CHAPTER 16
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WHEELCHAIR ROCKER

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INTRODUCTION

The primary goal of this project was to produce a device to provide sensory stimulation through motion using a client's existing wheelchair. Specifically, the device was designed to enable a rocking motion with comfortable rocking angles and speed. It was designed to be compatible with wheelchair ramps by following the ADA guidelines for appropriate dimensions. It accommodates a maximum weight of 300 lb., including both the child and the wheelchair. It is corrosion-resistant and operates on a standard 110-V outlet. The rocker utilizes wheelchair restraints to maintain a fixed relative position.

SUMMARY OF IMPACT

This rocker was requested for use by children with a wide range of physical disabilities. The soothing motion of a rocking chair is known to have a calming effect on irritable children. The Wheelchair Rocker was developed so children can be wheeled onto a platform and rocked without having to be transferred from their wheelchair. It utilizes industrial tie-downs to ensure safety and stability for the children.

TECHNICAL DESCRIPTION

The Rocker has four main components: 1) an aluminum square-tubular framework, 2) a motor with a linkage attached to the shaft and to the top plank of the rocker, 3) safety straps made for automotive use, and 4) an electrical control panel (See Figure 16.1). The aluminum structural framework is made from square 6061 tubing with an outer square area of 1 square inch and an inner square area of 0.5625 square inch. Welds were made using a MIG weld torch.

The volume contains six column pieces at 2.5 inches tall, four 50.5-inch pieces running the length of the rocker, and four 37.5-inch pieces running the width of the rocker. One 37.5-inch round tubular shaft with a diameter of ¾ inch is located 21 inches from the end of the rocker. This piece runs the length of the rocker and acts as the pivot axis. Another 37.5-inch square piece runs under the pivot axis and contains two 1.5-inch pieces located 13.5 inches from either side of the device. These pieces provide support for the pivot axis.

Pillow block bearings were placed 9 inches from each end of the pivot axis. These bearings attach the shaft (pivot point) to the rocking plank of the Wheelchair Rocker. The rocking plank has dimensions of 36 inches x 48 inches x .25 inches. These dimensions meet ADA requirements. The wheelchair was attached to the rocker using Sure-lok safety straps. The straps are retractable and bolted to the platform of the rocker in accordance with Federal Motor Vehicle Safety laws.

The rocking motion is created by a single-phase ¾ hp, 68-rpm alternating current gear motor that operates on 115 volts. The shaft of the motor turns in a clockwise direction, guiding a linkage that is offset from the center of the motor by 1.463 inches. The linkage is bolted to a shaft collar with a 3/8-inch grade A bolt attached to a female studded spherical rod end. The linkage has a female plain spherical rod end bearing with an ID of 0.375 inches on the opposing end. The linkage is connected to the rocking platform by a rod with threaded ends and a male plain spherical rod end that is bolted to the platform.

The linkage is made of a 7.45-inch rod that is threaded on both ends. The rocker motor is two-speed and has an external speed controller. Toggle switches determine high and low speed. There is also a stop switch. The control box is placed on the outside of the wooden paneling on the side of the rocker. The wiring, switches, and the bulk of the motor are housed within a control panel to ensure that other children do not tamper with the switches.

A key switch ensures that a staff member is present during operation of the device.

