CHAPTER 5

NEW MEXICO STATE UNIVERSITY

College of Engineering
Department of Mechanical Engineering
Las Cruces, New Mexico 88003

Principal Investigator:

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Wheelchair Tilting Tray
Tilting Writing Surface Wheelchair Attachment

Designers: Glenn A. Cordova, Joel Stahn, Phung Tran
Disabled Coordinator: Sherry Watson, New Vistas
Supervising Professor: R. A. Willem, Ph.D.
Mechanical Engineering Department
New Mexico State University
Las Cruces, NM 88003

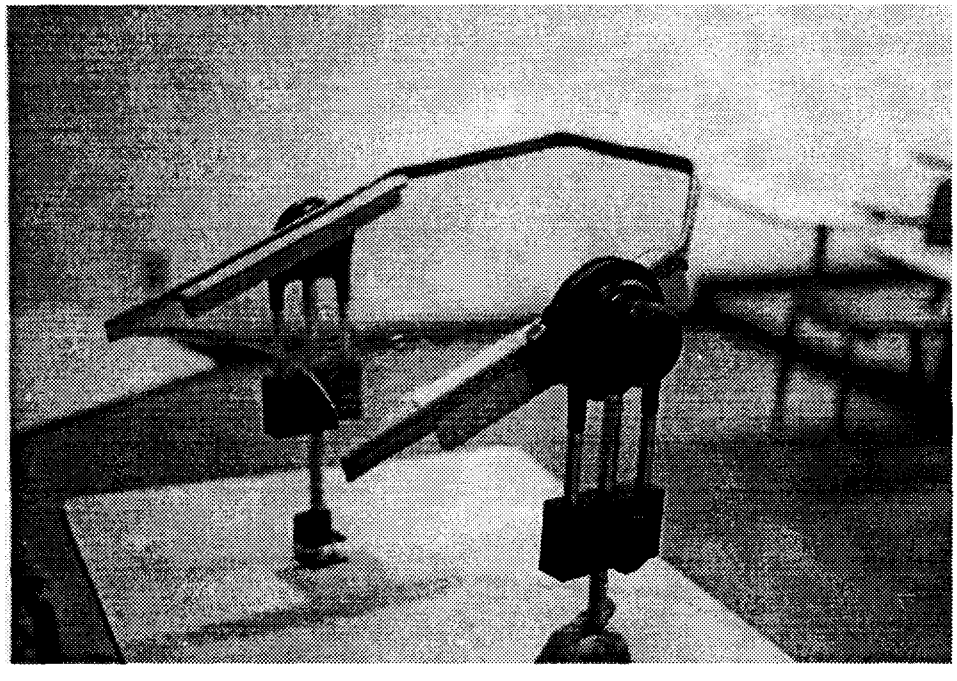
INTRODUCTION

Desk and table tops are often very difficult to access from a wheelchair. For this reason, there is a need for a writing surface that is easily attachable to a wheelchair. In addition, if this surface were tiltable, greater comfort in reading and writing would be obtained. In cases where the user has little upper body strength and control, ease of tilt adjustment is a necessity.

A wheelchair tilting tray was designed to accomplish this task. The large writing surface of this tilt tray is fabricated from Plexiglass to provide a forward view of obstacles. This surface is tiltable in 15 degree increments and will automatically lock in the next position. Rubber stripping was applied to the outer edge to prevent books and papers from slipping off the tray and for safety. This tray then attaches to an ordinary wheelchair through clamps.

SUMMARY OF IMPACT

The student who will use this tray is interested in using it for her art classes and other studies. She is a paraplegic with limited use of her right arm and hand, and very little left arm motion. The tray was designed so that once attached, she can adjust it herself, with no assistance. This provides her with a comfortable, reliable, and easy to use reading and writing surface.



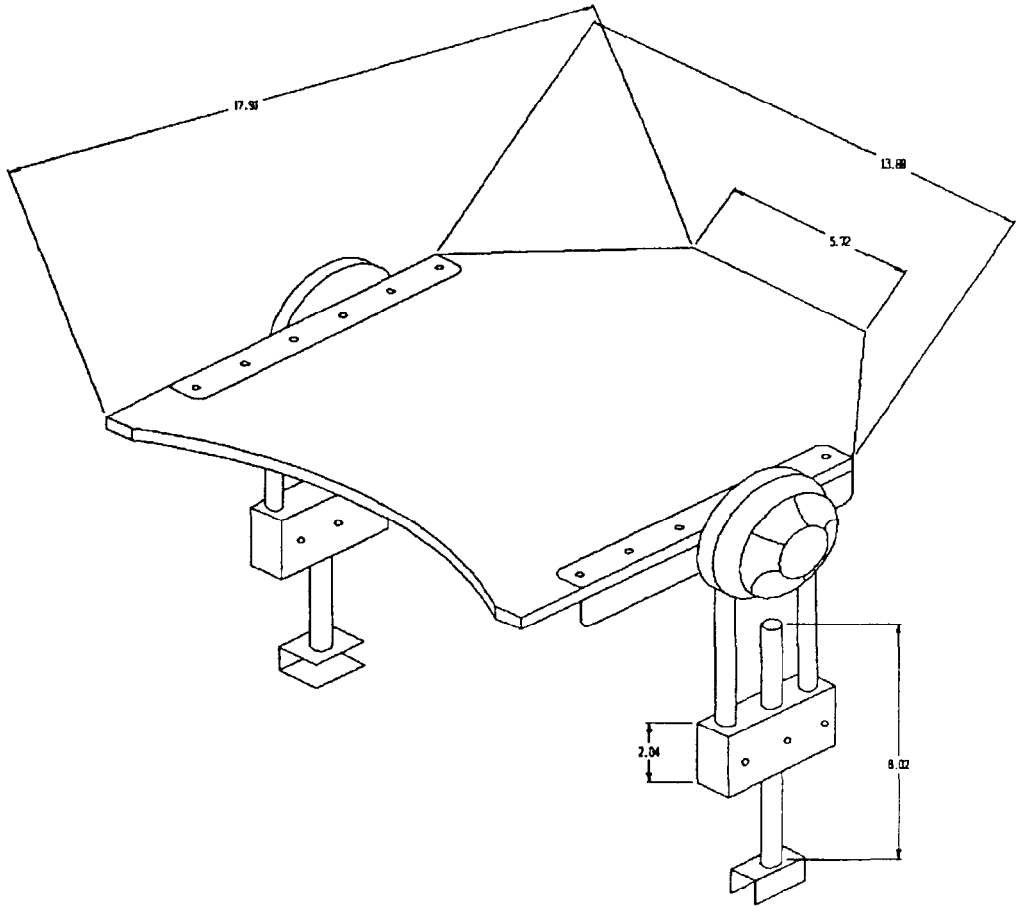
TECHNICAL DESCRIPTION

The wheelchair tilting tray is shown in the photo. The tray is made from 1/2 inch thick Plexiglass with a 17 by 20 inch top surface. The inside edge of the tray was cut with a 15 inch radius to fit the user comfortably and provide better access. The corners of the tray were trimmed to eliminate dangerous projections and a rubber safety strip was applied to cover the sharp edges. This rubber strip also provides a high friction lip that stops books, papers, and other objects from slipping off.

The legs, including the tilting mechanism, are bolted to the sides of two pieces of aluminum angle. These aluminum angles are then mounted to the bottom of the tray. The tilting device was obtained from a K& E drafting machine. This tilting device enables the tray to lock at 15 degree increments. The tilt is controlled by a lock release lever in the tilting mechanism, attached to the leg on the right hand side of the tray. The leg on the left side of the tray can rotate freely on a bearing pivot also obtamed from the same drafting machine as the tilting mechanism.

From the top down, each leg consists of either the tilt mechanism or bearing pivot attached to two stainless steel tubes (units from the drafting machine). These tubes are then mounted into an aluminum block. Through this block passes a steel rod with a piece of channel at its end. The steel rod is held in place by set screws. This rod controls the height.

Finally, the tray attaches to the wheelchair by placing the pieces of channel over horizontal bars on the wheelchair. The clamp (channel) in the left leg prevents motion in the upward, downward, and left directions. The clamp in the right leg prevents motion in the left, right, and downward directions. The total cost to build this device was approximately $500.



