CHAPTER 15
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PORTABLE SWING SET

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INTRODUCTION

A child day care program for children with cerebral palsy requested a portable swing set for indoor use by children ages two through four. The device should be easily assembled and disassembled, and easily transported by staff members traveling in a minivan. Design requirements included that it:

- Meet all appropriate playground equipment standards,
- Provide for translational swinging,
- Accommodate interchangeable seating, including a hammock seat,
- Have no individual section over eight feet long, and no component wider than 13 inches, and
- Enable assembly in less than five minutes.

Use of this product is restricted to children under 43 pounds.

SUMMARY OF IMPACT

The child day care swing is being used in early intervention service delivery in satellite programs which involve visiting rural locations. Although the primary users are children age three and under with disabilities, it has also been put used by a preschool program for children age three to five, with and without disabilities between. The swing has enabled the therapists to provide state-of-the-art therapy techniques that require suspension equipment. The satellite programs have limited space and almost no equipment for therapists. While the main center has suspension equipment, it is in one area only. Having the portable swing means that more than one child at a time can benefit from use of the swing in different locations. The device meets the specifications given.

TECHNICAL DESCRIPTION

The completed device is shown in Figure 15.1. The top support bar is AISI 1020 cold drawn steel tubing, 2-in. diameter with 0.065-in. wall thickness. It attaches to the upper leg units via two assembly fixtures, consisting of three tube pieces, welded together and reinforced with a gusset plate made of 1/16-in. steel sheet. Four upper leg sections and four lower leg sections consist of 1.5-in. diameter tubing with 0.065 wall thickness, and are each 41-in. long. The legs attach at joints where a 1.75 in. diameter tube is welded to the lower leg unit, which slips over the upper leg unit and locks in place with quick release pins.

The suspension system consists of a climbing rope (yield strength = 3000 lb.) and caribiners (yield strength = 2500 lb.). A hammock swing, a "Teddy Bear Swing," and a ratcheting system were purchased from established vendors. The entire swing set is disassembled and transported in a carrying case, a plastic golf bag on wheels, which easily holds the disassembled components.

The constructed device was tested according to ASTM 1148, which specifies standards regarding loosening, instability and structural failure. More specifically, the swing set is stable on a 5-degree slope in line with the swinging elements and withstand lift-off for a 43-lb. (95th percentile in weight) four-year-old boy swung in a 90-degree arc. The top support bar withstands a static load of 1.5 times his weight for 5 minutes. Each swinging element withstands a dead weight of 105 lb. swinging through 90 degrees. Seats, seat hooks and swing space are all specified in the ASTM standard.

The device is painted, which makes it attractive.

The total cost of the swing set was approximately $1,260.

Figure 15.1. Assembled Swing Set, Shown with Hammock Seat Attached.

THE POWER-ENHANCED ENTERTAINMENT TABLE

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INTRODUCTION

This table was requested for the use of eight clients with physical disabilities who live in a group home. There was only one table in the facility at which all clients could sit. It was so high as to preclude any group of more than two people successfully engaging in a joint activity when seated around it. This was a serious limitation to any group engagement, a problem in a setting where clients tended to stay isolated in their rooms or in front of the television. The new table allows multiple client use and interaction. It is painted to be attractive. The completed device is shown, along with users, in Figure 15.2.

SUMMARY OF IMPACT

The Power-Enhanced Entertainment Table (PEET) has enabled group engagements because of its height adjustability, cutout area on one side, and open area underneath. Groups ranging in size from two to eight people can sit at the table to play various tabletop games and engage in a variety of craft activities. The adjustable height switches allow the clients to change the height of the table independently during a game if one person needs to see or reach the surface more easily. The wheels on the table allow it to be moved easily to any location within the living quarters. Having the table means that staff members are able to offer activities and recreational pursuits to groups of clients, which facilitate social interaction and group planning. It has given community groups who come to the group home an area in which to work with clients.

The table is lightweight and attractive. The surface can be easily cleaned. The designers of the table put position sensors into the table that enable it to sense when it is nearing a person's lap and then stop. This feature prevents any pressure on a client's body or wheelchair. The large, easily depressed switches that control the table's height can be adjusted using the loc-line attachments. These attachments are troublesome, however, as the loc-line links are too long and flimsy, causing them to droop almost to the floor at times, where it is difficult for clients to reach them.

TECHNICAL DESCRIPTION

The tabletop is made of two pieces of ¾-inch birch plywood (60 in. x 30 in.) coated with Minwax Polyurethane Sealer and Protector. There are two armrests located on each side of the client. Structural support is provided by four 30-in. A36 steel C-channels (4 in. x 1.72 in. x 0.321 in. thick). Two pieces support the tabletop while two pieces comprise the base on which the actuators and the casters are mounted. Constructed to meet the design standards as established by ANSI/BIFMA X5.5 1998, it was made to withstand a functional load of 200 lb., and a proof load of 300 lb.

