CHAPTER 18

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Infrared Head Switch

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INTRODUCTION

The objective of the design was to develop an adjustable head switch that would not need continuous adjustment. An adjustable infrared switch was developed for this purpose. The switch was fitted to a stand that would then be suitable for facial activation by the client, providing comfort, ease, and reliability. Once the IR transmitter and receiver have been aligned, the client will be able to activate devices attached to the switch without further supervision.

The client will need to interrupt the IR signal by placing his head between the IR transmitter and receiver. Once done, this will send a signal to the control box. When the beam is interrupted again, the control box will deactivate the device attached to it. The major benefit of the IR switch is that it eliminates the need for physical contact by client. Since it requires no physical contact it is a safe and stable design. It is very easy to position due to the flexible goosenecks arms that contain the IR transmitter and receiver. The device requires an external current source. The switch is designed to work off a standard 120–Volt AC outlet. Although this limits mobility of the device, it takes away the need for further maintenance that would be required for an internal current source.

SUMMARY OF IMPACT

The desired outcome was a switch that could be activated by the client to operate electrical devices. Previous attempts by the client to use a switching device were met by a continuous need to reposition the switch due to the uncontrolled excessive contact force by the client.

The switch design based on the IR signal meets our client's requirements. The stable stand and use of the floor mount and the gooseneck adjustment make the device very convenient and easy adjustment

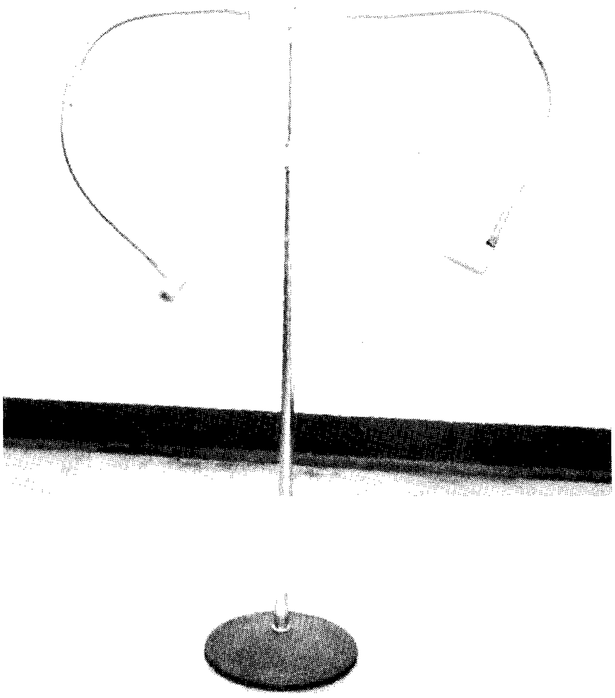

Figure 18.1. Infrared Head Switch

TECHNICAL DESCRIPTION

The device stand is an adjustable microphone stand from 33" to 61" high. Mounted at the top of the stand is a small box. This box contains the pulse generator and one transistor amplifier for the infrared detector. On the two ends of the box, the mountings for the goosenecks are attached. These mountings are reinforced with steel plates inside the box. Each gooseneck arm consists of two 13" goosenecks and is capped with a PVC right angle pipe fitting. One gooseneck arm contains the IR transmitter, and the other arm houses the IR receiver. From the center of the box a $\frac{1}{4}$" jack is used to interface with the control box.

The IR remote controller utilizes the interruption of an infrared beam to change the status of a relay. The relay contacts are connected to any device requiring a relay contact for operation. The controller is operated by first aligning the IR transmitter and IR receiver on the remote unit. Once alignment has been established the power switch located on the left side of the control unit can be turned on. When the unit is first turned on, operation of the relay is inhibited for one second to allow time to establish the operation of the missing pulse detector. The red/green LED located to the right of the power switch will come on green and remain green until a missing pulse is detected. Once a missing pulse is detected the red/green LED will change to red and at this time the relay will energize and remain in that state until another missing pulse is detected. When the relay is energized the red/green LED will always be red, and when the relay is off the red/green relay will be green. Located to the right of the red/green LED is a second LED which will light green when an IR signal is established, if necessary this relay can be used to determine proper alignment. Located to the right of the green LED is a $\frac{1}{4}$" jack used to interface with the remote transmitter and receiver. Located to the right of the $\frac{1}{4}$" jack is a $\frac{1}{8}$" jack used to interface with the device to be controlled. The remote unit is the location of the transmitter and receiver electronics.

The IR remote controller operation is based on transmitting a pulsed modulated IR beam to an IR detector. The IR LED is pulsed with a 40,000 Hz carrier wave modulated by a 465 HZ signal. The IR detector receives the signal, amplifies it, and converts it to a square wave at a frequency of 465 Hz. The signal is further amplified by transistor Q1, and the signal is coupled by capacitor C10 to the system logic and control unit using a 3 conductor cable. The 3 conductor cable is also used to supply the remote unit with power for operation.

The system logic controller is composed of a 12-Volt DC power supply, signal inverter, missing pulse detector, signal conditioner, second signal inverter, tone signal, and relay controller. The 465 Hz signal from the remote unit is inverted by transistor Q2 from a negative going square wave to a positive going square wave for use by the missing pulse detection system. Q3 and $\frac{1}{2}$ of IC5 detect missing pulses, which are passed to the other $\frac{1}{2}$ of IC5 that output a single pulse of one hundredth of a second for each missing pulse. The missing pulse detector lights a small green LED that indicated pulses are being received. Transistor Q4 inverts this signal and feeds to the tone signal and the relay status circuit. A missing pulse causes a $\frac{1}{2}$ second tone to be generated to alert personnel that a missing pulse has been generated. The tone is generated by a piezo buzzer and the time duration is controlled by IC7. At the same time the tone is generated, the status of the output relay is changed from ON to OFF or from OFF to ON depending on its previous status. The relay is controlled by IC6 that is a dual flip flop. IC6 changes its status every time a missing pulse is received. IC6 also controls the status of the red/green relay. Control of the relay is provided by Q5 that provides power to drive the relay. The relay contacts are connected to J1 to interface with peripheral devices.

By interrupting the beam as desired, it is possible to control any device that is designed to operate using an ON/OFF operation. By using other interfacing devices it is possible to control many types of equipment with special applications.

The device costs $175 to build.

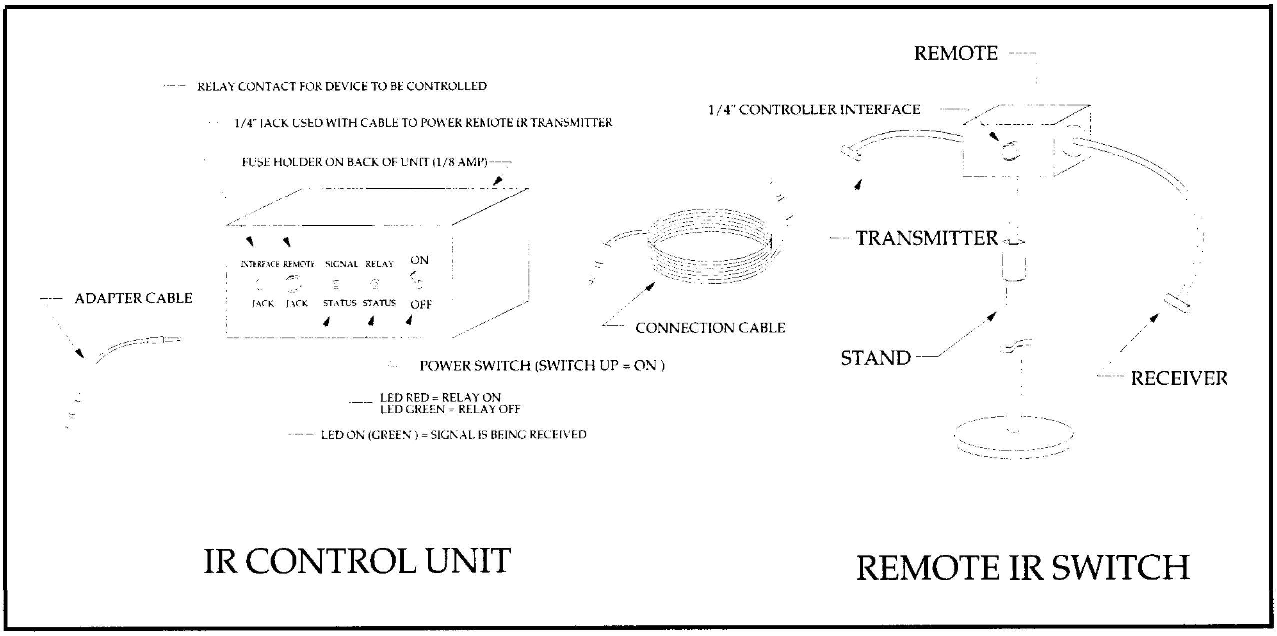

Figure 18.2. Diagram of Infrared Head Switch.

