CHAPTER 3
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Beauty Pageant Wheelchair

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INTRODUCTION

The beauty pageant wheelchair is designed for a student currently using a wheelchair for use in the Miss Mercer Scholarship Pageant. Current wheelchairs do not allow for the occupant to look their best. The rear wheels usually extend above the legs and the back support covers a significant portion of the occupant. Also, present electric wheelchairs are too bulky and have side rails that block the viewing of the occupant. In addition, present electric wheelchairs move too fast for beauty pageant modeling. The wheelchair described in this report allows the occupant to look their best by keeping the seat level above the rear wheels, and utilizing a small back with no side rails. Also, this chair moves slowly and gracefully with no jerky movements. The footrest is designed to hold the feet together to obtain a more pleasing seating position than conventional footrests that hold the feet apart.

SUMMARY OF IMPACT

The design of this wheelchair has given a disabled student, diagnosed with spinal bifida from birth, the ability to participate in a beauty pageant more competitively.

TECHNICAL DESCRIPTION

The beauty pageant wheelchair is a modification of an outdated electric wheelchair donated by C.H. Martin Company, Inc. of Macon, GA. The arm rails of the donated frame were totally removed and the back support was shortened. A footrest assembly was added to keep the occupant's feet together.

The large motors of the donated frame were discarded. The wheelchair now uses two small 12-volt DC gear motors. Each gear motor weights 1.2 lbs and has torque of 20 in-lbs. One motor is used for each rear wheel using a direct drive system. The motors are directly coupled to the axles and are permanently fixed to the rear wheels. For forward and backward movement, both motors turn in the same direction. For spinning the wheelchair, the motors turn in opposite directions.

The controlling circuit involves the use of a donated joystick, op-amps, transistors, capacitors, and voltage regulators. The donated joystick uses two 10kΩ potentiometers for directional control. The circuit varies the voltage and polarity to the motors due to the position of the joystick. Two 12-volt motorcycle batteries (Dimensions: 2"×4"×3") supply ±12-volts to the motors. The chair accelerates smoothly and quietly during operation.

The wheelchair was covered with polyethylene. The plastic was first cut to fit around the chair. A heat gun was then used to form the plastic. The plastic was attached to the wheelchair by the use of Velcro.

The wheelchair's dimensions are approximately 23"×30"×23". The fully assembled wheelchair -weighs 70 lbs. The wheelchair was painted a neutral color (gray). The wheelchair maintains speeds between 0 and 1.5 m.p.h. With generous donations from C.H. Martin Company, Inc., the parts cost was approximately $532.

Many tests were performed to ensure the safety of the occupant. Tests included structural strength tests, tipping tests, individual component tests, and motor tests. The structural strength test was performed to ensure that the frame members were securely welded together. A tipping test was performed by having a person sit in the chair while leaning in different directions. The final chair design was shown to have no tendency to tip. The couplers connecting the motor and wheel were examined carefully to ensure they would not slip off or fracture. The motors were tested to ensure enough torque was available. Shown in Figure 3.1 is a photograph of the wheelchair.