Spraygun Guidance Device

Designers: Bill Rucker, Mutahher Mufahher, Dirk Keeler
Disabled Coordinator: Jim Thompson
Supervising Professor: R. A. Willem, Ph.D.
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INTRODUCTION

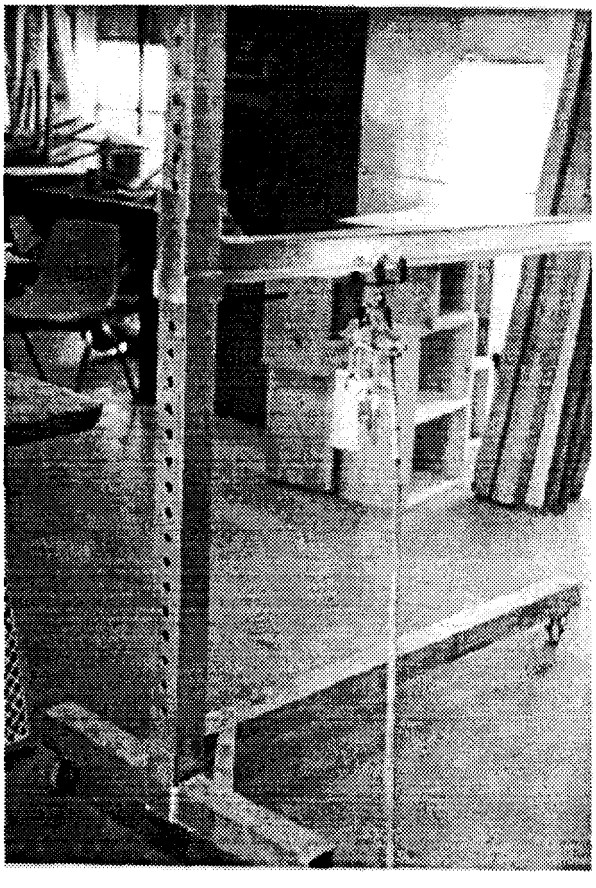
While using or learning to use a spray paint gun, the user must keep the gun a specific distance from the object to be painted. The user also must keep the paint gun in the same general orientation (with respect to the workpiece) when painting. Failure to do this results in uneven paint coverage or runs. A handicapped student may have trouble holding the paint gun in the desired position, or may have difficulty holding the paint gun for an extended amount of time.

The spraygun guidance device was designed to keep the spraygun in the desired position while painting. It provides a means of supporting the spraygun and allowing the user to move it in the horizontal direction. Vertical adjustment is provided at two inch intervals, allowing the user to paint the workpiece across in the horizontal direction and then raising or lowering the device to continue painting.

The main use of this device will be to aid in painting desks that are being refurnished for the school district. The device is large enough to handle workpieces as big as 4 feet wide by 5 feet tall. To paint a desk will require the user to turn the workpiece after finishing one side. The device is mounted on locking casters and is very light, so that it can be moved if needed.

SUMMARY OF IMPACT

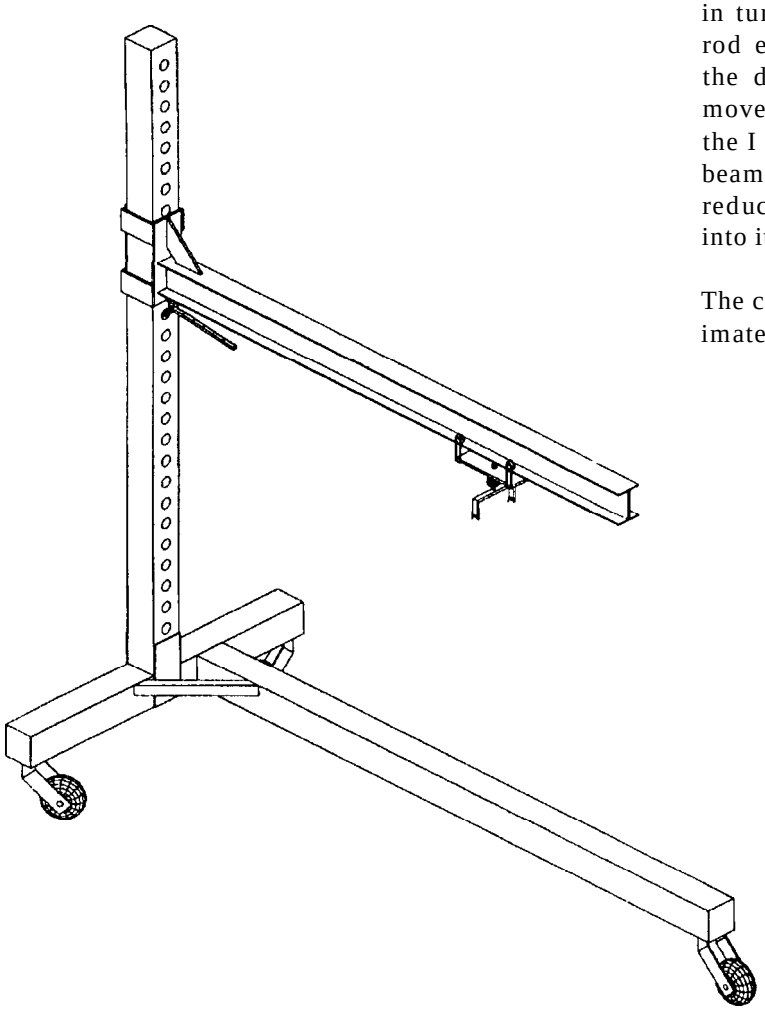
The handicapped students for which this project was designed have been previously unable to use the spraygun. Although at this time only one student has used the device, the mechanism of the device worked well, and the painted surface was very uniform. The student seemed to have no difficulty in operating the device, and it is hoped that all students who use the device will have equal ease in using it. The device is also meant to be a training tool, so that a student can use it to develop the manual dexterity needed to operate a spraygun without mechanical aid.



TECHNICAL DESCRIPTION

The spraygun guidance device is shown in the accompanying figure. The device consists of three parts: the base, the horizontal support, and the trolley/spraygun holder.

The base is constructed from 3x3 inch aluminum square tubing. It is configured in a nonsymmetric T shape, with a 3x3 inch vertical post mounted on the left hand side. The vertical post is offset from the leg of the T, so that the leg is not directly under the equipment attached to the vertical post. The base is mounted on lockable casters. Also, the vertical post has 3/4 inch holes drilled at 2 inch intervals all the way up its inside surface.



The horizontal support consists of a 3 inch aluminum I beam attached to a square box section on one end. This box fits over the vertical post, allowing the horizontal support to move up and down the post. The support is held at a particular position by a steel bar used for a catch. The catch is mounted on the underside of the I beam. The catch fits into the 3/4 inch holes in the post. Helical coil springs mounted on the pivot of the catch provide the force necessary to keep the catch in the hole. The catch is designed so that the horizontal support can be raised without disengaging the catch, but the catch will lock automatically on lowering. To fully lower the support, the catch must be held in the disengaged position while the support is lowered.

The trolley/spraygun holder is fabricated from two steel parts. The trolley consists of a steel frame with nylon rollers that ride on the lower flange of the I beam. The spraygun holder consists of a C shaped steel strap, an eye hook, and a wing nut. The hook attaches to the hook found on the top of the spraygun. By tightening the wing nut, the spraygun is drawn firmly against the steel strap. The steel strap in turn is attached to the trolley by a rod end. The rod end allows enough freedom of motion to give the device a natural feel, allowing for some wrist movement. In addition, a pin is placed at the end of the I beam to prevent the trolley from rolling off the beam. The corners of the beam are also rounded to reduce the chance of injury should someone walk into it or hit their head against it.

The cost of the spraygun guidance device is approximately $675.

Reading Aid

Designers: P. Treat, A. Atzam, J.Trujillo
Disabled Coordinator: S. H. Davis, Las Cruces Public Schools
Supervising Professor: R. A. Willem, Ph.D.
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INTRODUCTION

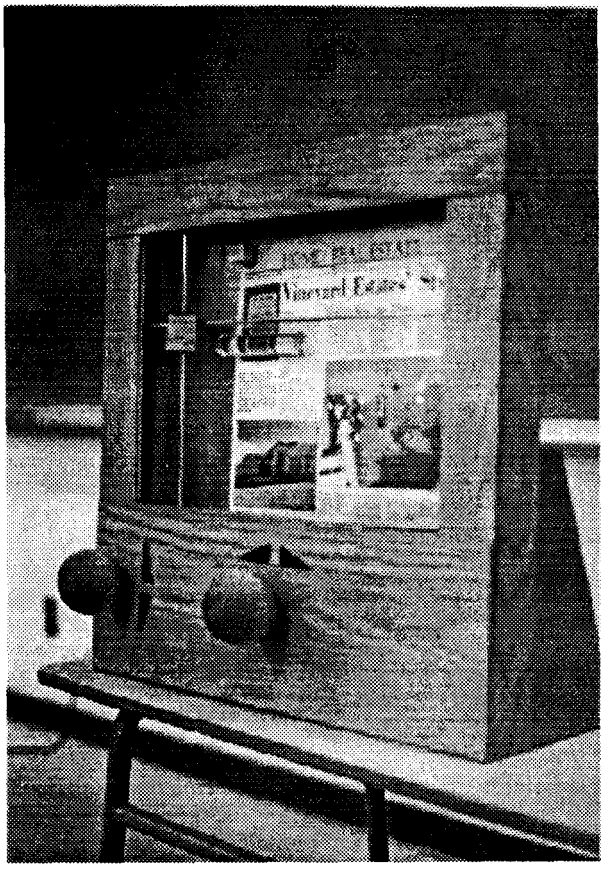
Our client was a normal eleven year old boy when one night he seemed restless and full of anxiety. He was taken to the hospital and it was discovered that his body was full of water; a kidney failure was thought to be the cause. The doctors drained his body, but did not get all the water. He then went through three heart attacks. After the third heart attach he became comatose. He was in a coma for eight weeks. When he came out of his coma he was blind and could not speak. There was some brain damage, but the extent is not known. This occurred nine years ago. Since then he has regained his speech but still has problems with his vision. Our project was to design something that could help him read.

