CHAPTER 10
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A Silent Whistle: A Device To Help The Deaf Play Refereed Sports

Student Designer: Bonnie L. Wetzel
Client Coordinator: Dr. Salvatore Esposito, Directorfor Facilities and Special Events
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INTRODUCTION

Sports are so well integrated into our social life that many people devote considerable time participating in some way. However, physical disabilities have prevented many handicapped individuals from participating in team sports. A hearing disability can affect performance in competition since the athlete cannot hear the referee's whistle. Although deaf athletes may be physically capable in all other respects, they could be discouraged from participating. It is the author's belief that today, deaf athletes should be able to participate equally in sports with the aid of technology. Hence, a device was designed and built to assist deaf athletes.

The design integrates a microphone and a transmitter that together send a low frequency signal to a receiver worn by the athlete. When a whistle is blown, the microphone, which is mounted to the whistle, signals the transmitter to send a low frequency signal to the receiver. The receiver then actuates a vibrating motor. Hence, the athlete feels a vibration when the whistle is blown.

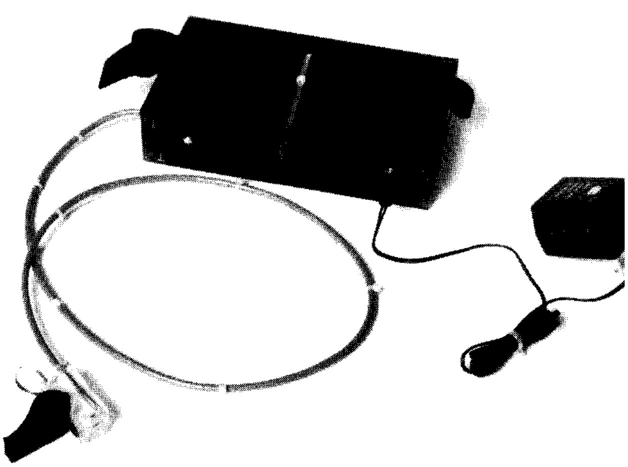

Figure 10.1. Finished Unit.

Several aspects were considered to insure the design was practical and reliable. In the selection of the transmitter and the receiver, the safety, reliability, size, weight, range, cost, and durability were considered. The aesthetics of the unit were also taken into consideration to enhance the acceptability of the device.

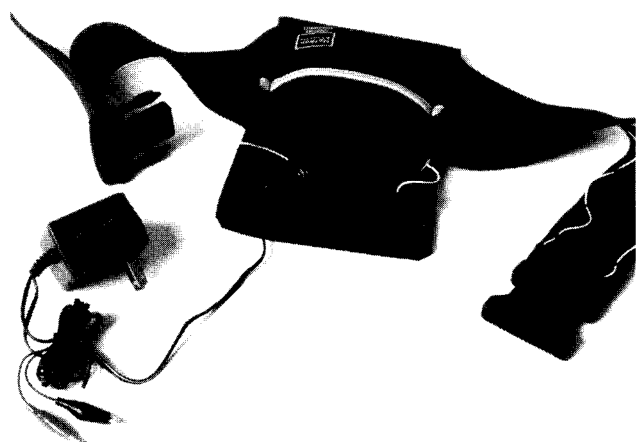

Figure 10.2. Finished Unit in Case.

SUMMARY OF IMPACT

It is hoped that the silent whistle will have a significant impact on the participation of deaf athletes in team sports by allowing these athletes to interact directly with the referee in competition. The design is intended to encourage handicapped individuals to participate more actively in sports and to inspire engineers to continue developing new assistive devices that will improve the quality of living for handicapped individuals.

TECHNICAL DESCRIPTION

The project is logically divided into two parts, namely the circuit design and the final assembly of the components. The transmitter and the receiver from a Futaba Attack-Sport digital proportional radio control unit were used in the development of the silent whistle. The Attack-Sport is a high performance two channel AM radio control unit. The operating frequency is 75.550 MHz.

The required new circuit design consisted of two parts. First, converting an audible signal from the whistle to an on/off switch in the transmitter and secondly, converting a pulse width modulated (PWM) signal in the receiver into an on/off switch. Refer to Fig. 10.3 for the schematics of the circuit.

A piezo-electric microphone and a 4.7 KΩ resistor were used to drop the 12 volt power supply to the nominal operating voltage of the microphone. A 47 μF capacitor was used to remove the ac element at the supply point to the microphone. The signal from the microphone was coupled via a 4.7 μF dc block capacitor to a 5 K potentiometer together with a 47 KΩ Darlington resistor as a gain control and a bias resistor. The Darlington transistor acts as a signal amplifier. Finally, the signal from the Darlington transistor was coupled through a 5 μF capacitor to the base of a NPN transistor that acts as a switch due to the high power drive. The sensitivity of the microphone to background noise is adjusted by rotating the shaft of the potentiometer.

In order to convert the PWM signal into an on/off switch in the receiver, a 33 μF capacitor was used to provide an average dc voltage in the circuit. The signal was directed to a 3.3 K current limiter resistor into a NPN transistor that actuates the motor. The duty cycle of the PWM signal increased from 6% with no signal to 30% with a signal. As the duty cycle is increased, the capacitor is charged. When the signal is terminated, the charge on the capacitor decays exponentially to power the transistor. A single power supply was used for the receiver and the motor to minimize space and weight.

After the circuit design was completed, the transmitter and the receiver were packaged. See Fig.'s 10.1 and 10.2. A $\frac{3}{8}$" diameter microphone was mounted in a $\frac{3}{4}$" square Plexiglas rod to protect the wires and the solder joints at the microphone from fatigue. The Plexiglas rod was milled to conform to the shape of the whistle before being solvent bonded to the whistle.

The electrical board for the transmitter, the potentiometer, and eight 1.5 volt batteries with an on/off switch were mounted in a $7\frac{1}{2}$" L x $4\frac{1}{2}$" W x $1\frac{5}{8}$" H polycarbonate case. The transmitter is worn on the referee's lower back with an adjustable Velcro belt. The board was shock mounted to minimize damage. The corners and edges of the case were rounded with a file to prevent injury.

The receiver, motor, and a 6.0 volt Ni/Cd battery with a jack and on/off switch were mounted in a separate $3\frac{3}{4}$" L x $2\frac{1}{4}$" W x 1" H case. As with the transmitter, an adjustable Velcro belt was used to strap the receiver to the athlete's waist. The receiver and the motor were cemented to the case with silicone. Special care was taken in mounting the motor to the case to allow the greatest transmission of vibration from the motor to the athlete.

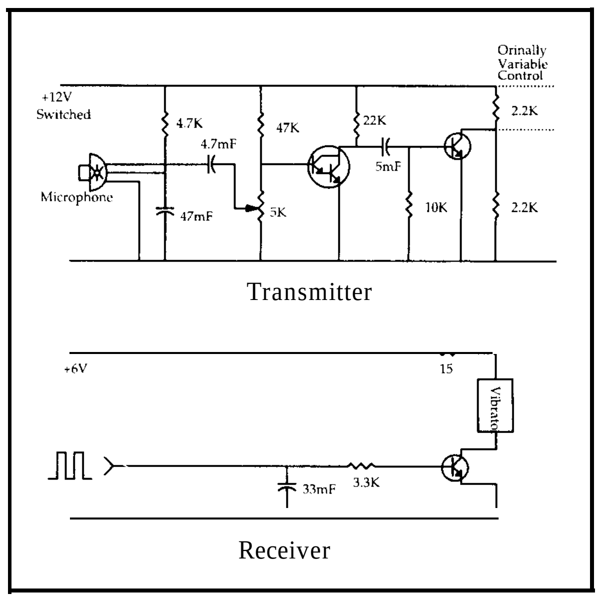

Figure 10.3. Circuit schematic

I would like to express my appreciation to Judah Wolf for his much valued work in the circuit design for the transmitter and the receiver. I would also like to thank Kenneth Peebles and Bill Macy for their assistance in machining the cases for the receiver and transmitter. Finally, I would like to acknowledge William Willerth and Roger Krupski for their valued suggestions that enabled the project to succeed in the initial stages.

