CHAPTER 9
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Mechanical Feeding Device

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INTRODUCTION

Arthrogryposis Multiplex Congenita is a congenital condition that affects the function of joints, particularly elbows and knees. This disease often leads to a condition commonly known as anklosed elbows, which has resulted in our client having limited use of his arms. Because of this limited ability, simple daily routines such as eating are difficult for him to accomplish. Eating is often a very tedious, dependent process for our client who does not have access to an expensive commercial feeder and who requires the help of another person. In addition to self-feeding, our client's requirements also included that the feeder not call attention to him during public use. The feeder designed in this project serves simply to elevate a utensil holding the food to a comfortable level so that the user can independently eat a meal.

SUMMARY OF IMPACT

Before the delivery of our feeder (see Figure 9.1), our client was assisted by his mother at all meals. He is now able to feed himself most foods at home and in public places without calling attention to his disability. He and his mother have both expressed great satisfaction with the feeder. Our client has a newfound feeling of independence that he maintains will positively influence his attitude toward the aspects of daily living.

TECHNICAL DESCRIPTION

The general functional design of the feeder consists of a carriage and utensil holder that can move up or down a tubular upright via a spooled wire cable fixed to a reversible 12 VDC motor. The available power source for the motor is either transformed household current or an internal rechargeable battery.

The electrical components of the design consist of a reversible 12VDC motor, battery, recharger, a double-pole, double-throw (DPDT) switch and an on/off switch. The diagram in Figure 9.2 illustrates the placement of these components.

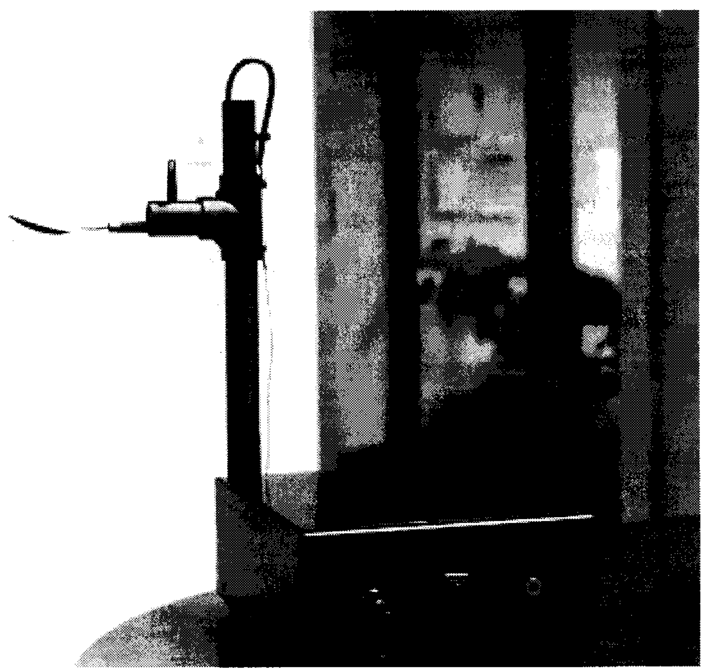

Figure 9.1. The Mechanical Feeding Device.

The motor was selected in order to achieve a food delivery rate characteristic of typical eating motions. The gearhead motor is rated at 80 rpm and 30 oz-in torque, and the final speed of the utensil carriage is determined by the combination of motor rpm and cable spool diameter. The motor is powered by a sealed lead-acid rechargeable battery rated at 2.2 amp-hours or via transformed household current. The portable source was chosen to provide enough power for three meals a day on a single charge. The recharger was selected to give a full charge to a completely drained battery overnight. To ensure safety during recharging a circuit breaker was installed.

Two switches control the operation of the motor. A DPDT momentary contact toggle switch is used to reverse the polarity of the current to the motor and move the carriage up or down. The on/off rocker switch is included in the circuitry in order to prevent the battery from unnecessarily discharging.

A nominally 3-inch diameter aluminum drive spool transmits the rotary motion of the motor to the vertical motion of the carriage. Wire cable is attached to the top and bottom sides of the carriage and routed through cable guides and the tubular upright onto the drive spool in a closed loop. The cable is wrapped around the spool three times in order to take up tension and slack. This connection allows the carriage to move up when the motor turns one direction and returns the carriage to the loading position when the motor direction is reversed.