The limitations that he has to work with are that he has partial use of his left hand, almost no use of his right hand and is confined to a wheelchair. Regarding reading, the main problem is that he has difficulty in keeping attention on one line while reading. In other words, his eyes wander.

This "Reading Aid" is designed such that his attention is brought to only one line at a time and his movements are minimal. The device provides a movable reading "window", a magnifying glass, which makes the words much easier to read. The window is moved up and down or left and right by two knobs. The knobs are placed such that they are easily turned by the left hand.

SUMMARY OF IMPACT

This device was designed for a twenty year old person who has had a physical disability since he was eleven. He has read very little since then because he could not go from one line to another without skipping lines. This is due to a focusing problem. After the "Reading Aid" was built he was delighted because now he can read without any problem. Thus, this device has helped to improve his reading and increased his enjoyment.



TECHNICAL DESCRIPTION

The reading device is designed to hold a standard size magazine or quarter-folded section of newspaper. The space to accommodate the reading material is nineteen inches long and eleven inches tall. A guide, consisting of a magnifying glass and a paper lined slit, rides a quarter inch above the text. The paper lined slit is easy to remove and shape for different text sizes. The guide is moved across the text vertically and horizontally via knobs.

The slow, fluid motion of the guide and it's ability to stay in place are due to it's cable construction. The guide is mounted on a movable "crosshair" of horizontal and vertical rods that are attached to a closed system of pulleys and cables. The action of the guide is comparable to the action of an Etch-A-Sketch toy. When the guide is at an extreme position the knobs can be turned without harming the guide or the cables. The knobs are wooden spheres three inches in diameter, one rotation of a knob moves the guide approximately 1.5 inch.

The device rests on a table top at a slight angle from the vertical with the knobs placed near the bottom. Small protrusions on the bottom prevent the device from sliding away during use. Text is held inside the device by small magnets.

The frame of the reading device is wooden. The rods are made of one quarter inch aluminum dowel. The pulley-cable system consists of one inch diameter plastic pulleys and thirty pound test nylon fishing line. The cost of manufacture (no cost for labor) was approximately $80.

Cerebral Palsy Feeder

Designers: D. Bertini, A. Drigo, L. Lomas, A. Martinez
Disabled Coordinator: L. Anjnson, Las Cruces Public Schools
Supervising Professor: R. *A. Willem,* Ph.D.
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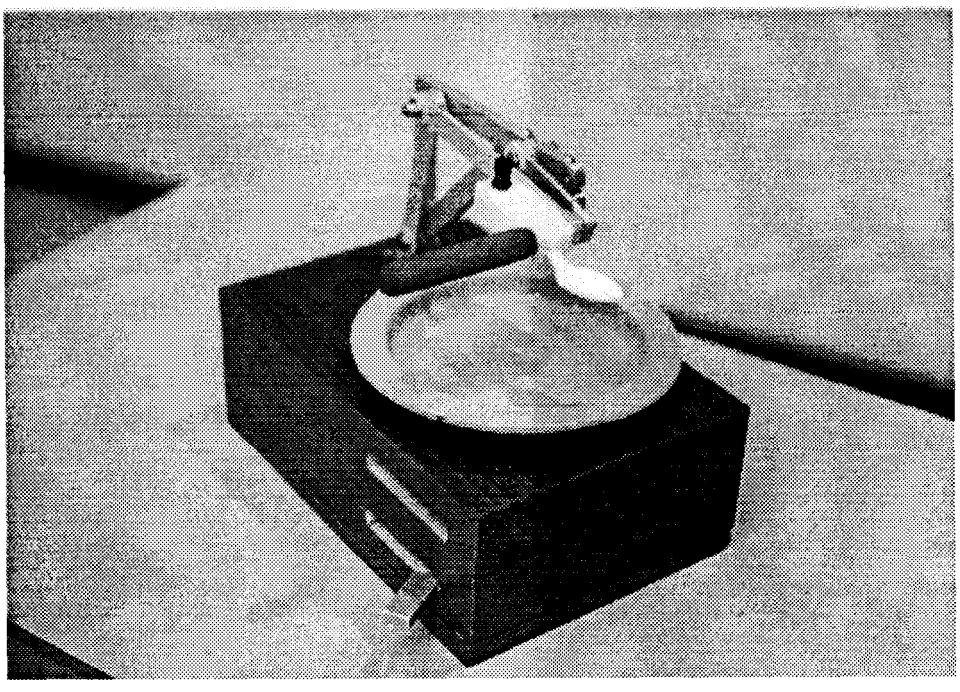
INTRODUCTION

Most persons suffering from Cerebral Palsy have limited control over their motor movements. Usually they have to be fed by someone else. A Cerebral Palsy (cp) feeder was designed and built to help its user to feed themself and eliminate the need for constant close supervision while eating. The cp feeder controls the motion of the spoon and is operated by user's power. The user uses a handle to move the spoon through the plate and bring it up to their mouth level where it locks into place so that the user can lean forward and eat off the spoon. Then the user has to nudge the handle upwards and a spring carries the spoon back to the plate. A separate handle is used to rotate the plate to get more food in line with the spoon for the next scoop. Then the process can be repeated.

SUMMARY OF IMPACT

The student for whom this device was designed appreciated it and made a great effort to become acquainted with it. The cp feeder allows him to feed himself with the minimum possible effort. Because he has to stretch his arm, use his wrist and shoulder muscle, the feeder also acts as a form of therapy for him and it should increase his coordination and strength. He still has to get used to the motions that the device requires him to use. But after a few tries he was definitely getting accustomed to it and with continued effort we are confident that it will adequately function as it was designed to perform for him and he will feed himself with very little or no supervision.

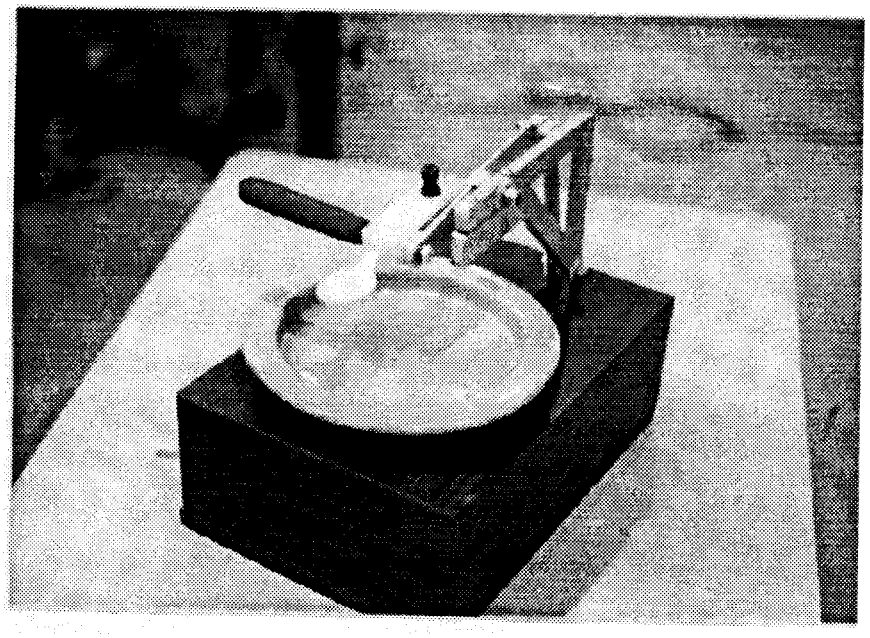


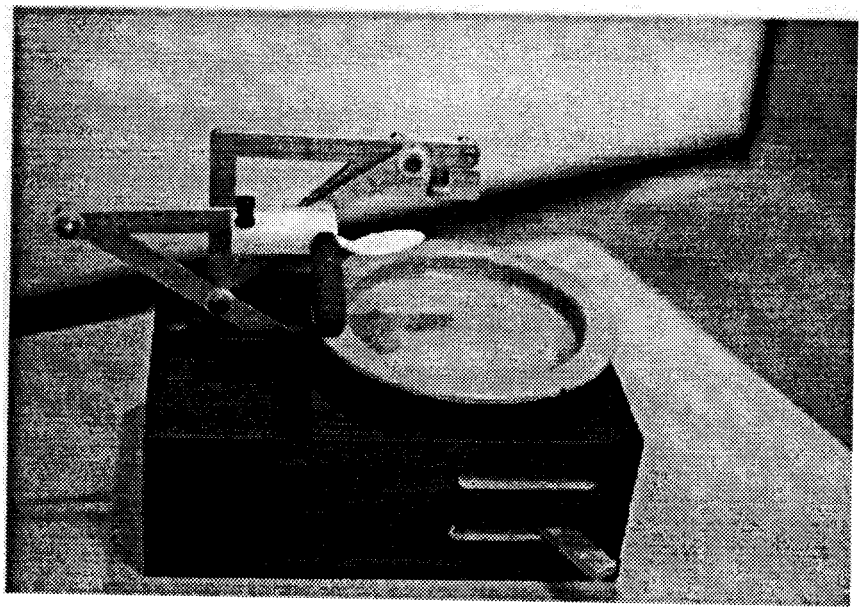
TECHNICAL DESCRIPTION

The major aspect of the design is a crank-rocker form of the four-bar mechanism. The spoon is attached to the coupler at the pivot point to the crank and follows a circular path from the plate to the user's mouth where it locks into place to allow the user to eat from it. The spoon is locked into place by a device attached to the cantilever beam support (ground bar). Once the person has eaten they push the handle upward and a spring attached to the rocker continues the motion back to the place.