The total cost of the project was $216.

A Remote Rotary Control: A Device To Turn An Oven Temperature Control Knob For The Disabled

Student Designer: Jeffrey S. Swayze
Client Coordinator: Carolyn Teeter, OTR/Erie County Medical Center
Supervising Professor: Dr. Joseph C. Mollendorf
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INTRODUCTION

This project addresses a problem that affects people with arthritis, hand or arm muscle injury, or general lack of hand strength or control. A person with such an affliction has great difficulty with the "pinching" and "twisting" motions of the hand. One result of this problem is difficulty in turning a control knob on an appliance.

Though not designed for one particular individual, the Remote Rotary Control is a device that was designed specifically for a vertical-mount oven used in a kitchen at the Occupational Therapy Department of the Erie County Medical Center(ECMC). The kitchen employs a variety of assistive devices, all used by the department to provide therapy for its patients. The benefit of this location for the Remote Rotary Control is the variety of use it will encounter.

Since the unit can only activate one control knob, the oven temperature control was chosen. With the knob at 90°, the oven is off, and as the knob is rotated clockwise, temperature is increased.

Figure 10.4. Mounted Unit.

SUMMARY OF IMPACT

The device has two components, the control unit and the motor unit. The link between the two is a modular phone cable.

The control unit is the heart of the device and contains most of the pertinent features. Most obviously, there are two sets of controls on the unit. The first is a set of two large buttons. These were designed to allow individuals with spasmodic hand or arm control to operate the appliance accurately. The second control is a two-position switch in the form of a joystick. Moving the stick left or right activates the corresponding rotation of the control knob. This control was designed to accommodate individuals with little or no digit control. By simply pressing a hand or a prosthetic against the joystick, the control can be operated.

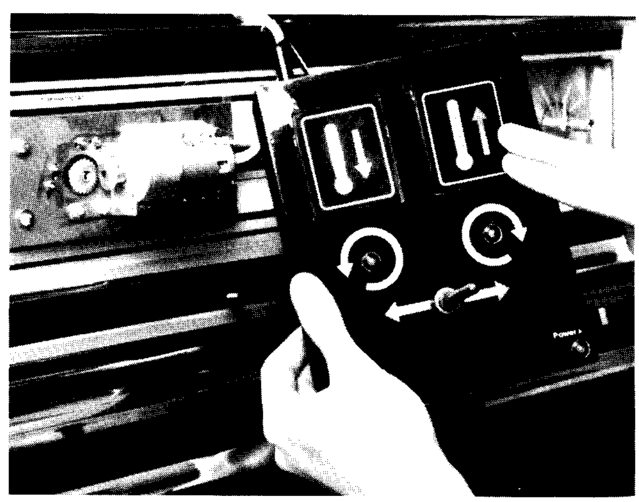

Figure 10.5. Exposed Motor.

Additionally, two jacks are located on the side of the unit. Any switch can easily be modified to interface with these jacks and therefore control the unit.

Feedback is accomplished both audibly and visually. Visually, LEDs illuminate on the display face to indicate the direction in which the knob is rotating. Audibly, relays inside the box click when the switches are activated.

The control unit was designed to allow for vertical mounting on the side of the oven enclosure with hinges, so the unit could swing out when needed and swing against the cabinet when not in use. As delivered, the unit was left unmounted to allow for portability during its use at ECMC.

TECHNICAL DESCRIPTION

Essentially, the control unit is a junction box that provides output with switchable polarity. Power comes from a 12-volt power supply that plugs into the wall and into the unit. All components (see Fig. 10.6 - Simplified Schematic) are rated at 12–volts. Relays are 4-pole double-throw.

There are two basic requirements: 1. that the motor only be allowed to travel within the range of the control, and 2. that both switches cannot be activated simultaneously. These requirements were satisfied by an excellent circuit designed by William Willerth, an electronics technician at the University. To satisfy the first requirement, limit switches were installed on the mounting plate of the motor unit.

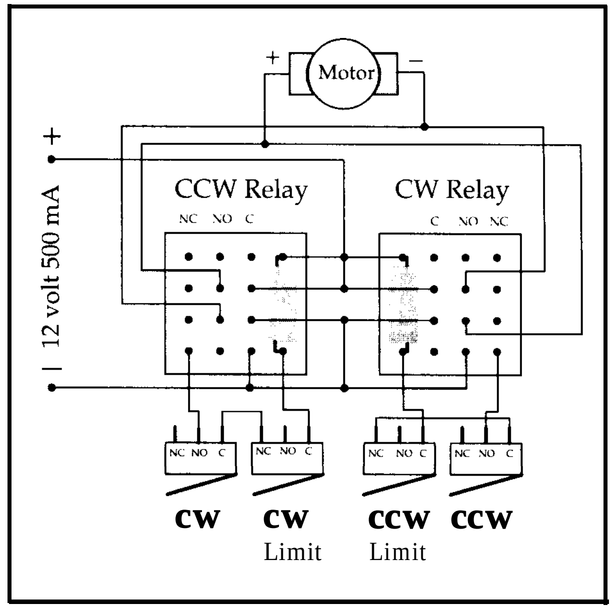

Figure 10.6. Simplified Schematic.

The motor unit consists of a 12–volt geared motor, two limit switches, a pair of bevel gears and a mounting plate. All components are attached to the mounting plate, and the plate attaches to the oven's glass face plate with suction cups. To prevent the unit from appearing bulky, it was necessary to mount the motor flush with the oven's face plate. This required the use of two 45" bevel gears to transmit the motor's shaft rotation 90" to the shaft of the control knob. A sliding enclosure covers the unit, allowing for easy access.

The Remote Rotary Control addresses a problem important to a fairly large group of people. Though there is always room for improvement, it functions properly and will surely provide ideas on which others can build. The total cost of this project was $160.

A Motorized Toy Train to be Used in Therapy

Student Designer: Renee M. Bartochowski
Client Coordinator: Christa Robach, Child Life Department, Children's Hospital of Buffalo
Supervising Professor: Dr. Joseph C. Mollendorf
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INTRODUCTION

The objective of this design project was to create a new effect device to be used in conjunction with an existing cause switch. The cause switch and corresponding effect devices will be used in therapy to help teach mentally disabled children the concept of cause and effect.

The existing cause switch, a modified Fisher-Price piano, had a modified cassette tape player as its only effect device. A desire for a collection of effect devices was expressed by Ms. Robach and Dr. Mollendorf. This project consisted of motorizing a toy train to create an additional effect device. The mechanized train is both visually and aurally entertaining. The ultimate goal of therapy is to teach the children to press and hold the correct piano key when he/she wants to activate a particular effect device.

SUMMARY OF IMPACT

The motorized train works effectively with the piano cause switch. When the proper piano key is pressed and held, the motor and contact wheel inside the enclosure adequately move the train wheels. Motion of the train wheels triggers other internal motions through a system of gears, which can easily be seen through the transparent train body. Interior gears and a plunger in the chimney of the train that creates a "toot" sound are powered by the train wheels.

The electrical components have all been enclosed in a Plexiglas housing. Enclosure of the components ensures the child's safety and prevents tampering and possible damage to the driving system. The overall design is relatively compact and easily portable. The system has also been designed to facilitate easy maintenance.

TECHNICAL DESCRIPTION

At the start of the project, some design requirements were imposed. The modified toy must be durable, compact and easily transported. Since the safety of the child is extremely important, no sharp objects, pinch points or dangling wires could exist. The train was chosen because there were no small external parts that could be lost or broken off.

Initially, the train was dismantled and studied. It was important to analyze the original power source to adequately substitute a compatible power source. The torque and speed of the original power source (a spring mechanism wound with a key) were determined to be approximately 0.5 oz-in and 140 RPM, respectively. A 12-volt DC motor was selected to obtain the desired output speed.

Ms. Robach indicated that the therapeutic toys would most likely be used on a tabletop or on the rolling tray next to a hospital bed. Due to the nature of the train, a housing support was designed to keep the train stationary. The housing allows movement of the train's components, but prohibits forward motion. This was accomplished by fabricating small risers to elevate the train off the surface of the housing, which allows free operation of the train wheels.

