CHAPTER 4
MERCER UNIVERSITY

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Navigational System for the Blind

Designers: Mike Smith, Dave McCrory, Jack Shaw
Client Coordinator: Queenie Broast; Georgia Academyfor the Blind
Supervising Professor: Dr. Edward M. O'Brien
Department of Electrical and Computer Engineering
Mercer University School of Engineering
Macon, GA 31207

INTRODUCTION

Our Navigational System for the Blind (NSB) was designed in response to a specific need presented to us by the Georgia Academy for the Blind. In addition to being non-sighted, a group of students is also hindered in their movement between locations by an inability to commit to memory the paths to those locations. These students require a guide every place they go, they have no independence and place an enormous burden on an already undermanned staff. In developing an electronic system to help lessen the student's dependence on a guide, we were asked to incorporate music, in the form of a radio or tape player, into the solution. Because all students like to listen to music, the staff believed that this approach would be best accepted.

SUMMARY OF IMPACT

For the student with poor map making skills, the NSB provides an infrared pathway to a desired location. As delivered, the NSB is configured for three discrete locations; the girls' bathroom, the boys' bathroom and the kindergarten classroom. After testing the NSB with several students and because of the system's ease of use, the staff at the academy believe that the NSB will allow them to dedicate more of their time to teaching students and that the NSB will, more importantly, give the students a measure of independence and a feeling of accomplishment.

TECHNICAL DESCRIPTION

Our design includes two complete systems. Each system includes a transmitter pair, receiver, personal portable radio, headset and detector module, which is mounted on top of the headset. The transmitter and receiver circuit schematics are shown in Fig.'s 4.1 and 4.2, respectively. The transmitters are wired as time-multiplexed directional pairs, with one direction being from the classroom to one of the bathrooms and the other, from that bathroom back to the classroom. A transmitter pair is defined as being both the classroom and bathroom transmitters for either the boys or the girls. The transmitters were mounted above the doorways of the rooms close to the ceiling and each pair of transmitters emits two different time-multiplexed signals, one for the bathroom and the other for the classroom. The transmitter signal creates an infrared pathway from the classroom to the respective bathroom and back. The presence of a detector module in line with the infrared pathway, will allow the receiver to detect the signal and turn a personal music source on as a means of communicating to the student that he or she is on the desired path. However, once the student strays from the infrared pathway, the receiver will detect this, power will be removed (from the headset only) and the music will stop until the student is once again on the correct path. A half-second off delay is included in the receiver circuitry to allow for short periods of time when the signal is off because of signal multiplexing or physical blockage of the infrared signal.

The detector module is mounted on the headset and hardwired to the receiver that supplies its power. The headset is plugged into the receiver that is in turn plugged into the personal music source. The headset is switched by the receiver but with the exception of that switch, draws no current from it. The two receivers are each powered by a single 9 volt battery and the four transmitters are powered in pairs by a 120/9 volt adapter that can be plugged into a standard wall outlet. The system has a maximum range of about 65 feet between transmitters and receiver and this range may be increased via the use of higher power LED's and/or better optics. The cost of the system, (4) transmitters, (2) receivers, (2) radios w/headsets and detector modules, was $193.00.

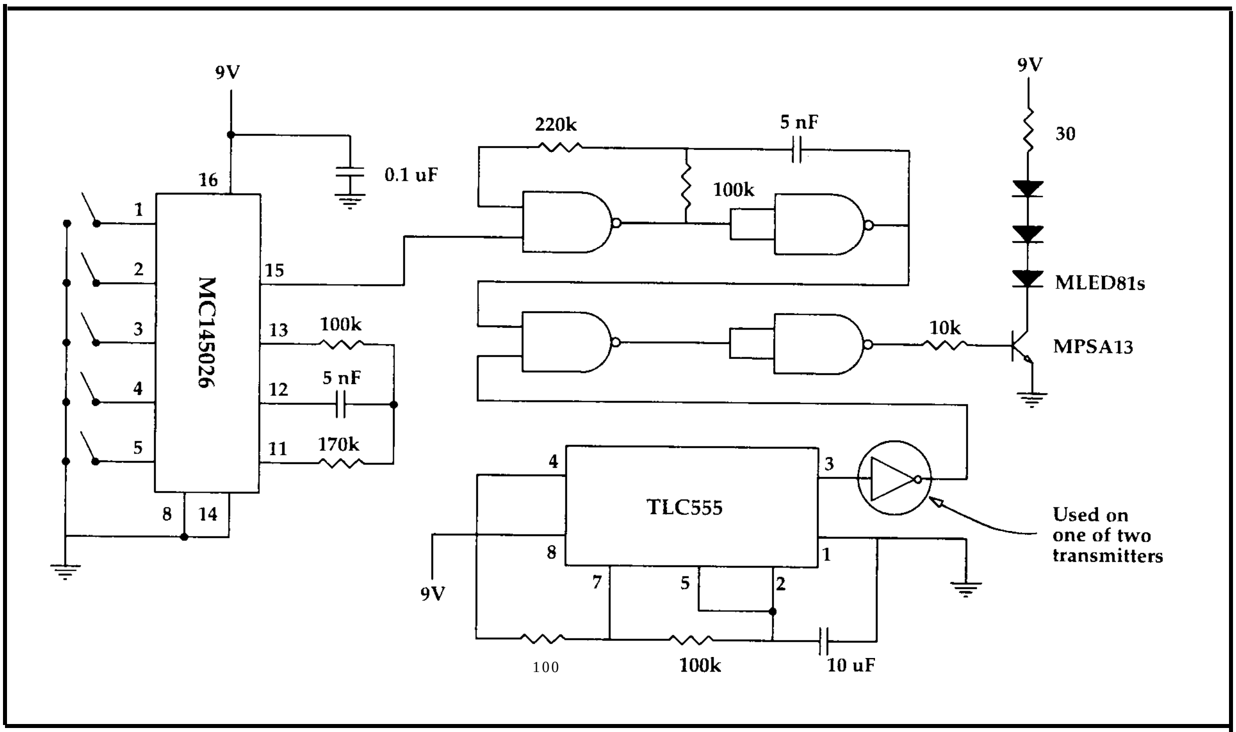

Figure 4.1. Transmitter Schematic.