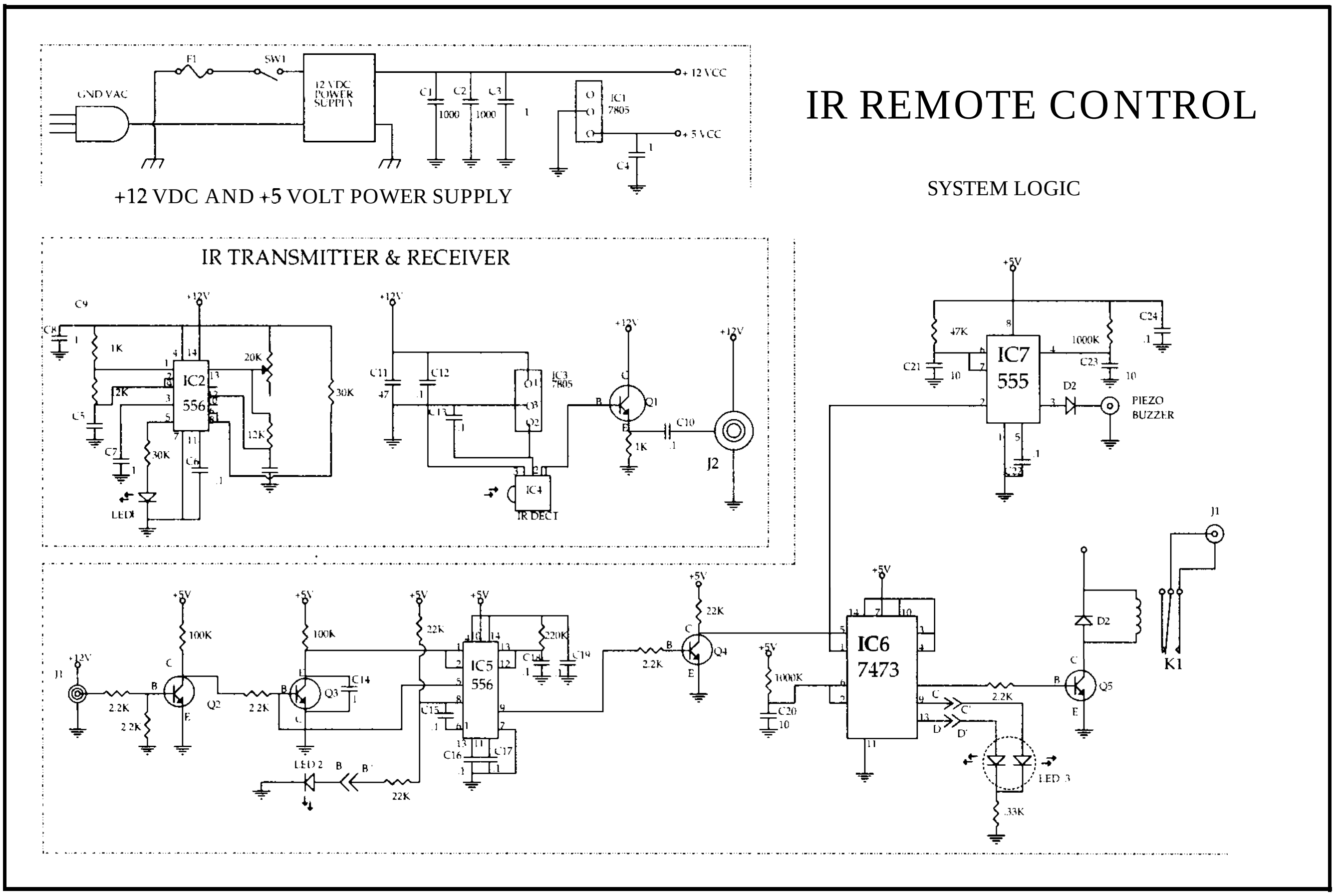

Figure 18.3. Circuit Diagram for Infrared Head Switch.

Chair for Vestibular Stimulation

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INTRODUCTION

The design problem was formulated as, “Design a device for the client, a deaf and blind eight-year-old, which will encourage independence through a vestibular stimulation device of a swing type nature that will encourage independence through self-operation of the vestibular movement.”

Various alternative solutions were considered and the one selected was a spring mounted “rocking” chair. A frame was built and mounted on a spring to accommodate a purchased tumble seat. One of the requirements was that the device not take up too much space and that it be portable so that it could be moved from room to room. To accomplish these objectives and still be stable while the client is in motion, a steel plate formed the base and fold out legs were attached to add stability. Wheels were added to the base to promote portability.

The client is able to move by holding onto the hand grips and moving from side to side. An adjustable foot rest is also included.

SUMMARY OF IMPACT

The client, an eight year old child that weighs 50 to 60 pounds, is multi-handicapped. His major disabilities include being legally blind and hearing impaired. The client, however, shows response to tactile and vestibular stimulation, which is movement stimulation. The major problem is that he displays a variety of self-stimulatory behavior. He, for instance, will hit his head with his fist, bang on objects with his elbows, and slaps his legs with his hands. Physically, he is fairly mobile and functional. The client is very excited to use the device and it fulfills its purpose of encouraging the client to decrease his self-stimulatory behavior.

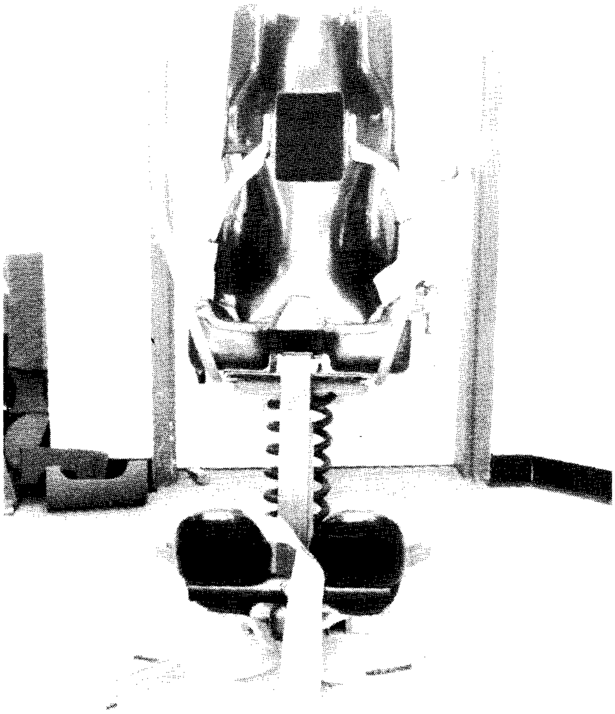

Figure 18.4. Picture of Vestibular Stimulation Chair.

TECHNICAL DESCRIPTION

The design and construction of the chair for vestibular motion presented three major problems: a chair that would provide the necessary support for the client, a stable base that would be portable and fit through a door, and a means of attaching the spring to the chair and the base.

After reviewing the options the group and the client coordinator decided that the best solutions was to use a prefabricated health care seat which would provide the necessary support and come with the necessary straps and footrest for safety purposes.

In order to accommodate the need for portability, the base was made from a plate that would fit through the door and fold down supports that would provide the additional stability. The base plate was 30” x 30” x $\frac{1}{2}$" steel plate. On each corner a 2'6” fold down leg was added for stability. The legs pivot and are held in place by two bolts. On the end of the leg is a leveling screw. Wheels are added to the steal base plate to allow the base to be tilted and rolled from place to place. The legs serve as handles for maneuvering the base plate when in the up right position. Additional details are shown below.