The store-bought toy train had two rubber tread strips on the rear wheels for traction, therefore enabling forward motion. These rubber treads are still used to cause motion. An aluminum contact wheel with knurled edge surface was fabricated and attached to the motor. Several holes were bored to lighten the wheel. The contact between the knurled surface and the rubber tread of the train wheels induces motion.

An electrical circuit containing several unique features was created by Mr. Willerth. The circuit was designed to recharge the batteries when the unit is plugged into an electrical outlet. A plug with recessed terminals and a computer cable are used. An added feature is an internal switch to transfer the system from battery to recharging mode. When the cable is inserted, an electrical switch is used to detect current and connect the batteries to the charging circuit. This switch prevents the charging circuit from draining the batteries after the plug is removed. Due to the circuit configuration, the unit will also work with the cause switch when the recharging cable is plugged in. For safety reasons, it is recommended that the train not be plugged into an electrical outlet when used in therapy sessions.

To make the housing more visually pleasing, blue opaque Plexiglas was used. Thicker pieces of clear Plexiglas were used for the side panels. Upon completion of the housing, the central compartment was left uncovered to allow viewing of the inner components. The areas containing the batteries were covered with pictures and cartoons.

The author would like to gratefully acknowledge several individuals for their assistance with this project: Mr. William Willerth for designing and constructing the electrical circuit, Mr. Kenneth Peebles for design assistance, and Mr. Roger Teagarden for his exceptional workmanship. The total cost of the project was approximately $180.

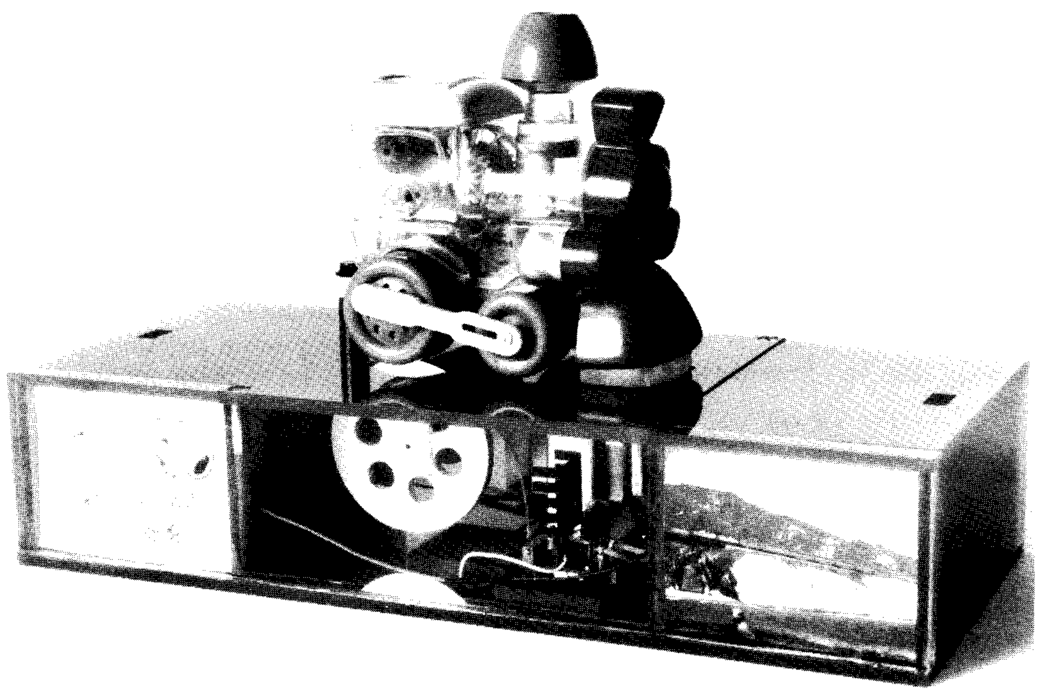

Figure 10.7. Toy Train Effect Device.

A Motorized Toy Aeroplane to be Used in Therapy

Student Designer: Stelios Zacharioudakis
Client Coordinator: Christa Robach
Child Life Department, Children's Hospital of Buffalo
Supervising Professor: Dr. Joseph C. Mollendorf
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INTRODUCTION

The objective of this project was to design and construct an effect device, that could be used with an existing cause switch.

The toy that was selected to be motorized is a pull-along plane made by Fisher-Price. Having in mind that the cause switch is going to be used in therapy to teach mentally disabled children the idea of cause and effect, the pull-along plane provides both visual and aural excitement, in order to achieve this goal.

SUMMARY OF IMPACT

The motorized pull-along plane was designed to work with a piano cause switch. When the correct piano key is depressed, the propeller and the wheels of the motorized plane rotate.

All the parts of the mechanism that are driving the pull-along plane are enclosed in a cylindrical Plexiglas housing. This was done in order to ensure the safety of the user.

One of the main concerns when the mechanism was designed was to ensure easy maintenance and durability of the different parts. Both of these two goals were achieved by making the mechanism as simple as possible and constructing the different parts from strong and durable materials. Aluminum and Plexiglas were the two major materials used in the construction of the motorized pull-along plane.

TECHNICAL DESCRIPTION

The main goal of this project was to motorize the pull-along plane. Along with this goal, there were some design requirements imposed. First the modified toy had to be powered by batteries and the batteries had to be rechargeable. Also the toy had to be easily transported, so weight was a factor. Finally, safety was the most important requirement for the design of the toy. No sharp edges, loose wires and pinch points could exist.

The first step in the design was to decide how the toy was going to be driven. It was decided to drive the propeller by driving one of the wheels of the plane and then transmitting the torque to the propeller through a shaft that already existed in the plane.

The next step was to find out exactly the torque needed to drive the plane wheel and the angular speed of the wheel. Using a lever and weights, the torque was found to be 0.015Nm. The angular speed was found to be 187 rpm.

After the motor was selected, a housing support was designed to house the motor, the batteries needed to drive the motor and the toy on the top side of the housing. Because the toy would most likely be used on a tabletop or on a rolling tray next to a hospital bed, I decided to make the housing in a cylindrical shape with height of 6 inches. The cylindrical shape was chosen so that the toy can be seen from different angles.

The torque between the motor and the wheel of the toy is transmitted through an aluminum contact wheel. In order to increase the traction between the toy wheel and the fabricated aluminum contact wheel a rubber ring was placed around the toy wheel. The contact wheel was attached on the motor shaft using a set screw.

Once the motor was installed, it was determined that the power requirements were 7.5 V, and 0.26 amp to drive the toy successfully. Knowing those requirements six "D" size, high-capacity, rechargeable batteries were selected to power the toy.

In order to recharge the batteries when the unit is plugged into an electrical outlet, Mr. Willerth designed and constructed a circuit that could perform this task together with other features. The circuit is designed in such a way that an internal electrical switch is used to detect current and connect the batteries with the charging circuit. Also this switch prevents the circuit from draining the batteries after the toy is disconnected from the electrical outlet. Although the toy does function when connected to the electrical outlet, for safety reasons it is recommended that the toy should not be used when it is recharging.

Another interesting component of the toy is the base motor. The base allows the motor to move in four directions back, forward, upwards and downwards. Those movements of the motor can be achieved by just adjusting the four screws located in the motor base.

The final product is both visually interesting and technically efficient. The way it is designed allows easy maintenance and guarantees durability and safety.

Finally I would like to gratefully acknowledge Mr. William Willerth and Mr. Kenneth Peebles for their assistance with this project.