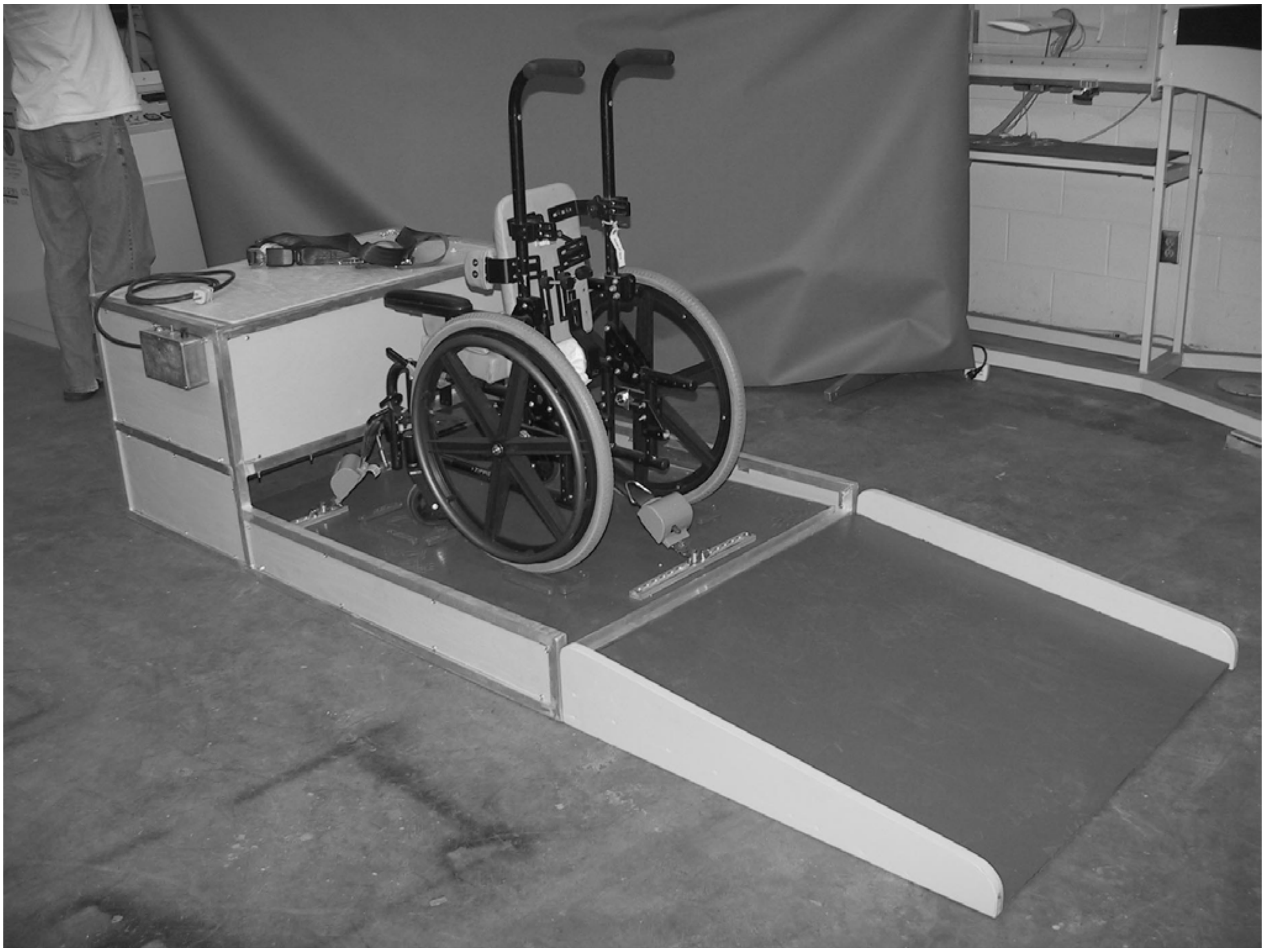

Figure 16.1. The Wheelchair Rocker.

THE DRIVER'S SEAT

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INTRODUCTION

This project is a modified floor sitter. It helps children with cerebral palsy sit in a position that enables them to play with other children at floor level. The project was designed for a child with the following measurements: 10″-15″ arm length, 7″-10″ shoulder width, and 8″-12″ seat to shoulder height. The device will accommodate up to 50 lbs. The child is secured in the sitter by a seat belt system. This system may be adjusted to increase or decrease the force needed to keep the child's back and neck in the correct position. It does not inhibit lateral, horizontal, or vertical motion of the child's arms. The device is lightweight, portable, and corrosion-resistant. It is lined with padded material for comfort.

SUMMARY OF IMPACT

A device was needed that assisted children who are unable to sit up on their own to do so. This would provide them the opportunity to play with toys on the floor and interact with their peers. The biomedical focus of the floor sitter is to control the child's pelvis by promoting neutral rotation in relation to the abdomen. This position allows no lateral flexion of the trunk.

TECHNICAL DESCRIPTION

The final design is constructed from ash (Figure 16.2). Ash is a fine-grain wood ideal for construction of small, lightweight components that require high strength. The fine grains of the wood are also ideal for preventing splintering and fracture. The sitter is sealed with a low gloss, polyurethane, non-toxic coating. This coating prevents warping and bowing associated with environmental conditions such as humidity and temperature.