The spring is attached to the base plate as shown in the figure below. A $\frac{1}{2}$" thick steel “donut” cut to fit the spring is welded to a 6” x 6” x $\frac{1}{2}$" steel plate. The steel plate is welded to 1” square steel tubing so that the assemble can be bolted to the base plate using $1\frac{1}{2}$" x $1\frac{1}{2}$" x $\frac{1}{4}$" angle iron which has been welded to the base plate. The spring is place around the “donut” and held in place by a 2” x 6” x $\frac{1}{2}$" anchor plate using two $\frac{3}{4}$" steel bolts.

The cost for the device was $600, including approximately $500 for the chair and leg rests.

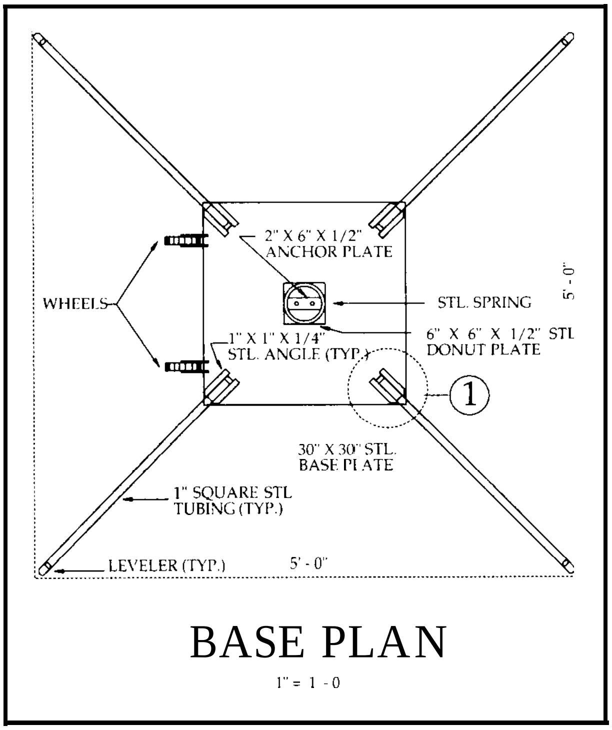

Figure 18.5. Base Plan for Vestibular Stimulation Chair.

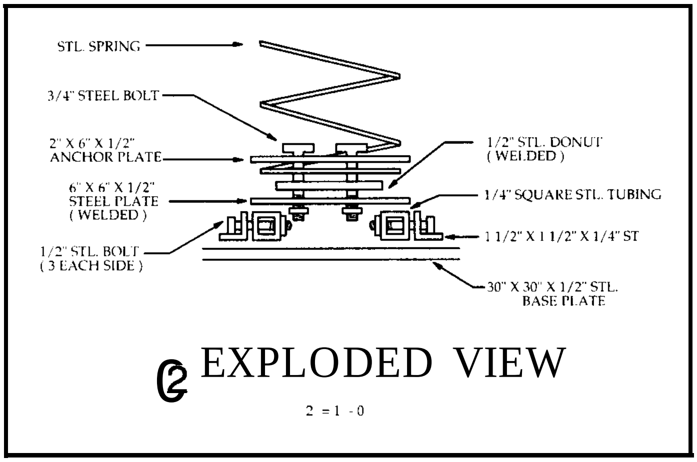

Figure 18.6. Exploded View of Base Plan for Vestibular Stimulation Chair.

Wheelchair Passive Exercise Device

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INTRODUCTION

The patient needed motor activity for lower extremities to increase muscle tone. The design is a piece of equipment to attach to her wheelchair that would allow her to realize "pedal motion" when pushed (as in tricycle apparatus).

This device is designed to passively exercise the lower extremities of a non-ambulatory person while confined to a wheelchair in order to increase and enhance muscle tone. The device is adjustable to ensure that the patient is in proper position to prevent any problem by confinement. The wheelchair must be pushed by someone to move. A belt attached to a rear wheel sprocket transfers a force to a sprocket attach to an S-shaped bar. When the belt moves, it rotates the S-shaped bar that makes a circular motion with a 6 inch diameter. Patient's legs are pushed up as high as 6 inches by the circular motion of the S-shaped bar.

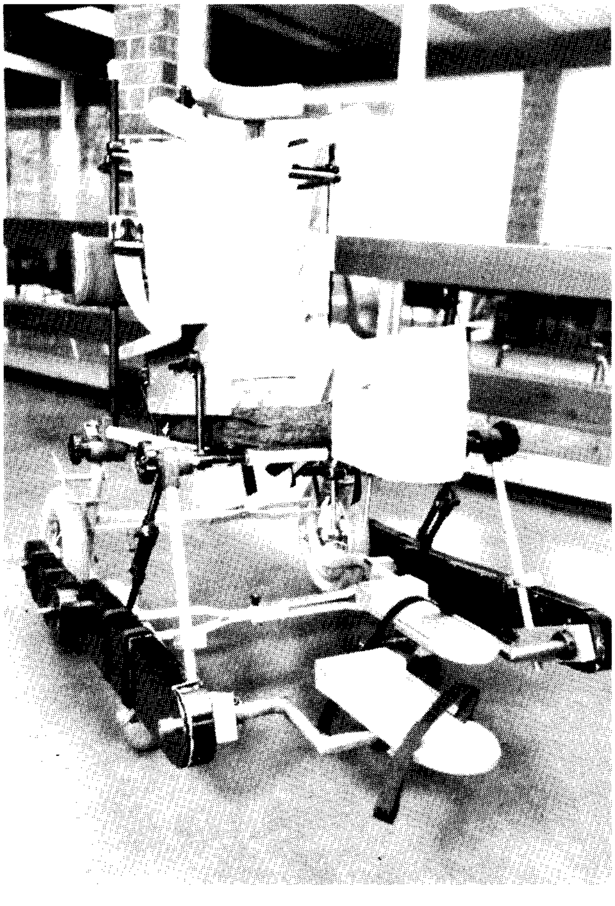

Figure 18.7. Picture of Wheelchair Exercise Device.

SUMMARY OF IMPACT

The device operates as designed and provides the necessary passive exercise for the client. It was necessary for the wheel chair to have full mobility and be safe to operate. These conditions were met with the design. Another important criteria was that the pedals be adjustable, both in length (to allow for growth) and angle. With limits this criteria was also met. Additional adjustability can be obtained by changing the chain length. The device meets the criteria given to the group and the device performs well.

TECHNICAL DESCRIPTION

Drive System:

One of the initial problems was that the wheelchair would pull to one side when pushed due to a drag from the pulley if only driven from one side. One solution was to add another pulley system to the other side of the wheelchair to eliminate the drag. However, when going around corners, the drive systems, both attached to the single S- shaped bar, would turn at different speeds. The drive problem was solved in the following manner.

The drive system for each side contains two chains, a rear hub, intermediate hub, and crankshaft hub. The rear hub contains one bicycle sprocket, axle, and $\frac{3}{8}$" set collar for security. The intermediate hub contains two bicycle sprockets, one axle, and one $\frac{3}{8}$" set collar for security. An intermediate clamp holds the intermediate axle in place. The crankshaft hub contains one bicycle free-wheel sprocket and set screws for security. When the wheelchair is turned, the outside radius of turn is much greater than that of the inside radius; therefore, the chain system on the outside radius of turn has to turn faster than the inside chain system. With a regular sprocket, the chair cannot function during a turn due to the variations in speed since both chain systems are driven with the same speed. This is the reason for the free-wheel sprocket. The free-wheel sprocket allows the chair to turn at the driven speed and is only driven at that time by the chain system on the outside radius. The entire drive system is adjustable for foot-positioning height and angle. When the chair is pushed, the rear spokes drive the rear hub which in turn drives the crankshaft hub through the intermediate hub using the chains and sprockets. The main reason for the intermediate hub is to restrict slack in the chain.