The motor drive and battery are mounted on a 3/4-inch sealed plywood base. The housing is made of 1/8 inch anodized aluminum sheet. The tubular upright is made of l-inch diameter steel pipe and is mounted to the housing with a modified plumbing fixture.

To meet our client's needs, the utensil holder is designed for easy removal of the utensil from the carriage. This allows our client to load the utensil himself. The holder consists of a PVC tube into which the utensil handle is placed and a thumbscrew that is tightened down to hold the utensil with added stability. An interlocking guide is located on the top of the utensil holder to ensure that the utensil remains upright when the holder is placed into the carriage.

Total cost for materials used in the automatic feeder was $125.

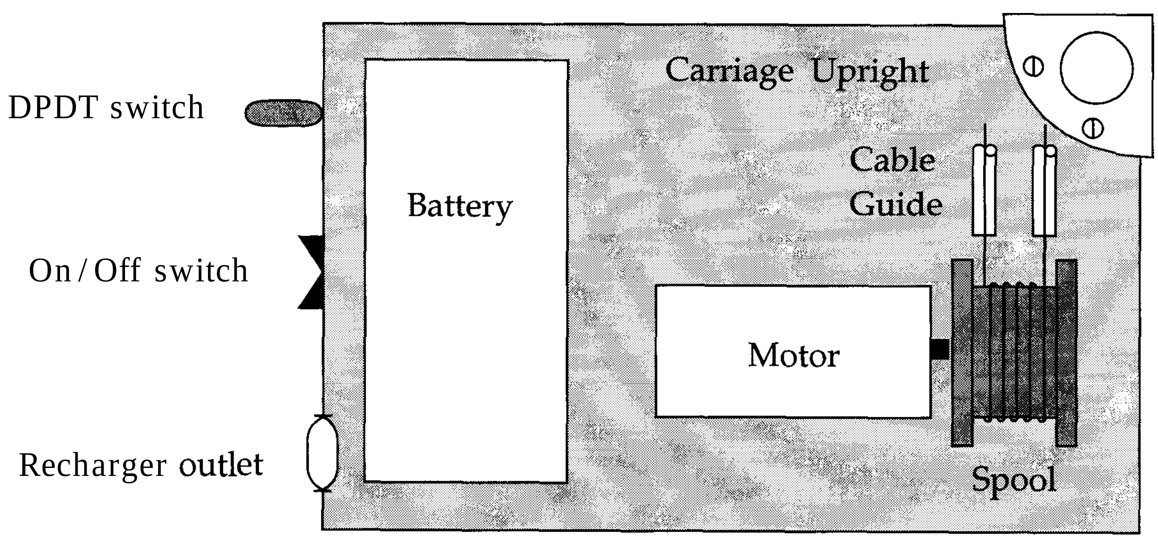

Figure 9.2. Conceptual Diagram of Internal Components.

Wheelchair Seating Simulator for Evaluation of Proper Positioning

Designers: Paul Jeffords, Angela Smith, Giang Nguyen, Greg Tombragel
Client Coordinator: Eileen Bohan, Children's Hospital @New Orleans
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INTRODUCTION

Pediatric seating evaluations are frequently performed to meet the positioning needs of clients with a variety of diagnoses. Wheelchair seating evaluations determine the need for appropriate insert hardware including, but not limited to: lateral trunk supports, medial and lateral pelvic positioning guides, anterior chest supports, multi-adjustable head supports and seat and back inserts. Simulators are often used to determine the desired combination of seating components, and provide the therapist team with the technical information required for the assembly of an individually designed seating system. The problem is that the commercially available wheelchair seating simulators are too expensive, sometimes costing as much as $20,000.

SUMMARY OF IMPACT

Proper pediatric seating and positioning enables children to have increased comfort, an optimum position for functioning in a home or school environment, improved endurance as a result of upright and midline positioning, and independence in self-care. This proper seating can be accomplished by implementing a wheelchair-seating simulator in seating evaluations. Our simulator, shown in Figure 9.3, includes fully adjustable positioning components to fit children ages 2-16. With these adjustable positioning components, the simulator is capable of being custom-fitted to each child to meet his or her specific positioning needs. The therapists at Children's Hospital are currently using our simulator in their seating clinic with satisfactory results.