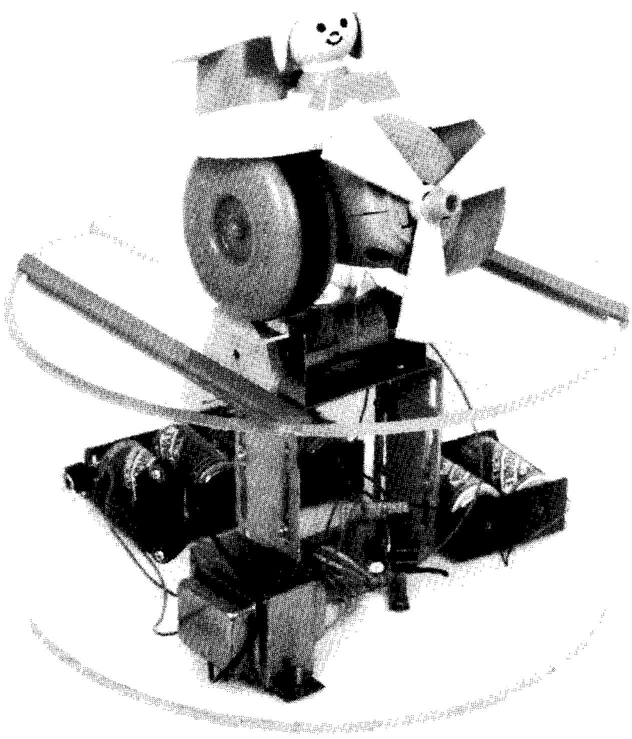

Figure 10.8 Toy Aeroplane Effect Device.

A Motorized Toy Poppity-Pop Car

Student Designer: Eleftherios Varsos
Client Coordinator: Christa Robach, Child Life Department, Children's Hospital of Buffalo
Supervising Professor: Dr. Joseph C. Mollendorf
Mechanical and Aerospace Engineering Department
State University of New York at Buffalo, Buffalo, New York, 14260

INTRODUCTION

The objective of this design project was to create a motorized device that could help mentally disabled children to comprehend the cause and effect concept.

A Fisher-Price piano miniature is used as the cause switch, but other toys could easily be used. The electrified pop-car is used as the effect device. It is exciting for the children because it combines action and sound at the same time, and it also gives the opportunity for the therapists to achieve their goal.

SUMMARY OF IMPACT

The pop-car is operated by connecting a single cord in the cause effect switch. When the appropriate piano keys are pressed and held, then the rear wheels turn causing the internal spring to move back and forth so the balls at the top of the cart pop continuously causing sound and visual entertainment. The toy is mounted at the top of a cylindrical base made from transparent Plexiglas. This enables the viewer to see the motor base and the motor itself. Also, the interior circuit can be viewed without touching it.

As a result of the design of the base, the electrical and the mechanical components are enclosed in the Plexiglas cylinder. This ensures the safety of the user and also provides an easy way of maintenance. Also, the upper side of the cylinder is designed in such a way that by sliding it in and out the service maintenance personnel can work without space constraints.

TECHNICAL DESCRIPTION

The main concern in the design of the toy was the safety of the child (user). Also, the poppity pop-car was selected because it is compact and amusing. Additionally, it does not contain external parts or complicated mechanisms that can be broken or lost easily.

After the toy was bought, it was taken apart for further study. It was important to analyze the motion that the car should attain to achieve its goals. The experimental power source we used was a spring scale attached to one of the two wheels. This experimental process had to be accurate because the torque measurement combined with the angular velocity measurement were used for the selection of the proper motor. The selected motor was small in size (3 in long), and had a maximum speed of 475 rev/min. The torque was 10 oz in at 0.708 amp of direct current.

The next step was the design of a proper base. Having in mind that the therapeutic toys would most likely be used on the top of a table or a rolling tray, the idea of the cylindrical base was very effective. The advantage of this base is that by turning it, the user could not miss the action. Also, the cylindrical base does not have any sharp edges so the possibility of injuries is reduced. The base allows the movement of the components of the toy but it does not allow any forward or backward movement. This was done by raising the toy about one inch higher than the surface of the top of the cylinder using a tubular piece of transparent Plexiglas.

The motor was mounted on a base made of aluminum. This base is designed to permit small adjustments of the motor in the up and down, and back and forth directions. Prior to the attachment of the drive disc to the motor shaft, the surface of it was knurled. For the same reason a rubber tube was used to wrap the wheel with which the disc comes in contact.

The power requirements of the project were provided by using five rechargeable "D" batteries. When the batteries are discharged, the therapist can easily plug in a single cord and recharge them without the need of replacement.

The final design of the motorized poppity pop-car accomplished the goal of this project. It is hoped that its action will be exciting for the mentally disabled children and thus can be effectively used for therapy. Also, this design can be very easily maintained and repaired when needed. The author would like to acknowledge two individuals for their assistance with this project: Mr. W. Willerth and Mr. K. Peebles.

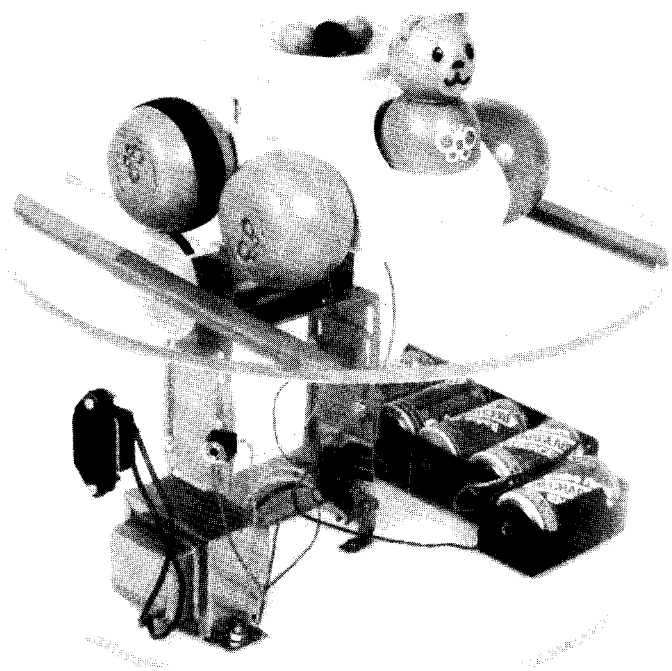

Figure 10.9. Poppity Car Effect Device.

Motorized Toy Gears

Student Designer: Pasquale V. Selvaggi
Client Coordinator: Christa Robach, Child Life Department, Children's Hospital of Buffalo
Supervising Professor: Dr. Joseph C. Mollendorf
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INTRODUCTION

Many children are mentally disabled and do not respond well to their environment. With the aid of Christa Robach, these children will undergo cause switch and effect device therapy. The main purpose of the therapy is for the children to understand that when the "cause" switch is pressed (such as a toy piano key) the "effect" device will run and when the "cause" switch is released the "effect" device will stop. Ms. Robach and Dr. Mollendorf are interested in obtaining a large collection of cause switch and effect devices. Since many effect devices are connected to a cause switch, more effect devices were needed. The objective of this design project was to modify a toy to become an effect device. A gear train toy was chosen to be modified because it contained a lot of motion to keep the child interested. The cause switch the effect device is to be connected to is a toy piano. Hopefully, this will help the children understand the concept of cause and effect.

SUMMARY OF IMPACT

The gear train effect device is the toy Busy Gears. This toy originally operated by placing a handle in any one of the gears of the gear train assembly and turning it. The toy was modified by motorizing it. Since the effect device was to be used with mentally handicapped children it was designed to be child safe. The motor and all the electrical components were enclosed in a Plexiglas case and the parts of the device that are accessible to the child were rounded and smoothed. The effect device operates on rechargeable batteries so it can be taken any place where there is not an outlet. This effect device along with other ones are connected to a cause switch (e.g. a toy piano). Each effect device is connected to a different set of keys on the piano. When the keys for an effect device are pressed, the device will run and when the keys are released, the device will stop. When the keys for the gear train effect device are pressed, the fixed gear in the center turns and causes all the other gears to turn. The benefit of this effect device compared to other ones is its ability to change. It is hoped that the different configurations of the gears will keep the child interested in the device. All the gears and wires can be stored within the device when not in use. The design of the effect device allows for easy maintenance and portability.