The entire chain and pulley system has been guarded with 16-gage sheet metal for safety purposes. The chain guards fit together fairly tight, but are also held with Velcro straps for safety. Chain guard brackets are used on the angle adjustability bar to stabilize the chain guards. Figure 5 shows a side view of the wheelchair with the chain guards in place.

Crankshaft

The crankshaft designed by the team is a $\frac{3}{4}$ inch-diameter two-throw aluminum crankshaft with 180” throws. Two pedals are attached to the crankshaft with aluminum bushings that are held in place with $\frac{3}{4}$" set collars on each side of the bushings. The crankshaft hubs are held in place with set screws. The crankshaft simply replaces the standard foot rest on the wheelchair and is held in place with a crankshaft bracket on each adjustability bar.

Self Containment

One criteria for the wheelchair design was that it be self-contained. Although the pedal and drive design is not contained in a single unit, the attachment on the Mulholland Wheelchair can be removed, and the wheelchair restored to its initial condition. To remove the pedal system, the crankshaft must simply be removed by loosening the screws on the crankshaft brackets. The initial foot rest may then be replaced. Also, the chain guards, chains, hubs, intermediate clamps, and set collars must be removed. The hubs, intermediate clamps, and set collars may be removed by loosening the screws.

The cost for the device was $410.

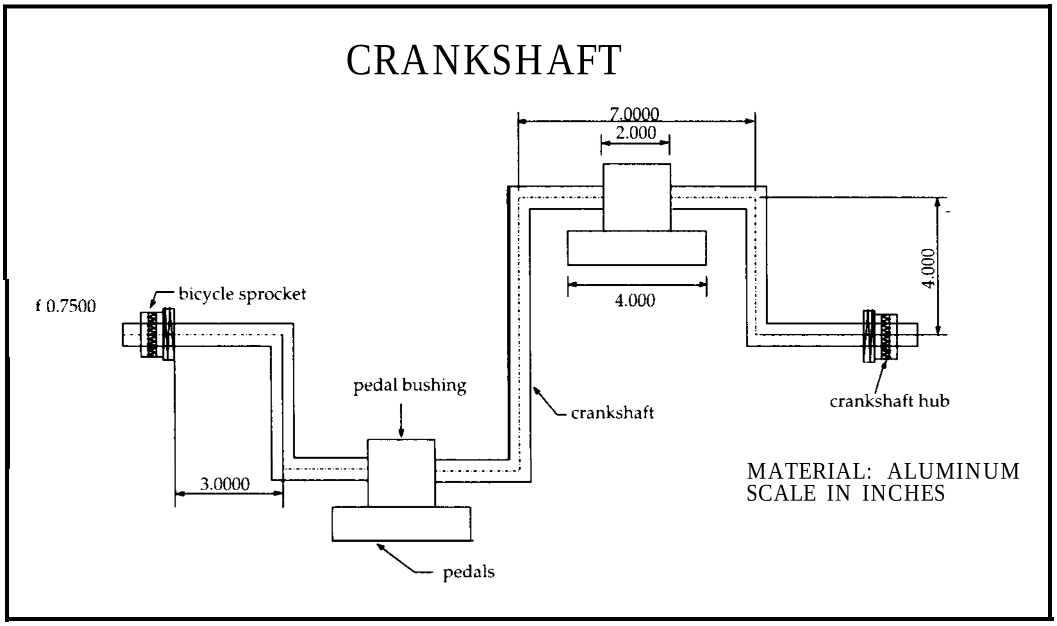

Figure 18.8. Diagram of Crankshaft for the Wheelchair Exercise Device.

Visual Communication Device

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INTRODUCTION

The communication board was designed to provide the client with more choices so that the instructor is able to use a development technique called Aided Language Stimulation. The technique employs the use of light to help the client focus on the picture that he desires. By placing a light behind each picture the client's ability to focus is strengthened, with the ultimate goal of preparing the client for a future computer-aided communication package.

The communication board has two basic modes. In the automatic mode, the lights illuminate the pictures automatically from left to right and then from top to bottom. The teacher will have the ability to stop the progression or to reverse the order. By carefully watching the client's eyes the teacher is able to detect the object the client wants to access. In the manual mode the client actively chooses a picture by scanning the pictures himself and then fixes his eyes on the one he desires. The teacher will then be able to illuminate that picture. Thus the client's activity level is progressively more active rather than passive.

SUMMARY OF IMPACT

The client is a 12-year-old child. The client is continuously attached to a heart-apnea monitor that is a warning system for cardiovascular dysfunction. He is not able to use his limbs and his only means of communication, at the present, is eye movement.

The client is shown pictures or drawings and, using the system, he can answer yes or no questions to make choices. He responds by directing his eyes to yes/no badges that the workers wear on their shirts. However, because of his eye muscle imbalance, he has difficulty fixing his gaze on one picture or object for a sufficient amount of time.

The previous methods were limited by the number of pictures and control on the part of the client. This device allows for more pictures and more control by the client. In addition, with practice the client will have the potential to learn the skills to use a computer device that scans a matrix of choices.

TECHNICAL DESCRIPTION

To maintain a low power consumption, the lighting, which accentuates the pictorial choices, was a key issue. Both LED and incandescent lighting systems were considered and tested. Incandescent lighting was ruled out due to its high power requirements. Various LED's were tested and the one with a highest intensity red light was selected.

The board was made of polycarbonate sheeting. While this material is more expensive than Plexiglas, it is safer and easier to machine. The top sheet was $\frac{3}{16}$" thick and the back sheet was $\frac{1}{16}$" thick. The two panels were fastened together with plastic nuts and bolts to enable disassembly for maintenance if necessary. The board was made 16” high and 20” long The center hole, for the teacher to watch the clients eyes through, was five inches in diameter.

Manual Mode

We needed some way to 'hold' this pulse indefinitely. One easy solution to our dilemma was to introduce four J-K flip-flops, one for each BCD bit. A new problem emerged in how to reset all the flip-flops (so that a new code could be installed) and then set the proper flip-flop(s) to the new BCD pulse. This was accomplished using a CMOS version of the popular 555 Timer configured in the Monostable or One Shot Mode for each incoming pulse bit. The actual output of the Encoder was used to reset the 555's and the J-K's. The time delayed output pulse of the 555 easily set the proper flip-flop'(s). Once the BCD code had been transmitted to the output of the J-K's, it was a simple matter to decode back to the original decimal equivalent.

Automatic Mode

In this section of the circuit, another 555 (as an Astable Multivibrator) provides a variable clock pulse to a BCD counter. Depending on the position of the Up/Down Switch (which provides a logical HI or LOW to the proper pin), the counter will count up or down in BCD. As in the manual mode, the output from this stage was easily decoded back to its decimal equivalent.

Decoder/Driver Stage

Since it is important that the two modes be entirely independent, 2-input OR gates were used to interface between both modes as they entered the Decoder. A DPDT switch (with center off) was used to deliver power, individually, to inputs and devices of each mode. Great care had to be taken that no input was derived from any power source but its parent mode. An exception was the decode/driver section, which has power in both modes.

After the OR gate interface, the BCD signal was translated into its decimal equivalent. A Darlington, high-power, eight segment Driver was used to sink the proper anode of the LED array (which had a common cathode).

Supply Power

The power is supplied by combining two 7.2V ('9V type cell') to achieve a maximum of 14.4V on a full charge at 0.1Amp-hr. This was quite adequate for the power needs and exceeded our voltage requirements easily.

The cost for the device was $155.