Dayton 115V AC linear actuators (load rating = 500 lb., retracted length = 20.25 in., travel distance = 12 in.) move the table up and down, and are fixed within telescoping tubing and bolted to the channel steel at the tabletop and base. Power is distributed to the actuators through a 12V DC power supply and solid-state relay switches. The base was equipped with urethane casters (4 in. diameter, 154-lb. load capacity). Two of the casters are equipped with locks to hold PEET in place.

Ablenet jellybean buttons (green and red) are used as the up and down controls. The buttons are attached to the table by Loc-Line modular hoses that are sturdy enough to suspend the buttons for access

by the clients, yet flexible enough to be easily adjustable to different heights.

A sensor system was added to prevent the table from lowering down onto the legs of the client. The Sick Optic VS/VE18/DC through-beam photoelectric sensor is positioned by a bracket located 2 in. below the table surface. Once the beam is broken the actuators stop lowering.

The total cost of the device was $1,538.

Figure 15.2. The Power-Enhanced Entertainment Table (PEET) and Users.

THE POKECART: A THERAPEUTIC HAND DRIVEN CART

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INTRODUCTION

A toy car or cart, the Pokecart, was designed for children with cerebral palsy to drive with only their hands. The desired outcomes include the following: entertainment increased upper body strength, increased cardiovascular endurance, mobility and motorization, enhanced cognitive abilities, and encouragement of neutral hand grasp a neutral upright posture.

SUMMARY OF IMPACT

The Pokecart was just delivered, so a full summary of its impact is not possible. This cart is intended to increase the strength of both upper limbs in children who have asymmetrical arm impairment due to cerebral palsy. Typically such involvement leads to minimal use and subsequently limited strength in the more impaired arm. The Pokecart was designed so that both arms must be used to make it go. The children who use it will develop greater strength and grasp, and have the ability to explore their environment in a way they have not before. Increased environmental exploration and use of the cart should increase cardiovascular status and respiratory capacity. A secondary gain of this exploration will be increased problem-solving and cognitive skills.

TECHNICAL DESCRIPTION

The general design is a tubular aluminum frame (length = 32 in., width = 28 in.) supported on either side by a 20-in. bicycle wheel. 6063-T4 aluminum tubing (o.d. = 1.66-in., thickness = 1/8-in.), has a higher strength-to-weight ratio than steel, is readily available, is inexpensive, has good weldability and is ductile enough for bending. The sides are made of two lengths of tubing each, bent to 90° to make each of the four corners. The two lengths of tubing on each side are cut at an angle and welded together to form an apex angle of 136° about 1-in. behind the wheel shaft. A triangular bracket made of 3003 1/8-in. thickness, aluminum sheet with a predrilled hole is welded to the frame at the bend so that the wheels can be bolted onto the frame at the wheel shaft. The two side portions join to a length of tubing that widens the cart with four 3-way 6061-T6 aluminum tees and sets of stainless steel hex head bolts and acorn nuts. The frame also has two straight pieces of tubing that join its front and the back. This tubing forms the support for the seat. These are connected to the outside frame by the perpendicular outlet of the four 6061-T6 aluminum 3-way tees—two for the front and two for the back lengths of tubing. All of the fittings are bolted to the incoming tubing using three sets each of hex head bolts and acorn nuts.

The maximum load carrying requirement for the cart was 129 lb. Stress analysis showed that all of the stresses on the cart were very small (less than 150 psi) compared to the strength of the material, 13 ksi. The maximum shear stress on the bolts is 118 psi, (< 30 ksi yield strength of 316 stainless steel bolts). The stress at the bracket weld and the force required to move the cart were also calculated. The shear in the weld was found to be 132 psi when fully loaded. The allowable stress is 0.4 times the shear yield stress. The shear yield stress of 6063 aluminum in the annealed condition has a value of 10 ksi.

Two 2-in. casters are attached to the frame, one on the front piece of tubing and the other on the back, to ensure stability and prevent tipping. The cart generally rests on the front caster because the center of gravity is located in front of the wheels. The force required to move the cart was calculated as 1.5 lb. This is acceptable since the average force that the children are capable of applying is 2.2 lb.

The driving mechanism of the cart includes two crank and gear systems, one for each wheel, similar to that of a bicycle. It is made up of two gears and a roller chain. The handles, which were machined from bicycle pedals, screw into the end of the crank arms and face the inside of the cart. The crank arm makes a 7-in. circle as the user turns it. A gear cover houses the gears and chain.

A prefabricated seat with the desired dimensions and seat belts already installed was purchased through Abilitations®. An additional seat belt is added at the children's hips or the tops of their thighs. The seat is attached to the frame with a series of two bolts and piece of aluminum sheet metal with two slits extend along the length of the frame, so the seat position can be adjusted. The final desired position of the seat is locked into place using wing nuts. Footrests (from National Seating®) are attached to the front tubing between the two central lengths of tubing that the seat rests upon.

The wheels are bicycle wheels. Therefore they require some type of covering to prevent the children's hands from getting caught between the spokes. Custom-made spoke covers, commonly used on wheelchair wheels for users that play sports, were purchased from Durable Medical®.