TECHNICAL DESCRIPTION

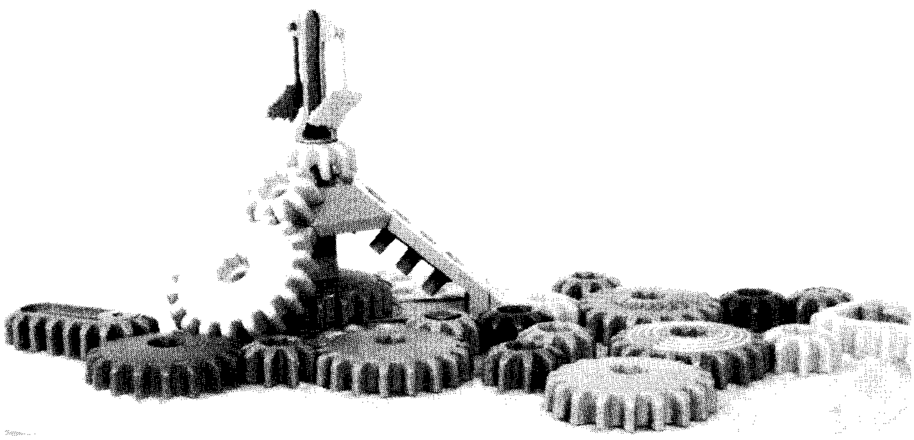
Before the toy was modified, certain general requirements had to be met. The toy had to be safe for children. There were to be no sharp edges, no electrical components accessible to the children, and no parts that could be swallowed. The toy had to operate on rechargeable batteries. The toy had to be durable, compact, easily maintained, and portable. The Busy Gears toy was chosen because all the parts are large and smooth, therefore, the children could not hurt themselves.

The first step toward modifying the Busy Gears toy entailed the studying of the motion of the toy. It was decided that a good way to motorize the toy was by fixing a gear in the center of the toy from which all the other gears could run. The torque to turn the gear and the rpm that looked appropriate was measured to be 8 oz-in and 33 rpm, respectively. A 36 volt motor was chosen with a torque of 60 oz-in and 80 rpm to allow some margin.

Since the operation of the toy is the main concern of this project, and because the toy is large, a Plexiglas case smaller than the base of the toy was designed. The toy overshadows this case giving full attention to the toy and the overall weight of the toy is decreased. The smaller case also allows for easy carrying of the toy. The case is made of clear Plexiglas with a sliding door in the rear. There are two compartments, the first compartment holds the toy gears, cord, and plug when the toy is not in use. The second compartment holds the motor, batteries, and the rest of the electrical circuit. The Plexiglas case is 16” x 18” x 4½". The components were arranged to obtain an even distribution of the weight.

The electric circuit was designed by Mr. Willerth. When the device is plugged in, the device will run and recharge the batteries, when the device is unplugged it will operate just on the batteries. The circuit also has an outlet for the connection of the cause switch. The voltage across the motor was decreased to 8.5 volt where the rpm and torque approximately matched the desired values. The device requires 6 "D" size high capacity batteries and 0.23 amps per hour to operate. High capacity batteries were chosen so the device could run approximately 18 hours before needing recharging. The device needs 14 hours to fully recharge.

The Gear Train effect device satisfied all the previously stated requirements. The final design is shown in the pictures. I would like to thank Mr. Kenneth Peebles for help in building the Plexiglas case, and Mr. William Willerth for his help in designing the electrical circuit. The total cost of the project was approximately $185.



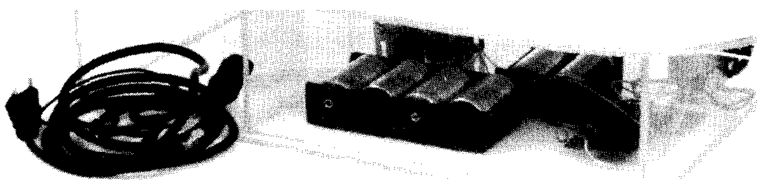


Figure 10.10. Toy Gears Effect Device.

A Trunk Supporting Walker

Student Designers: Theodore E. Powers and Erez Wolf
Client Coordinators: Judy Ragonna, Physical Therapist/North Collins Elementary
Supervising Professor: Dr. Joseph C. Mollendorf
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INTRODUCTION

Very often handicapped individuals face the fact that they cannot readily exercise all parts of their bodies. A person afflicted with cerebral palsy is usually confined to a wheelchair at a relatively young age. This confinement worsens his condition through lack of muscular stimulation. This stimulation is usually carried out manually by a physical therapist who visits the school and performs various procedures. By producing a device capable of allowing a handicapped individual to exercise independently, he or she may build up their muscles on a daily basis. The objective of this project was to allow the user to get around by himself. This will play a large role in the integration with "normal" students since he will be in a nominally standing position.

A ten-year-old child named Joe, afflicted by cerebral palsy, required a device that will allow him to walk. This device was also to provide trunk support. Joe exhibits a lack of musculoskeletal control and, therefore, requires external support while walking. This device would provide a means of exercise for Joe's legs that he would not get in a wheelchair.

No single commercially available design met the requirements for this specific individual's needs. All available products were also beyond the school's budget.

SUMMARY OF IMPACT

The walker was to exhibit various functions. The walker must provide support for the child while he walks. There must be a support that will hold his trunk at a specified angle. This angle was found to be 80 degrees from the horizontal. This trunk support should also provide lateral support. A strap was added to a contoured support to securely hold him in place.

Since walking for this individual would prove to be a tiring event, there should be a place for him to rest, When being supported upright, Joe assumes the pronated position. This problem may be alleviated by providing a "grip bar" that keeps his arms extended. This bar serves another purpose, support. Gripping this bar allows Joe greater control of his balance. The device was also to accommodate for growth, and, therefore, an adjustment for height was included in the design. This height adjustment must be easily changeable.

Finally, the device must be aesthetically appealing. One of the most important problems facing handicapped individuals is the fact that they stand out. Anything that could be done to the device to make it less conspicuous would be ideal.

TECHNICAL DESCRIPTION

The design was based on the combination of two existing designs. One existing walker provided the necessary trunk support, however, it was very unattractive and expensive ($873). The second existing walker was aesthetically appealing, but did not provide the necessary trunk support and was also expensive ($672). On the basis of these two existing designs, a CAD model was developed.

The main supporting member was constructed out of $\frac{7}{8}$" diameter steel tubing, and the base was constructed out of $1\frac{1}{2}$" diameter aluminum cylindrical tubing and 90" elbows. When it came to mobility, we obtained the highest quality ball bearing caster wheels available. It was necessary to minimize the rotational friction since the force produced by Joe would be relatively small. Conventional bicycle handle bars and bicycle neck were employed as the Grip Bar assembly. This allowed for many degrees-of-freedom for adjustments in the bar's position. The bar's location and rotation could therefore be adjusted. The knee abductor was made of Plexiglas that was heated and then molded to shape; a computer mouse pad (cut-to-shape) was used as padding.

Joe's very first attempt at using the walker was deemed a success. For the first time, Joe was capable of walking without any assistance. The physical therapist feels that Joe shows a lot of potential to make progress with the walker. Since the walker is adjustable, it would most likely be used in the future by some of the other disabled students at Joe's school.

The author would like to gratefully acknowledge the gentlemen in UB's machine shop: William Macy, Gary Olson, Kenneth Peebles, and Roger Teagarden for their invaluable input and extraordinary machining throughout the design process.

The final product is both durable and functional. We hope that it will provide Joe with many years of service. We feel that we produced this custom-made walker with as high or higher quality for less than half the cost of a commercially available product.

The cost of this project was $350.

