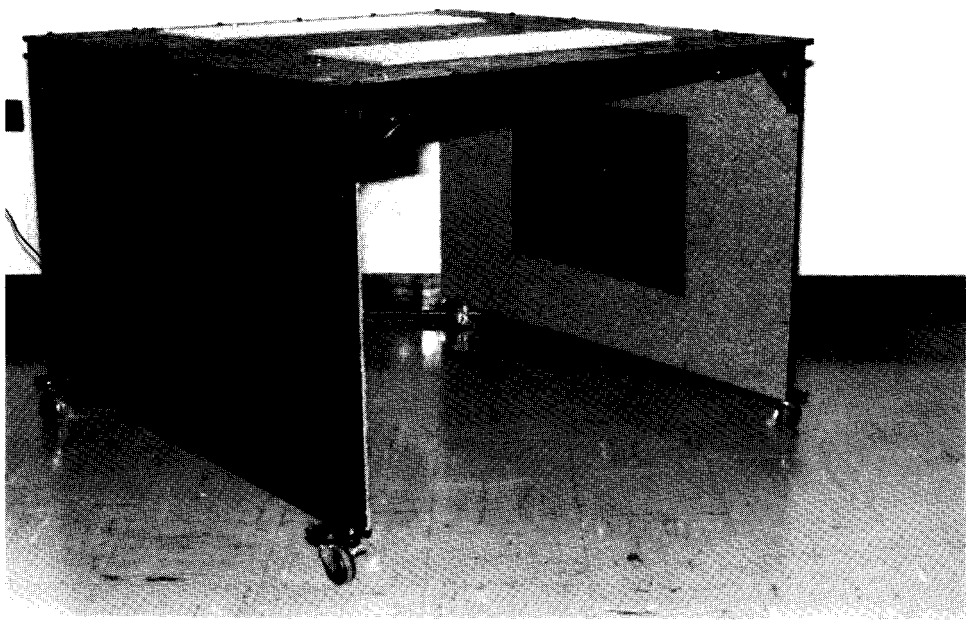

Figure 5.1. Sensory Stimulation Unit. The dark panel on the inside wall contains 35 LED's which are lit in patterns.

the teachers are working one-on-one with other students in the class, it is hoped that the sensory stimulation will continue to engage the student and assist in his/her mental development. This device has been well received by teachers who view this as an easily accessible form of sensory input that requires almost no setup time. It has also been received well by the parents who view this as a means of providing their children more time in a stimulated environment.

## TECHNICAL DESCRIPTION

The sensory stimulation unit was designed as a rollable box-type enclosure that could be rolled over a student when that student is lying on his/her side on a side-lying positioner cushion. Aluminum angle was used to construct a frame to which three 0.64 cm (1/4 inch) thick plywood panels were attached. These panels serve as the two sides and the top as seen in Fig. 5.1. The walls were lined with carpet. Four locking casters were mounted to the frame so that it could be easily rolled around the room. The overall size of the structure is 91 cm long, 91 cm wide, and 61 cm high (36 x 36 x 24 in).

On one of the inside walls of the unit, a 7.9 x 4.7 cm (20 x 12 in) light panel was installed. Thirty-five light emitting diodes (LED's) were arranged in a square (S), triangle (T), and circle (C) pattern as shown in Fig. 5.2. Each of the three patterns were totally lit in the following sequence: S+C, S+T, S, T+C,

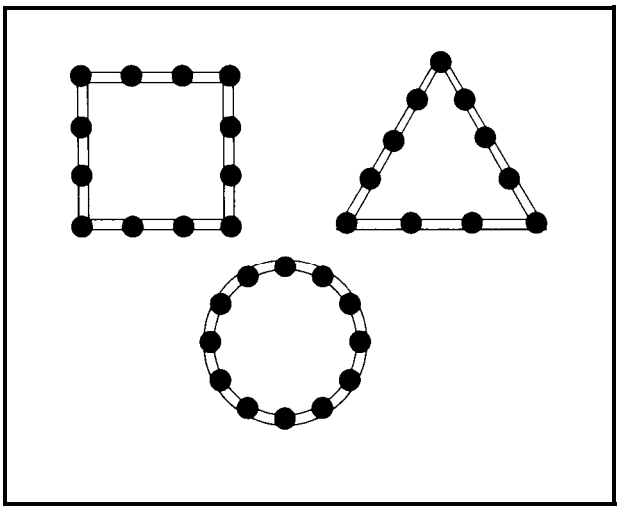

Figure 5.2. LED Patterns on the Light Panel.

