CHAPTER 14

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Adaptive Trunk Support Harness for a Congenital Cerebral Palsy Patient

Designers: Drew Amery, Ken Anderson, Stephanie Riley
Disabled Coordinator: Claudia Senesac, P.T., Kids On The Move
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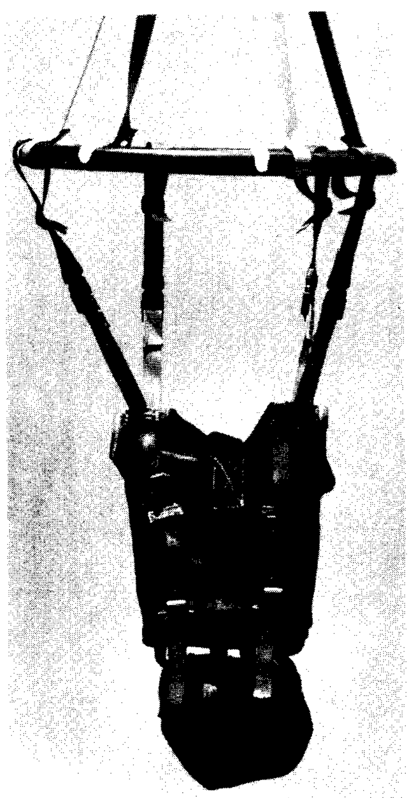
INTRODUCTION

An Adaptive Trunk Support Harness was necessary to offer a young child with cerebral palsy proper support while being held in a seated position on the ground under a special portable frame. This harness permits trunk support to be adjusted over a wide range by the adjustment of the angle of support straps and the attachment points of the straps on the harness itself. A spreader assembly above the harness facilitates this angle adjustment. These adjustments were intended to make the patient work to his limit and facilitate development.



SUMMARY OF IMPACT

The Portable Support Frame and Support Harness for a Congenital Cerebral Palsy Patient were designed to facilitate independent sitting and use of the upper extremeties (UE's). The child is hypotonic with cerebral palsy. He is unable to sit independently, has poor head and trunk control, limited mobility and use of his UE's. It is extremely difficult for this child to attain an erect head and trunk position and then be able to use his UE's independently to explore toys, play and interact with his peers and environment. These activities are so basic to learning about our world and ourselves. Learning is a sensory-motor experience.

The Support Harness gives the child trunk support, pelvic stability (through the seat cushion and length of the suspension straps) and the opportunity to use the UE's as described above. The device offers variability in the amount of support given to the trunk and the amount of excursion anterior/posterior and lateral with diagonal movements available. Through proper positioning, strengthening of neck and trunk musculature is possible. With the adjustments as mentioned it is possible to increase the range the child can safely perform in independently.

TECHNICAL DESCRIPTION

This trunk support harness was designed to support a two year old who weighed 25 pounds. It was intended to be adaptable to the child in fit and function in as many ways as could be incorporated. These included first adjustability of the vest and shorts for fit as he grew. Next, a method for adjusting support constraints to permit control over the demands put on the child's own musculature was developed and included. Means for adjusting the support height was also necessary to adjust the vertical support position with respect to the play surface.

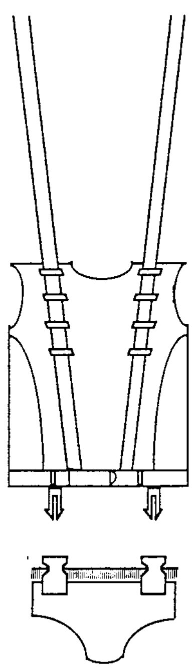
The harness is illustrated in the figures below. It consists of three functional pieces: shorts, vest, and support ring. The shorts and vest are made from denim fabric which provides a reasonably lightweight but strong support. Both the shorts and the vest are split on both sides and possess velcro closures which make dressing the child an easy task. A wide range of adjustment to the child's size is also made possible by the design of these closures.

Straps which function to both lift the user a small amount and restrict forward-backward and side-to-side motion are attached to the shorts and the support ring above, but removable at both ends. These straps are made of a 3/4" tubular nylon strapping material commonly used in camping or climbing gear. It is much stronger than necessary for the application but is softer and more pliable than comparable flat strapping. Each strap may be attached to one of three locations on the support ring above the user's head. The point of attachment is related to the angle of the straps for each particular amount of support to be given.