The locking device is a simple latch that is built into a piece of 1" by 3/8" aluminum bar. It prevents the spoon holder from falling back to the plate when it stops to allow the user to eat. At this point the crank-rocker is at one of its dead points and requires an upward nudge from the user after they have eaten to allow it to continue its motion. Another feature of the design is the ability to rotate the plate using a handle. This brings the food on the plate in the path of the spoon so that it can be scooped.

The mechanism is mounted on wooden box of dimensions 4 x 9 x 12 inches and is very light, compact and portable. The cost was approximately $400.





Page Turner Device
A Feasibility Model for Use With Severely Handicapped Individuals With Limited Motor Functions

Designers: C. Lucero, N. Nik Yusyoff, G. Gallegos
Supervising Professor: R. A. Willem, Ph.D.
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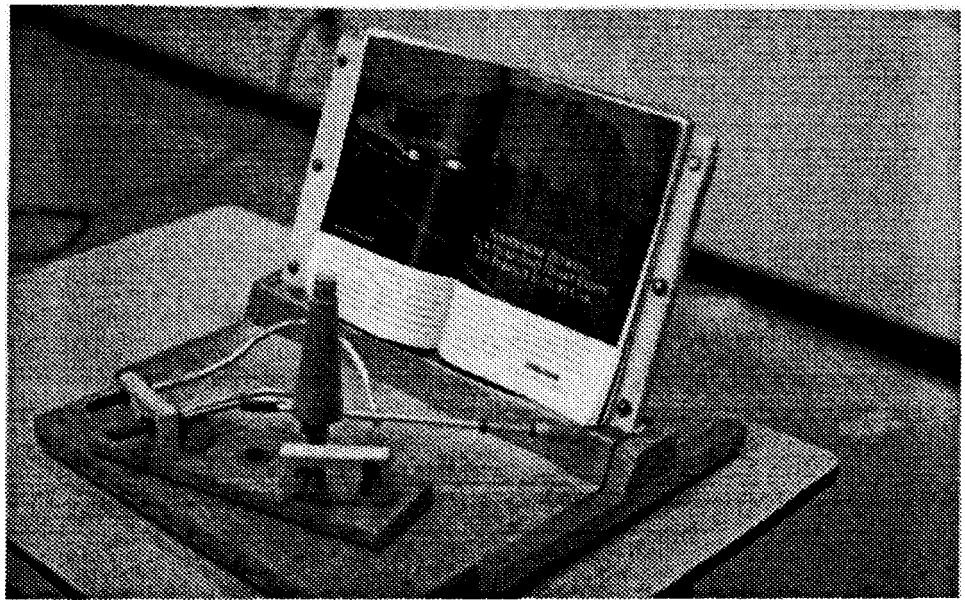
INTRODUCTION

Many individuals are severely handicapped and unable to perform simple motor functions such as turning the page of a magazine or book. This function, which is so rudimentary to most people, can be the reason some handicapped individuals may never enjoy reading. The feasibility model presented here addresses this problem. It is designed to aid in page turning when the individual has limited motor coordination, motor strength, and motor range.

The page turner is small and light weight. It has few parts and the simplicity of the design makes it not only economical but also aesthetically pleasing. The page turner's central mechanisms are the stylus curves (see Figure 2). This trajectory in turn is transformed into a desired path across the page of a magazine or book. The actual motion is based on human mechanical motion when flipping a page. This motion was observed many times to determine the approximate path line across a page. The small amount of force and motion to move the stylus probe through the battling is due to the stylus curves. The handicapped individual in turn is required to have only 15 degrees of motion in their arm in either direction. The amount of force required is also only about 1/2 pound to 1 pound of force in either direction.

The design as a whole is largely successful and although some accessory parts are not fully developed, the main turning device is. Two other important components are the spring loaded stylus probe with the rubber finger cover, and the slip bearing. The spring loaded stylus is important



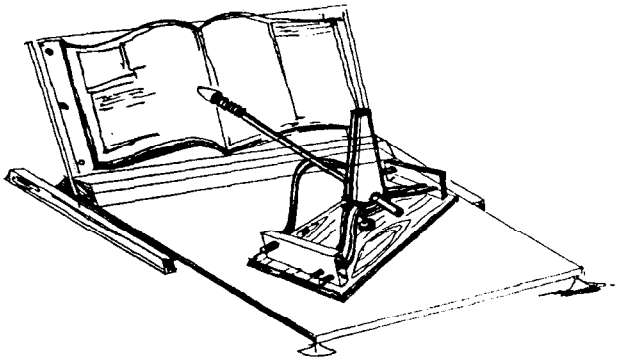
because it gives positive contact with the page throughout the motion of the stylus probe. The slip bearing allows the stylus probe to move around the bottom two stylus curves with very little friction.

SUMMARY OF IMPACT

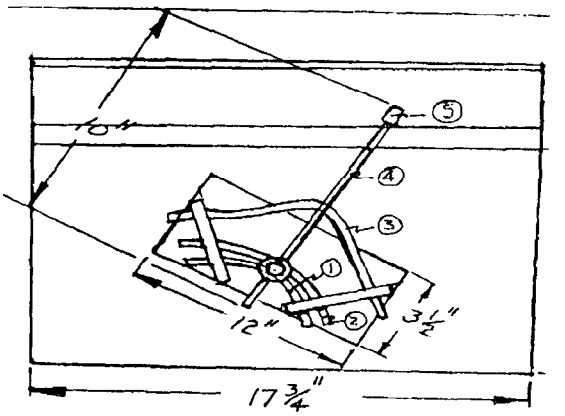
The device is just a feasibility model; however, it is based on the needs of a specific client. The actual production model would need to be refined. The model itself accomplishes the task for which it was designed and that was turning the page of a magazine or book. With further development it appears to be a feasible means of turning pages for people with partial loss of arm and hand use.

TECHNICAL DESCRIPTION

The model itself was built with a base that is 13.5 inches wide by 17.75 inches long. The stylus curves were made of the .25 inch OD copper and aluminum tubing. The reinforcement around edges of the base was made of .5 inch by .5 inch redwood. The book backboard was made out of one piece of 10.5 inch by 17.75 inch 1/4 inch plywood. The stylus probe was made out of 9/32 inch brass tubing with a 1/4 inch brass tubing insert. The base for the stylus curve was made out of 3.5 inch by 12 inch piece of 1/2 inch pine wood block. The cost of the model was $20.



PAGE TURNER FEASABILITY MODEL



TOP VIEW

Saw Cutting Aid

Designers: Keith Webb, Morgan Kirby
Coordinator: Jim Thompson, MVVTP
Supewising Professor: R. A. Willem, Ph.D.
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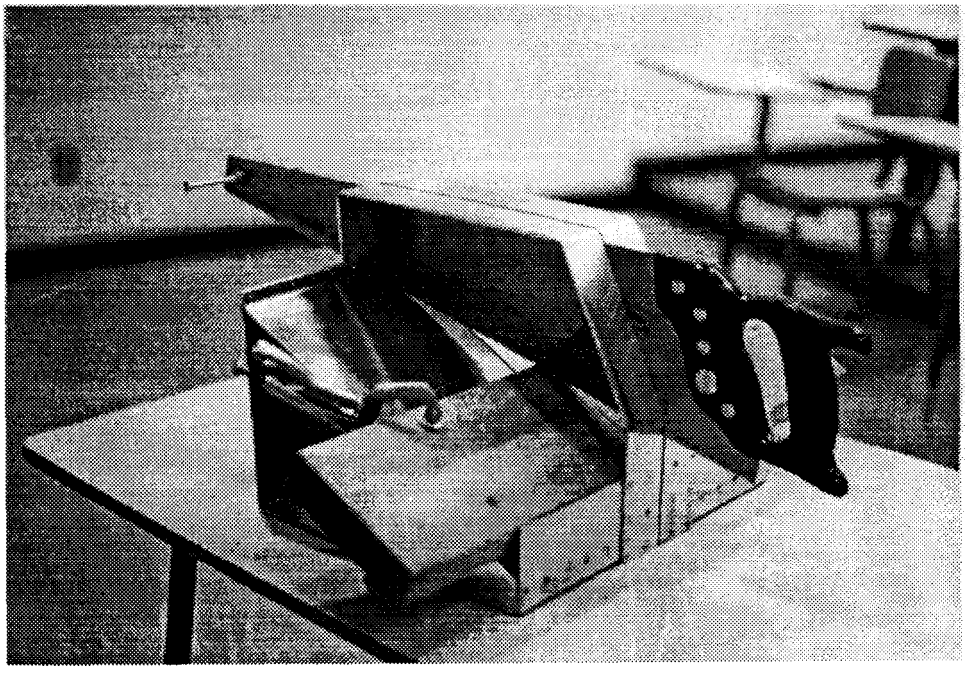
INTRODUCTION

A modified miter box was designed and fabricated to guide disabled students in making straight saw cuts across and through a wood piece. It was designed to give a 30 degree angle of cut with the horizontal and keep the saw from slipping off the wood pieces of various widths and thickness.