A hinge and lock mechanism maintains a backboard structure capable of positions ranging from 20° (folded forward) to 125° (completely extended). The back support rotates on a set of wide-leaf utility hinges. They are swaged for mounting into panels and zinc plated to provide maximum protection against rust and corrosion. Locking pins are used to secure the back support structure at the appropriate angle. These pins are positive locking, with ball bearings that lock the pin into its receptacle. The ball, ring, spring, shank, receptacles, and spindle are all made of stainless steel.

The floor sitter is lined with a urethane padding with density of 32 kg/m3. This density retains shape and stiffness under a concentrated force of 50 lbs. The urethane is upholstered in washable vinyl. A four-point chest support strap (body point harness) along the back support structure is used to keep the spine and head erect and aligned. The straps are made from a polymeric material called Rubatex. Velcro attaches the chest support to the back support and keeps the child's pelvis correctly oriented in the chair. Metal end-fittings and slides are provided for a strong, adjustable means of attachment. Medial placement of the secondary straps secures the position of the pad and keeps the hip belt from sliding up to the abdomen. The seat belt is adjustable and locks into place. An adjustable footrest is held in place with a set of plastic dowels.

Racecar stickers were added to the final product to enhance the racing theme of The Driver's Seat. The total cost was approximately $500.

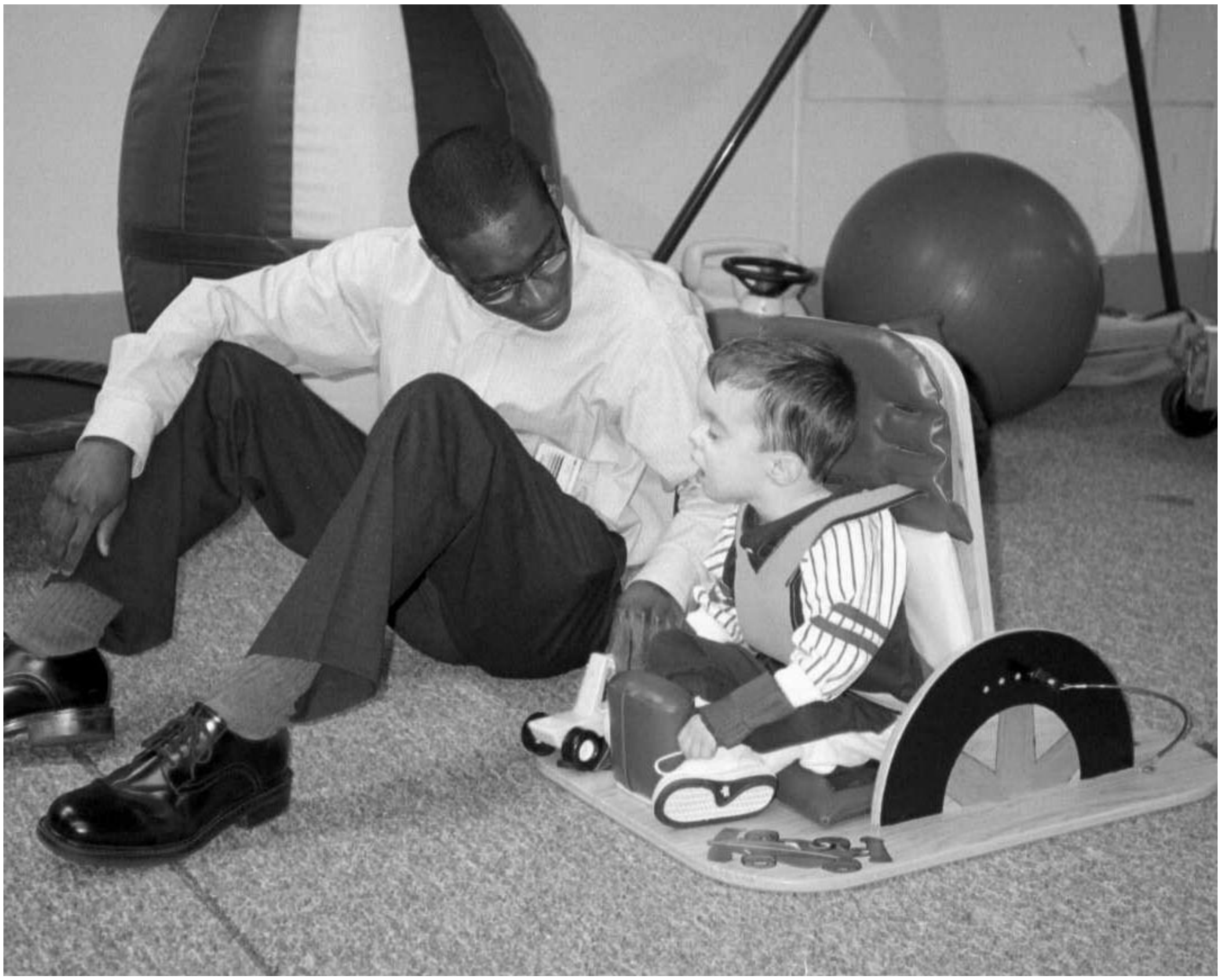

Figure 16.2. The Driver's Seat.

MULTI-SERVICE MODIFICATION TO THE WINSFORD FEEDER

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INTRODUCTION

The Model 5 Winsford Feeder is an automated feeding aid used by local physical and occupational therapists. Slight movements of the head, hands, shoulders, hips, or knees control the feeder. The original design accommodates only small amounts (1 teaspoon) of food. The therapists wanted to add components to enable the feeder to hold a larger item, such as a sandwich, napkin, or drink. The present design includes a sandwich holder accommodating sandwiches up to 2 inches thick. The napkin holder holds the napkin securely and is curved outward so it can be used comfortably. The device is corrosion resistant and electrically safe, with all the wires insulated and hidden. The arm accelerates and decelerates at less than 27.57 ft/^{s2} to prevent spillage. The additions to the feeder have a combined weight of less than 15 lbs.