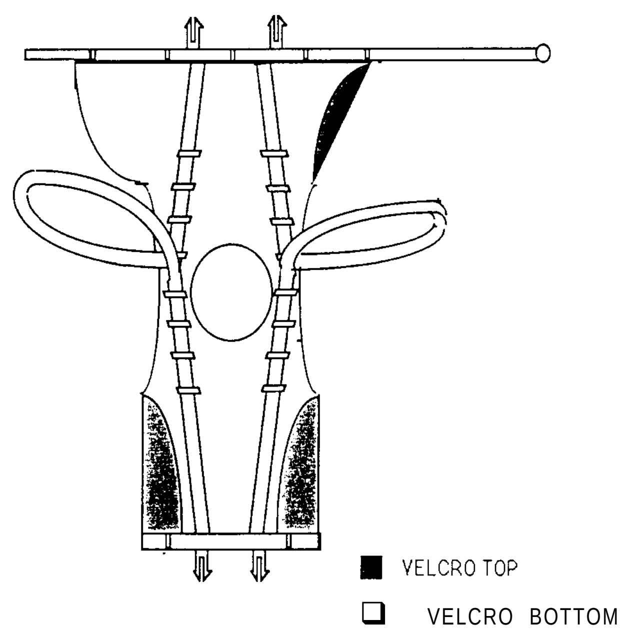
Between the shorts and the support ring above, the straps run along the front and back of the vest passing through various guideloops. These guideloops determine the point of withdrawal of the support along the upper trunk of the body. Initially the uppermost loops are used. The child has very little trunk and neck control, therefore with the support at the top of the shoulders he will not need to work the trunk muscles very much. This will permit the concentration on development of the neck for strength and control.

As he develops the straps may be taken out of the top loops to move the point of support downward along the trunk. This will permit more freedom of movement and demand more development of strength and control. Eventually it is expected that support straps will be passed only through the bottom loop in the vest thus giving maximum freedom and demanding maximum self sufficiency on the child's part.

Cost of materials for this harness was $80.44.



Front view of harness



Expanded chest harness

Portable Support Frame for a Congenital Cerebral Palsy Patient

Designers: Ivan Howard, James Larson, Herb Sivitz, Hai Vu
Disabled Coordinator: Claudia Senesac, P.T., Kids On The Move
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INTRODUCTION

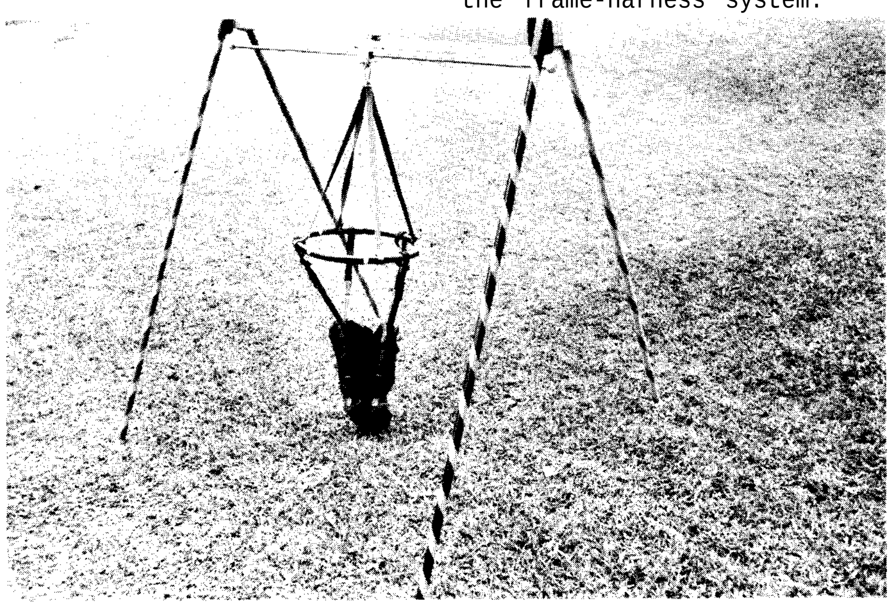
The Portable Support Frame was designed to offer a circular space on the ground in which this child is safely supported but still has some freedom to move and explore his toys and the environment. The frame was designed to supply the support over this circular range of motion while being light and easily "broken down" for transport. It is also brightly colored to appear like a toy to the child and be as unobtrusive as possible in his environment.