The saw cutting aid was developed to satisfy these needs. To keep the saw straight, the miter box concept was used, having a base with two sides opposite each other with slits. The saw slides in the slits and cuts straight across and through the wood. A ramp was designed in the miter box that the wood could be placed on to achieve a 30 degree cut angle. The saws used are standard cross cut saws which have a hole at the front tip of the blade, and a pin was placed in the hole. When the saw is used with the saw cutting aid, the pin hits the front face of the miter box, on the return stroke, and keeps the saw from slipping through the guide slot and sliding off the wood.

SUMMARY OF IMPACT

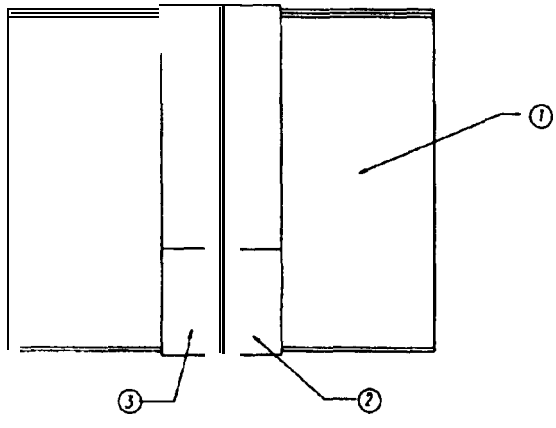
The aid relieves the handicapped student from all operations except the cutting motion of the saw, reducing the effort required to cut a wood piece. Most important is the safety that the aid provides. The student no longer has to initially guide the saw with their hand risking injury from the saw, the overhead guide does this. In addition, the pin at the tip of the saw with the overhead guide, keeps the saw controlled throughout the cutting operation while providing a satisfactory cutting stroke.

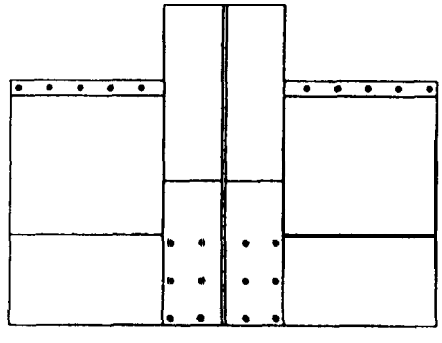


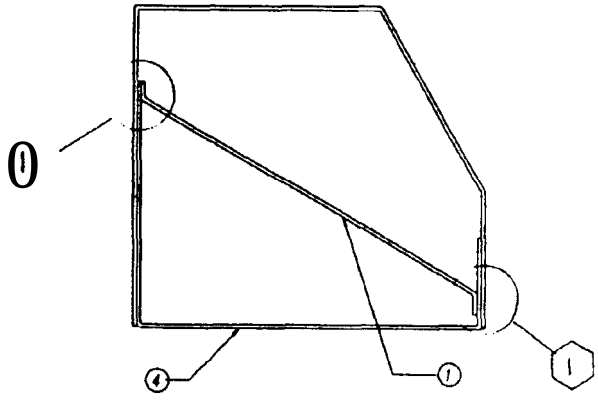
TECHNICAL DESCRIPTION

The saw cutting aid was constructed of 1/8 inch thick aluminum plate. It was constructed as five components that were then riveted together. The components consisted of 2 ramps, 2 over/head guides, and the base with sides. The sides of the base had 1 inch slits cut down their middles. The overhead guides were riveted to the sides of the base, so that they overlapped the 1 inch slit resulting in a new width of 1/8 inch for the saw to slide between. The ramps were riveted to both sides of the base providing a 1 inch slit between them that matched the 1 inch slit in the sides of the base. The approximate cost of making the saw cutting aid was $500.

The slant of the guide was designed to provide full sawing strokes at the beginning of the cutting operation while shortening saw strokes at the end of the operation for a cleaner cut. The sizes of the wood pieces to cut ranged from 4 to 12 inches wide and 3/4 to 2 inches thick, so the dimension of the cutting aid were calculated using a maximum wood size of 12 inches wide and 2 inches thick. Easy set up of the wood piece was accomplished by using C-clamp vice grips to clamp the piece to ramp. The vice grips are self locking and the width adjustment is easily made by turning a set screw on the handle. They require little strength to clamp down tightly. Swivel pads are attached to the C-clamp tips to protect the piece being clamped. The saw cutting aid was constructed with 1/8 thick aluminum into components that were riveted together. Aluminum was chosen because it makes the saw cutting aid light and easy to move around. Components were used so if one gets damaged it can be replaced without replacing the whole box. Fixing the saw cutting aid to a surface such as a table top was left as an option to the user. It can either be bolted down through the base or toggle clamps can be fixed to a surface and used to clamp down the base, making the saw cutting aid portable. A space of 1 inch between the base and the ramp was made to allow space for a scrap piece of wood to protect the base from being damaged by the saw teeth and vice versa.







ASSEMBLY DRAWING

Wheelchair Writing Tablet

Designers: E. Keppler, R. Weber, S. Evans
Supervising Professor: R. A. Willem, Ph.D.
Mechanical Engineering Deparfmenf
New Mexico State University
Las Cruces, NM 88003

INTRODUCTION

For a paraplegic in a wheelchair, some type of portable, self-contained writing surface is not always easily obtained. Many tablets used by paraplegics today are awkward to use and are usually expensive.

The portable, self-contained writing tablet that will fit a wide range of different wheelchairs has been developed. The writing tablet gooseneck is simply inserted into the arm of the wheelchair and the shift knob handle is turned clockwise to secure the table firmly to the wheelchair. The shift knob is conveniently located just beyond the tablet for easy access, and the tablet shape allows the wheelchair occupant freedom of movement and plenty of writing surface area.

SUMMARY OF IMPACT

The designers of the wheelchair writing tablet met with the recipient several times before the design operation began. These first meetings were to determine the client's extent of movement and needs. During the design operation, the client was aware of the general design. Since the tablet is custom made, she chose the shape of the table and color of the surface laminate. Our client was pleased with the aesthetic quality and ease of operation. She indicated that it performed flawlessly during several conferences and meetings. She also received complements on the quality of the writing tablet.

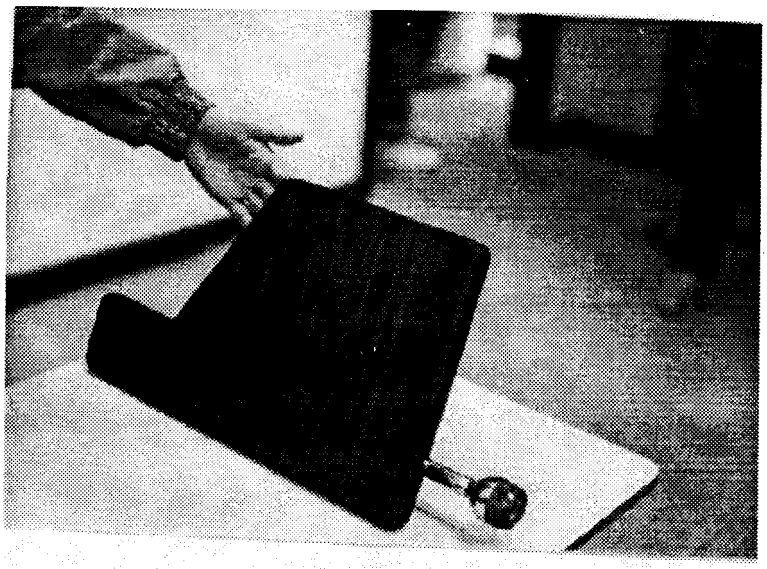
TECHNICAL DESCRIPTION

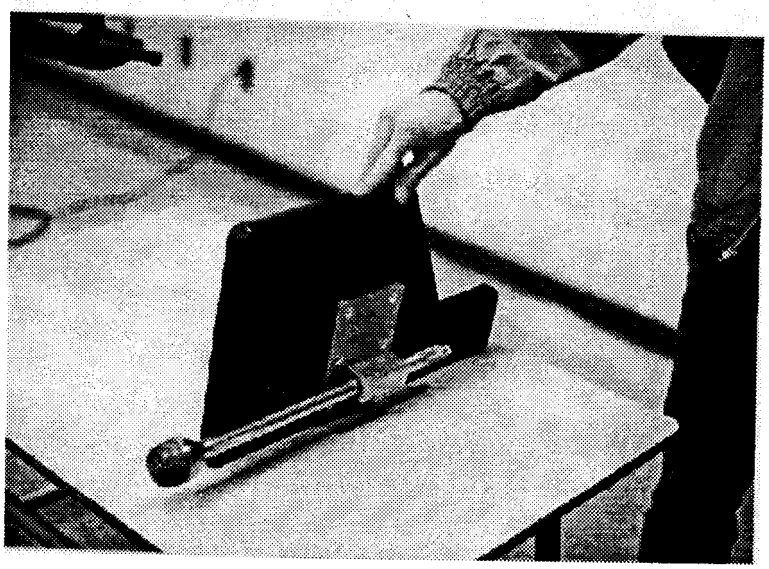
The wheelchair writing tablet is shown in its most basic form. The 3/4" particle board tablet has been finished in a natural rosewood laminate. The corners of the tablet and all associated mounting hardware have been rounded for the safety of the client.