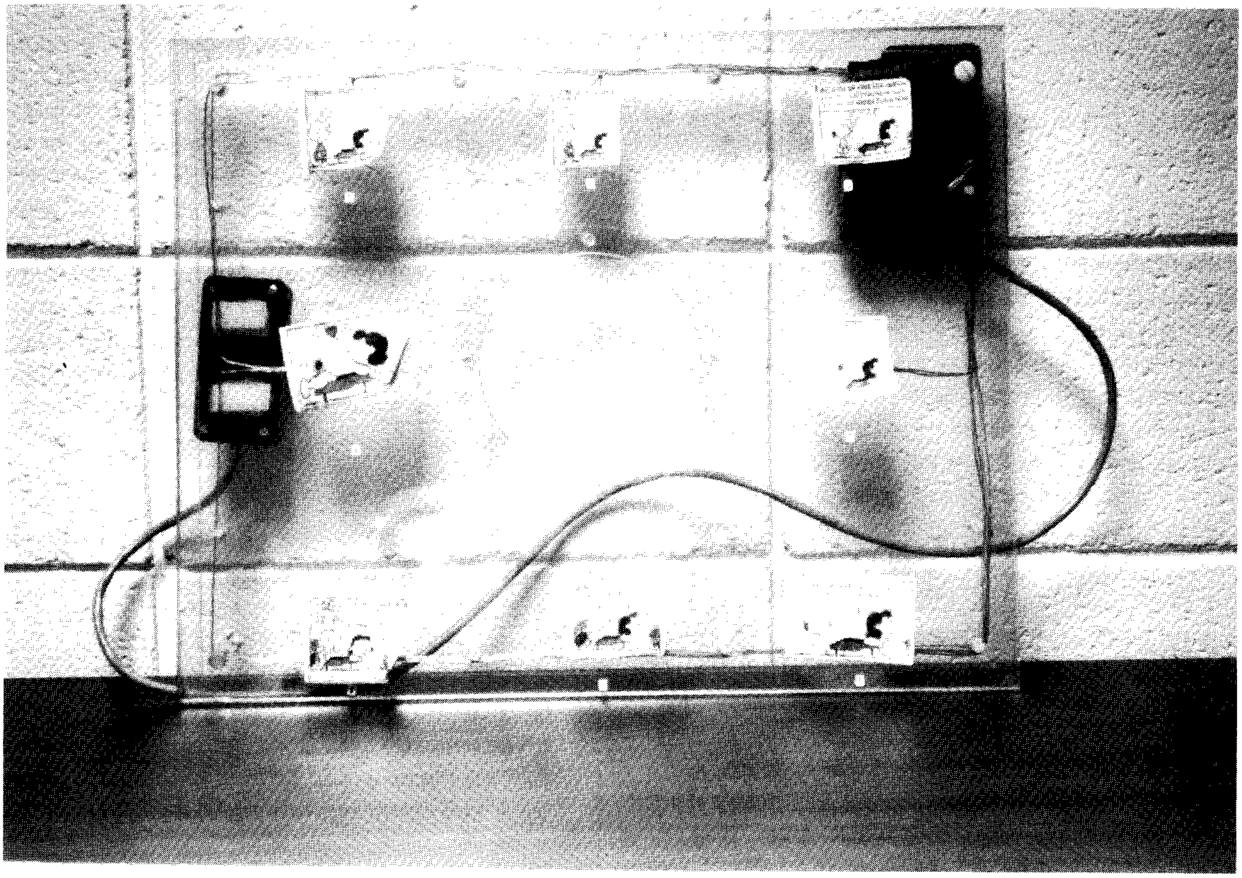

Figure 18.9. Visual Communication Device.

Suspended Walking Device

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INTRODUCTION

The goal was to design a suspended walking device so that the client could use his own legs for support during walking exercises and not depend on his arms for support. He needed something that he couldn't get hurt on, that wouldn't drop him, that would support his weight if he were to pull his feet up and try to swing, even though the teacher has never seen him do this, she said that it was possible.

The design consists of a harness supported on a track system. The harness is put on the client. The harness is attached to a strap either on the back of the harness or the shoulders of the harness. The strap is attached to a roller that travels on a track suspended from the ceiling. The length of the track is 28-feet. The client can walk back and forth to exercise.

SUMMARY OF IMPACT

The client needed a device that he could use for unassisted walking. He also needed motivation and encouragement during walking exercise. Unfortunately, the teacher couldn't provide this emotional support while she was assisting him during the walking exercises. Previously, it required three people to assist the client with his walking exercises. The design presented here allows the client to exercise unassisted and performs as designed.

TECHNICAL DESCRIPTION

The main components of the design are the harness, the track and the straps/hooks.

Harness

The harness is a Full-Bodied Harness from Klein Equipment Company. The harness has heavy duty shoulder straps, leg straps and waist strap. It is adjustable and should be able to fit most adults. There are two sets of rings for support; one set on the shoulders and another on the top middle section of the back. Either attachment may be used, however, in testing the back ring was more comfortable. The two sets of rings should not be used at the same time.

Overhead Track and Roller System

The alternative selected is sliding door track. It is easily constructed and the availability of the fitted roller will minimize slipping and jamming of the rollers; it consists of three, 12-gauge, slotted-strut "C" type, with dimension of $10'' \text{ x } 1\frac{5}{8}'' \times 1\frac{5}{8}''$, as well as, a four-wheel trolley, and 12 inches threaded steel rods.

The three pieces of the tracks were be connected with square tubes to eliminate the need for welding on site. The track was hung from the ceiling. In order to do so, 12 inch rods were used to serve as supports. The rods were welded to the tubing and other locations on the track. Since the ceiling had support members every four feet, the track was attached on it every four feet. This way the weight was distributed evenly. The rods were attached to the ceiling members using an angle rod. The angle rods were welded in the middle to the rods of the track. Each side of the angle was screwed to the members.

Pre-assembly

The track and roller portion of the system were purchased in three 10 ft. long pieces of 12 gauge $1\frac{5}{8}$ inch square slotted steel strut. This track was rated for a load capacity of 600 pounds. The roller was made specifically for the size of strut we purchased and rated at 800 pounds. A double-ring pivot was attached from the roller to the harness so that the client would be able to turn at the end of the track and continue walking in the other direction.

The track was preassembled before installation. The track was left in its three separate sections for easier transportation. The track was to be supported from the ceiling trusses which were 8 inches above the ceiling tile and spaced four feet apart. In order to have a support at each end, the track was cut to 28 feet, evenly divisible by four. For supports, a section of $\frac{3}{8}$" steel square tubing just large enough to fit tightly over the track, was purchased and cut into eight 6-inch pieces. To the tops of each of these 6-inch sections, an S-inch piece of 1 i-inch diameter black pipe was welded. The circular brace provided support in every direction. A 3 x 5 inch t-inch thick steel plate was welded to the other end of the pipe. A second, identical plate was made for each support. Two holes were cut in either side of both plates for bolt attachment. Next, the spare tubing pieces were slid over the track and hammered into their positions. The bottoms of the spare tubing had been cut out wide enough for the roller to pass unobstructed. With this arrangement, the supports could easily be moved to exactly the right positions by hammering the bolt holes directly under the ceiling trusses. Square tubing was also placed around the ends of each of the three sections so that they could easily be joined together. Both ends of the track were capped by welding them shut. Finally, the entire track and supports were painted black.

Installation

At Orange Grove, the ceiling tile first had to be removed in the designated area. A chalk line was used to mark a straight line on the metal runners used to support the ceiling tile. The metal runners were then taken down every 4-feet where there would be a support, and a 2-inch section was cut out at the chalk mark. The track was lifted into position, one piece at a time, and bolted into place. The bolts were not tightened so the track could be straightened when all three pieces were up. The next piece was lifted and butted to the first piece, then bolted in place. The same was done for the final section. The ceiling runners were put back in place and wired to the ceiling trusses. The track supports were hammered over next to the runners to be assured of being straight. When we were satisfied with the straightness, each track support was tightly bolted into place. The ceiling tile was replaced and carved around the pipe supports.

Straps

An adjustable strap with hooks on each end had been purchased to attach the harness to the pivot. The hook that attaches to the harness was replaced by a threaded ring to assure safety. A design team member put on the harness and began to walk with the aid of the suspended walking system. The system supported the his full weight without problem. The device was also stable with side to side movement. When the strap was adjusted to the right position, it held the walker up straight, even when he tried to lean one way or the other.

The cost of the device was $320.