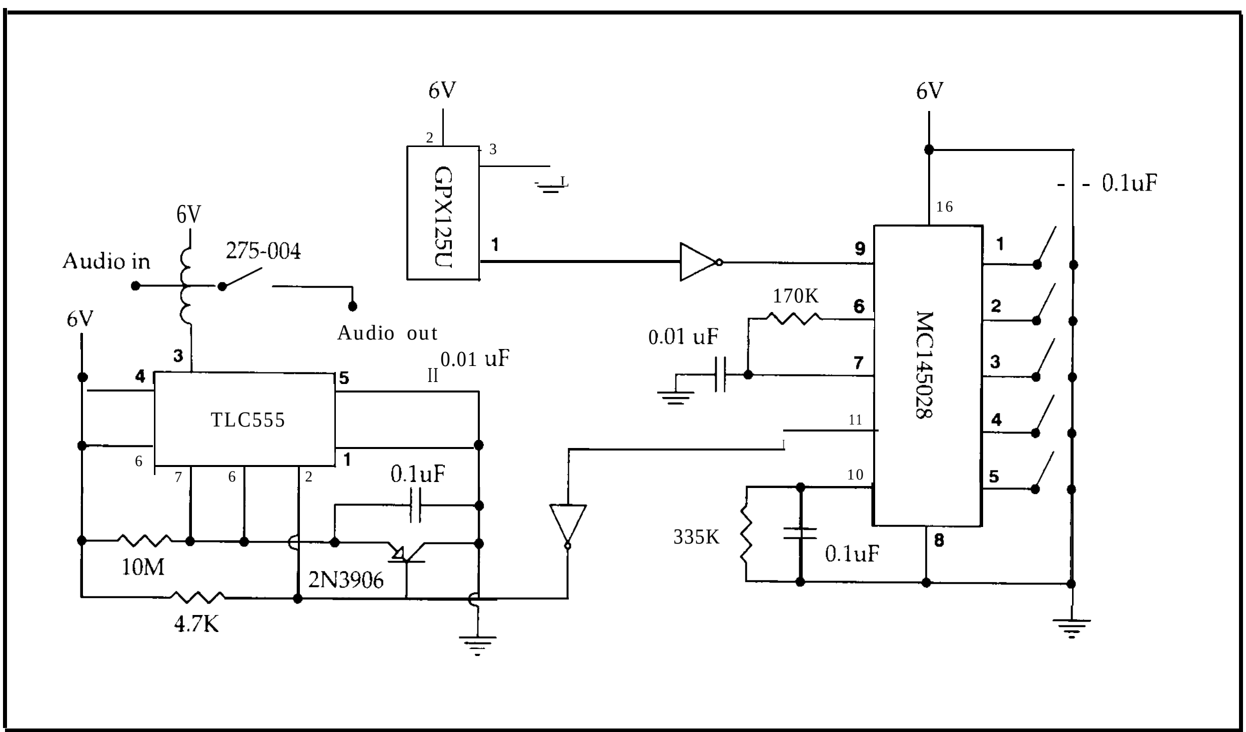

Figure 4.2. Receiver Schematic,

Adjustable Foot Stand for an Electric Wheelchair

Designers: Norman Encarnacion, Darrell Redden
Client Coordinator: Brenda Banks
Supervising Professor: Dr. Robert Gray
Department of Biomedical Engineering
Mercer University
Macon, Georgia 31207

INTRODUCTION

The adjustable foot stand is designed to allow paraplegics the ability to custom fit the foot stand on their wheelchairs to their legs. The foot stand is targeted at adult paraplegics that only have use of one arm and experience spasms in their leg(s). The foot stand is equipped with padding and Velcro straps to provide comfort and restraint to the user's leg(s); the leg supports are affixed to a sliding pin locking mechanism to allow the user easy adjustability.

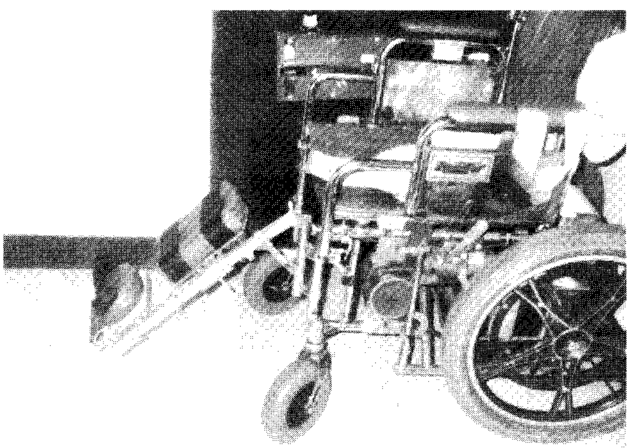

Figure 4.3. Picture of the Foot Stand Connected to Client's Wheel Chair.

SUMMARY OF IMPACT

The adjustable foot stand was designed to relieve three main problems – (1) poor circulation caused by the rigidity of present foot stand adjustments, (2) discomfort caused by the firmness of the supports (lack of pads), (3) injury caused when spasms vibrate the leg off of the foot stand.

To remedy these problems, the adjustable foot stand was designed to be adjustable with just one arm. It also includes contoured pads and Velcro restraints (Fig. 4.3). The adjustable foot stand has three primary adjustments capable of independent movement: the upper leg support adjustment, the main shaft length adjustment, and the lower leg support adjustment. There is also one dependent adjustment, that being the ability for the upper leg panel to rotate at ±10° angles on a shaft perpendicular to the main shaft.

TECHNICAL DESCRIPTION

The design of the adjustable foot stand can be divided into five principal areas: the upper leg support, the lower leg support, the main shaft, the pads, and the Velcro restraints. A detailed drawing of the foot stand is shown in Fig. 4.4.

The upper leg support was equipped with both a sliding length adjustment and rotational adjustment to allow for better circulation through the upper leg. The upper support is capable of a net two-inch length adjustment along the main shaft. This allows the user to reposition the upper leg support to relieve any pressure points that may occur. The ±10° angle rotation increases the circulation through the upper leg by allowing the user's upper leg to be positioned ergonomically relative to the lower leg and pelvic areas.