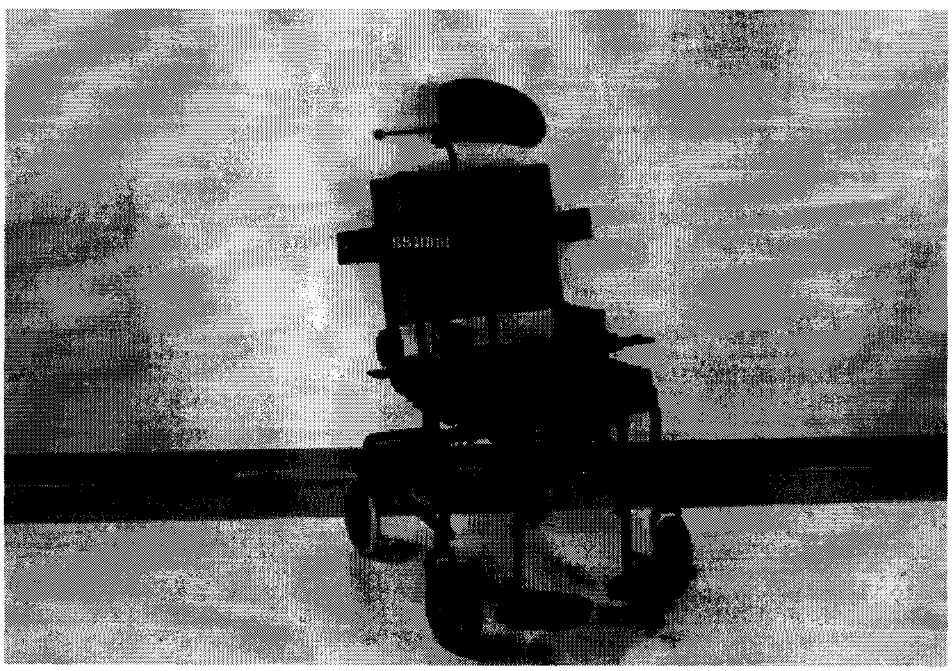

Figure 9.3. Wheelchair Seating Simulator.

TECHNICAL DESCRIPTION

Customer Requirements: The key customer requirements of this wheelchair seating simulator were that it fit children ages 2-16, tilt 30” from the horizontal, recline 30” from the vertical, and have fully adjustable components in the three major anatomic planes.

Chair: A used wheelchair was obtained that performed the necessary tilt and recline functions. The wheelchair was adult size, contained a headrest and footrests, and contained no torso positioning components.

Components: Designing around the existing frame and using anthropometric data for 2-16 year old children, the lateral pelvic guides and lateral trunk supports were developed. Beam deflection analysis was performed on the longest sections of the components that could potentially experience high forces from spastic patients. It was found that 1/4-inch aluminum provided acceptable deflections that did not cause the metal to yield. Both the lateral trunk and lateral pelvic supports adjust to fit from the anthropometric 5th percentile for a two-year-old to the 95th percentile for a sixteen-year-old.

An abductor pommel was also designed out of 1/4-inch aluminum. The existing headrest and footrests were modified to accommodate a larger range of sizes. Removable seat and back inserts were fabricated to allow for the proper positioning of small children. An adjustable anterior chest support was added to support the shoulders, and brakes were added to the rear wheels for stability while positioning.

Seating: A typical seating session includes engaging the brakes, adding the necessary seat and back inserts, seating the child, attaching the anterior chest support, positioning the lateral pelvic guides, abductor pommel, lateral trunk supports, and positioning the headrest and footrests. This series of steps occupies 4-7 minutes.

Cost: The total cost of this seating simulator was $410.

Redesign of a Standing Chair for a Quadriplegic

Designers: Douglas P. Kraus, Jr., Charles J. Schmidt, III, Luana Taylor, Melissa Boyd
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INTRODUCTION

This project involved the redesign of an existing standing chair prototype for a 22 year-old quadriplegic Tulane student. The standing chair was meant to take our client from a sitting to a standing position in order to improve his circulation and organ functions. The chair prior to redesign was mechanically functional, however, the supporting padding and restraint devices which actually held our client were inadequate to prevent him from sliding out of the chair and required modifications to be of use.