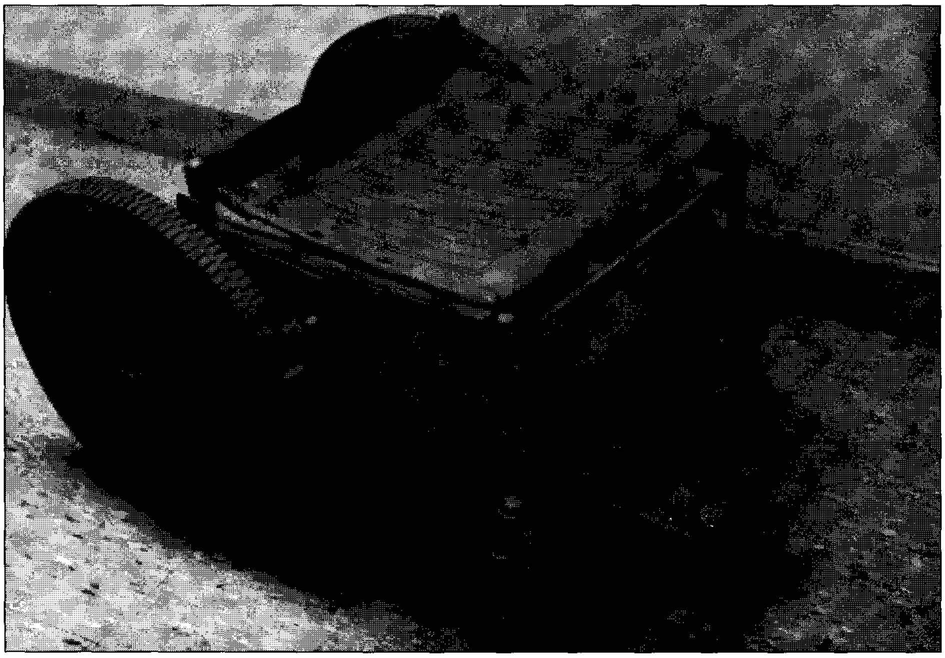

Figure 3.1, Beauty Pageant Wheelchair

Cause-Effect Feedback System

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Client Coordinator: Joan Radikar
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INTRODUCTION

The cause-effect feedback system is a device that allows severely mentally disabled children to associate responses from their environment (effects) to actions that they initiated (causes). The system is a self-contained wooden unit that provides two types of stimulus or effects to the child. The first stimulus is an auditory response and the second stimulus is a vibratory response. Both stimuli are generated instantly as the child lowers their hand onto two distinct areas of the table-top unit.

SUMMARY OF IMPACT

The feedback system is primarily used for severely mentally disabled children. The degree of disability may be so severe that the child has difficulty with basic motor skills, such as lowering his/her arm to the tabletop of the wheelchair. The unit provides two infrared areas that trigger the stimuli. An infrared area requires no force to activate the switches. The child only needs to lower his/her hand somewhere in the vicinity of the infrared area on the tabletop. The unit has a timer that stops the system. This requires constant input from the instructor to monitor the child's progress and m-activate the system.

TECHNICAL DESCRIPTION

The cause-effect feedback system is constructed of $\frac{3}{4}$" pine with overall dimensions of $14" \times 11\frac{1}{2}" \times 5\frac{1}{4}"$. The weight of the unit is approximately 7 pounds. A photograph of the system unit is shown in Figure 3.2. As seen in Figure 3.2, the unit has two large areas that are infrared activated to trigger the stimulus. The surfaces of these areas are also covered with a textured fabric to provide a tactile difference between the two sides.

The rear cabinet section contains all of the electronics, speakers, and a control panel. The major electronic subsystems that make up the system include the audio subsystem, the power supply, timer subsystem, the massager subsystem, and the infrared switching subsystem.

The audio subsystem consists of a TEAC portable cassette recorder/stereo, and two amplified speakers that plug into the audio outport of the cassette player. The sound is halted by using a relay to interrupt the signal to the speakers. A metal bracket is provided on the rear of the unit for mounting the cassette player.

Power is provided to the system unit with a 12-volt DC, l-amp AC power adapter. The audio speakers require a 9 volt input, and the cassette player requires a 6-volt input. A 7809 linear IC and a LM317T linear IC are used to step down the voltages for the audio speakers and the cassette player. The remaining components of the system utilize the 12-volt supply directly.

The timer subsystem utilizes a 555 IC configured for a 10 minute delay. The timer stops all power to the system to prevent excessive use in an uncontrolled situation. The massager was provided with a purchased AC back massager. The back massager is modified to operate with 12-volt DC supply. The infrared switches are assembled using 2 TIL41 phototransistors and 2 XC880 Infrared LED's. Switches are also provided for power, timer start, and a DPDT switch to allow the infrared areas to be reversed.

Testing of the system was conducted at T.D. Tinsley Elementary school in Macon, Georgia. The system was delivered to Tinsley Elementary on June 4, 1993. The total cost of the complete system was $200.