The lower leg support like the upper leg support was equipped with a one-inch sliding length adjustment along the main shaft. Similarly, this adjustment can be used to relieve pressure points and increase the circulation through the user's foot. The length of the main shaft can be increased by 1.0 inch. This increase in length of the foot stand allows for better circulation from the upper to the lower leg.

All panels of the upper and lower supports were padded. The padding increases the user's comfort and decreases the rate at which pressure points occur. Velcro straps were also attached to the pads as a means of allowing the user to restrain his/her leg to prevent any injury to his/her leg during violent spasmatic movements of the leg.

A variety of materials and parts were used to construct the foot stand. The main shaft, the upper and lower leg support, the locking mechanisms, and the pins were constructed with 2024-T3 aluminum. The contoured pads were constructed with foam.

The material used to cover the contoured pads was vinyl fabric. The material used to restrain the leg(s) was Velcro. Elastic cords were used to keep the pins from falling to the floor. A stainless steel piano hinge was used on the lower leg support of the adjustable foot stand for light weight and to allow the lower leg support to flip up out of the way when entering and exiting the wheelchair.

The total cost of the adjustable foot stand prototype was $162.14.

A human acceptance test, in the form of a questionnaire, was evaluated to see how our client accepted the prototype. The results of this test confirmed that our client was quite pleased with the prototype.

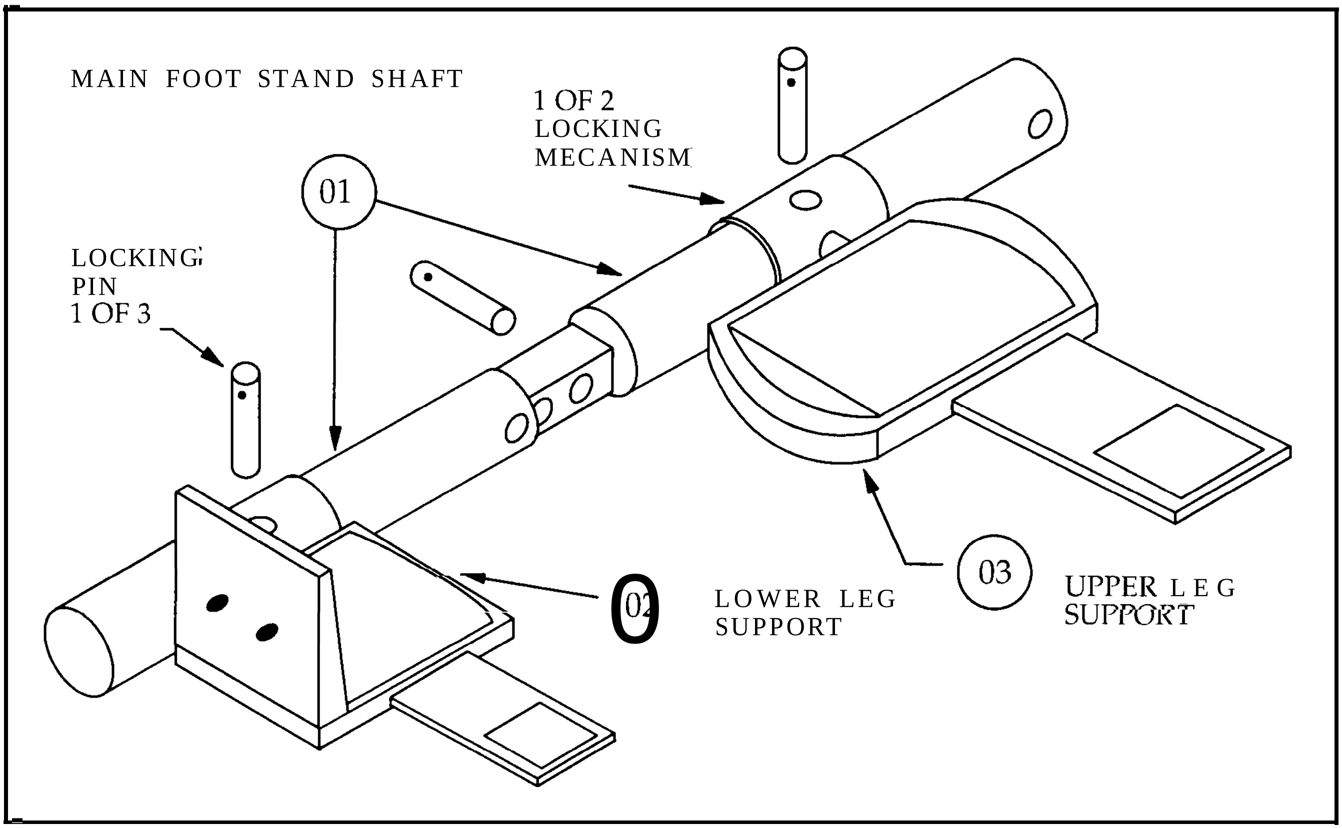

Figure 4.4. Drawing of Foot Stand.

Cerebral Palsy Muscle Trainer

Designers: Barry F. Hollis, Joel Baker, Ken Rountree
Client Coordinator: Joan Radicker, Bibb County Schools
Supervising Professor: Dr. *Edward O'Brien*
Assembly Advisor: Tom Hisel, Mercer University
Mercer University School of Engineering
Macon, Ga. 31207

INTRODUCTION

Cerebral Palsy is caused mainly by perinatal asphyxia, a lack of oxygen to the brain during birth. The resulting brain damage usually affects the child's muscle control. Some of the more difficult motions for the child are midline body motions, that is, left to right hand or arm movement. This would clearly affect the child's ability to write. The Cerebral Palsy Muscle Trainer is designed to help re-educate the arm muscles of a child with Cerebral Palsy to move in such a manner.

SUMMARY OF IMPACT

The Cerebral Palsy Muscle Trainer is a device that will help children afflicted with Cerebral Palsy to train their arm muscles that cause midline body motion, the same muscles used when writing. A child using the device is forced to follow a template from the left to the right side of the device. Several templates are used to ensure that a child does not become acclimated to one specific path. A braking system, which can be disengaged, is incorporated into the design so that a child can only move his/her arm from left to right. A signalling device offers the child some positive reinforcement when he/she reaches the end of a pattern.