C, T, S+T+C. Each pattern is lit for about 1.3 sec so that the total sequence takes about 9 seconds. The sequence runs continuously. The timing of the display was controlled by a circuit composed of two oscillators, a counter, NAND gates, and transistor drivers for the LED's. The circuit was powered by a 5v DC power supply. A schematic of the circuit is shown in Fig. 5.3.

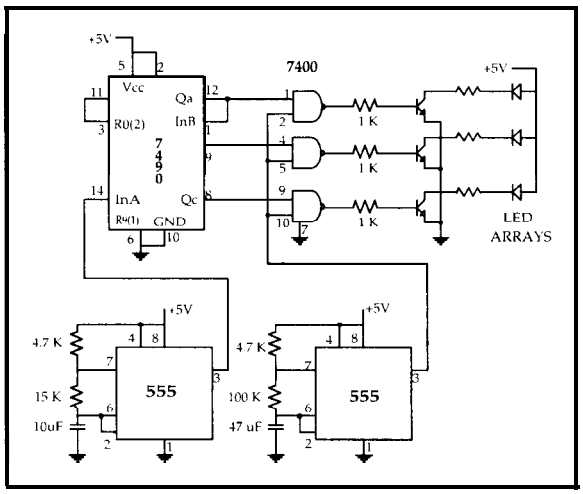


Figure 5.3. Circuit to Control LED's

In addition to the LED light board, two Plexiglas panels were placed over two 53 x 15 cm (21 x 6 in) openings on the top of the unit to allow for transparencies to be viewed. An 8.9 cm (3.5 in) diameter speaker was mounted on one of the side walls, and a phone jack was connected to it and mounted on the plastic electronics box attached in one corner. The total cost of the project was $148.

# Activator for a Pedal on an Electronic Organ

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## INTRODUCTION

A mechanical device was designed to assist a physically disabled woman in playing the organ. Ms. S. Cook suffered from polio as a child and was left with limited use of her right leg. It was impossible to operate both the organ's floor pedals and the crescendo pedal with only her left leg. For this reason, she needed a device that would provide a means of operating the crescendo pedal with her knee or hand.

The activator consists of two air cylinders mounted to the organ and connected with tubing. The cylinders are connected in such a way that the horizontal motion of one cylinder mounted under the keyboard will translate to the vertical motion of the other cylinder attached to the pedal (Fig. 5.4).

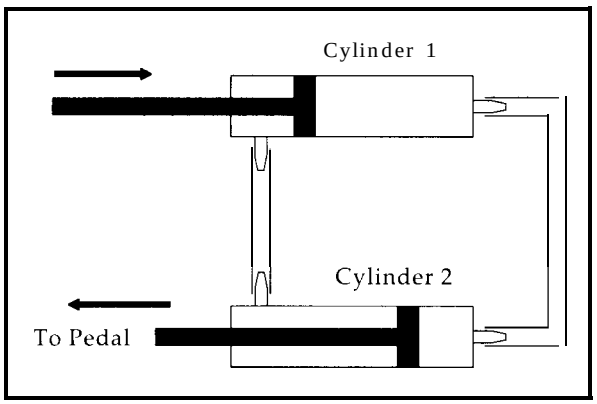


Figure 5.4. Arrangement of Air Cylinders.

## SUMMARY OF IMPACT

The assist device offers Ms. Cook a much wider range of musical expression by allowing her to control the volume of the organ at all times without interrupting the flow of music. Since it is a passive mechanical device, it does not require alteration of the electronics of the organ and can be easily disengaged or removed.

## TECHNICAL DESCRIPTION

The design requirements were: 1) it had to provide the client with a means of operating the pedal with her hand or knee; 2) it could not inhibit another person from using the organ; 3) it could not limit her left foot's normal range of motion; 4) it must be relatively inexpensive.

The activator consists of two double-acting air cylinders connected with polyurethane tubing. The air cylinders have a 1 1/16" diameter bore and a 4" stroke length. The tubing has outer and inner diameters of 3/8" and 1/4", respectively. The cylinders are connected as shown in Fig. 5.4. As the operator compresses cylinder 1, air is forced through the system causing cylinder 2 to expand, therefore depressing the pedal. This system also works in the reverse direction.

Figure 5.5. Organist with Left Hand on Handle attached to Cylinder 1.

Two cylinder mountings were designed to attach the cylinders to the organ (Fig.'s 5.5 and 5.6). Both mountings are made of 1/4" thick steel and consist of a base plate, a front plate, and two rear side plates. The base plates are 8 1/2" long. The front plates have 5/8" diameter holes drilled to allow for movement of the shaft of the cylinders. The two rear side plates are 3/8" in height and act as supports to keep the cylinders from rotating.