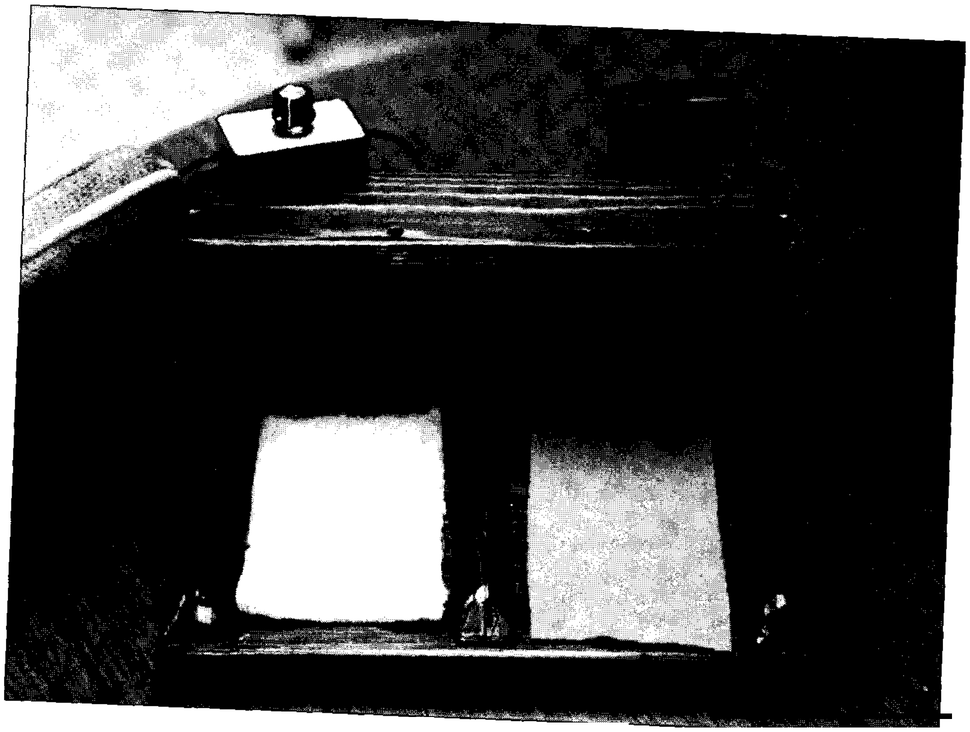

Figure 3.2. Cause-effect feedback system.

The Light Array Panel

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Introduction

The main objective of the light array panel is to enhance the ocular-motor-tracking skills of disabled children. Exercises to enhance ocular-motor-tracking teach the student to disassociate head movement with eye movement, that is, to teach them to move their eyes independent of their head's.

Summary of Impact

Two of the problems encountered while instructing the students are their short attention span and inability to read in a left-to-right fashion. The manual technique uses a rectangular piece of cardboard with an array of holes. The instructor holds the piece of cardboard in front of the student and uses a flashlight to direct the light through a hole. The student is instructed to follow the light movement from hole-to-hole in a left-to-right pattern. Once power is removed from the flashlight, the child is asked to identify the location of the last hole lit. The problems with this method include the inconsistent rate of change, the amount of light that passes through the hole due to the angle of the light beam, and the intensity of the light from the flashlight. The light array panel is an automated approach to the method currently used.

The hand-eye coordination of the students can also be developed by allowing the student to stop/start on the specified position. Also, counting can be incorporated in the student sessions.

Technical Description

The light array panel consists of the following: a power supply, timing circuit, interrupt switch, controller, output stage, and an enclosure. The light source chosen was the C-9.25 bulb and socket commonly known as a Christmas tree bulb and socket.

A 555 timer was designed as an astable multivibrator to allow the output period to equal the interval chosen by the user via the rotatory switch. The rotatory switch has three positions that correspond to one-second, two-second, and three-second intervals.

The start/stop inputs of the light array panel are user selected via a single pole double throw switch (SPDT). When the user selects the stop position, a logic 0 will be selected and turn all lights off. When the user selects the start position of the SPDT switch, the controller will begin to generate the waveforms necessary to control the output stage.

The controller of the light array panel refers to the circuitry necessary to generate the appropriate logic levels to be applied to the output stage of the design. The controller consists of the following components: three 74LS164 8-bit parallel shift registers, one inverter, one 2-input OR-gate, and one 74LS74 D-flip flop.

Each output stage of the light array panel was implemented using the following components: two TIP47 Motorola NPN bipolar transistors in a Darlington configuration, one 11 kΩ resistor, and the light source. It should be noted that twenty of these stages are necessary to meet the 4-by-5 array requirements. The transistors operate in their cutoff or saturation region (that is, operating as a switch).