TECHNICAL DESCRIPTION

The frame and mechanical parts of the design are built mainly of a high density plastic. This material was chosen due to its strength, cost, weight and ease of fabrication. The unit looks similar to a drafting table that is able to sit upon a table or desk top. The base of the unit (.375" x 23.5" x 18.75") and templates (.375" x 18" x 22") are constructed from sheets of the high density plastic. The templates have different patterns cut out of them and are mounted to the front of the unit with four small bolts that can be tightened and loosened by hand. As the child's skill increases, the more complex patterns can be placed on the unit. Rubber feet are attached to each corner of the base to prevent movement of the unit during operation. Only four wheels (1.25" diameter) are needed for horizontal movement of the vertical bar. Two wheels on each end of the vertical bar (1" x 20.5" x 4") move along two parallel horizontal bars (1" x 1" x 20.25"; .25" x 1" x 20.25") to cause horizontal movement of the device. When the vertical bar reaches the end of the pattern it will trigger a momentary switch (Radio Shack #275-609) which will in turn activate an electronic chime (Radio Shack #273-071). The chime, which is powered by a 9-volt battery, will go through two cycles and then shut itself off. This entire signalling unit was placed on the frame of the device to signal the completion of a cycle and provide a positive response to the user. The handle bolt is attached to a square piece of plastic that will slide in the vertical bar to allow vertical movement. To prevent the vertical bar from backward motion during operation, rubber stops on the end of a lever are attached to the vertical bar.

The total material cost of the unit was $210.

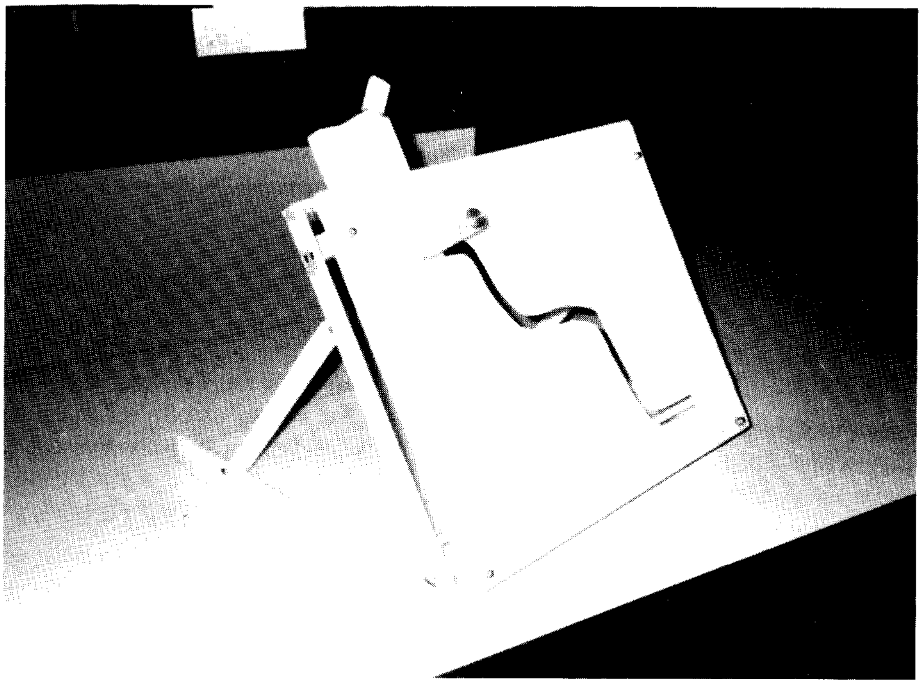

Figure 4.5. Front View of the Trainer.

Figure 4.6. Back View of the Trainer.

The Drop Ball Game

Designers: Kristi Phillips and Anthony Wheel
Client Coordinator: Joan Radikar
Supervising Professors: Dr. Edward O'Brien and Dr. Robert Rozett
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INTRODUCTION

The drop ball game is a wooden, box-like unit meant for use by elementary school children. The purpose of the drop ball game is to both monitor and improve the motor skills (hand-eye coordination) of handicapped children. The game's three wooden balls are dropped down a calibrated wooden dowel into a wooden base. The instructor drops the ball from a pre-determined height with the intent for the child to catch it. If the ball is missed, it will proceed down the dowel to a bell mounted to the base. This bell serves as a signal for both the instructor and the student that the ball has been missed. When not in use, the dowel can be taken out of the base and the balls can be stored in the base of the game.

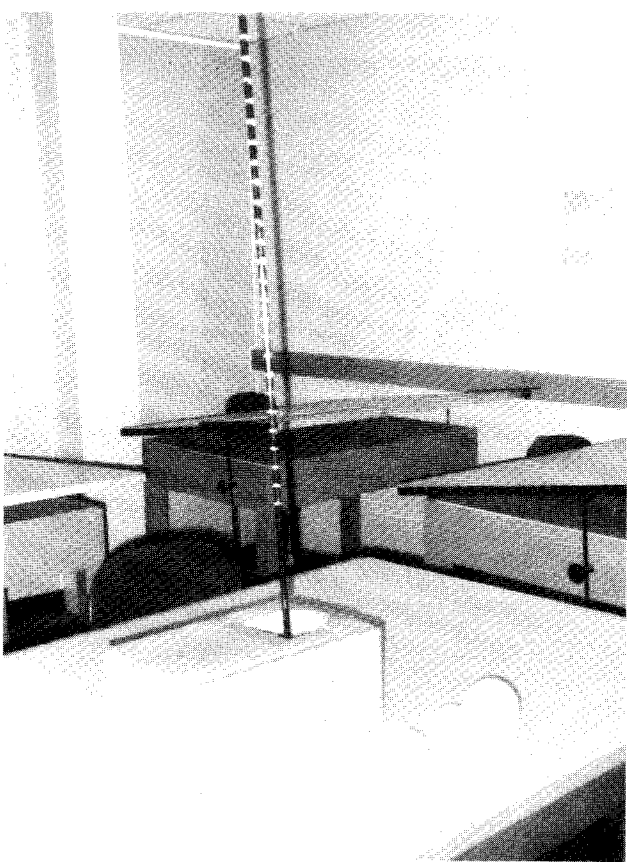

Figure 4.7. Picture of the Drop Ball Game.