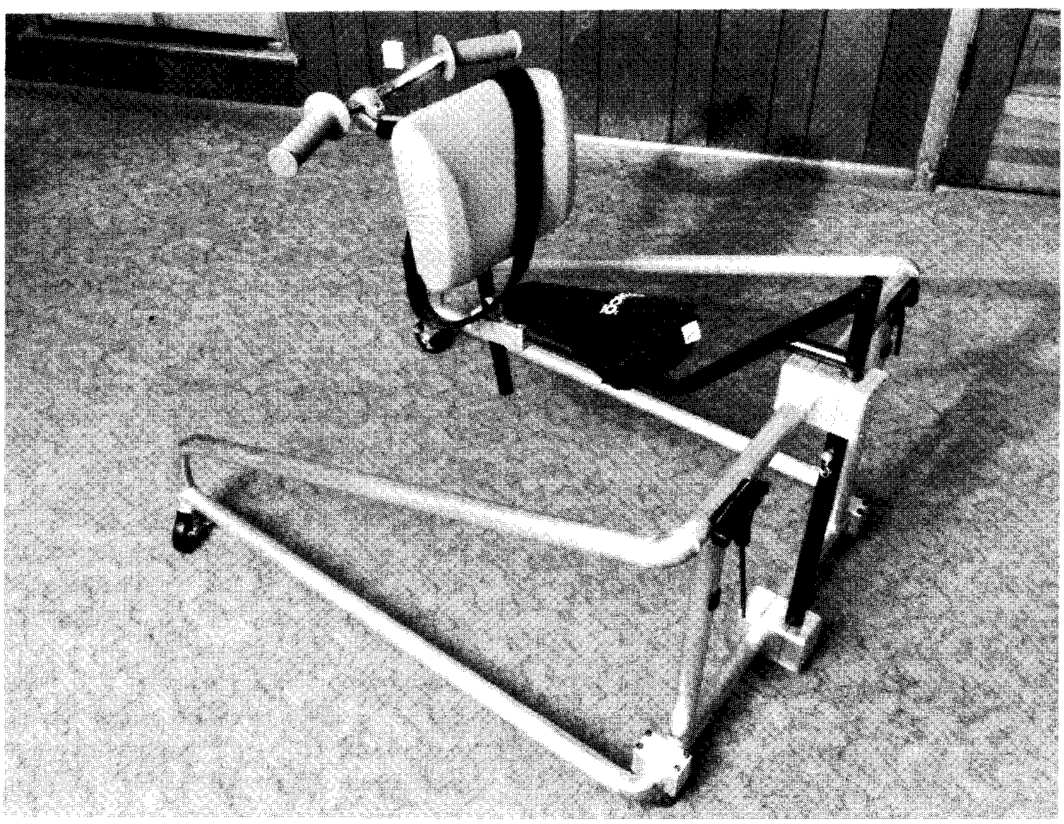

Figure 10.11. Trunk Supporting Walker.

An Infrared Remote-Controlled Electrical Light Switch

Student Designers: Parviz D. Ali, Maria Him-Ckang
Supervising Professor: Dr. Joseph C. Mollendorf
Mechanical and Aerospace Engineering Department
State University of New York at Buffalo, Buffalo, New York 14260

INTRODUCTION

This project was suggested to us by Dr. Ronald Stein. The challenge was to enable a motor-impaired person to operate a regular electric light switch with a remote control. A major challenge in doing this is packaging. The most obvious requirement involved the dimension of the circuit board to occupy the limited room available in a standard wall panel light switch box. To accommodate the reduction in size and to enable it to be compatible with a DPDT (Double Pole Double Throw) switch a relay was used in the circuit. After discussing the project with Dr. Mollendorf, it was apparent that the device had to be designed in a fashion that could be easily installed. Since the user could be a motor impaired person or not, the device was made to be operable by both the existing manual switch on the wall and the infrared remote control. Motor impaired people who can move a single limb or any other mechanical object, are (with a touch of the infrared remote control button) able to control a light switch equipped with this device.

SUMMARY OF IMPACT

After it was found that the basic system worked as expected, what remained was to make it easier to install into a wall switch panel.

TECHNICAL DESCRIPTION

The ultimate goal for this project was to create a unit that would be simple and convenient to operate. Using the appropriate infrared signal sensor, the device is able to receive a mixed signal from an infrared remote control. The “breadboard” circuit readily obtained for this purpose worked well. The problem then was to somehow scale it down. Size reduction was needed in order to replace the existing light switch panel with the newly designed device that was to be attached to a similar panel for easy installation. Faced with the problem of limited room available inside the wall-mounted light switch panel box, we were advised by Dr. Mollendorf to physically divide the circuit board into two portions. This idea worked.

Upon consulting with Dr. Mollendorf, the circuit was redesigned using the same principle but changing the components and replacing the I.C.'s with the help of Roger Krupski. After constructing the circuit and connecting it to the circuit board, it was tested. While doing so, it was kept in mind that the room available to install the circuit was very limited and that the electric switch, the wiring and the transformer took most of the available volume.

After the circuit was built, it was tuned with the transmitter and tested with an oscilloscope to ensure that it received the signal. When it was certain that the circuit worked as expected, the entire device was put into an outlet-box. A hole was made on the switch cover plate for the I.R. remote sensor. This process involved a great deal of trial-and-error in fitting the components in their respective spaces, since there were other aspects to keep in mind, along with the constraints from the electrical connecting wires.

After constructing and testing the receiver without major problems, the device proved to be successful. It was tested both at close and long ranges. The operating range was found to be about 20 feet.

The question arose that this unit might pick-up infrared signals from sources other than the transmitting device made for it. Fortunately, this problem was eliminated by tuning the receiving frequency to the mixed signal that its remote control circuit produces. It should be kept in mind though that without a proper filter, when exposed to any bright light having the possibility of infrared radiative capability, the sensor will malfunction. Attaching proper lenses to the transmitter would diffuse the beam enabling it to be more flexible to use. Using a 1 ampere 120 volt rating contact relay constrains the circuit to the load carrying capacity of 100 watts only, which could easily be modified.

The authors would like to gratefully acknowledge the help of Dr. J.C.Mollendorf, Mr. William C. Willerth and Mr. Roger Krupski.

The cost of the entire project was $35.

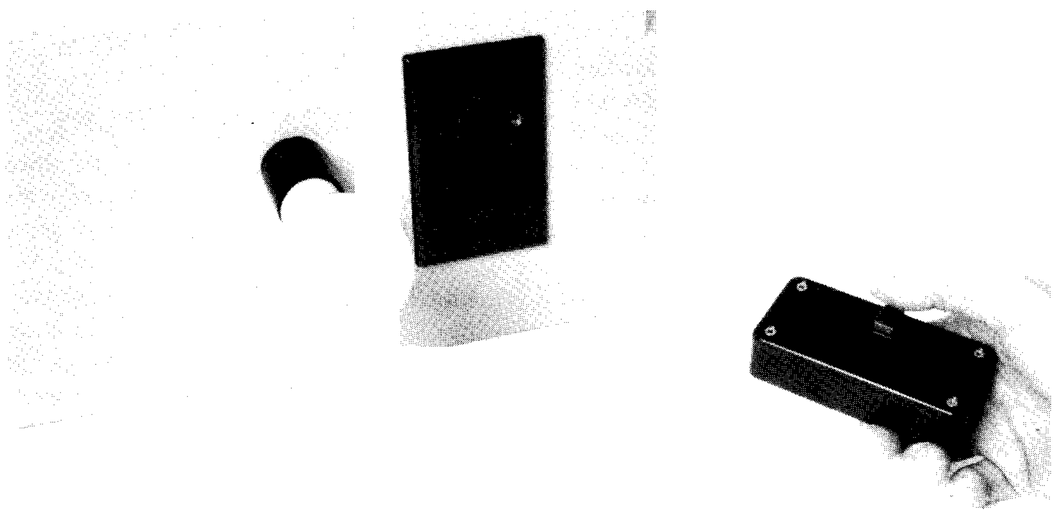

Figure 10.12. Mounted Switch And Demonstration Bulb With Infrared Remote Controller.

A Joy Stick Unit to Facilitate Hospital Remote Controllers for TV and VCR

Student Designer: Clinton Erich Smart
Client Coordinator: Lee Griffin/Recipient's Husband
Supervising Professor: Dr. Joseph C. Mollendorf
Mechanical and Aerospace Engineering Department
State University of New York at Buffalo, Buffalo, NY 14260

INTRODUCTION

Linda Griffin, the wife of Public Safety's Chairman Lee Griffin, was diagnosed with Multiple Sclerosis in the early 1980's. This disease, more commonly known as MS, strictly affects the central nervous system. Slowly, the patient's ability to control their body's motion is impeded. This condition worsens as time goes on; slowly for some, quite rapidly for others. At this time, Linda is confined to a wheelchair at Erie County Home and Infirmary. Some days, though, she is too weak to even sit in her chair and is required to stay in bed. Either way, her main source of entertainment is watching television in her private room.