The two necessary voltages for the design are a rectified 120-Vrms, and a 5-V DC. The power supply design incorporated the following components: one 1-to-l transformer, one 120-m-12.6 transformer, three 1N5400 diodes, one 7805 voltage regulator, one 4700 µF capacitor, one 0.1 µF capacitor, one MDA2502 full-wave bridge rectifier, two 1.5-A fuses, one 0.25-A fuse, and other associated hardware.

The material used to construct the enclosure panel is $\frac{1}{4}$ and $\frac{1}{2}$ inch plywood. Wood screws and glue are used to assemble the enclosure. The enclosure panel is dull black in color with dimensions 16"×20"×3". The front panel was cut so the 4x5 array of lamps are equally spaced with a distance of $1\frac{1}{2}$" edge to edge. A handle is attached to the top of the enclosure panel to increase transportability. The panel is freestanding with the option to hang if desired (see Figure 3.3 for illustration). The total cost of the complete light array panel is $273.97.

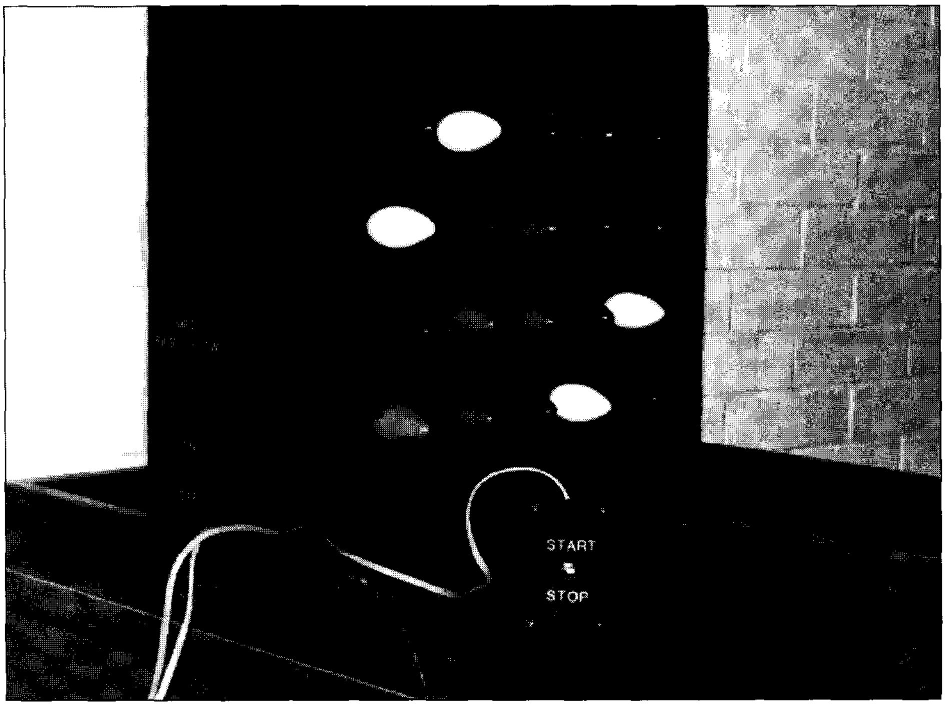

Figure 3.3. Light Panel Array.

The Motorized "Sit and Spin"

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Client: Cathy Putkowski, R.P.T.
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INTRODUCTION

The motorized "sit and spin" provides positive reinforcement for the performance of head-extension exercises by cerebral palsied children. The positive reinforcement is provided by the rotation of the platform upon which the child sits. The rotation stops immediately when the child lowers his/her head.

SUMMARY OF IMPACT

The children responded very positively to their new physical therapy device. This device is an excellent way to condition children to hold their head upright.

TECHNICAL DESCRIPTION

The top platform, which is 28" in diameter, is large enough for a child to sit "Indian style". This platform is carpeted and has a back support, as well as two arm rests with hand grips that are fabricated out of PVC pipes. The column of PVC pipe for the back support is adjustable to a minimum height of 12" and a maximum height of 18", using a bolt and wing-nut. A strap, made out of 2" nylon webbing and Velcro, is attached to the t-bar of the back support to secure the child's torso. For padding, a layer of foam covered with vinyl was used. A photograph of the device is shown in Figure 3.4.