SUMMARY OF IMPACT

The chair, shown in Figure 9.4, which tested successfully with our client, reduces venous pooling and improper organ settling resulting from being confined to a sitting position. Furthermore, the chair eliminates the need for several people to hold him in a standing position. The greatest benefit of the chair, however, has been the psychological boost it has given our client. He can now stand without the aid of others, something he has not done on his own since the age of seventeen.

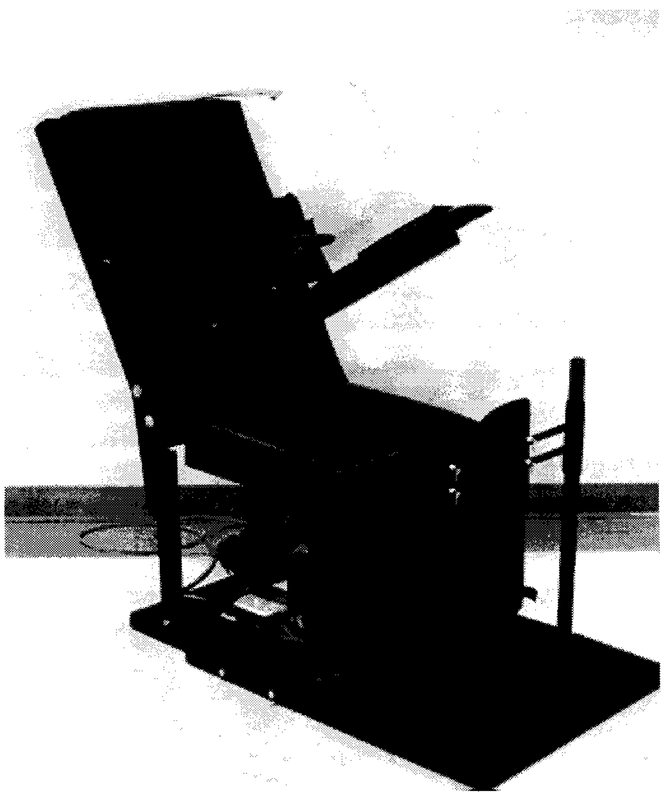

Figure 9.4 Standing Chair for a Quadriplegic.

TECHNICAL DESCRIPTION

Chair: The chair itself was fabricated using 1 1/2" x 1 1/2" steel tubing welded to form the seat back, the seat, and the chair frame. The seat back was connected to the seat and the seat was connected to the frame using a continuous steel hinge with a 1/4" pin. To provide further support to the seat back, hinged steel bars were added to each side. An electric 24 VDC screw type linear actuator, rated for 880-lbs. thrust, was fixed between the base and to the bottom of the seat. This actuator provided a force against the bottom of the seat that allowed the chair to reach a standing position in approximately 5 seconds. The motor was powered via transformed household current. A restraining cross bar was incorporated into the chair frame in order to absolutely prevent the chair from extending past a 65“ angle. Beyond this angle the efficacy of the seating system was reduced and the possibility of chair instability became a concern.

Seating system: The seating system components consisted of a padded chest harness, raised handrests, a locking steel cross bar with knee pads, ankle straps, and a non-slip base plate. By limiting the chair angle and the maximum displacement of the chair, all of our client's weight was directed along the chair seat to the kneepads.

In order to prevent our client's feet from slipping, 2” wide Velcro@ straps were wrapped around each ankle, and an expanded steel mesh was attached to the floorboard.

The chest harness prevented forward or lateral movement of the torso without restricting pulmonary function. It was made of 2” thick padding and nylon belting.

Operation: The chair may be raised 1 of 2 ways. A manual up-down switch located on the backrest of the chair allows an attendant to raise or lower the chair. A sip and puff switch and mouthpiece located at the top of the backrest allows our client to control the actuator. Both of these switches are powered by the same 24 VDC supply that drives the linear actuator.

Cost: The total cost for the standing chair was approximately $400.