A bracket was designed to attach the mounting of cylinder 2 to an inside panel of the organ (Fig. 5.6). This bracket is made of 1/4" steel and has a pin that passes through it and the two rear plates of the cylinder mounting. This pin allows the cylinder to pivot to compensate for the arc movement of the pedal. The bracket is attached to a vertical wooden panel inside the organ with wood screws. Cylinder 2 is attached to the pedal with a hinged clamp. Air release valves were placed in the air line to allow others to play the organ without the device in use. The total cost of the project was approximately $115.

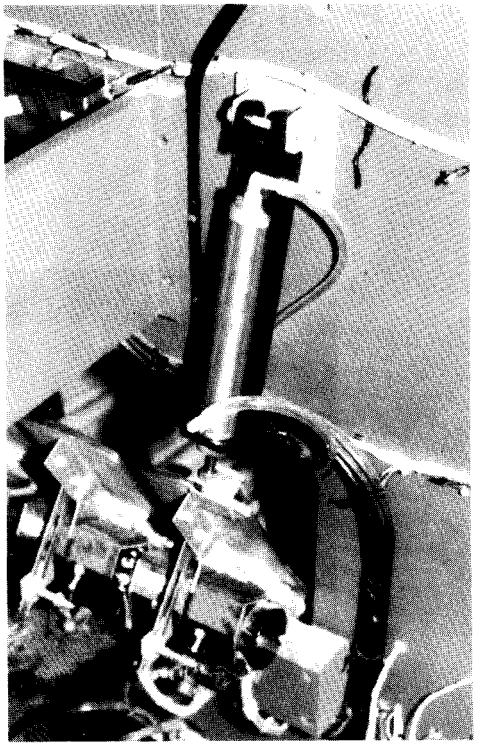

Figure 5.6. Mounting for Air Cylinder 2.

# Automatic Page Turner

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## INTRODUCTION

The automatic page turner was designed for use by quadriplegics with little or no control of their arms. By activating a puff switch, the user can turn a page of a book. The page turner would then automatically switch off once the page has been turned. This page turner uses a vacuum to pick up the page. This approach was decided upon due to the problems experienced by users of page turners that employ padded rollers to turn the page. The padded rollers occasionally slip or turn two pages instead of one. That frustrating problem is solved by the use of a vacuum.

## SUMMARY OF IMPACT

The page turner was designed to be used with any type of switch. A puff switch was chosen for the prototype because the client is unable to control his arms effectively enough to operate other types of switches. Only minimal assistance would be necessary to the user once the page turner has been set up with a book in place. The design allows the pages to be turned in only one direction. However, since no more than one page would be turned at a time unlike some other page turners, this should not pose a problem with most books.

## TECHNICAL DESCRIPTION

The page turner can be used with books of a wide range of sizes. The maximum open-book size is 10.5 inches high and 17 inches wide. The minimum open-book size is 5.5 inches high and 11 inches wide. Also, the book can be up to 2 inches thick. The device, as shown in Fig. 5.7, consists of a wooden base in which a motor and vacuum pump are housed and a tilted vertical support surface upon which the book is rested.

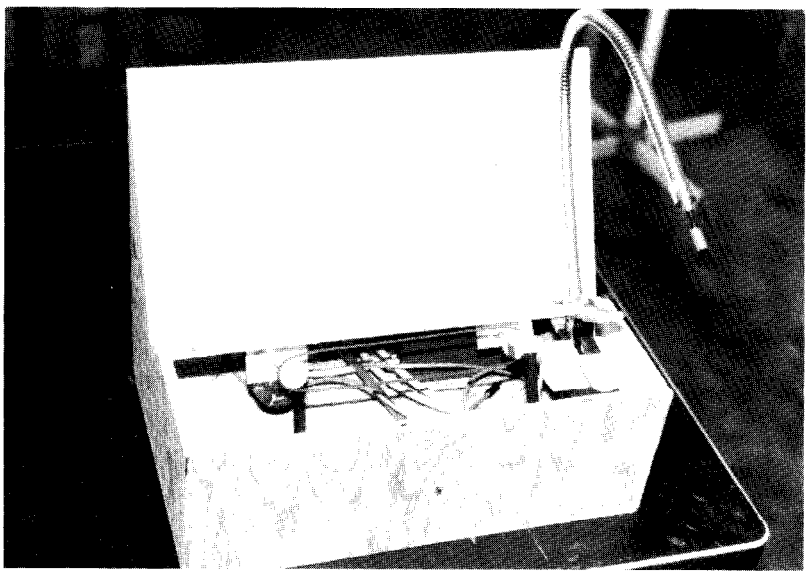

Figure 5.7. The Page Turner in the Construction Phase.