Once the child is strapped in, the headband is placed on their head. The headband consists of two mercury switches, 1" nylon webbing and Velcro. The mercury switches are located on the side of the headband. Both switches are oriented in such a way that the child must attain the correct head position. The first switch is to detect when their head is up and the second mercury switch is needed to ensure no aspiration occurs.

When both mercury switches are activated, the platform the child is seated on rotates. The platform can rotate at 6 or 10 r.p.m.

The base houses the batteries, recharger, motor, gears and shaft. The frame of the base is composed of 2x4's and Birch plywood. One side of the base has a hinged door that will permit easy access for maintenance purposes. The device is powered by rechargeable batteries that are type H Power Wheel ® batteries, and are fused with 10 amp fuses. The motor has a full-load r.p.m. of 17 and a full-load torque of 30 m-lb. For the motor to operate at a full load, a gear ratio of 1:2 was required to ensure the platform rotated at 6 or 10 r.p.m.

The electrical system provides speed, direction, head position sensing and on/off controls for the device. These controls are in a control box, which is connected to the device via a 6' cable for safe operating distance by the therapist. The control box incorporates a circuit consisting of two 555 timers that are configured as a pulse width modulator to provide speed control for the device. A 555 timer configured in the monostable mode is triggered by a 555 timer configured in an astable mode. The pulse width modulator modulates two control voltages, 1.8 and 3.4 volts, and provides speeds of 6 and 10 rpm, respectively. Direction of rotation for the platform is provided by a switch that changes the battery polarity across the motor. Sensing of the child's head position is provided by a mercury switch configured with a transistor that turns off the control voltages at the input of the 555 timer in the monostable mode. On/off switching is provided by a rocker switch that disconnects the battery from the electrical system. A commutator, below the rotating platform, is used with the electrical system to insure that the wires from the mercury switches do not wrap around the shaft when the platform rotates. As the platform rotates with the shaft, carbon brushes brush against a copper disc providing contact with the mercury switch and the electrical system in the control box.

The overall device weighs approximately 80 pounds and costs $554.30 to fabricate.

Testing was performed at the Tinsely Elementary School in Macon, Georgia. The children responded positively to the device.

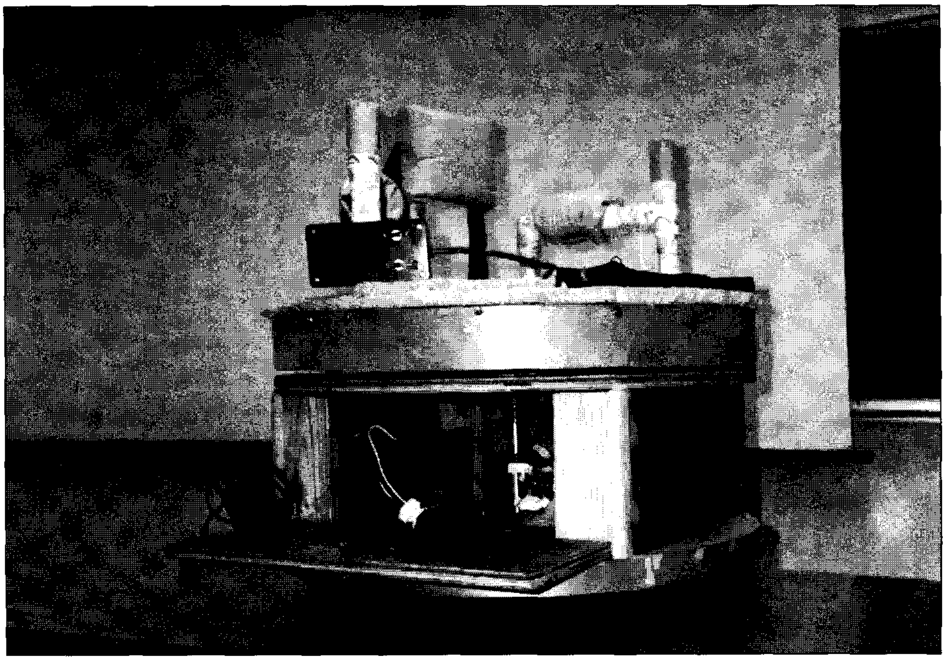

Figure 3.4. Photograph of the "Sit and Spin." The control box and head switch are resting on the top. The battery is easily seen inside the "Sit and Spin." The charging unit is resting on the interior compartment door.