The finished cart is painted bright yellow and a royal blue canopy is attached. This canopy is made from flag material that is easy to wash. It is also easily removable, so the teachers can put the children in the cart more easily. Pokémon® stickers add to the playful nature of the cart, which is shown in Figure 15.3.

Figure 15.3. The Pokecart, Shown with Removable Canopy in Place.

ADJUSTABLE HEIGHT COMPUTER TABLE

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INTRODUCTION

An adjustable keyboard computer table was requested for a group home for adults with cerebral palsy. The existing computer table could not accommodate varying wheelchair heights and the keyboard was fixed in a stationary flat position. In addition, the monitor was stationary and could not accommodate patients with various visual problems. The present design allows the table to translate vertically for wheelchair height adjustment, while the keyboard pivots to allow for the patients' ease of use. These movements are electronically controllable by the clients via large buttons. Also, the monitor is manually adjustable to slide on the tabletop to a position where the monitor face is flush with the edge of the keyboard.

SUMMARY OF IMPACT

The home has eight residents between the ages of 24 and 65 years with varying physical disabilities. A computer was recently purchased for this facility with the goals of:

- Allowing individual client use for personal business such as letters and possibly check writing,
- Recreational use by playing games, both individually and in groups, and
- Eventual use of the Internet for communication via email and investigation of resources.

With the wide range of client size and visual status, it was difficult for all persons to use the computer without extensive staff involvement. The adjustable height computer table has given virtually all clients access to the computer by:

- Allowing the table height to be customized to client needs,
- Providing keyboard adjustability from the flat surface to an angle for better access and visibility, and
- Enabling the monitor to be moved closer for persons with visual impairments (a majority of the home's residents).

Since the table was delivered, two residents previously not interested in the computer have begun using it. The four clients who were using the computer before have found it easier to see the screen and reach the keyboard. Persons with hand use and reach have been able to adjust the monitor themselves, and all can adjust the keyboard angle without assistance. Table height adjustment has been left to the staff, since there is no sensor on this table to stop the heavy table when it comes near clients.

This table meets most of the specifications. The range of height adjustability will work with virtually all current clients and probably most in the future as the resident population changes. The keyboard and monitor adjustments have made a big difference in visibility. The switches work well, but the attachments are problematic. The loc-line pieces are not stable. The designers put rods in part of the loc-line to hold it stable, but the placement of the rods prevents several people from sitting close to the monitor. The addition of a bladder or other sensor to the keyboard that would cause the table to stop before hitting a client would be helpful. In spite of these two problems, the table has been a great asset to the residents.

TECHNICAL DESCRIPTION

The tabletop consists of ¾-in. plywood with an applied veneer laminate (84 in. x 30 in.). The wood panels are cut from ½-in. oak plywood and stained for a pleasing appearance. Foam is applied to the edges of the keyboard tray to soften the table edges.

The table lift mechanism consists of two AC linear actuators with a tubing guidance system housed in C-channel sections. The 18″ stroke linear actuators are centered and secured via pin attachments inside the 6″ A36 steel C-channel bolted below the table. ASTM A500 steel square tubing guidance system under the table consists of four telescoping sections of tubing under the four corners of the table. The A36 C-channel and angle were selected to meet ASME Specification SA-36.

The tubing is welded (AWS Specification E7018) to the inside of the C-channels that also house the linear actuators. Each telescoping section consists of 2 square tubes, one smaller tube with a 2 1/2″ OD and one larger tube with a 3″ ID. These telescoping tubes are greased to ensure smooth sliding during table lifting. The actuators and guidance system are concealed inside two telescoping wood panels, one of which was stationary while the outer panel extends as the table was raised. These panels are guided using ball bearing drawer slides between them.

The keyboard pivot consists of a universally sized keyboard housing to hold the keyboard with a Velcro patch to secure the keyboard in the housing made from A36 steel plate. A third linear actuator is connected to the keyboard housing and flat bar via pin attachments such that, when retracted, the keyboard would begin in the flat position (180°), while the fully extended length would pivot the keyboard to a maximum angle of 80°. The keyboard housing pivots about its center axis. Jellybean buttons control the table height and keyboard pivot adjustments, attached to the tabletop via Locline® flexible neck rods.

The monitor slide/support mechanism consists of two 2 x 4-in. pieces of pine, bolted to the tabletop with two additional pieces offset at a 2-in. height and connected to the support pieces using 20″ heavy duty full extension zinc-plated carbon steel slides. These slides are rated to carry 115 lb./slide at the fully retracted and fully extended positions. The oak wood platform for the monitor is bolted to the top 2 x 4-in. pine support beams. The extension slides allow the monitor to move up to 12″ past the tabletop, flush with the keyboard edge. The device is illustrated in Figure 15.4.

The total cost was $1,463.

Figure 15.4. Close-Up View of Adjustable Computer Table, Showing Adjustable, Inclined Keyboard Tray, Sliding Monitor Stand and Jellybean Control Buttons.