SUMMARY OF IMPACT

As stated before the drop ball game can be used to evaluate and monitor the motor skills of handicapped children. To accommodate this the spheres used in the game are of varying sizes. Each size has a certain function. The largest ball is 3" in diameter, and is to be caught with two hands. The smallest ball is 2" in diameter and is meant to be caught with one hand. The third ball is 2 1/2" in diameter. This ball serves to bridge the gap between the largest and smallest balls. In addition to the balls, the game's dowel rod can also be used to monitor a child's progress. Twenty-five inches of the thirty-six inch dowel are marked. This allows the instructor to use varying heights of the ball depending on the child.

TECHNICAL DESCRIPTION

The drop ball game is of 3/4" pine construction with dimensions of 12"x81/2"x51/2" with the dowel removed. The weight is approximately 5 pounds. A drawing of the game is shown in Fig. 4.8. As seen in the Fig. 4.8, two cavities are formed by a center board. One of the cavities houses the bell and dowel base assembly while the other accommodates the three wooden balls and the springs the game uses as recoil mechanisms. A cover is slid into 1/2" grooves on both sides of the assembly, keeping the unit self-contained. The game is fastened together with internal 1/4" dowels. This provides a flush surface and unmarred external appearance. The exterior of the game is stained then covered with child-safe shellac. The dowel is black with white markings, while the balls are white and yellow, providing high contrast. All paints are lead free for children's safety.

The signal mechanism is provided by a desktop call bell mounted to the base of the game. Flush to the bell is the base for the 3/8" dowel. This is constructed from high impact plastic and, like the bell, is fastened to the base with screws. The top of the dowel base is covered with self-adhesive foam to provide protection as well as a recoil mechanism for the balls. The purpose of this recoil mechanism is to allow only limited contact between the smallest ball and the bell. Thus acoustic quality is enhanced. The two larger balls use a 3/4"x3/4" spring for a recoil mechanism.

The dowel extends from this base through a hole large enough to accommodate all three spheres. Around the hole are self-adhesive felt strips. This gives the child a sensory indicator of where their hands should be prior to the release of the ball.

The parts cost of the game was thirty-four ($34.00) dollars.

Testing was conducted at the T.D. Tinsely Elementary school in Macon, Georgia. The children who played the game were disabled and between five and eight years old. After the first attempts, the children seemed to respond to the game very positively.

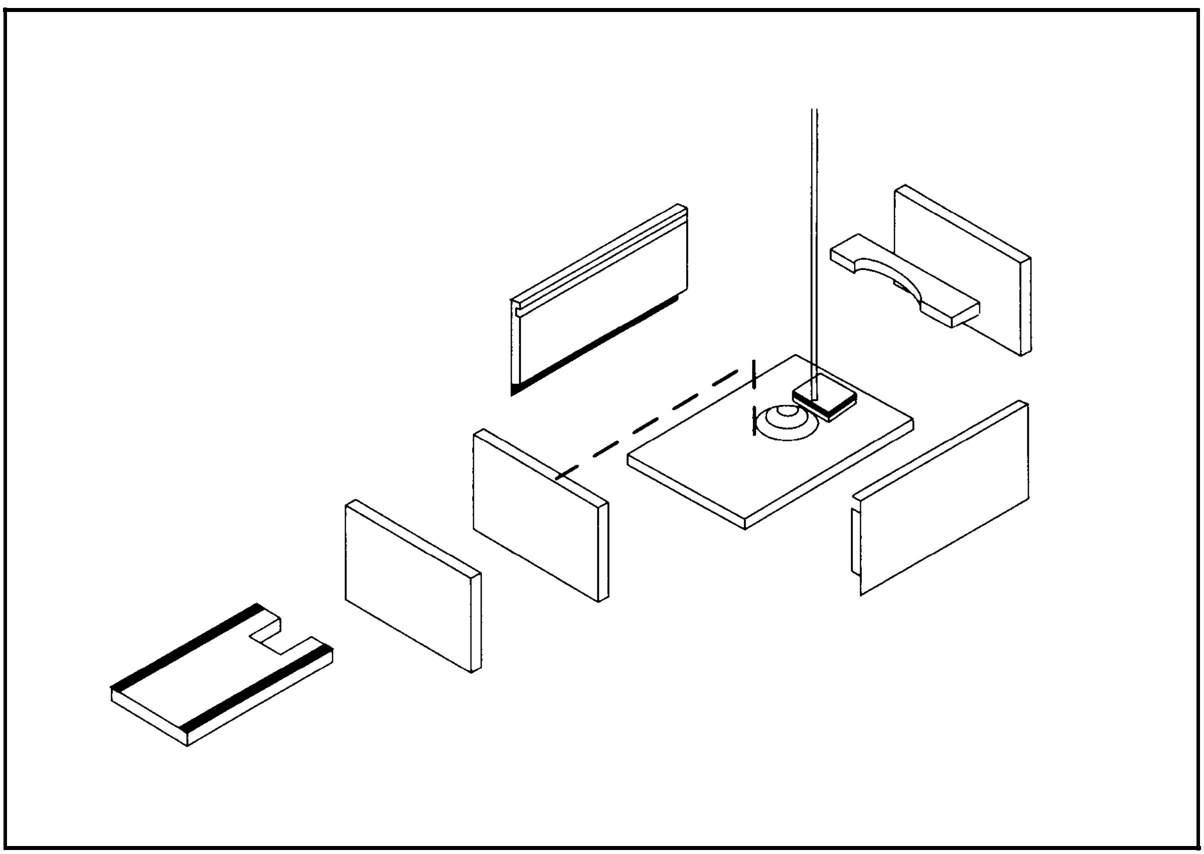

Figure 4.8. Exploded View of the Drop Ball Game.

