CHAPTER 7
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EVEN LATERAL PRESSURE THERAPY DEVICE FOR A CHILD WITH AUTISM

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INTRODUCTION

A client with autism has successfully used pressure therapy in the past to act as a calming influence when he is overwhelmed with sensory stimuli. His school desired to have a device built that would allow the student to activate the pressure at his desired level and time. The Even Lateral Pressure Device (ELPD) is controlled by the student, safe to use, and was delivered to the school for the student's use at the completion of the project.

SUMMARY OF IMPACT

With the ELPD, the student now has control over his environment, and can make choices about when he needs pressure therapy. Previously, a teacher or aide would provide pressure by hugging him or placing weighted beanbags on him. As he grows older, however, it becomes difficult and physically challenging for the teacher to provide adequate pressure. The student immediately accepted the ELPD, and currently uses it several times per day. Additional students may also be able to benefit from the device in the future.

TECHNICAL DESCRIPTION

The chair was fabricated from wood (2×4s, 4×6s and plywood), covered in foam for comfort and painted, as shown in Figure 7.1. The front of the chair has steel rods (diameter of 0.25 in) that connect to the back. These steel rods provide the track for the platform that provides the pressure. The platform is hinged so that the student can enter and is equipped with a removable cushion. A latch in the platform, similar to a car trunk latch, is used to securely close the door and can be opened by pressing a switch (for the user) or from an outside lever (for a supervisor). Bushings were inserted into the platform to provide a smooth motion on the steel rods. A set of pulleys connects the platform to the drive motor, and a locked compartment in the rear of the chair contains the drive motor and associated circuitry. Figure 7.2 shows the inside of the rear compartment of the ELPD.

Figure 7.1. Front of Even Lateral Pressure Device.

To operate the device, the student opens the door, sits in the chair, and presses two buttons at his side. The platform must be completely closed and both buttons must be depressed for the motor to operate. This prevents the possibility of one arm getting caught in the mechanism or accidental operation. The motor may be stopped or started again at any point to either maintain pressure or provide additional pressure. When the student is done with his pressure therapy, he pulls a lever, which first slightly releases the pressure and then opens the latch so that the door in the platform may open. The initial release of pressure prevents the platform from opening in a forceful manner and accidentally injuring a nearby student.

One of the challenges of this design was selecting a motor that would provide an adequate amount of torque, pull the platform at an appropriate speed, maintain the pressure once the desired level was obtained, and operate on standard AC. The motor selected was a worm reduction motor (A0280 Texatron 1/3 HP AC Motor with 70:1 worm reduction). The worm gear maintains the position of the platform when it is not operating. A gear ratio was employed to produce the desired speed of the platform of approximately 8 seconds from start to maximal applied pressure. At this gear ratio, the motor could develop a torque of 440 ft · lbs., which was significantly higher than the torque deemed necessary (110 ft · lbs.). Several safety mechanisms were developed to address this concern.

The first safety mechanism is a rotational limiting switch, located on the drive pulley, which prevents the platform from traveling more than eight inches. As the pulley rotates, if the travel of the platform exceeds eight inches, a copper plate on the pulley activates the limiting switch. Once the limiting switch is activated, the power to the motor is immediately turned off. This limiting switch may be easily adjusted to change the linear travel allowed for the platform. A second safety mechanism, an adjustable current limiting switch, prevents the motor from developing too much pressure, or more pressure than is deemed necessary by the student's teacher or therapist. This switch is located in the rear of the chair, and is only accessible through unlocking the rear panel. The current drawn by the motor increases as the pressure exerted on the student increases. This switch senses the current drawn by the motor, and when the current exceeds the level set by the teacher, the motor will stop. An adjustable knob sets the current level.

Figure 7.2. Inside of Rear of Chair, with Pulley (Upper Left) and Motor (Lower Right).

The cost of parts/material was about $925.