When switched on by a puff from the puff switch, a vacuum tube, resting on a pivot, is used to lift the page. The end of the vacuum tube lowers onto the page. (Fig. 5.8 schematically depicts the bellows and pump arrangement.) Once the suction cup at the end of the vacuum tube makes contact with the page, a vacuum is created by the vacuum pump. At this time a bellows connected to the

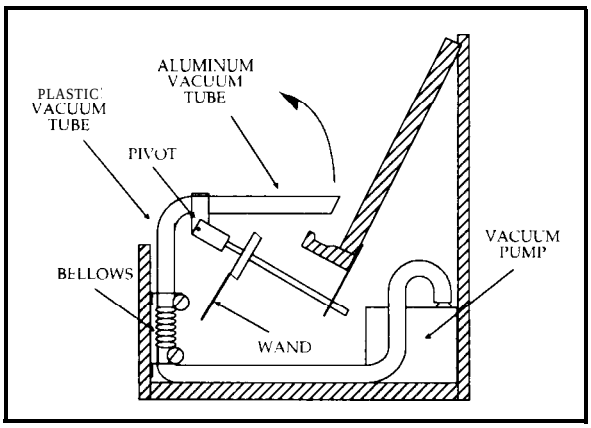


Figure 5.8. Side View of Page Turner, Showing Bellows and Vacuum Pump.

vacuum tube compresses. This causes the end of vacuum tube attached to the page to pivot up. At the same time, a motor attached to the left sprocket turns on. This causes the track below the base of the book to move. Attached to this track are page-turning wands. One wand moves under the page and moves the page to the left, pulling the page from under the vacuum tube to the other side. Once the page has been turned, the wands trigger a limit switch that turns the page turner off. This stops the wands in a position ready to begin turning another page. Four wands are attached to the track. Two wands opposite each other on the track are used to turn pages. The other two wands (which are placed just after each of the page-turning wands) are used to hold the newly turned page in place. Once the page turner has turned off, the bellows expands back to its original height. This causes the end of the vacuum tube to pivot back down onto the next page. Now the page turner is in position to turn the next page. The electronics controlling the action of the device is shown in Fig. 5.9.

To hold the book in the proper position, large bands connected to the book base are used. The book cover is simply slipped under each of the bands. The book base is tilted at a 60 degree angle to allow easier reading for the customer who is confined to bed. The case and book base are constructed of plywood. The pivot for the vacuum tube is attached to an aluminum plate which attaches to the right side panel of the case. The track arrangement is attached to a large aluminum plate (angled at 60 degrees) which is attached to the base of the case.

The automatic page turner costs four hundred forty dollars ($440) to build. Unfortunately, the prototype was not completed due to time constraints and various technical problems.

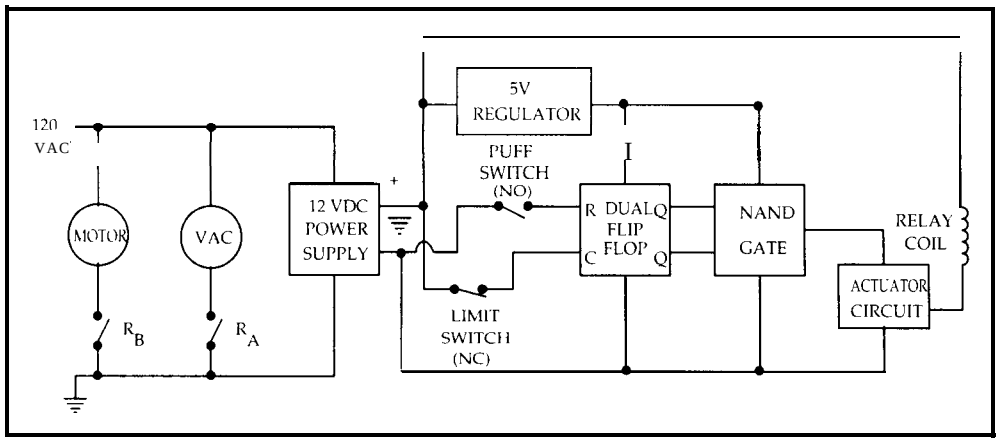


Figure 5.9. Schematic of the Control Electronics.