Ping-Pong Paddle Game

Designers: Dominiquie S. Tardif, Kristin Herrick, Tyson Long
Client Coordinator: Joan Radicker
Bibb County School System
Supervising Professor: Dr. Edward M. O'Brien
Department of Electrical and Computer Engineering
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INTRODUCTION

The exercising of motor skills for physically challenged children plays a vital part in their development. Games and activities employed to strengthen their body must be devised in such a way that the students will not lose interest. Many games have already been developed thanks to the creativity of teachers and the skills of many handymen. However, some games do not always live up to their expectations or perform in the intended manner. Improvements must frequently be made on already existing skill-developing games. The client coordinator had a paddle game that she had constructed. The game consisted of a board with slight front-to-back incline. A target plate at the back edge of the board had been installed along with the addition of side panels, to keep the ball in the game. A movable paddle set on side rails was used to hit the ball through "mouse hole" openings in the target plate. The incline kept the ball in play. The main problem with the game was that the paddles would easily come off the rails due to the spastic movements of some of the children. The client coordinator also wished that the inclination of the board could be changed, that different target plates could be installed. Each plate would have a different hole shape to keep the interest of children plus different shapes and sizes of holes could make the game more challenging for the more adept children. The coordinator also wanted to be able to vary the resistance of the paddle that was to be designed for two hand operation.

SUMMARY OF IMPACT

This game can be used by the client coordinator to help children who experience motor control difficulty. Children who suffer from Cerebral Palsy especially have problems controlling their muscles and exercising hand-eye coordination. By using this game, children, in a fun and exciting way, can improve their muscle control without the frustration of having the paddle separate from the game. Also as their skill level improves they can be challenged by increasing the slop of the game board, decreasing the size of the target holes, and by varying the resistance that it takes to move the paddles.

TECHNICAL DESCRIPTION

The final version of the game is shown in Fig.'s 4.9 and 4.10. Fig. 4.9 shows the back side of the game and Fig. 4.10 shows the game from the front. The game was made from varnished hardwood to increase the durability of the game and to prevent the surface from denting easily. The playing surface could be elevated by adjusting the two threaded rods shown in Fig. 4.9. The rods have rubber pieces on bottom to keep the game from marring the supporting surface. The rods are threaded into nuts that are counter sunk into the playing board. The rods are approximately 7 inches long. Thus they protrude through the playing board and help stabilize the target boards which have holes drilled in them to accommodate the rods. The target boards are also stabilized by dado cuts in the side boards. Three target boards are shown in the figures. Notice that the sizes of the holes vary to make the game more challenging. The paddle was designed to not disengage from the game even with vigorous play. This was accomplished by the railing system shown in the figures and the "L" shape of the paddle. The variable resistance of the paddle was accomplished by attaching an appropriate number of rubber bands to the handles of the paddle. The other ends of the bands are attached to nails that were driven into the end of the playing board and through vertical holes that had been drilled in the rear edge of the playing surface. These holes are covered by the paddle in both figures. The large bottom surface of the paddle cause an unacceptable amount of friction. This was reduced to a very low value by the application of a dry silicon spray to the playing surface and the bottom of the paddle.

The game was tested with the client children who reacted with great enthusiasm to the improved version of the game. The paddle did not become disengaged. The height of the game and the resistive tension of the paddle were easily adjusted by the client coordinator.

The total cost of the project was approximately $60.00.

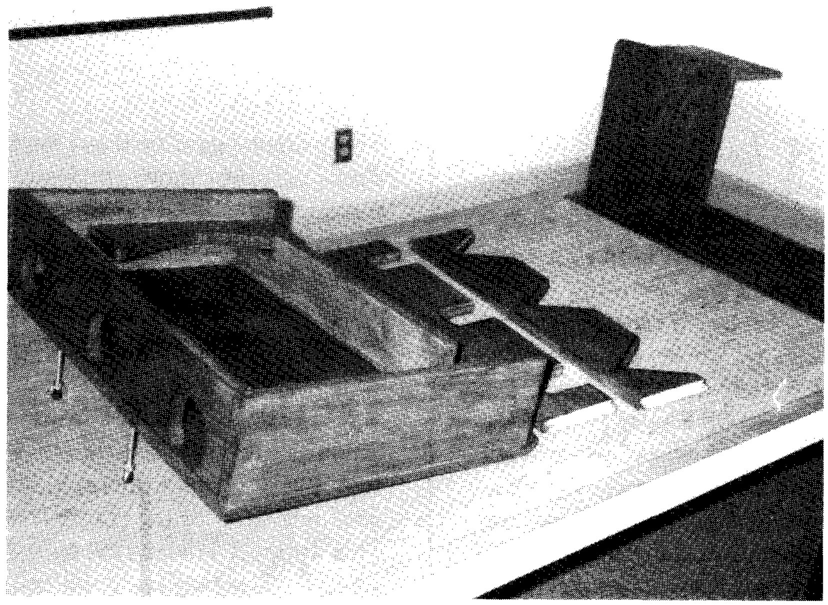

Figure 4.9. Back Side View of the Ping-Pong Paddle Game.

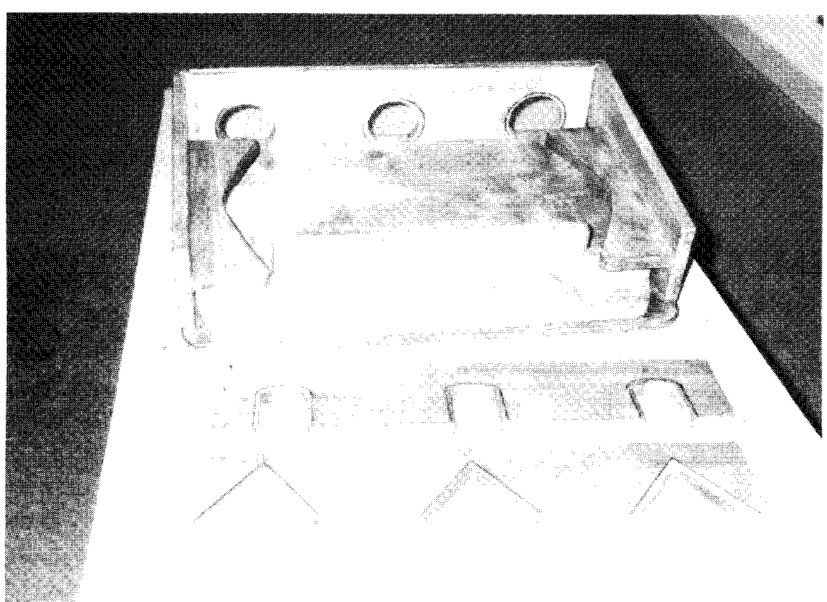

Figure 4.10. Front Side View of the Ping-Pong Paddle Game.