The tablet is attached to the gooseneck mounting hardware by a 1/4" aluminum plate that is screwed to the table with six countersink wood screws.

The aluminum gooseneck piece is attached to the mounting plate (mentioned above) with two screws that thread into tapped holes into the gooseneck piece itself. A 5/16" steel rod has been inserted through this piece and the mating steel part of the gooseneck attaches to this rod by a nut that is pressed into the knurled steel end. The steel mating part is kept from screwing off the threaded rod using two nuts tightened together on the end of the threaded screw.

When the tablet is mounted on the chair and the crank knob is tightened, the gooseneck mating components tighten against the inner surface of the arm, thus securing the tablet in place. A carrying bag was purchased so that the table could be portable and easily hung on the back of her wheelchair. The total cost of the tablet and associated mounting hardware was $100.





Crawling Aid

Designers: R. Fas, W. Bannister
Disabled Coordinator: Marion Dawson, Las Cruces Public Schools
Supervising Professor: R. A. Willem, Ph.D.
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Las Cruces, NM 88003

INTRODUCTION

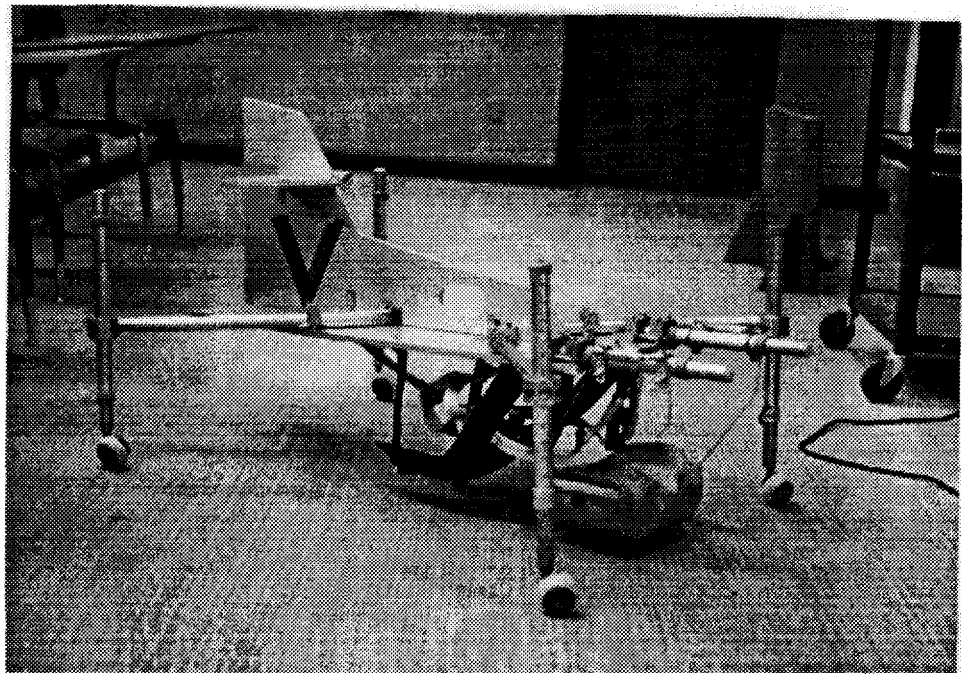
A specific nine year old child had several different physical disabilities that limited the use of her arms and legs. The child could not walk, and could only crawl with assistance. Although a type of crawling aid was readily available, it did not satisfy the needs of this child. A device was not only needed to provide mobility, but also to allow the child to develop muscle tone. It was also necessary for the device to be easily adjustable so that the child's growth could be accounted for.

To solve this problem, the Crawling Aid has been developed. It consists of a frame constructed from aluminum tubing and a plywood base, which supports a nylon harness and a head rest. Each of the four legs may be independently adjusted to allow for the size of the child, and to cause the child to develop strength in certain muscles at the discretion of the physical therapist. For example, if the physical therapist determined a need for the child to work predominantly on arm development in one particular exercise session, the device could be adjusted to cause the child to use her arm strength as the primary means of propulsion.

It was necessary to prevent the child's head from dropping below the centerline of her body. To solve this problem, a detachable head rest was fabricated. The head rest may be removed at the discretion of the physical therapist to cause the child to develop strength in keeping her head upright without assistance.

SUMMARY OF IMPACT

The child for whom this was designed has enjoyed the mobility that the Crawling Aid has provided her. In addition, her teachers and her physical therapist have been pleased with how very well the completed Crawling Aid has met their needs. Strengthening exercises that were



difficult previously are now performed without difficulty, and it appears that the child's excitement about the device has contributed to her motivation to overcome her disability.

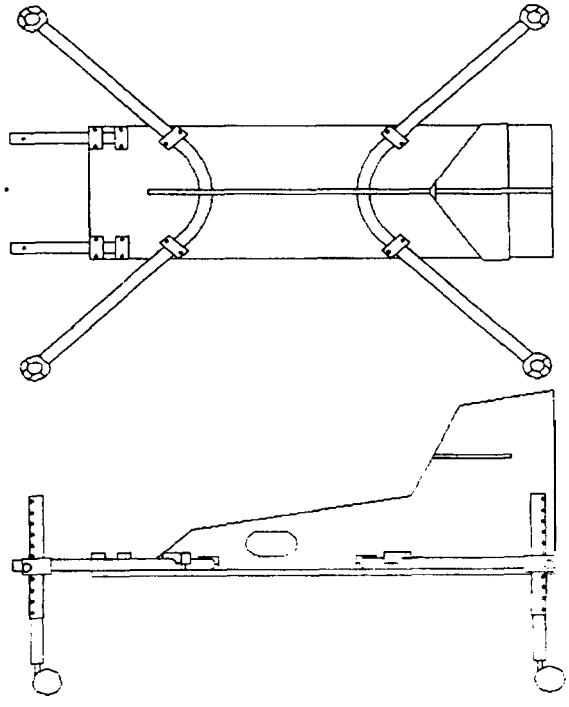
TECHNICAL DESCRIPTION

The Crawling Aid is shown below in its basic form. Most of the materials were readily available, except for the clamp blocks, which fastened the aluminum tubing to the plywood base, and the couplers linking the vertical supports with the frame. These parts were applications specific and were machined solely for this purpose.

The harness is constructed of nylon strap, and consists of leg loops, shoulder straps, and sternum strap. To insert the child into the Crawling Aid, the device is first tipped back to rest on its rear legs. The child's legs are then inserted into the leg loops and her arms through the shoulder straps. A fastener is provided for the sternum strap, which prevents the shoulder straps from separating during use.

Adjustments are made by spring loaded pins that insert into one of a series of adjustment holes on the vertical supports. The head rest slides on two aluminum tubes on the front of the device, and may be adjusted by the same method to allow for growth of the child.

The vertical support on the wooden base was added due to the apparent need for a structural member. For aesthetic purposes, the support was made to look like the tail fin of an airplane. A handle was added for ease of carrying. The approximate cost of fabrication of the crawling aid is $1000.



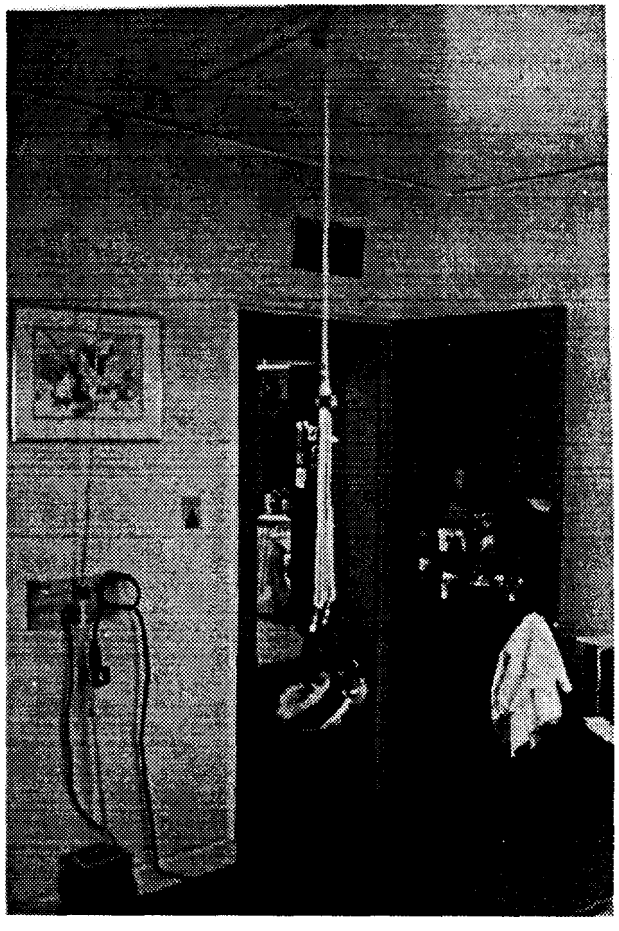
Personal Lifter

Designers: S. Fuehrer, G. Bacon, A. Al-Burain
Disabled Coordinator: May Ann Ahrens
Supervising Professor: R. A. Willem, Ph.D.
Mechanical Engineering Department
New Mexico State University
Las Cruces, NM 88003

INTRODUCTION

A problem experienced by many paraplegics is that of getting dressed. Putting on a pair of pants or a dress requires the individual to get out of their wheelchair and get dressed on a bed where they are not required to lift themselves vertically.