The parents of this child wanted a support that could be used as easily in the house as it could in the back yard or playground. Component parts of the frame disassemble and pack in a carrying case for ease of transport. The device has also been used in sessions with the child's therepist.

SUMMARY OF IMPACT

The Portable Support Frame and Support Harness for a Congenital Cerebral Palsy Patient were designed to facilitate independent sitting and use of the upper extremeties (UE's). The child is hypotonic with cerebral palsy. He is unable to sit independently, has poor head and trunk control, limited mobility and use of his UE's. It is extremely difficult for this child to attain an erect head and trunk position and then be able to use his UE's independently to explore toys, play and interact with his peers and environment. These activities are so basic to learning about our world and ourselves. Learning is a sensory-motor experience.

The Portable Support Frame permits the child to be supported seated on the ground in a special harness anywhere within a fixed radius from the center of the frame. As the child gains strength and control he may move at will within that circle as he explores his world and interacts with others all the while benefitting from the support afforded by the frame-harness system.



TECHNICAL DESCRIPTION

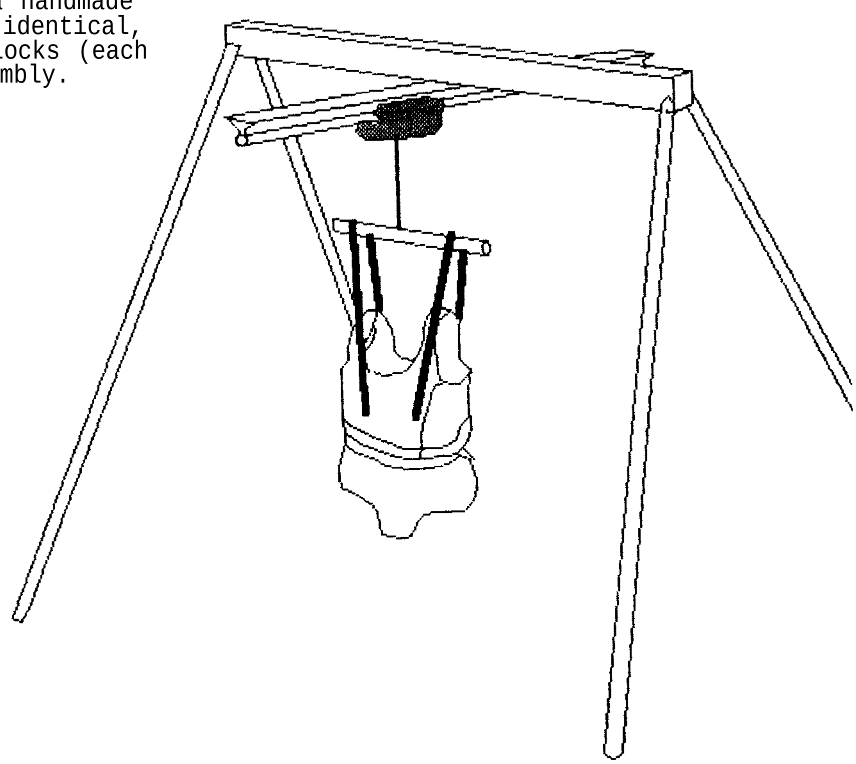
Design of this portable support structure was done under the following constraints. The structure must be self-supporting through normal and routine usage. Its static load capacity must possess an adequate safety margin to handle possible impulse loading, due to bumping, etc., without serious structural instabilities which could injure the user. The structure should be as light as possible for ease of carrying. It should be collapsible into as small a volume as practical. Ease of assembly and disassembly should be high. When assembled it should yield a large area of support for the child underneath.