SUMMARY OF IMPACT

Children with cerebral palsy, spinal cord injury, muscular dystrophy, upper extremity amputation, or brain injury may not have adequate motor control to feed themselves. The existing Winsford Feeder is the result of a mechanical engineer's dream to develop a device that such children could operate. Although it is fully functional, the original feeder requires staff members to cut the food into very small pieces. The present improvements allow a drink, napkin, or single bulky food item (e.g., sandwich, cookie, piece of pizza) to be safely raised to the mouth of the child. Giving the children the abilities to eat more diverse substances and wipe their faces with the napkin increases their independence. The device also makes feeding time quicker and more efficient.

TECHNICAL DESCRIPTION

The final design consists of an instrument box and a mechanical arm. There is a rotating circular plate with partitions for the napkin, cup, and sandwich on the instrument box. The mechanical arm engages one item and brings it forward to the child's mouth after the switch is activated (See Figure 16.3). The instrument box has two sections at different heights. The section on which the plate is mounted is 3.375 inches high. The top surface of the instrument box, which is triangular in shape, is 5.5 inches high. This extra height provides a vertical-mounting wall for the mechanical arm. The height also provides additional space in the instrument box for the mechanical and electrical system.

The plate is supported on three rollers and is rotated along a ¼-inch stainless steel drive shaft mounted at the bottom of the plate. The drive shaft enters the enclosure through a bearing assembly mounted on the instrument box. The opposite end of the drive shaft is fixed to a steel bracket and bearing assembly inside the instrument box. A cam block and pulley are mounted onto the steel drive shaft with a socket head screw. The cam block serves as the drive motor switching system, and the pulley serves as the plate rotation. The plate is made of acrylic, which is approved by the U.S. Food and Drug Administration to be used as a food contact surface. It can be cleaned using soap and water. The plate motor is mounted onto a steel bracket and drives a beveled gear system mounted on a 0.250-inch diameter shaft between two sealed bearing units. The sealed bearing units enable the rotation of the drive shaft. A timing belt connects the two drive pulleys and the idler pulley.