Portable Automatic Door Opener

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INTRODUCTION

Currently there exist many different devices that assist physically challenged or wheelchair bound people by opening and closing doors. However, these devices are generally only present on main doors in select public facilities. In order to increase accessibility for those who need assistance in door opening in other areas such as the home or office, a portable, automatic door opening device was developed.

SUMMARY OF IMPACT

While there currently exist many different types of door openers to aid the physically challenged, most are designed to operate on one single door throughout the entire working life of the device. The patient's quality of life could be significantly improved if they had access to a device that could easily be moved and installed on any door,. The door opener described herein (see Figure 9.5) was designed with the general population as the customer base. In order to maximize the potential application of this design, the functional requirements to be satisfied included installation with a minimum of tools and expertise, portability, adaptability to door sizes, and activation via motion detection in order to provide accessibility to even the most restricted user.

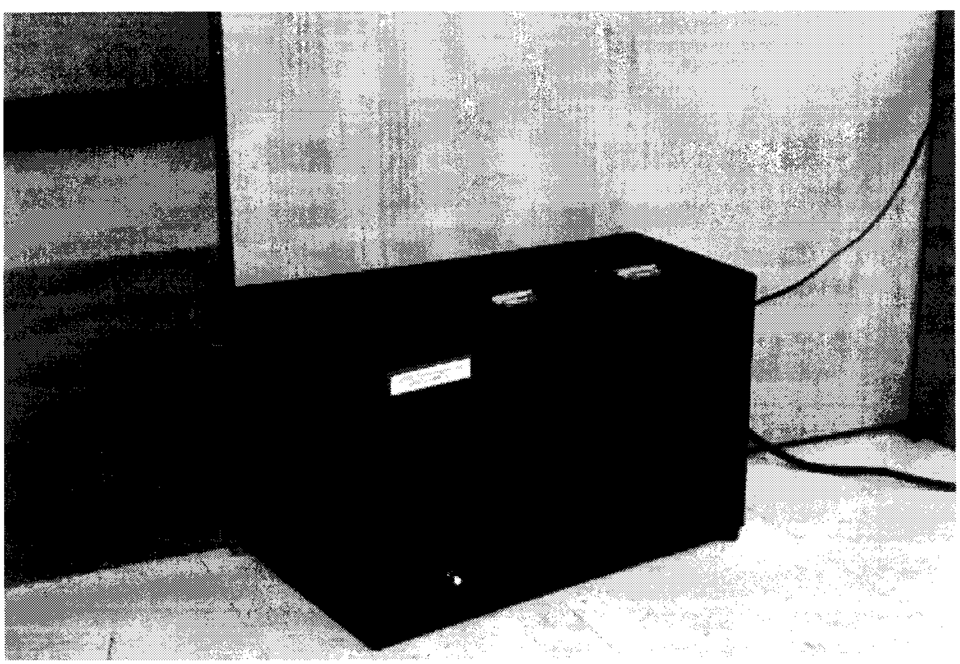

Figure 9.5. Portable Automatic Door Opener

TECHNICAL DESCRIPTION

Power train: The portable automatic door opening device, shown in Figure 9.6, operates on a reversible 1/20 HP, 90 volt DC motor, powered by rectified 110V AC, 60hz, which drives a 1/2" steel shaft and a 6" diameter non-pneumatic rubber wheel which is in contact with the floor during normal operation. The steel shaft is mounted through two pillow block bearings on aluminum brackets supported by a 11.25 x 18 x 3/4" reinforced plywood base. The base is angled at 8" to facilitate door motion.

Door Attachment: The device can be easily attached to any door by the use of hook and loop fasteners (Velcro@). Approximately 200 square inches (20" x 10") of Velcro@ is applied to the lower base of the door by the user. This interfaces with the Velcro@ already present on the back face of the device. The device is mounted a specified distance from the hinge axis on an angle to provide a circumferential path for the wheel about the door hinges. The entire device is encased within an attractive custom molded plastic case that permits access to the manual controls while keeping the wiring and all moving parts secure.