Turbo Scooter

Designers: Patrick Collins and Dave Mitchell
Client Coordinator: Bernadette Luce
Macon Cerebral Palsy Association
Supervising Professor: Dr. Edward M. O'Brien
Assembly Advisor: Tom Hisel
Department of Electrical and Computer Engineering
Mercer University
Macon, GA 31207

INTRODUCTION

The "TURBO Scooter" is a therapeutical device designed for children of ages 1 to 2.5 years. The device is specifically designed for children suffering from cerebral palsy, Downs syndrome, or other conditions leading to under-developed motor control movements. The goal for the scooter is to help the children strengthen and control their neck muscles. The child lays face downward on this self-propelled device. However, it will only move when their heads are held up. This provides positive reinforcement to hold their heads up. The motion control is achieved by a spring-loaded headrest on the inclined portion of the scooter. Allowing the headrest to rise closes a circuit, and engages a "Power Wheels" motor and transmission. This device will help small children gain greater control over responsive neck and head movements. Conveniently located straps secure the child to the device, protecting them from falling off while using the device. Enhancement of the general strength is expected, plus hours of enjoyment, from use of the Turbo Scooter.

SUMMARY OF IMPACT

The Turbo Scooter was designed for the therapist of a local development center for handicapped children. The center is primarily a day care facility modified to the special needs of the clientele. The center basically attempts to help the children with their motor movements and general muscle control. A large percentage of the children at the center suffer from cerebral palsy. These children go through phases of dull, slow motion inter-mingled with spurts of nearly violent jerking motions. Cerebral palsy children, in general, have extremely poor control over muscles in the neck area.

The primary goal of this scooter is to help the children achieve more normal motor control and movement. By supporting the child's trunk and partially supporting their head, the children are allowed to focus on just holding their head erect. They are encouraged to hold their head up by the motion of the scooter.

TECHNICAL DESCRIPTION

Square aluminum tubing is welded together for the two piece frame construction and a plastic sheet covers the top of the frame for support of the child. This support is attached to the frame by four steel screws. The two rectangular frames are connected by four interlocking joints, which are adjustable up to $1\frac{1}{2}$ inches. Four ball-bearing mounted casters complete the basic framework of the Turbo Scooter. The upper frame is inclined approximately 10 degrees for comfort and improved vision. A limited support chin rest is mounted on the upper frame as a triggering device. The lower frame houses all of the drive and power apparatus. Within the confined space of the lower frame is a 6-volt Power Wheels battery, a Power Wheels motor and gearing mechanism, and a drive wheel we had to manufacture because of size limitations. The drive wheel is made of solid aluminum with plastic adapters for the drive shaft. The wheel is covered with rubber tread. The square drive shaft passes through lubricated brass bushings that are welded into the frame. The drive wheel extends down slightly lower than the casters to prevent slipping. There is a main power switch at the rear of the device and another switch under the headrest at the front. The main power switch can be used by the therapist to deactivate the scooter at any time. The headrest is mounted on a hinge so the normally-on switch will create an open circuit when the headrest is depressed. A resistor is used to control the speed of the device. The extensive gearing in the transmission act as very effective brakes when the motor is not powered. Fig.'s 4.11 and 4.12 show the right and left sides of the scooter.

The operation of the device is quite simple. First, with the main power switch off, the child is placed on the device and strapped to it using the harness. The child should be positioned so that their chin rests on the plastic headrest. Now, the main power switch can be turned on. If the child's chin pushes down on the headrest, the device will not move. When the child raises his or her head, the motor will be engaged and the device will begin to move.

The only parts expected to undergo considerable wear are the plastic gears and the motor because it will operate at high speeds. All other parts should last for hundreds of hours of operation. The total length is 15.38 inches. The height at the front is 8.50 inches and the height at the back is 7.38 inches. One inch square tubing is used for the frame. The radius of the drive wheel is 2.25 inches and the plastic casters have radii of 0.59 inches.

The final product meets all the criteria set by our client and the design may be adapted for use in other applications. Further improvements, such as a small bell, can be used to further stimulate the child.

The motor, battery, and charger were $56. The total cost of the prototype was $182.98.

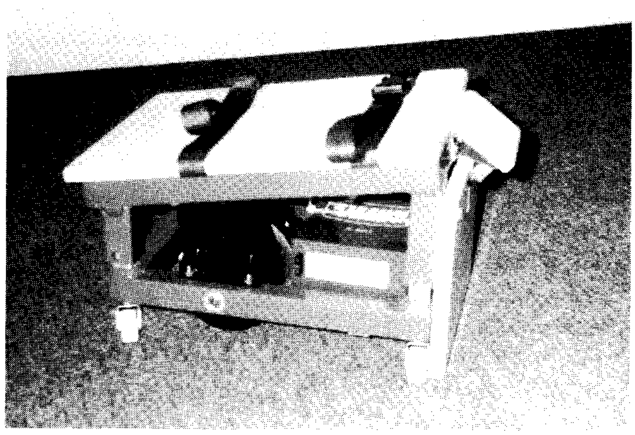

Figure 4.11. Right side picture of the Turbo Scooter.

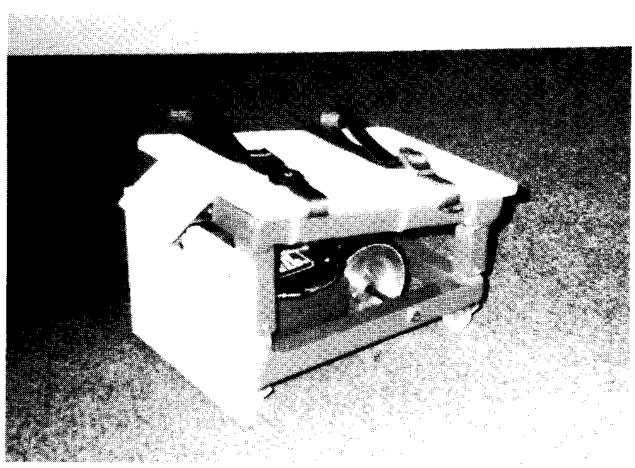

Figure 4.12. Left side picture of the Turbo Scooter.