The arm mechanism is 9-1/2 inches long by 2 inches tall by 0.5 inch wide. It is mounted to the 45-degree vertical wall on the instrument box. It has a diameter of 0.3125-inch and is made of stainless steel. The arm rotates 130 degrees at an average angular velocity of 0.58 radians per second. The arm interior contains a drive belt that holds the arm at a level position while it lifts to the feeding position. The arm mechanism consists of a 7.7-rpm motor that drives a crank and connecting rod. One-half of the revolution of the drive motor raises the arm and the next half lowers it. The switch stops the motor after each half revolution. The torque needed to lift the arm is 400-in-oz. A motor was chosen accordingly. A .5-inch x .5-inch Type 304 SS square bar that is 4 inches long extends from the lifting arm. It is held parallel to the ground by the arm assembly mentioned earlier and will lift the holders off of the plate. A 0.365-inch x 0.365-inch square peg extends 2 inches vertically from the bar. A square tube with a nominal wall thickness of 0.0625 inch is welded onto the end of the sandwich, cup, and napkin holders. The peg on the end of the bar inserts into the tube upon lifting of the arm.

The switching control system addition consists of three single throw switches, an additional wiring harness, a six-lead system, and a four-position switch. Pushing and releasing the control switch activates the arm motor. When the arm starts to lift, the arm position switch closes to keep the arm moving. The arm stops at the top of its movement. Pushing and releasing the other control switch activates the plate motor. The gears are made of nylon. The motor for the original feeder was also utilized for this device.

Total cost of the modification was approximately $1,200.

Figure 16.3. Schematic of Winsford Feeder Modification.

WHEELCHAIR SHOPPER

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INTRODUCTION

This project provides a strong and stable carrying unit that attaches to a child's wheelchair. The device is for use with manual (non-motorized) wheelchairs. Design requirements were that the device fit a specific wheelchair (dimensions given below), have a storage capacity of at least 1.95 cubic feet (3354 cubic inches), and support at least 85 lbs. of groceries. When placed in the folded position, the shopper measures 36 inches x 36 inches x 18 inches. The weight of the device is less than 25 lbs and it can be assembled and connected to the wheelchair within 1.5 minutes. It is capable of traveling up a grade of 6% (ANSI Standard A117.1-1986).

SUMMARY OF IMPACT

Parents of children who use wheelchairs are in need of a device they can attach the children's wheelchair to make shopping an easier experience. Currently, many of these parents have to push their child in front of them and pull the shopping cart behind them. This is difficult for the parents, and the wheelchair shopper will eliminate this problem. There are also financial benefits because the parents do not have to hire a sitter to stay with the child while they go shopping. The wheelchair shopper also allows parents to spend more time with their child.

TECHNICAL DESCRIPTION

The device is for use with manual (non-motorized) wheelchairs with the following dimensions: maximum weight = 50 lbs, height from floor to handlebars = 34 - 38.5 in., inside distance (width) between frame rails = 9 - 11 in., outer diameter of rear wheels = 12.5 in., frame tubing outer diameter = 1 in., wheelbase (center to center) = 18.5 in. The final design incorporates a rigid frame and a basket (Figure 16.4). Two symmetric sides of the frame are constructed from round 1026 steel tubing. The tubes are welded at the joints. The two sides are connected with a folding brace comprised of ball joints and connecting rods. They are separated by approximately 10 inches in the front and 20 inches in the back.

Two 4-inch caster wheels are mounted at the rear, one wheel per frame side. The top bars have two purposes. They serve as a "steering wheel" used to push the wheelchair, similar to the handlebars on the wheelchair. They also serve as a place to hang grocery bags. The vertical tubes, one on each side, provide a place to mount the rear caster wheels. These wheels act as anti-tipping mechanisms. The entire frame is mounted so that no more than 0.5 inches exists between the bottom of the caster wheels and the ground.

The shopper extends into a clamping mechanism installed and adjusted by National Seating employees. The mechanism does not interfere with the normal operation of the wheelchair while the basket attachment is not in use. The clamp has a 3-inch tube extension that is butt-welded to the mounting blocks. The inner diameter of the each tube has a 50 thousands tolerance between the outer diameter of each of the 3-inch tube extensions. This tolerance provides room to slide the tubes together.

The basket is made of a rubber-coated polyester with rip-stop protection. This provides weight savings and the ability to use quick clamps to attach the basket. These quick clamps use 1-inch cotton straps to attach to the nylon quick clamps. There are three connection straps on both sides of the basket. The corners are double stitched to retain the strength of the polyester.

Total cost of materials was approximately $448.46. The total cost of assembly and construction was approximately $420.00.

Figure 16.4. The Wheelchair Shopper.