Circuitry: The door opener is powered by 110 volts AC at 60 Hz. It is activated when a signal is sent from either of the motion sensors to the motor. The motor current is supplied and is controlled by a 90 volt DC speed control unit. The duration of motor activation that corresponds to the length of time the door opens and closes, is controlled by two timer relays. These timers operate on a 12-volt DC control signal generated by a 12-volt power supply. This supply also activates a relay that reverses the polarity of the motor circuits, to reverse the direction of the motor to close the door. Limit switch circuitry exists to turn off all power to the device, and thereby may be used to provide safety-sensing capabilities.

Manual Operation: Any user can easily operate the device. The manual controls consisting of the main power switch, door speed control, and opening and closing time controls are accessible via an easy access flip-top door located on the top edge of the front panel. Once the power switch is turned to the "on" position, the door will run a test cycle, allowing each individual user to adjust the controls as necessary for custom use. After approximately one minute, the device will begin operation when a motion signal is detected.

Cost: The total materials cost of this device was $330.

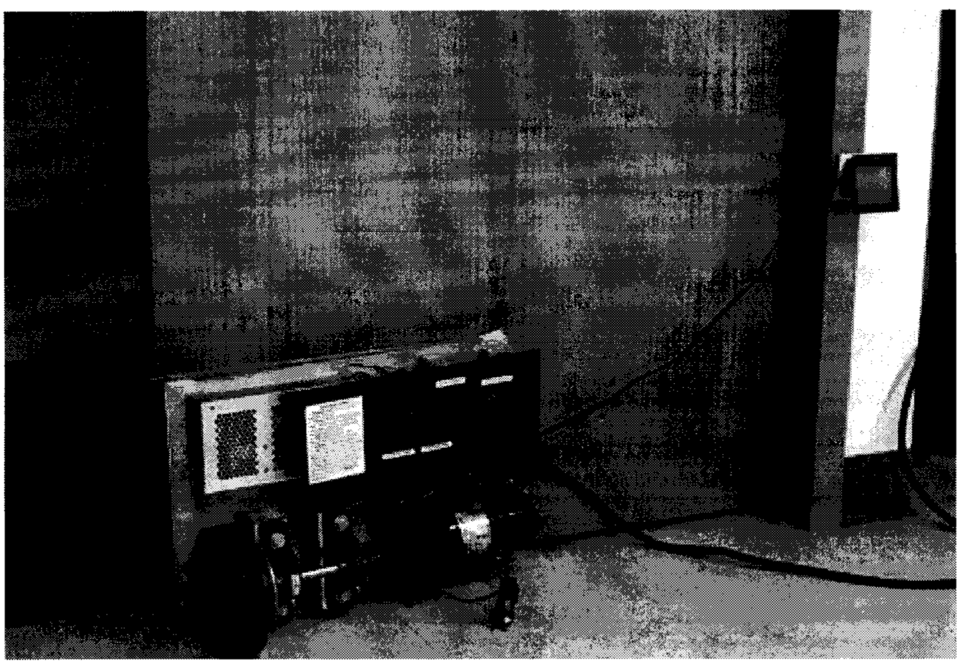

Figure 9.6. Internal Arrangement of Door Opener Components.

A Carnival Game for Quadriplegic Children

Design Team: Do Nguyen, Edith Haber, Vince UyBarretta, Jose Torres, Dung Tran
Client Coordinator: Nora Steele, L.S.U. School of Allied Health
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INTRODUCTION

Each year, the Louisiana State University School of Allied Health hosts a weekend camp for their patients, which includes a number of quadriplegic children. One event at this camp is a carnival. Previous carnivals included games in which the quadriplegic children can not truly participate. For example, one previous game involved these children only by having them guess which car on a racetrack will cross the finish line first. Accordingly, our design provides an interactive game for these children, which will increase their self-esteem by allowing them to participate in the carnival. The game incorporates a special breathing apparatus to allow the children to control the cars on a racetrack.

SUMMARY OF IMPACT

The carnival game shown in Figure 9.7 is currently undergoing product evaluation. The game consists of a modified flow meter used to control the speed of HO scale racecars on a standard toy racetrack. This arrangement will not only allow the children to actively participate in the events of the carnival, but also to compete with each other. Both activities were felt to be psychologically very beneficial. Additionally, by employing a controller based on respiratory function, the children will receive valuable and self-motivated therapy. The final version of this design will meet the goals of delivering an inexpensive game for use in a carnival setting as well as providing parents with a design that they can execute easily to produce a similarly modified racetrack for home use.