One of the major problems that Linda has encountered is that she is unable to control her television or VCR with their respective remotes. The reason is not because the infra-red remote controls are defective, but because they operate by pushing fairly small buttons with one's fingers. With Linda's current condition, she does not have enough hand/finger motor skills to operate the small buttons found on almost all TV/VCR remotes. Since she can only use her right arm for controlling things, her inability presents a problem.

What the student is then presented with is a fairly simple problem. First, the student must combine both the TV and VCR remotes into a single unit. Having two different remotes is simply a complication unnecessary in Linda's life. Once accomplished, the student must then devise a method for Linda to control this single remote easily. If the remote is too difficult to operate or understand, she will not use it and the design will be a waste. Finally, once these two objectives are reached, it is necessary to create a final product that is durable enough to function properly even in case of accidental dropping or bumping -- while still being ergonomically attractive.

SUMMARY OF IMPACT

This project can be broken up into three major subsections. The first of which involves the purchasing and disassembling of a suitable universal remote. This remote must be aesthetically pleasing, functional, and alterable. From the dissection of the remote, the student learns the basic wiring of the button panel so that he can wire secondary switches in parallel. The switches, being connected in parallel, enables the remote to retain its original properties.

Once the dissection, learning, and wiring is completed, a means by which the secondary switches and universal remote can communicate is needed. In order to alleviate the possibility of this connecting bridge becoming tangled, there must be a simple way to disconnect the switches from the remote.

The second major goal is to create and/or purchase a switching system suitable for Linda Griffin's needs and abilities. Linda wants to be able to control: the power for the TV and VCR, TV channels Up and Down through the VCR's tuner, and Play and Stop on the VCR. Since the number of controls is small, it's decided that the second remote will also control the VCR's Fast Forward and Rewind controls, along with the TV's volume. These expansions should not, of course, infringe upon Linda's ability to control the other functions she desires.

Once the infrared remote is wired and the secondary switches decided upon, the third goal will be to make the system as usable for Linda Griffin as possible. This goal requires that the case be as durable as possible without being cumbersome. The case should also be oriented in such a manner so that her disability is assisted and not enhanced.

After these goals are achieved, Linda Griffin will have an easily usable infra-red remote that will control her television and VCR in her room at the Erie County Home and Infirmary.

TECHNICAL DESCRIPTION

The final remote system was broken up into two separate units. One unit is a universal remote that is wired up to a number of different wires that allow secondary switches to be hooked into the remote's original circuitry. The second unit is the secondary switching system. These switches are simply joysticks mounted into a Plexiglas case. Since the joysticks have four switches each, it's possible to allow four different options to be controlled from each of the two joysticks. The options chosen were: TV channels Up/Down, TV volume Up/Down, and VCR Play/Stop/Fast Forward/Rewind. The TV and VCR powers are controlled by two separate switches located on the top of the Plexiglas unit.

The cable connecting the two units is simply a serial computer cable. The fact that durable plugs exist on these particular cables gave this an excellent advantage over the parallel cables also used in computers. Since the cable also houses 32 separate wires, more than enough wiring was available for the patching process.

The author would like to thank Dan Cook from the UB Engineering Machine Shop for his insight in construction techniques and materials.

Total Prototype Cost: $162.67.

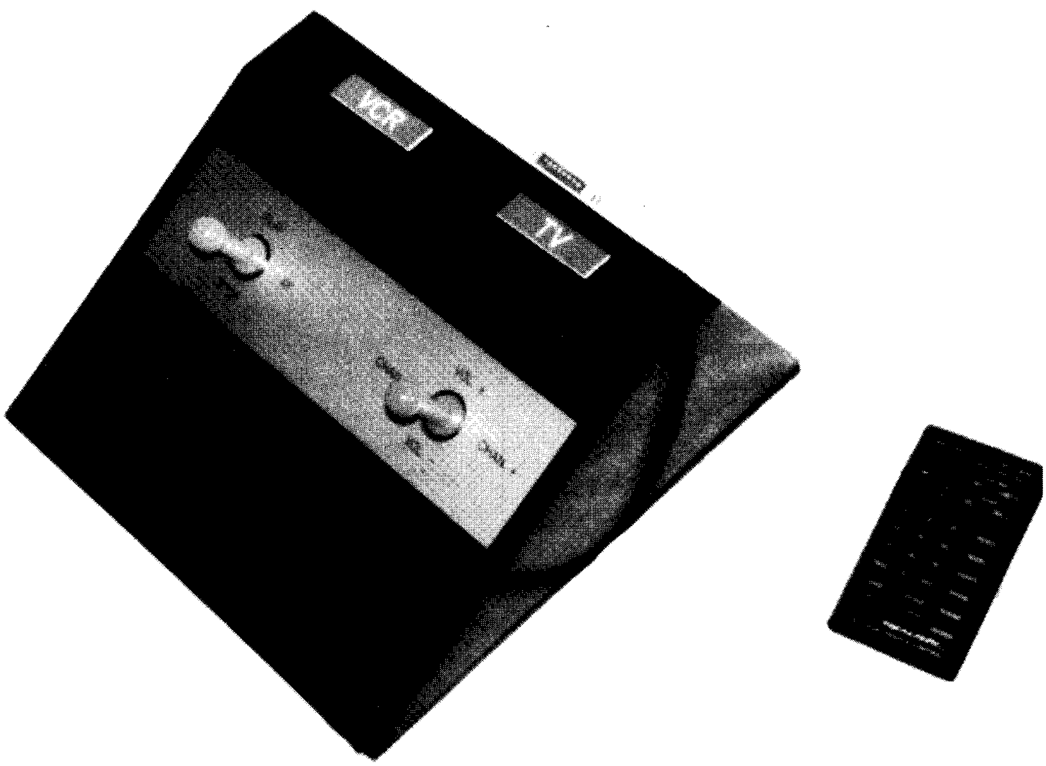

Figure 10.13. Joy Stick Unit.

A Free Standing Motorized Arm Support

Student Designers: Leon Wolinski, Jr., Lynn Baldwin
Client Coordinator: Kathy Ganley, Physical Therapist/Roswell Park
Supervising Professor: Dr. Joseph C. Mollendorf
Mechanical and Aerospace Engineering Department
State University of New York at Buffalo, Buffalo N.Y. 14260

INTRODUCTION

Leon Wolinski, Sr., a patient at Roswell Park, lost complete movement and functioning of his upper right extremity (or right arm) following the removal of lesions from the right auxiliary region, and radiation treatments due to small cell lung carcinoma. Consequently, Mr. Wolinski developed severe lymphedema and muscle atrophy in the right arm. In other words, the muscles cannot pump bodily fluids back from the injured extremity. Severe lymphedema causes swelling of the arm when the arm is unsupported and subject to gravitational effects. Presently, Mr. Wolinski must keep his arm extended at a ninety (90) degree angle from his body, or against his chest, where the forearm is kept above the heart with a sling. Due to the lost capability, his day-to-day activities have been drastically affected. Therefore, the need for a body-mounted arm support was evidently apparent.

Recently, the small cell lung carcinoma has recurred in Mr. Wolinski. This fact forced the designers to modify the original body-mounted design. Instead of mounting the arm support to the body, to enable mobility, the support was mounted to a free standing, self-contained unit. This unit supports the arm above chest level, as desired, and can also be moved to different locations where Mr. Wolinski will be needing it.

SUMMARY OF IMPACT

The goal of the project was to design a device that would allow Mr. Wolinski's arm support while sitting or while walking. The support, in turn, would allow increased endema out of the distal extremity, in addition to increased blood flow and circulation.