The personal lifter was designed to easily solve this problem. It provides the means of lifting an individual up a few inches out of their wheelchair so that they can pull on a pair of pants or a dress. This eliminates the need to climb out of their wheelchair to get completely dressed. It also allows the individual to get dressed in front of a mirror, which makes getting dressed that much quicker and convenient.



SUMMARY OF IMPACT

The lady that this was designed for is paralyzed from the waist down. The design allows her to park her wheelchair in front of her dressing mirror, pull on the harness and lift herself a few inches above the seat while leaving her arms free to pull on her garment. She is very happy with the design, it has made getting dressed in the morning much easier.

TECHNICAL DESCRIPTION

The major components of the personal lift consist of: 1) 1200 lb., 110 V AC winch, 2) floor mounting bracket, 3) ceiling pulleys, 4) safety limit switch, and 5) custom fitting harness.

The winch is a 1200 lb. capacity model that is operated using household AC 110 V current. This allowed it to be installed with no major electrical modifications. Also included on the winch is a remote switch that allows the winch to be operated up to ten feet away. The 3/16 inch steel aircraft cable that was provided with the winch was replaced with 3/8 inch nylon rope for ease of use and aesthetic value.

The mounting bracket was constructed of 3/16 inch steel plate bent into an "L" shape. A three bolt pattern was utilized to mount it to the hardwood floor. The vertical surface of the bracket had a bolt pattern identical with that on the winch mounting plate.

The ceiling pulley system consisted of two 3/8 x 5 inch "J" hooks from which the pulleys were hung. The "J" hooks were bolted directly into the 2 x 4 ceiling joists with a 2 inch diameter washer on top to prevent pull-through.

The safety limit switch was incorporated into the design to provide a "kill" switch in the event of failure of the normal switch. It allows only 40 inches of vertical movement of the rope before shutting off. At its maximum height the individual is approximately 10 inches off the seat of the wheelchair. Therefore, the individual can get out of the harness and lower themselves down without and risk of danger of a long fall.

The harness was custom designed to fit the individual. It was constructed of 2 inch nylon webbing strap and "D" ring for attachment points. The harness is padded under the arms for a more comfortable fit.

The entire system is installed as a permanent unit to provide a means of lifting a person up a few inches out of a wheelchair to allow them to get dressed more easily. The approximate cost of the project was $400. The designers and recipient feel that the Personal Lifter is a success.

Walker/Pusher with Seat

Designers: M. Erickson, L. Goerss, M. T. Awang Pa
Disabled Coordinator: M. L. McKay, Las Cruces Public Schools
Supervising Professor: R. A. Willem, Ph.D.
Mechanical Engineering Department
New Mexico State University
Las Cruces, NM 88003

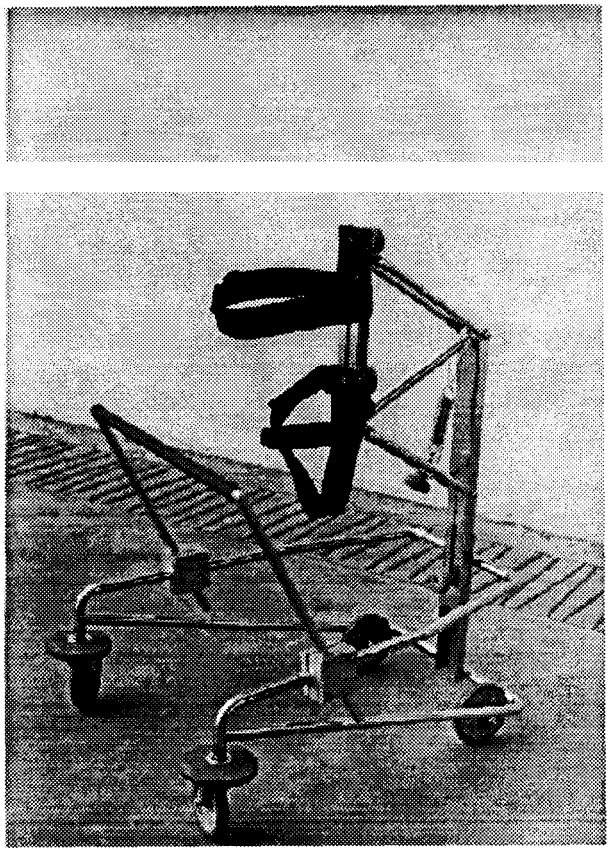
INTRODUCTION

Persons with muscle disorders often require the use of a walker-type device to become more mobile and self-sufficient. Walkers constructed from aluminum tubing are often utilized because of their light-weight, yet durable characteristics. Even greater mobility can be achieved by adding wheels, which eliminates the need to lift and carry the device.

The goal of this project was to develop a walker that would have the following characteristics:

Stable	Safe
Durable	Portable
Lightweight	Adjustable

Also required were a restraint device to keep the subject from falling and some type of seat so that the person could sit and rest if needed. A rest for the person to lean on with arms fully extended was also needed.



SUMMARY IMPACT

This project was undertaken to assist a middle school student to become less dependent on her teachers and guardians in moving around a room. The subject's teachers requested a device that would allow her to maneuver around and have a restraining device that would catch her if she lost balance and fell. Portability was also a requirement so that the device could be transported between home and school.

At the time of this report, the recipients of the device find it successful in meeting its objectives. Not only is the device extremely maneuverable, it has kept the person from falling down and injuring herself. The adjustable bar at the front of the device has been adjusted so that the subject's arms are extended when strapped into the walker. The back-support and seat were also adjusted.

TECHNICAL DESCRIPTION

Because the device needed to fulfill so many requirements, it was decided that the design of the device be divided into three main design goals: 1) Frame design; 2) Restraint/Seat design; and 3) Adjustable Push-Bar design.

It was decided early that the design and construction of the entire device was not necessary. Rather, a modification of an existing walker seemed appropriate. Searching through catalogs we found an already existing walker that satisfied the first two design goals. The base of the walker, sold by J. A. Preston Corporation, was constructed from steel tubing that made it fairly lightweight. Casters were mounted on the bottom for increased mobility. The restraint/seat portion of the walker consists of a four-bar linkage with a rubber coated seat mounted on a bottom corner. A spring and adjustable shock absorber were mounted on the four-bar so that a cushioning and dampening effect is achieved when the person strapped to it decides either to sit or actually falls. Velcro straps, attached to the padded back support in two places, can be fastened snugly around the chest and the waist to keep the person in the walker at all times. The cost of the walker was approximately $625.

Since the purchased portion of the device took care if the first two design goals, the only remaining portion left to design was the adjustable push bar. The final design of the push-bar consisted of a 3/4" diameter, aluminum bar bent 90 degrees in two places that was attached to the walker by aluminum brackets. The brackets (see Figures 1 and 2) consisted of three pieces each. The outside and middle pieces have a 60 degree groove milled into them where the push-bar was allowed to slide between. By adjusting the cap screws holding the pieces together, the push-bar height can be adjusted. Similarly, a groove was milled into the other side of the middle pieces and the inner pieces so that the brackets could be mounted on the walker. Allen screws were also used to hold the inner and center pieces together so that the entire push-bar assembly (see Figure 3) can be moved back and forth on the walker's frame. The exact drawings and specifications for the brackets and bar are included in latter pages of this report. The total cost of these machined parts is approximately $120.