The support is shown in the picture on the previous page. The frame consists of an aluminum 1.75"x3" box beam approximately 4.5 feet in length supported by four removable legs. The legs are constructed out of 1" diameter aluminum tubing. These legs are connected on their bottoms by small vinyl covered cables (like fishing line leader) for stability and to minimize the bending moments generated in them. Special feet were designed and constructed for the ends of the legs. They are attached to the cable and are removable at disassembly time. Tops of the legs are held in specially milled blocks of aluminum which form receptacles for them. To make them easy to remove, the legs are just a slip fit in the blocks. Integrity of the structure is provided by the tensioning cables on the bottom, and once assembled the whole structure is quite sturdy. Since this frame is a handmade prototype and no two legs are identical, they are color coded to the blocks (each one different) for proper assembly.

At the center of the beam, a rotating arm is supported on a shaft which is held in a bearing support block in the beam. This arm is four feet in length, and made up from a hardened .5" diameter bar and a special two foot support "T" in its center span. The arm follows and supports the child as he moves about under the beam. For added flexibility, a carriage riding on a linear bearing on the rotating arm permits movement in a radial direction around the axis of rotation of the arm. Special stops prevent the carriage from running off the end of the bar.

Length of the legs is such as to have sufficient clearance for the arm above the ground to permit the child and harness assembly to fit. This distance was four feet, and the legs then are slightly longer than that. Weight of the entire apparatus including the carrying case is twenty five pounds. This is of the same order of weight as the child himself and does not pose a burden when carrying over short distances. Limiting static load capacity of the frame is the linear bearing which rides on the rotating arm. This will support well over four times the 25 lb. weight of the child in the loading configuration we are using. With the present abilities of the child in question, impulse loading on the structure is not expected to be a factor.

Cost of materials for the support frame was $389.24.



SUPPORT FRAME

(with harness)

"Head Position Sensor"
A Programmable Head Position Sensor
for the Developmentally Disabled

Designer: Drew Amery
Disabled Coordinator: Mark Frasier, Sunland Training Center
Supervising Professor: Dr. Robert J. Hirko
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INTRODUCTION

The Head Position Sensor(HPS) is a tool that can be used by physical therapists to help teach correct head posture to people who lack the necessary motor control. The device consists of a sensing helmet worn by the patient and a separate Control & Interface unit. The Helmet and the Control unit are coupled by a wireless infrared link. The helmet transmits a signal to the control unit whenever the patient's head is within the programmable X and Y inclination limits, as set by the therapist. Upon receiving the transmission, the control unit can operate in one of two modes - direct or delay. In the direct mode, the controller turns the selected output device on when the signal is transmitted and off when it is not. In the delay mode, the therapist can program a time delay for the turn on of the output. This delay can be from 10 sec to 5 minutes and 30 seconds.

A third generation device, this head position sensor allows the therapist to control the angle and time parameters, parameters that were fixed in previous generations.

SUMMARY OF IMPACT

The patients with Cerebral Palsy who may benefit from this device are severely involved, non-ambulatory individuals who usually require external support to maintain a functional sitting position, The inability to support their head in a vertical position has a profoundly negative impact on their perceptual-motor, cognitive, and social development. External head supports are usually contraindicated since these tend to inhibit the development of head control and subsequent developmental skills.

The head position sensor activates any electrically operated device that might act as a positive reinforcer. Activation occurs only when the head is in a relatively vertical position. The angles of activation are adjustable in the forward/backward and side to side planes. Time span between the initial stimulus (head in vertical) and the activation of the positive reinforcer can also be adjusted from 0 seconds to 5 minutes in 10 second increments. The time delay and the angle limit adjustments allow the device to be gradually re-adjusted as the individual's head control improves, so that he is encouraged to support his/her head more vertically, and for longer periods of time.

In the past, devices of this type usually employed glass encased mercury switches as position sensors. The sensors on this device contain a saline solution, thus eliminating problems with using mercury. In summary, the adjustability, safety, and low weight of this device make it vastly superior to other devices that we have used.