As originally designed, the mechanized arm support was to be body mounted which would allow Mr. Wolinski mobility while using it. It was designed to be rigid enough for the needed strength for support, in addition to being comfortable and light enough to be worn for extended periods of time. All the components were also geared to be easy enough for Mr. Wolinski to put on and utilize by himself. Due to unforeseen circumstances, though, the support was modified to only be used to lift the arm, placed in a hemi-sling, by a reversible motor to a desirable level above the chest. The entire device can also be moved to different locations, because it is a free-standing, self-contained unit. These accomplishments, in turn, have a positive impact on Mr. Wolinski, by assisting in the decreased discomfort due to the severe lymphedema that aids in his daily activity.

TECHNICAL DESCRIPTION

The motorized arm support is a free-standing self-contained unit. It will support Mr. Wolinski's arm above chest level from a hemi-sling wrapping.

The paralyzed arm is initially placed into the hemi-sling by the other hand. It can then be lifted to the desired level by a reversible motor. Note that a toggle switch, attached to the vertical stand in front of the motor, can be used to raise and lower the arm in the hemi-sling (see photograph).

The hemi-sling is attached to the geared motor using a nylon twine attached to a reel-mechanism which in turn is coupled to the motor. The nylon twine has tensile strength of 254 lbs and is permanently attached to the reel. This ensures that the cord will not break or come free from the reel, which could have detrimental effects on Mr. Wolinski. Finally the hemi-sling is padded to provide comfort and is detachable from the cord support. In addition, there is a cotton outside covering, over the padded support, which can be removed for washing.

The free-standing support was designed to be used next to a chair or bed. It does not need to be clamped or permanently mounted to any hospital or home furniture. Except for the vertical supporting pole, the entire base can be slid under a chair and/or bed, not to be seen. It has the capability to lift the arm and support up to fifty (50) lbs, though will be used to lift only a 10 to 20 lb arm. Mr. Wolinski can also use the support to raise and lower the arm without assistance, though in order to recharge the battery pack and move the entire device, Mr. Wolinski will require assistance.

The application for this device is not only for relief of lymphedema, but also to reduce it. In addition, it can be used as a supplement to pneumatic pumping of blood out of the injured arm. The height of the support can be adjusted to fit the application.

The student designers would like to gratefully acknowledge the following people for their help with this project: Dr. Joseph Mollendorf, Ken Peebles, William Willerth, Gary Olson, Kathy Ganley, P.T., and Jeanne D. Mehls, O.T.R.

Total Cost of Project: $162.49.

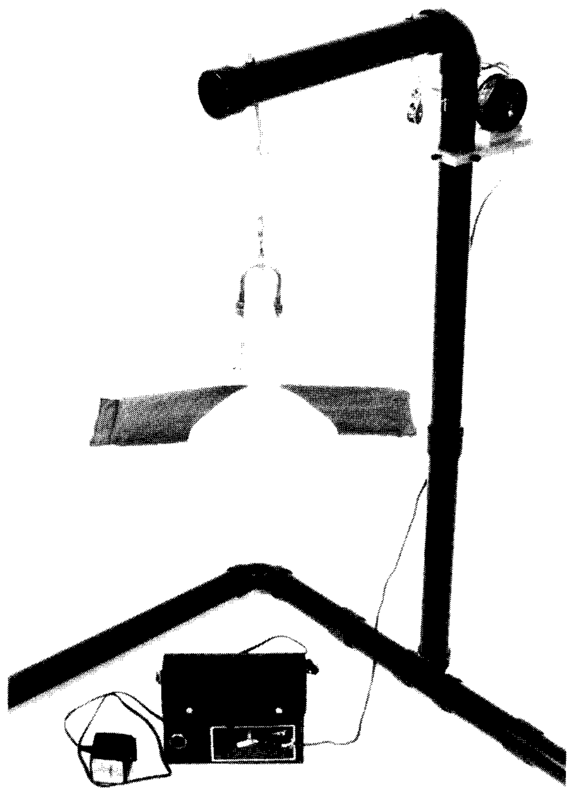

Figure 10.14. Motorized Arm Support.

Prone Support Walker

Student Designer: Daniel Steinberg
Client Coordinator: Margaret Comers, Physical Therapist
Supervising Professor: Dr. Joseph C. Mollendorf
Mechanical and Aerospace Engineering Department
State University of New York at Buffalo, Buffalo NY 14260

INTRODUCTION

Cerebral Palsy is a handicapping condition that progressively limits an individual's movement and integration into a society free of barriers and limitations. Being confined to a wheelchair worsens the condition of Cerebral Palsy because of the lack of stimulation to the muscles. The muscles usually receive manual stimulation by a physical therapist. The major advocate for individual's with disabilities is to lead as normal a life as possible with as little intrusion as possible. The objective in designing this walker was to allow the user to become more independent in all of his daily activities. The walker was designed to support the user in independent daily activities without intrusion from a physical therapist or family members.

Matt is a six-year-old boy who has Cerebral Palsy. His condition affects every aspect of his life and is a serious health concern. Matt has very limited use of his legs. As a result, he is unable to effectively use any of the walkers currently produced for children with Cerebral Palsy. Matt gets very little exercise because of his limited ability to use his legs. This walker will provide a means of exercise for Matt's legs as opposed to sitting in a wheelchair.

SUMMARY OF IMPACT

Matt's original walker had many problems. The new walker must be light and easy to maneuver. The walker requires castors large enough to transverse carpeting and other floor irregularities. The walker needs to support Matt in a prone position. Matt is unable to support his own weight. In the prone position, Matt can use his leg strength to propel himself forward. A seat and chest support were used to provide prone support. Every aspect of the walker is adjustable. The adjustments serve several purposes. They allow for growth, a proper fit, and allow the walker to be used with or without the seat. A Velcro strap is attached to the chest support and worn by the user to prevent him from falling backwards. A leg partition was used to keep Matt's legs from crossing and becoming tangled while walking. Matt uses the side rails to support himself while standing. A hand support bar was needed to give Matt something to grip while using the walker. The physical therapist explained that a proper posture could only be maintained by keeping Matt's hands in a forward position.

The walker worked very well. Everyone involved was pleased with the outcome. On Matt's first attempt he was able to use the walker more than anyone had expected. The walker fit was perfect. The adjustability of the walker should ensure a good fit for years to come.

TECHNICAL DESCRIPTION

While working with Matt and his physical therapist, we decided that the walker would have to support Matt in the prone position. The walker would need extensive adjustability to provide a good fit at the best operating position.

The CAD program Ideas version V was used to develop a model of the walker. This program was used to perform a finite element stress analysis to ensure the safety of the user. A factor of safety of nine was determined.

The walker is made of $\frac{7}{8}$" diameter aluminum tubing. All block fasteners were machined from aluminum. The chest support system incorporates an automobile headrest, a bicycle handlebar stem, a Velcro strap, and a tube in tube arrangement fastened to the main support member by a moveable aluminum bracket. The headrest makes a perfect chest support. The headrest is mounted to a solid aluminum bar which sites in the bicycle stem. A set screw holds the headrest in the aluminum bar and allows for adjustability. The bicycle neck enables the headrest to be positioned at any angle. The neck's angled design does not interfere with Matt's knees. The tube in the tube arrangement allows for vertical height adjustment. The aluminum block fastener enables the chest support to be positioned anywhere along the main support bar. The Velcro strap attaches to the chest support. The strap is a safety precaution preventing Matt from falling backwards. The seat is a very comfortable gel bicycle saddle intended for touring. The seat can be adjusted vertically and horizontally by means of a block fastener. The seat can pivot 120” about its base. The crossbar is held by two aluminum block fasteners. The bar can be positioned anywhere along the top of the walker, above or below the side bars. The leg partition consists of $\frac{1}{4}$" Plexiglas melted onto two moveable Plexiglas block fasteners. The partition height can be adjusted to accommodate different surfaces and provide a proper fit. The partition and the seat can be removed when they are no longer needed. I would like to thank Kenneth Peebles and Gary Olson of UB's machine shop, for their expert welding and valuable input.

The cost of this project was $260.

Figure 10.15. Prone Support Walker.


S. VALENTA