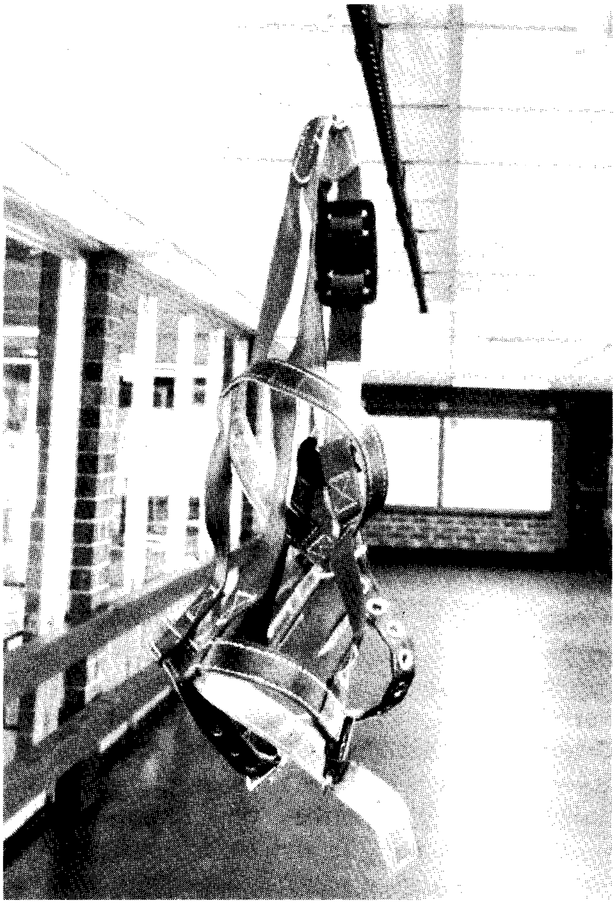

Figure 18.10. Picture of Suspended Walking Device.

Pivoting Swing

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Client Coordinator: Connie Jones- Wallace A. Smith School
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INTRODUCTION

The design is based on the familiar concept of a playground swing. As the seat pivots back and forth on the l-inch diameter rod, the center of gravity of the swing and user changes. This will propel the swing forward and backward because the motion of the seat causes a moment of force that is pivoted around the support frame. The client the swing is being built for has limited use of her arms and therefore will have to be strapped in with a seat belt arrangement similar to a four-point harness used in automotive applications. Handles are mounted in the swing so the client will receive passive exercise as long as she grips them. The exercise will come about as her body tilts back and forth with the swing seat while she grips the fixed handles. Gripping the handles is not mandatory to the swing's operation.

SUMMARY OF IMPACT

The client, a seven year old female, was the victim of a household accident at about two years old that left her with a partial upper body paralysis. She lacks the full use of her arms. At present, her left arm is the most useful. She can raise it but it takes some effort. Her right arm has some muscle tissue and exercise is needed to improve the use. She cannot raise it at the present time. She has normal function in her legs and walking is not a problem. Her paralysis also affects her breathing. She has limited endurance because her ability to inhale and exhale is impaired.

The client has good potential because, despite her handicap, she is as active as possible indoors and out. The pivoting swing provides an incentive to develop her upper extremities through the active motion of swinging and the passive exercise of the arms.

Figure 18.11. Picture of Pivoting Swing

TECHNICAL DESCRIPTION

The Swing Frame

This spring is mounted to a $\frac{1}{8}$" x 4” x 10” flat steel plate welded to the 1" x $\frac{1}{8}$" square steel tubing of the swing frame.

The swing frame is connected to its support structure by means of a knuckle joint welded to each of the uprights of the swing frame. These joints are fabricated from $\frac{1}{8}$" steel plate. A $\frac{3}{4}$" 0. D., grade 5 bolt is used to pin the two pieces of each joint together. This bolt is surrounded by nylon busing to reduce friction and wear. The upper part of the knuckle joint is bolted to the wooden support structure by means of four $\frac{1}{2}$" 0. D., grade 5 bolts.

The support frame is composed of four upright timbers and one horizontal cross member. The uprights are $5\frac{1}{2}$" x $5\frac{1}{2}$" square and 13 feet long. Each of the uprights have a $5\frac{1}{2}$" x $5\frac{1}{2}$" x 1" notch located 6-inches from the top. The uprights are oriented so that the notches face each other. The purpose of the notch is to cradle the $5\frac{1}{2}$" x $5\frac{1}{2}$" square cross member and prevent it from shifting on the bolts that run through each end. The cross member is 7-feet long and is supported by the bolts primarily and secondarily by the notches. The bottom of the support frame is buried 3-feet deep in concrete. This gives a height of 9-feet for the cross member and the distance between the uprights of 5-feet.

The cost of the device was $340.

See-Saw for Wheelchair Bound Children

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Supervising Professor: Dr. Edward H. McMahon
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INTRODUCTION

The seesaw design is a very simple concept. It operates in the same manner of a rocking chair, but needs the help of a third person to make it work.

The seesaw is equipped with a seat on one end, the Bunnel seat, and attachments on the opposite end to accommodate another seat. This second seat, the Mulholland, is commonly used by children who suffer from cerebral palsy or spina bifida. Attachments on the seesaw are designed such that a Mulholland seat of any size may be placed on either end of the seesaw.

For this purpose, the Mulholland chairs are detached from the base of the wheelchair and attached to the seesaw with the connections provided. The seesaw may be used in two different ways:

1) One child in their own seat (Mulholland) and the other in a Bunnel seat
2) Two children in Mulholland seats

Attachments at both ends will accommodate Mulholland seats. A child who is not handicapped may use the Bunnel seat if proper safety precautions are followed. Once the children are safely secured, a third party may begin rocking the children.

SUMMARY OF IMPACT

The client suffers from spina bifida and cannot walk without the aide of a walker or another person. She is 8 years old and is bound to a wheelchair. The support she needs would make it difficult to remove the client totally from the wheelchair. The design presented enabled the client to enjoy the wheelchair and interact with other students while realizing the necessary wheelchair support.

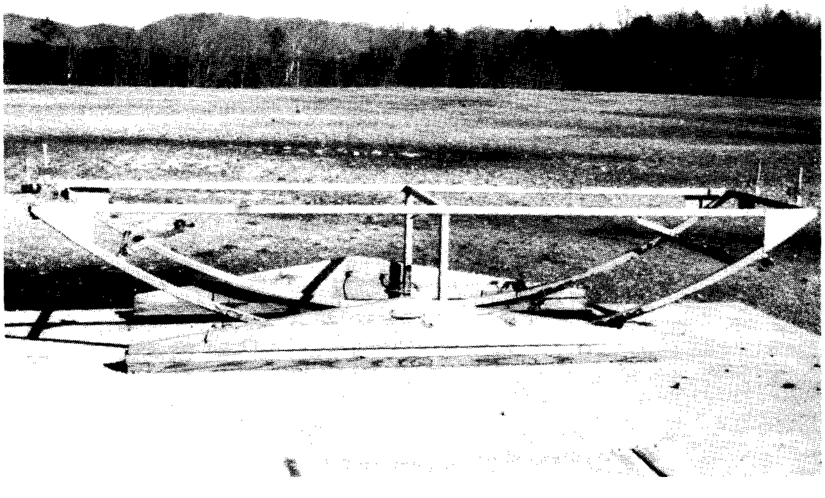

Figure 18.12. See-Saw for Wheelchair Bound Children.

TECHNICAL DESCRIPTION

In designing the frame the procedure used was in accordance with the Allowable Stress Design method established by the American Institute of Steel Construction. The criterion for acceptable design strength, stated by the AISC, is as follows: the calculated maximum stress, assuming elastic behavior up to anticipated maximum loads, is kept lower than a specified allowable stress. This design method uses basic engineering sciences, such as statics and mechanics of materials, to compute maximum moment in each member; however, in more difficult structures such as the seesaw, a computer analysis would prove advantageous.

The calculated maximum moment, along with the allowable stress, would then be used to determine the required section modulus using the equation; stress = moment/S. From the section modulus the member size is determined by referring to tables produced by the AISC. The specified design load for the seesaw was 2400 pounds; this load is considerably conservative. The reason concerns the complications involved with performing an accurate dynamic analysis that involves more than basic dynamic principals. The allowable stress, defined by the AISC, in each member is 60% of yield strength. The yield strength of the steel being used is 36ksi therefore the allowable stress is 21.6ksi.

The computer and software used to analyze the seesaw device was the IBM 4381 mainframe and ANSYS located on the UTC campus. The computer output indicates the seesaw frame is well over designed, which was intended. Other reasons for the selection of these member sizes were availability and ease of welding.