TECHNICAL DESCRIPTION

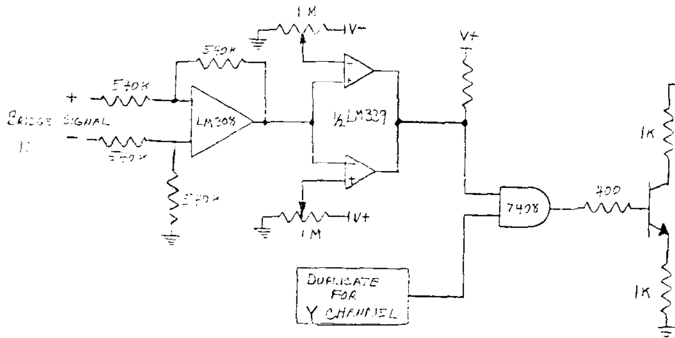
The device is divided into three units, a helmet which contains all inclination sensing and logic circuits, a receiver which contains a infrared receiver and delay circuitry, and a programming device to make the angle programming of the helmet easier.

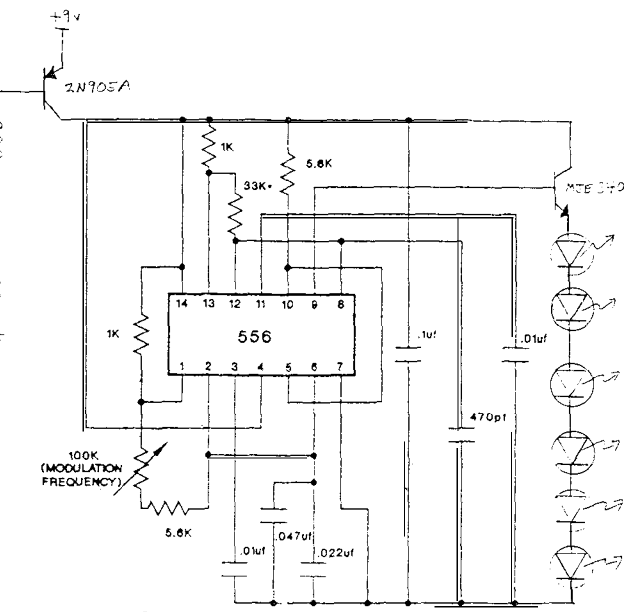
The helmet utilizes two electrolyte bridge level sensors to separately measure the X and Y angles of inclination. Each of the bridge units is modulated at khz with a 1 volt square wave signal. The bridge signals are rectified into bipolar DC levels (positive dc for clockwise movement and negative for counterclockwise movement). The output of the rectifier section is a voltage proportional to the angle of inclination from vertical. Both X and Y signals are then fed into a LM308 opamp to convert from a double ended to single ended output. Each of these signals goes into a window comparator constructed from a LM339 (1/2 of a LM339 for each). The reference voltages for the detectors are provided by 1 Meg trimpots tied to +/- V. Outputs of the two window comparators (logic high if within window) are anded together. The anded logic signal is fed into two switching transistors to control **the** power of an LM556 dual timer which Provides a 200 Hz modulating frequency on a 40 KHz carrier frequency to drive the six infrared LEDs (980nm).

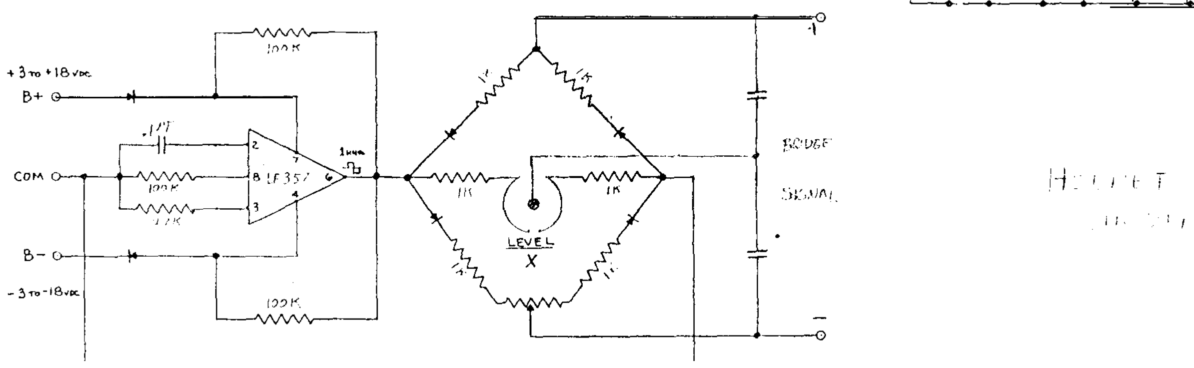
The receiver detects the presence of the infrared signal with a GP1U52X infrared receiver/demodulator module. Output of the detector is logic low when an infrared signal is detected. This logic signal is then fed into an LS7210 delay timer. The timer is programmable through an 8 pin dip switch accessible through the front panel. The output of the timer is fed into a four position slide switch. This switch allows the therapist to switch between three different low-voltage switching outputs and one 110 volt switching output.