INDEPENDENT RUNNING FOR A CHILD WITH VISUAL IMPAIRMENT

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INTRODUCTION

Students with sight impairment often have difficulties participating in outdoor track events with their classmates. Although they are capable of running, they are generally unable to maintain a correct bearing while running. Most methods of guidance require an additional person to provide auditory direction or accompany the runner in the race. A school requested a device that would allow for students with sight impairments to independently participate in track events. A device was fabricated that constructs an electronic "lane" and signals the runner when he or she needs to adjust direction. The device was delivered to the school at the completion of the project.

SUMMARY OF IMPACT

The independent running device provides an excellent way for the students with sight impairment to participate in the same events as their sighted peers. There are no known devices that perform this function. It can be operated with minimal set up time and training. The students currently use vibration devices for mobility training, so this device reinforces their current activities and allows them to participate in others as well.

TECHNICAL DESCRIPTION

The device consists of three major components (see Figure 7.3): a beam transmitter (1), a beam receiver with walkie-talkie transmitter (2), and a vest with walkie-talkie receivers and vibration devices (3). Two beams are created with a security detection system (AX-650 MKII donated by Optex); they have a range of 200 m. Straight-line races of up to approximately 150 m can be accommodated with this system. These transmitted beams create the lane for the runner by way of a receiver at the other end of the track. The runner wears the vest, stands in between the two beams, and begins the race. If the beam is broken, it activates the walkie-talkie transmitter (Bellsouth 1010). The walkie-talkie transmitter sends a signal to the walkie-talkie receiver in the vest and activates the proper vibration device in the vest (see Figure 7.4). The runner adjusts his course, based on which vibration device was activated. The vibration continues until

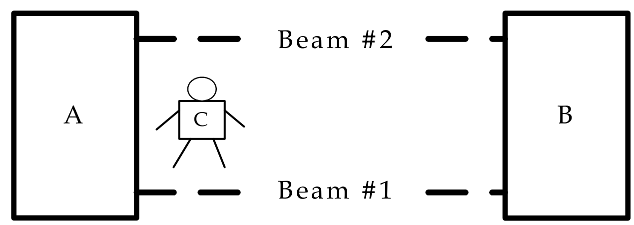

Figure 7.3. Schematic Illustrating Independent Running Device.

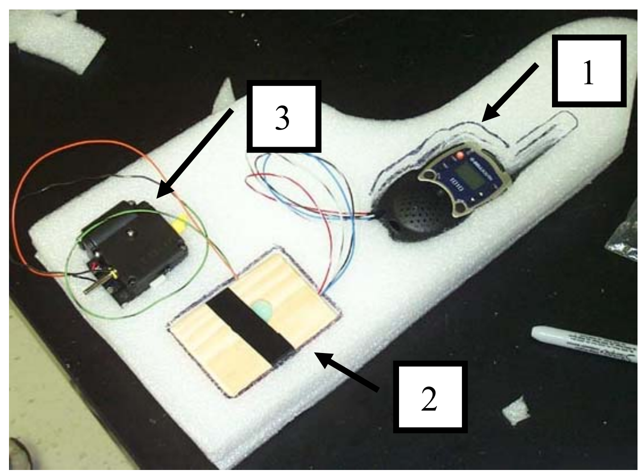

Figure 7.4. Inside of Life Vest: (1) Walkie-Talkie, (2) Circuit Board, (3) Vibration Device.

the beam is unbroken. At the completion of the race, a caller signals that the race is over with an air horn. No other runners can share the lane.

The Optex beams are powered by a 12-V tractor battery. The beam receiver is directly connected to the walkie-talkie transmitter. When the beam is broken, a voltage output in the Optex system changes, a switch is closed and the walkie-talkie transmitter is turned on. The walkie-talkie receiver is connected to the vibration device via a circuit. The circuit amplifies the voltage signal from the walkie-talkie and then converts it from AC to DC to provide power to the vibration device. The vibration device, obtained from a child's toy, has a motor with a rotating eccentric weight.

The Optex devices and associated circuitry are mounted on a tripod (see Figure 7.5). The tripod is equipped with a ruler and level so that easy beam alignment can occur. Both tripods and the vest fit into a plastic garbage can with wheels, so the system can be easily transported to the site of the race. It can be used indoors or outdoors. Because the runner is signaled via vibration, he or she can still hear team peers and the cheers from the crowd and fully participate in the race. The air horn used at the end of the race to signal the runner is significantly louder and more distinct than any of the other normal crowd noises.