The arc members are 13–feet long and were bent to a lo-foot radius. The frame was welded together and gusset plates were installed at the intersection of the arc and top frame. Wheelchair parts were obtained from a wheelchair distributor. The chair connectors on the seesaw were designed to connect to the exact places on the wheelchair so that the top half of the wheelchair could be removed from the wheels and frame and placed on the see saw. On one end, the connections to fit a Bunnel seat were also included. This seat can be used for a disabled or able bodied child.

The frame sits in a wood track that was fastened to a concrete base. A locking mechanism is attached to the base at each end to prevent the seesaw from being moved and to stabilize the device while the students are being loaded and unloaded.

The total cost for this device, including the Brunnel seat, was $350.

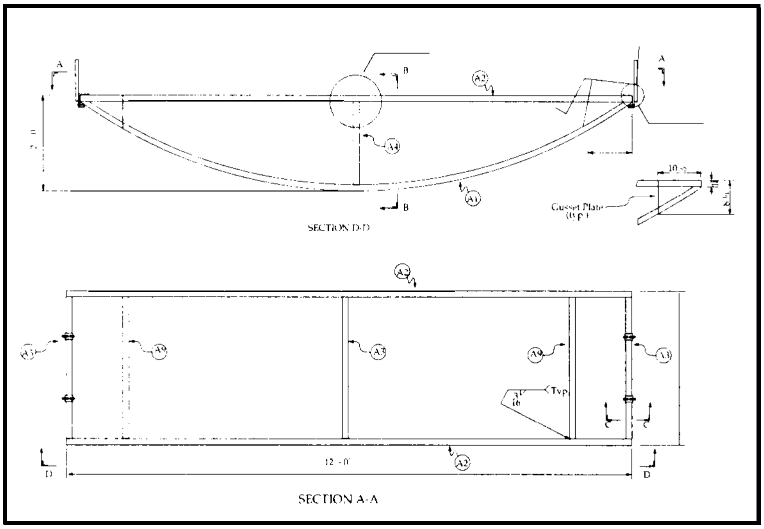

Figure 18.13. Diagram for See-Saw for Wheelchair Bound Children.

Merry-Go-Round for Wheelchairs

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INTRODUCTION

The device constructed in this project is a wheelchair accessible merry-go-round designed for up to three wheelchairs. The merry-go-round has been designed to accommodate wheelchairs directly onto the surface of the merry-go-round rather than have the children removed from their wheelchairs and placed into seating attached to the merry-go-round. The operation for the wheelchair accessible merry-go-round is essentially the same that would be used for a non wheelchair accessible merry-go-round. One or more children propel themselves using a handrail attached to the merry-go-round, or the children are propelled into motion by a bystander who sets the merry-go-round into motion. There are many safety requirements on an apparatus that is to be fabricated for physically challenged students that are incorporated into the construction of the *merry-*go-round.

The merry-go round is equipped with a four point restraint system. The front straps are adjusted for proper position with the hand rail and attached first. The straps holding the rear of the wheelchairs in place are the ratcheting-type. After the wheelchairs are loaded the loading ramp is pulled up and locked in place. The edge of the merry-go-round is protected with trim. Handrails are on both sides and the end of the ramp. When not in use, the merry-go -round and the ramp are locked together to prevent misuse.

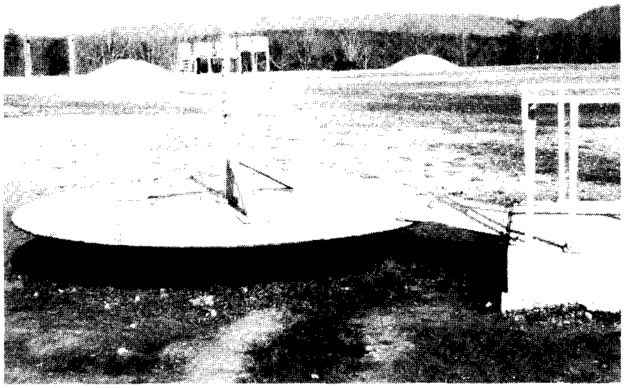

Figure 18.14. Merry-Go-Round for Wheelchair Bound Children.

SUMMARY OF IMPACT

The client is a victim of cerebral palsy and is primarily wheelchair-bound. He can use his upper body strength to lift himself up and swing his feet forward. The majority of his day is spent playing with his able-bodied counterparts in the non-handicapped first grade. His upper body strength is relatively good, his legs are weak and atrophied. He enjoys going outside and playing, which mostly consists of riding around in his wheelchair and watching other children play. With the addition of this device, the client is able to play with other children and propel himself on the merry-go-round designed for use with wheelchairs

TECHNICAL DESCRIPTION

The merry-go-round primarily consists of four main components: footing frame, bearing, deck, and handrail.

Footing Frame

To provide stability for the bearing and prevent rotation a frame was built to hold the bearing and shaft in the concrete footing. The footing frame consists of two 14” x 17” rectangular members joined together at each comer with a 3’ length of 1" square tubing. To attach the bearing a $\frac{3}{4}$" x 4” bolt was welded at each corner of the top rectangular section. To attach the center shaft, a 4” x 17” x $\frac{3}{4}$" metal plate was welded onto the top 14” x 17” rectangular member and also onto the bottom 14” x 17" rectangular member. The center shaft was attached to the footing frame. The center shaft is a solid 2” circular bar having a 9’length. The center shaft was attached to the 14” x 17” footing frame by arc welding the shaft to the bottom metal plate. The handrail is attached to the solid shaft. The footing frame was installed in a 2’x 3’hole and concrete was poured around the frame to hold it stationary.

Bearing

The bearing assemble consists of $4\frac{1}{4}$" inner diameter tapered roller bearings. A rubber gasket is installed over the bearings for protection from dirt and dust.

Deck

The required deck diameter for the circular merry-go-round deck was determined to be 9 feet. The deck was made in two semicircle sections which were arc welded together to form one circular disk having a diameter of 9 feet. The deck was placed on a hexagonal support frame. The support system was built from 2” x 2” x $\frac{1}{8}$" square carbon steel tubing. At the points of intersection of the hexagonal members, angles of 0”, 60°, 120°, 180°, 240°, 270°, and 300” measured from the horizontal a 2” x 2” x $\frac{1}{8}$" radial member was welded to the deck from these intersections to the center of the circular deck. For further deck support from the underside decking, the decking was bolted to the deck using $\frac{3}{8}$" hex head carriage bolts, $\frac{3}{8}$" flat washers, $\frac{3}{8}$" lock washers, and $\frac{3}{8}$" hex nuts. Angle iron was welded onto each side of every other radial member so that the top deck support members would have a point of attachment to the underside.

Three top support members were constructed of 2” x 2” x $\frac{1}{8}$" square tubing, and each was welded at a 16” angle measured from the horizontal onto a 4” x 6” x $\frac{3}{16}$" piece of carbon steel plate. A hollow center piece having an inner diameter of 2 $\frac{7}{8}$", an outer diameter of 3", and a length of 12” was constructed that would bolt directly onto the center of the deck. The top support members were arc welded to the center piece at a 64” angle. The three top support members were equally spaced on the deck surface at 120” angles. The deck was sanded and painted using an enamel paint. Window lace, also called dry-bone, was attached to the outer rim using a 3M adhesive. The purpose of the window lace is to prevent injury by the outer rim of the merry-go-round.

Handrail

The handrail is made of sixteen gauge, one inch o.d. round tubing bent into a circle with an outer diameter of two-feet. Three quarter inch square tubing with eleven gauge wall is used for the handrail supports which connect the handrail to the center pipe support. The handrail was tested with a 400 lb. vertical load.

The cost of the device was $630, excluding the bearing that was salvaged.