# A Sandwich Holding Device for Quadriplegics

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## INTRODUCTION

A lightweight mechanical device was designed and constructed to assist a C5 quadriplegic with limited arm control in the eating of sandwiches. A prototype was fabricated of 8 mm thick Plexiglas. The device fits over the wrist of the quadriplegic and allows him to clamp a sandwich of variable thickness in place and advance it as the front part of the sandwich is eaten. Advancement of the sandwich is accomplished by lightly bumping the back of the ratcheted advancing mechanism to push the sandwich forward in 14 mm steps.

The design criteria for the sandwich holding device were: a. must be able to hold a sandwich and advance it with some input from the disabled person, b. must be lightweight, c. must be washable, d. must not wear out or break in the period of one year, and e. must be relatively inexpensive. Based on the above criteria, a prototype was made out of 8 mm thick Plexiglas (Fig. 5.10) so that all of the design criteria were met with the possible exception of "d" that relates to its durability. Although the Plexiglas prototype will not wear out, it could very possibly be broken if dropped from table height. With this in mind, the final recommendation will be to machine the final device out of a solid block of nylon.

## SUMMARY OF IMPACT

At an initial meeting of biological engineering students and a group of disabled students, one quadriplegic expressed a desire to be able to independently eat submarine sandwiches. He had always liked sandwiches because he could balance them on his lower arm and eat them without much assistance. He did, however, have a problem with the sandwich inevitably falling off in the process of eating it. His desire was to be able to secure the sandwich to his wrist so that he could eat the whole thing without it falling and without any assistance once the sandwich was in place. This project thus began with the purpose to solve the sandwich-balancing problem for this one student with the idea that other individuals with similar disabilities

Figure 5.10. Prototype Sandwich Holder with a Sandwich in Place. The wing-nuts adjust the top plate and provide any needed compression to the sandwich.

would also benefit.

It has been estimated that 150,000 persons in the U.S.A. suffer from quadriplegia. A large number of these individuals would be able to benefit from a feeding aid like the one developed. In addition to this population, a large number of cerebral palsy and muscular dystrophy patients could also benefit from the device. Thus, there would be considerable potential demand for this aid.

## TECHNICAL DESCRIPTION

Simplicity of operation was a major consideration in developing the final design. Since the individual for which it was designed has some arm motion, it was decided that the advancement of the sandwich in the holder could be controlled by the user. Thus, a ratchet-type advancing mechanism was chosen so that slight bumping of the end would advance the blade and sandwich. This is shown schematically in Fig. 5.11.

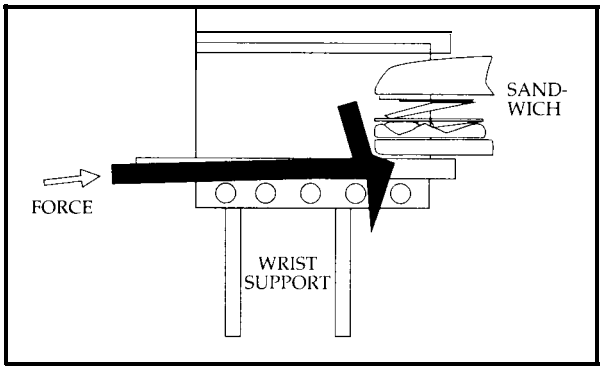


Figure 5.11. Schematic of the Sandwich Holding Device from the Side. The part shown in black is the advancing mechanism that pushes the sandwich forward.

When a force is applied to the end of the advancing mechanism, shown in black in Fig. 5.11, the bottom of the piece moves up and over one of the five 8 mm diameter rods along the bottom. These rods are spaced 14 mm apart. Not shown in Fig. 5.11 is a rubber band attached to the advancing mechanism to keep it pulled down and against the rods. There is also a top plate that can be used to compress the top of the sandwich.

The completed prototype is pictured in Fig. 5.10 with a sandwich in place. The device has two parallel plates attached to the bottom so that it can slip over the arm of the user, near the wrist. The prototype was custom fit to the arm of the particular individual for which it was made. The wrist support plates are shown in Fig. 5.10. The Plexiglas pieces were bonded together with a solvent. The total weight of the device, as constructed of Plexiglas, was 4.6 N. The material costs were under $25 and there was approximately two hours of shop labor in the cutting of the parts and their assembly. The final device will be machined out of a 5 cm thick block of nylon. The weight of the device will change less than 10%. The material cost of the nylon model will be somewhere close to $90, and at least four or five man-hours in the shop will be required to machine it.