The approximate cost of materials and supplies was $500. Optex Incorporated generously donated the Optex beams, valued at $850.

Figure 7.5. Beam Transmitters/Receivers on the Left and Right of Tripod.

WHEEL CHAIR ICE SKATES

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INTRODUCTION

A boy who uses a wheelchair desires to ice skate with his peers. A current device requires the user to exit the wheelchair and sit on a sledge, which resembles a standard sled. The user propels himself by using his arms and a spike that grips the ice. The user could also be propelled by an assistant pushing him. This device does not allow for normal interaction with his peers as he is seated very low on the ice, and the spikes are potentially unsafe for both the user and other skater on the ice. A prototype of an attachment to a wheelchair to provide natural ice-skating movement is discussed.

SUMMARY OF IMPACT

Although a prototype was developed, it was not suitable for active use. The design and potential modifications are discussed.

TECHNICAL DETAILS

The device is shown in Figure 7.6 attached to a wheelchair. One unit/skate would be attached to each wheel of a standard wheelchair. It would be connected to the wheel by a set of two nylon ratcheting tie downs. Each skate consists of two blades that are connected together by welding rods. The blades have the same circular arc as the wheelchair wheels, and are separated by the width of the wheels. Two sets of teeth are evenly spaced from the ends of the blades. Both sets of teeth resemble the “toe pick” on a standard figure skate; however, they span the width of the two blades. The forward motion teeth are slightly angled so that they grip the ice when the wheels are propelled forward, and the rear teeth are straighter, so that the chair will stop when those teeth contact the ice. Two portions of the blade allow for gliding motion – in front of the forward motion teeth and in between the two sets of teeth. Forward motion is provided by rocking the wheel to the front gliding portion, and then back to the middle gliding portion. During this process, the teeth responsible for motion grip the ice and provide acceleration. A change in direction can be accomplished by pulling back on one wheel. A cap at the end of the blade prevents the blade from slipping off.

The blades and assembly are custom machined. Each blade is laser cut out of ¼” sheet stock. The teeth are milled from stock steel, and the components are welded together using tig welding.

A natural gliding motion is not obtained using the wheelchair skates as described. To improve the skates, aluminum may be used to provide a lighter skate and less resistance for the user. The blades as described are flat; however, typical skates have a concave surface on the bottom of the blade. A concave surface increases the contact stress between the blade and the ice and allows for local melting of the ice, and ultimately, smooth gliding. These skates should be modified to provide a concave surface on the bottom of the blade. Finally, the gliding portion between the two sets of teeth must be optimized to allow for easier gliding.

The costs for parts and machining are approximately $250.

Figure 7.6. Wheelchair Ice Skates Attached to Standard Wheelchair.

MODIFICATIONS TO THE MULHOLLAND WALKABOUT STANDING FRAME

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INTRODUCTION

The Walkabout 2A (Figure 7.7), produced by Mulholland Positioning Systems of Santa Paula, CA, was analyzed and modified to specifically address rehabilitation needs of the client. The client is a 7-year-old boy with cerebral palsy and limited cognitive abilities. He is ambulatory and uses the Walkabout 2A during school hours. Modifications were requested to decrease scissoring, increase muscle tone, add directional damping to the Walkabout, and provide a reward system. Additional constraints require that the Walkabout be easily adjusted to fit other clients with different needs and make placement of the client in the device easier.

SUMMARY OF IMPACT

With the modifications, the client is able to walk normally with no damping in the system; however, damping is added to the system if he overextends during standing. This causes the Walkabout to be more stable. The addition of the braking system allows natural gait patterns to be established, while also providing resistance to help strengthen leg muscles. The new spring system removes the need to lift the client when placing him in the Walkabout. An added convenience is that the spring can be preloaded to allow adjustment for different clients. A reward system allows positive feedback to be given to the client. The inclusion of a digital level allows easy adjustment of the seat angle.