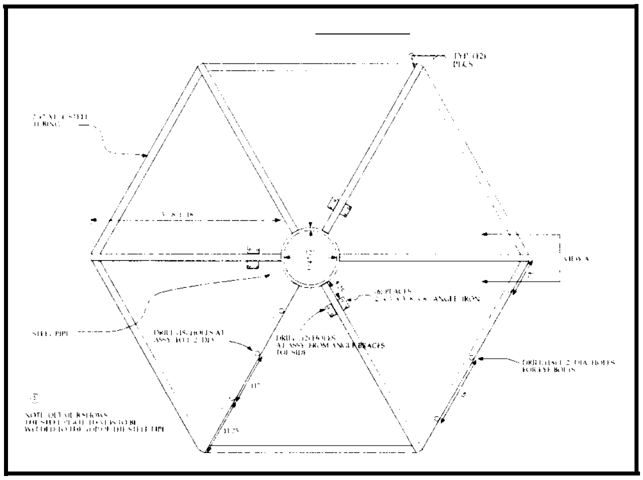

Figure 18.15. Diagram of the Merry-Go-Round for Wheelchairs.

Therapeutic Walking Device

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INTRODUCTION

The design consists of two treadmill devices on a concrete base surrounded by a wooden structure. The treadmills are made from conveyor rollers mounted on a metal frame. The metal frames are bolted together, parallel to each other, and anchored to the concrete base. The wooden structure that surrounds the conveyors is modeled after an automobile and is anchored to the concrete base and the conveyors.

The conveyors serve as treadmills for walking therapy. The student can access the treadmills by opening the doors on either side of the car. Each door is attached with two door hinges and fastened with a utility door latch. Once inside the car, the only section of the treadmill device that is exposed is a 14” x 44” area of the belt. A front wall, back wall, center wall, and door will surround the student. None of the components of the treadmill assembly are accessible. The walking level is approximately 10" above the concrete level. There is a wooden platform to stand on before getting onto the treadmill. The student can step onto the treadmill from the platform and begin walking. The conveyors are elevated at the front end off the concrete base to create a slope that will help initiate belt motion. There is a tension adjustment control mounted to the top rear of the car. The instructor can set this adjustment for each individual student’s exercise level. The tension control can also completely stop the belt motion. This adjustment is connected to the larger back return roller that is behind the inside back wall. There are two handlebars mounted on each side of the inside front wall for students to hold onto. Once in position, the students can begin to propel the belt by walking forward and holding onto the handlebar. The motion of the two belts are independent of each other. The two treadmills allow each student to exercise at their own exertion level. Each treadmill independently activates a sound and lighting system. The sound and lighting system is designed to motivate the user to exercise. The faster the treadmill is turned, the brighter the lights glow and higher sound pitch.

SUMMARY OF IMPACT

The client’s disability is the result of a head injury sustained in an automobile accident. Following the injury, the client had to redevelop his motor and logic skills. His physical condition is still slightly impaired, yet gradually improving. His motion is described as ataxic. He moves with limited control and a little off balance. His ability to walk unassisted in a normal pattern is the emphasis of his physical therapy. He can walk alone, but his movement is not considered completely normal. He tends to walk on his toes and leaning forward. His steps are strong, but slow and deliberate. This helps him keep his balance and control of his motions. As his sense of balance and coordination improves, he will walk in a more correct manner. The treadmill design provides an opportunity for walking therapy and interaction with other children. The lights and sound generated by the device help make the experience a pleasant one.

TECHNICAL DESCRIPTION

Brakes

The brakes were the main focus in the analysis performed on the device. They were to be used as a tension device, and a device to stop the motion of the belt when a person entered or exited the Pat Mobile to prevent falling. The brakes consisted of steel arcs lined with leather strips. Pressure was applied through a threaded rod connected to the arc onto the rear roller of the roller assemblies.

Sound and Lighting Description

The sound and lighting system enhances the exercise activities of the Pat Mobile. Both conveyers are equipped with identical systems. The sound and lighting system can be divided into three parts; power generation, lighting effects and sound effects.

Power Generation

A small bicycle generator is in contact with each treadmill belt. As the student walks on the treadmill, an alternating current is produced by the generator. The output voltage varies depending on the speed of the belt. The generator output is connected to a five light emitting diodes (LEDs).

Each plug is connected to a bicycle generator. The output from the generator is connected to five light emitting diodes (LEDs). When the conveyor belt begins moving, the LEDs will emit light. As the speed of the conveyer increases, the LEDs will emit a brighter light. Four of the LEDs are mounted to the face of the box. The fifth LED is mounted inside the box. This LED will activate the sound effects.

Sound Effects

The sound effects LED is coupled to a photocell. The photocell is connected to a 3909 flasher integrated chip. When the LED increases in intensity, the photocell increases in resistance. This causes the 3909 IC chip to oscillate at a higher audible frequency. The intensity of the LED will depend upon the speed of the conveyor. The output of the 3909 is connected to a 386 amplifier chip and speaker. The 386 IC is powered by a 9-volt battery. A 1.5 V D-cell battery will provide power to the 3909 IC. Since the circuits require little current, the estimated battery life is approximately six to eight months depending on use.

The cost of the device was $380, excluding the conveyors that were donated.

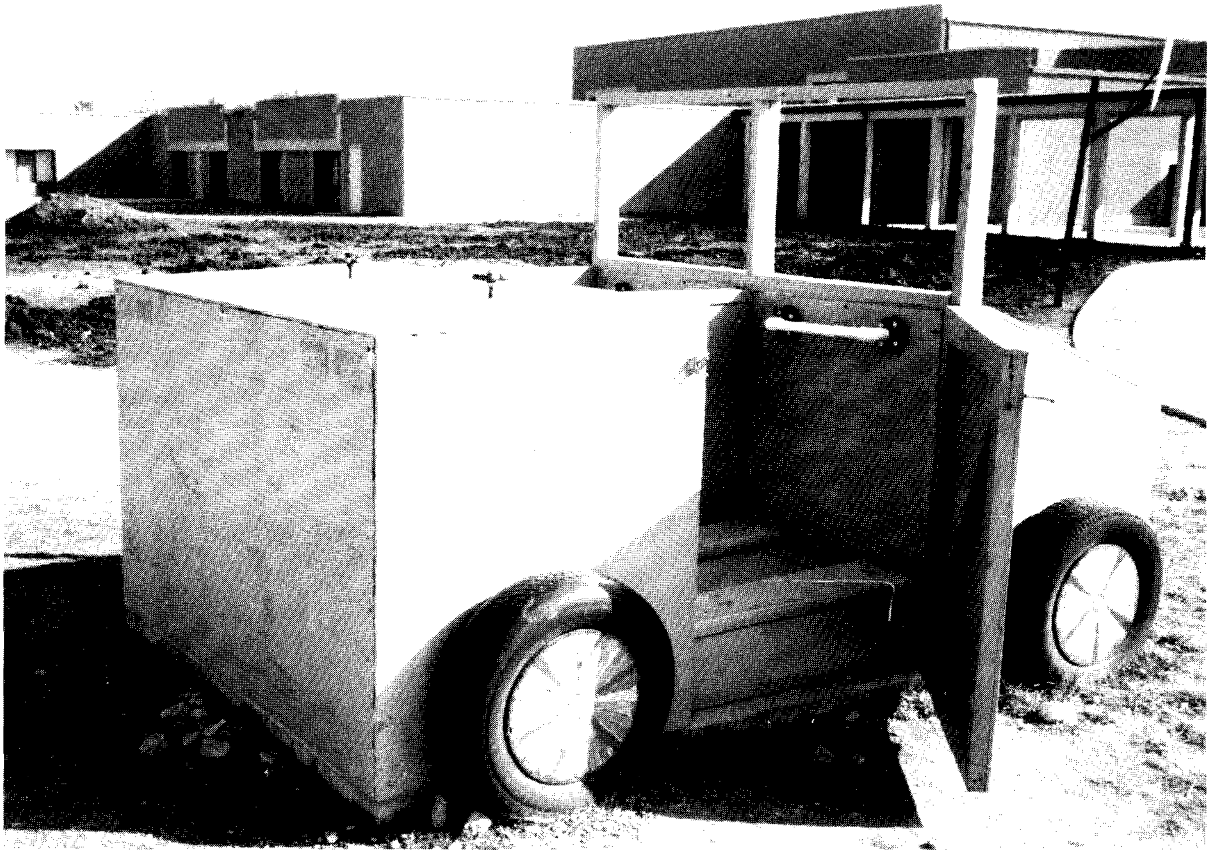

Figure 18.16. Therapeutic Walking Device.