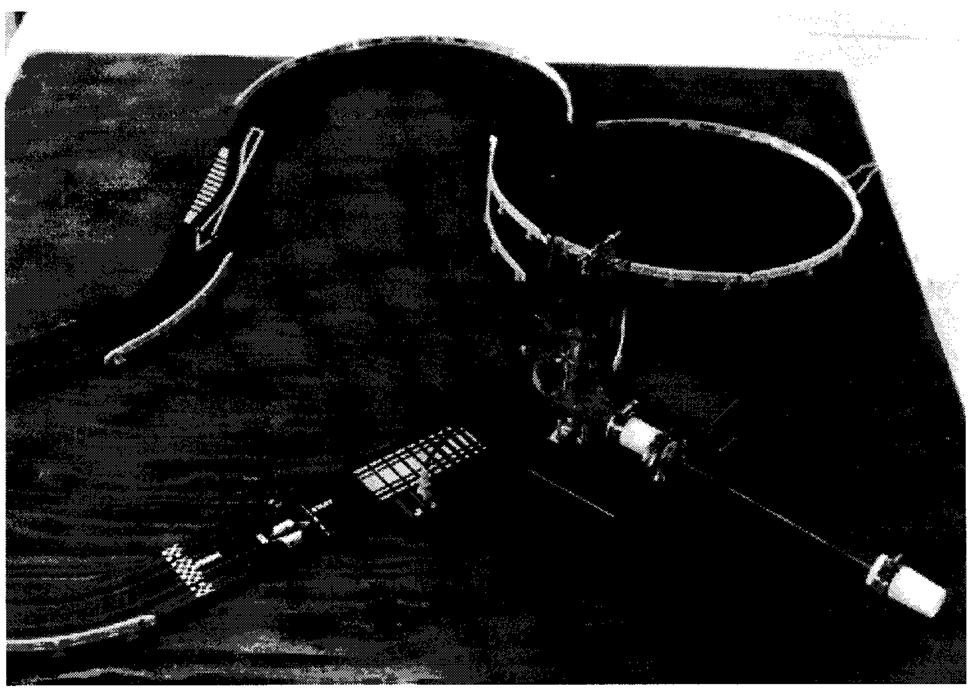

Figure 9.7. The Carnival Game for Quadriplegic Children.

TECHNICAL DESCRIPTION

The game consists of a standard HO scale racetrack and cars, a 120 VAC to 20 VDC transformer, and a modified ASSESS@ low range peak flow meter controller **that** acts to vary the current supplied to the motors.

The as-received flow meter consisted, in part, of a piston-like rectangular plastic slider that travels up a stainless steel guide pm in a rectangular graduated channel when air is blown through the flow meter. The plastic slider is fixed to the steel pm by a low-rated coil tension spring that returns the slider to the zero flow position. The flow meter has a relief hole in the body of the device that **can** be opened or closed to regulate the effort required to move the slider in the graduated channel. Breathing tubes are easily attached by adapters that can include m-stream filters to minimize contamination of the flow meter. These protective filters were left intact in the final design.

The modification of the flow meter involved chiefly the addition of a 2-inch long, coiled wire, variable resistor in order to regulate current to the track. The coiled wire resistor is fixed to the outside of the graduated channel with insulated standoffs and is oriented along an existing vertical slot in the channel. A copper wiper is fixed to the slider and passes through the slot to make contact with the resistor. A wiper guide parallel to the resistor coil serves to assure contact. Electrical contact is made between **the** wiper and the return spring such that wire leads are attached to the coiled wire resistor and the fixed guide pin. Thus, when the participant exhales and moves the slider up its guide pm, the wiper travels along the resistor, thereby varying the resistance and motor current.

The entire modified flow meter apparatus is housed in an acrylic tube to prevent user contact with the electrical and mechanical connections.

A five pm plug terminated the output leads to facilitate the interface between the game and eventual multiple users.

The total cost of the game and flow meter was $180.