The programming device consists of a four position switch, a five wire ribbon cable and two jacks to which are attached a digital voltmeter. This allows the therapist to quickly adjust threshold voltages for all four angles by just turning a switch and adjusting a pot.

Parts and supplies for the Head Position Sensor cost two-hundred ninety five dollars ($295).







"The S.C.O.O.T.E.R."
A Human-Powered Vehicle
for a Cerebral Palsy victim

Designer: Herbert L. Sivitz
Disabled Coordinator: Richard Healy, Res-Care 39th St. Cluster
Supervising Professor: Dr. Robert Hirko
Aerospace Engineering, Mechanics, and Engineering Science
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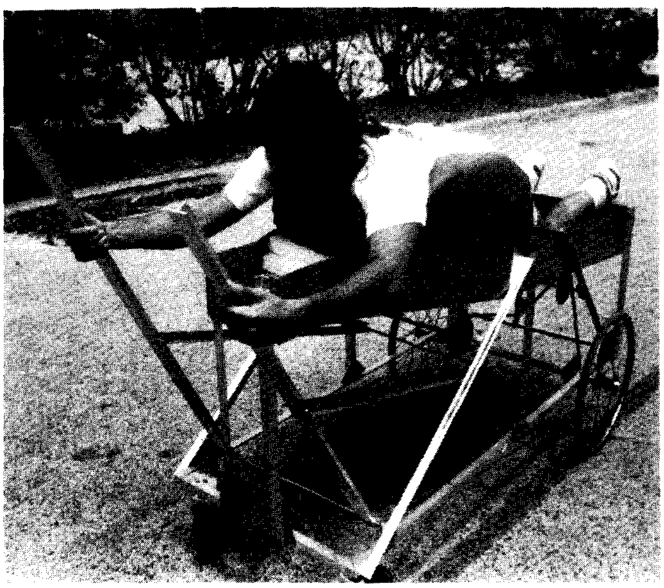
Gainesville, Florida 32611

INTRODUCTION

The S.C.O.O.T.E.R. (self-propelled cruiser operating on therapeutically engineered rehabilitation) is a therapeutic device designed for a specific individual with congenital Cerebral Palsy and severe Scoliosis. It allows for self-propelled transportation. The person lies in a prone face-down position and pulls the up-right levers towards himself for forward motion. This action can create muscle strength and tone in the arms and back of the individual. Orthotic devices are used to hold to his wrists to the levers. This will aid in the correction of the person's wrist deformities. The chassis is designed with a body-mold of his upper torso and for his hips and legs, cushions are used as guides to keep him in a comfortable position. This will help to correct his Scoliosis.

The individual will be closely monitored by physical therapists and aides when using the SCOOTER. Due to the person's disabilities, he is unable to operate conventional apparatus of this type.



SUMMARY OF IMPACT

Tony is a 25 year old young man who is profoundly mentally retarded and non-verbal. He also has Cerebral Palsy which effects the muscle tone in his arms, legs, and trunk (severe spastic quadriplegia). He has severe Scoliosis of the spine and limited range of motion of his arms and legs. He is unable to roll over or sit up. Tony can extend his neck and turn his head from side to side. He is also able to reach for objects with his left arm. He appears to have good vision and communicates by either smiling and laughing or by grimacing and groaning. Tony is totally dependent on others to provide for all his self-care and daily living activities. He is totally dependent on others for mobility.

The primary goal of the custom prone scooter is to give Tony the ability to move himself through space for the first time. He may learn to control his movements without depending on staff. Outdoors, Tony could experience self-powered mobility for the first time and perhaps benefit from the cardiovascular demands of the arm pumping mechanism. Beyond these benefits, the feeling of accomplishment would certainly have positive effects on Tony.