TECHNICAL DESCRIPTION

As stated in the product literature, the Walkabout is an "an assisted weight bearing device, which allows degree of lift to be adjusted to provide minimal to moderate assistance to stand. As the user steps forward, the stander provides lateral and anterior/posterior stability, in addition to spring assisted lift." The Walkabout was modified (see Figure 7.8) to provide a rewards system, digital level, dampening, modified suspension, and a braking system.

Figure 7.7. Walkabout 2A.

The rewards system provides positive feedback to the client. To operate, the therapist inputs a value into the pre-settable counter. This value corresponds to the distance the therapist wants the client to walk. Once the client has walked the specified distance, he is rewarded with audiovisual effects. The effects are provided by automotive running lights and a small bicycle siren that have been mounted on the Walkabout. A proximity sensor counts wheel revolutions to measure the distance traveled. The sensor sends inputs to the pre-set counter that opens a relay when the pre-set value is achieved. When the relay opens, power is provided to the lights and siren. Power is provided by a rechargeable battery taken from a cordless drill.

The digital level is a SmartTool digital level that has been shortened to fit onto the rear column of the Walkabout. The level is temporarily attached to the rear column using magnetic strips that are adhered to the level and rear column. When adjustment is complete the level is removed. The level has an operating range of 360 degrees and .1-degree accuracy.

Damping is provided by a Fox Float-R shock absorber. The shock absorber has an externally adjustable rebound damping mechanism with 15 increments of adjustment. The shock was mounted between the rear column and the upper crossbar and provides damping only when the user travels upwards with great velocity, such as when jumping (which causes instability). The damping slows the user and makes the Walkabout more stable.

The spring preload system replaces the original suspension system. The new system consists of two springs in parallel. The springs may be preloaded, which allows the therapist to change the suspension to compensate for changes in the client's weight. The preload is achieved by turning a crank, which causes the springs to compress. The spring preload system also eliminates the need to lift the user into the seat.

A braking system was added to prevent the client from rolling freely when in the Walkabout. The ability to roll freely allows the client to build up momentum and coast, rather than providing motion by taking strides. The braking system can be used to apply resistance to either forward or backward movement, or zero resistance if desired. This was accomplished by attaching a ratchet to the axle. The ratchet is adjusted to determine the direction of resistance. The resistance is provided by a spring-actuated friction plate. A handle is turned to compress the spring and increase pressure on the friction plate. The approximate cost of materials is $725.

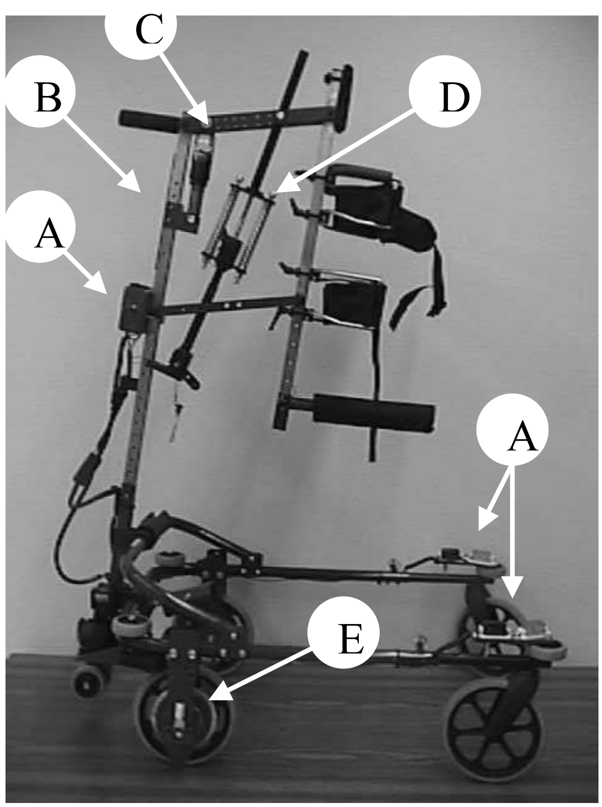

Figure 7.8. Walkabout 2A with modifications: A) Reward System, B) Digital Level (not shown), C) Damper, D) Spring Preload System, E) Braking System.