Rotary Infant Bed

Designers: Carmen Kavali, Firas Mourtada, and Joseph Yancey
Client Coordinator: Bernadette Luce
Macon Cerebral Palsy Association
Supervising Professor: Dr. Edward O'Brien
Department of Electrical and Computer Engineering
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INTRODUCTION

A bed was designed, constructed, and tested that will substitute for an ordinary bed for cerebral palsy infants and children in the Cerebral Palsy Center in Macon, Georgia. The bed is not for sleeping; instead, it is to provide a safe daytime support for a child. It would alleviate the need to manually turn the child every twenty minutes. Rotary beds are commercially available but they cost about $28,000 and rent for nearly $125 per day. These costs were prohibitive for the Cerebral Palsy Center.

SUMMARY OF IMPACT

A normal healthy person will change positions approximately every 11.6 minutes. A person unable to turn himself or herself often enough will be risk of developing complications from immobility, including pressure sores, pneumonia, and muscle atrophy. Some children with cerebral palsy lack the motor ability to turn themselves at a healthy physiological rate; therefore, the therapist or parent must reposition the child about every twenty minutes.

TECHNICAL DESCRIPTION

The bed was designed to maintain the child resting on one side for a period of about 20 minutes, then be positioned on his/her back for 10 minutes, and then positioned on the alternate side for a period of about 20 minutes. The process was then to be repeated in the opposite direction. The rate of rotation was a very slow 1.5" per second.

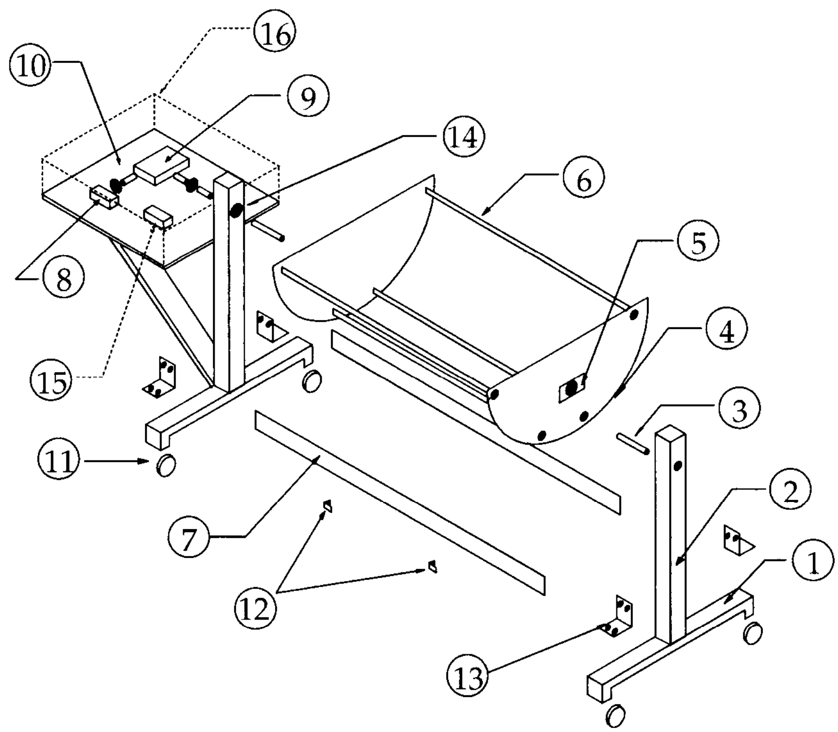
The exact configuration of the bed can be seen in Fig. 4.13 that shows an exploded view of the bed. As can be seen from the figure, the bed was crescent shaped. The rotation angle was limited to ± 50" from horizontal. This limited angle of rotation, plus restraining bars (not shown in the Fig. 4.13) at the edge of each side of the bed, plus Velcro straps to secure the child to the mattress assure that the child will not fall out of the bed. The motor, which turns the bed, is an AC gear motor that is coupled to a 50:1 speed reducing transmission. The transmission has a worm gear in it. This assures that the bed will not rotate when the motor is off. A spider coupling attaches the bed to the transmission shaft. The frame was made out of 2x4 lumber painted with nontoxic latex. The ends of the bed (part 4 in the figure) were made from 1/2 inch high density polyethylene. The two end pieces were joined by six l-inch diameter aluminum rods. A piece of 3/16 inch thermoplastic was affixed to these bars and provided the support for the mattress. The mattress was a l-inch piece of foam that had a vinyl cover. The Velcro straps to hold the child were securely stitched to the vinyl cover. A special pillow was designed to help relieve any stress on the child's neck.

Electrical safety of the child and attendants is assured in several ways. The spider coupler connecting the bed shaft to the transmission is made from nonconductive rubber. All electrical components are mounted on a wooden shelf and are covered with a Plexiglas box. A hospital grade power cord and plug also help assure patient safety.

The electrical control of the motor was accomplished with a 555 timer connected as an oscillator. The twenty minute intervals and the ten minute interval were determined by counting the changes in the output of the oscillator. At the end of the twenty minute intervals the motor was energized with its direction of rotation changed. At the end of the ten minute interval the motor was energized but its direction of rotation was kept the same as previously. The motor was turned on and off and reversed in direction via relays. The location of the bed at ± 50" and at 0" was determined by an opaque disk mounted to the bed shaft. Slots were cut in the disk.

Infrared sensors were use to detect when the slots were are at the correct position to turn the motor off.

The cost of the bed was approximately $600.



QTY	PART	DESCRIPTION
		PARTS LIST
2	1	BASE
2	2	FRAME
2	3	SHAFT
2	4	BED END PC.
2	5	FLANGE
4	6	ALUM BAR
2	7	BRACE
1	8	MOTOR
1	9	GEAR BOX
1	10	SHELF
4	11	WHEEL
4	12	SWITCH
4	13	BRACKET (L)
2	14	BEARING
1	15	CONTROL BOX
1	16	CASING

INFANT ROTARY BED

TITLE BED ASSEMBLY

SIZE	CLASS NO.	DRAWING NO.	REV.
B	EGR 485	1	

SCALE NONE SHEET 1 OF 4

Figure 4.13. Exploded View of the Rotary Infant Bed.