The scooter may also yield several secondary benefits. The contoured molded trunk support corrects Tony's scoliosis and maintains his trunk in better alignment than when he is in other positions. His legs are also maintained in better alignment when in the device. This customized prone position is far superior to the prone position in which Tony can be placed using commercially available equipment. This improved positioning should help prevent the progression of Tony's deformities, improve circulation, and increase lung expansion. Also, because of its height, it allows Tony to make eye contact with those around him without hyperextending his neck. This will allow staff to run a variety of programming with Tony while he is positioned on the device.

TECHNICAL DESCRIPTION

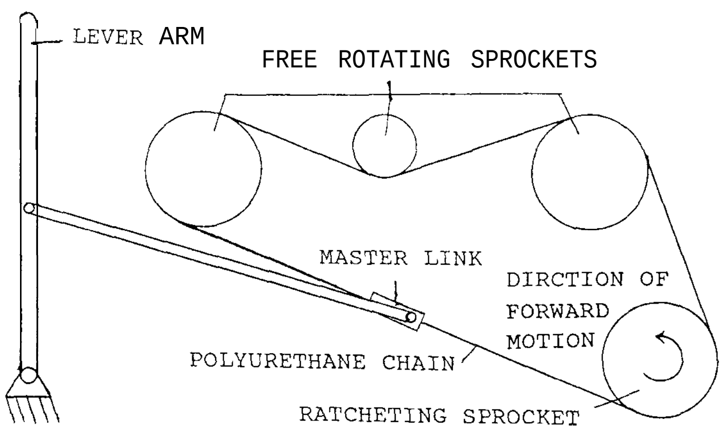
The specifications for the physical design criteria were; his weight, 70 lbs-m, the maximum force in his arms, 10 lbs-f in his left arm and 4 lbs-f in his right arm, his limited range of motion, +90 degrees to -45 degrees forward to backward of his upper arm about his shoulder with respect to the body line, zero degrees to +90 degrees outward away from his body of his upper arm and +30 degrees to +170 degrees for an elbow angle and little control of his wrists, and his cognition. For modeling computations, the weight of the vehicle, 70 lbs-m, and the maximum acceleration of the SCOOTER, 1 ft/sec^2, were arbitrarily chosen. A factor of safety of two was selected in order to assure the security of the individual.

The overall dimensions of the SCOOTER 64 inches long, 33 inches wide, 42 inches high and weighs approximately 55 lbs-m. The chassis is constructed entirely of 6061-T6 aluminum. The supported pan is one piece of 50 thousandth inch aluminum riveted together. The pan is supported by a truss of one inch by one inch by one-eighth inch angle and is capable of withstanding loads greater than 200 lbs-f. The rear wheels are 20 inch wheelchair wheels and are fixed to the rear axil. The front wheels are 8 inch casters, also from a wheelchair.

There are two sets of drive systems, one for each lever arm. The drive systems consists of three free-turning sprockets, one ratcheting sprocket and a light weight polyurethane chain. The master link also acts as the connection point for the members attached to the lever arm. The lever arms rotate about a bar fixed to the chassis and extend upward by the head. They are fixed shoulder width apart. Orthotic devices, molded plastic with velcro straps, are attached to the lever arms at shoulder height. These orthosis are used to secure the individual's hands and wrists to the lever arm in order that he may concentrate his strength on working the levers and not holding up his arms. The individual normally uses this device to correct his wrist and hand deformities. The action of pulling the levers towards himself facilitates forward motion. The levers are then free to ratchet back for the next stroke. For safety, the chain drive system is shielded by an aluminum sheet.

Due to the individual's cognitive skills, the SCOOTER is not equipped with steering capabilities, and for the same reason, there is no reverse mode. There is a wheel lock and this is to be used by the monitor to aid in turning the vehicle. The SCOOTER is meant to be used on flat level ground such as a hallway or sidewalk.

The SCOOTER cost five-hundred three dollars and eleven cents ($503.11) to build. It was created to be highly specialize for the intended individual, with some modifications it could be redesigned to be a useful mode of transportation to others capable of mastering a more complex vehicle.



DRIVE SYSTEM


S. VALENTA