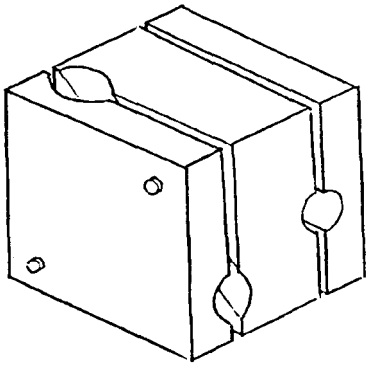


Figure 1: Left Side Bracket Assembly

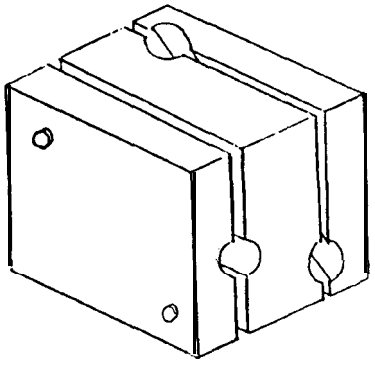


Figure 2: Right Side Bracket Assembly

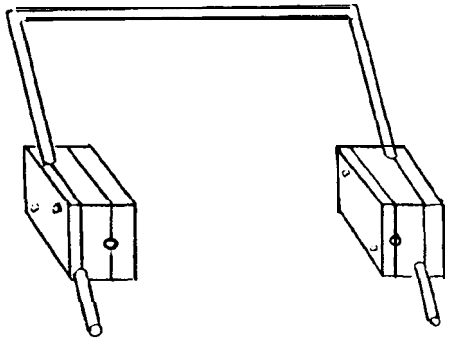


Figure 3: Push-Bar Assembly

Jumping Apparatus

Designers: *J. Baumgardner, K. Cartier,* S. Robertson
Disabled Coordinator: Michelle Key, Las Cruces Public Schools
Supervising Professor: R. A. Willem, Ph.D.
Mechanical Engineering Department
New Mexico State University
Las Cruces, NM 88003

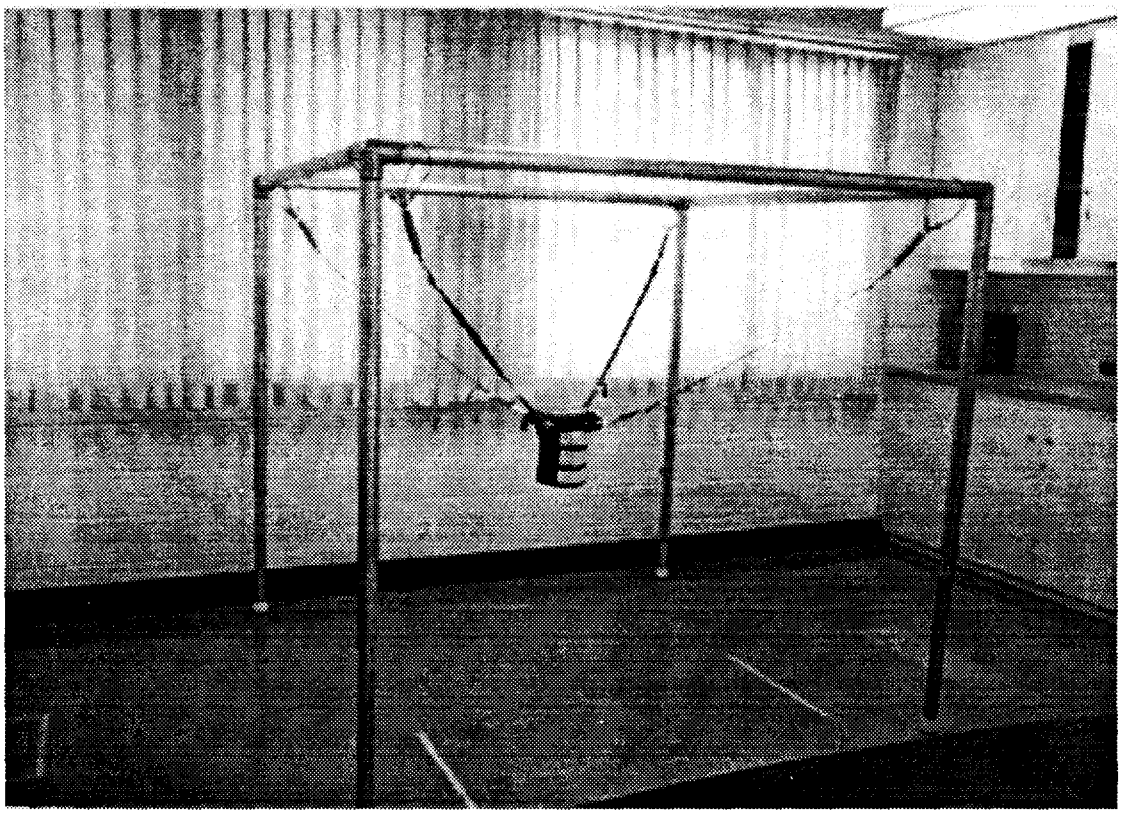
INTRODUCTION

A jumping apparatus for a small boy was necessary to help him with his coordination. The child has difficulty in coordinating movement that involves more than one motor skill at a time. The device was required to be very safe, since in the past his difficulties have caused serious injury during play. The apparatus allows him to jump from both a standing position and a low stool without injury. The goal of this project was to develop an apparatus that would allow the child to practice jumping safely, while providing something that is fun for the child to do.

SUMMARY OF IMPACT

This project was undertaken to help a child with coordination difficulties. The device consists of a portable frame and adjustable harness. The intention of the apparatus was to allow the child to increase his coordination skills both with safety and enjoyment.

The child seems to enjoy the device and his teacher, who was the contact person for the design, believes the jumping aid will help him immensely.

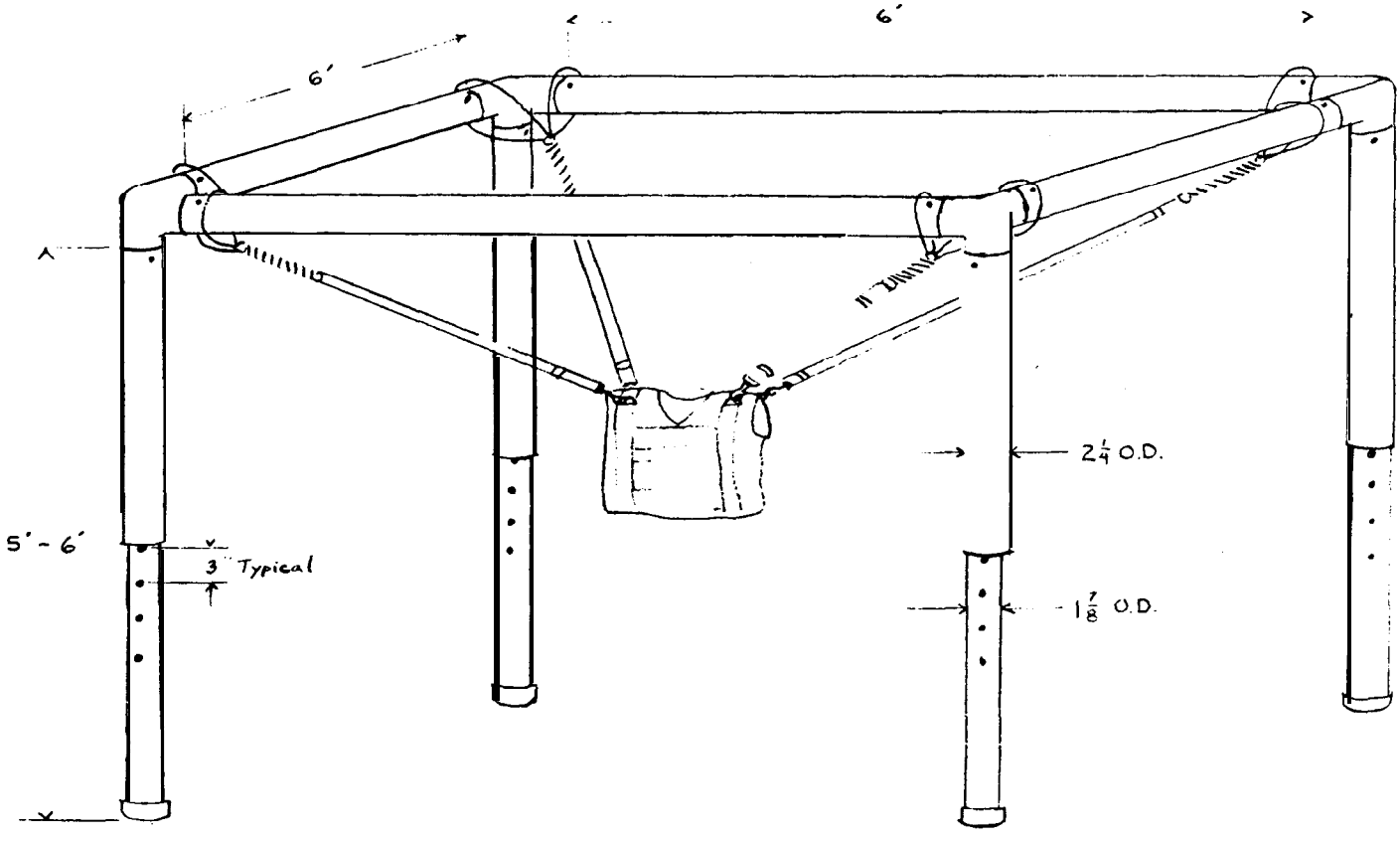


TECHNICAL DESCRIPTION

The framework was constructed of two different sizes of 6061-T6 aluminum tubing. The top frame and the top pieces of the legs were constructed of the larger tubing. A piece of steel pipe was inserted into each connector. This piece of pipe was then inserted into the end of the corresponding tube to facilitate connection at the corners. These steel pieces were then bolted into the larger tubing and set screwed into the connectors. The smaller tubing fits inside the larger tubing to complete the legs. The smaller pieces had holes drilled in them for pins upon which the larger tubing rested. This allowed the legs to be adjustable in height, hence "telescoping". The springs were attached to the comers of the framework by plastic coated cables. These springs were then connected to straps of nylon webbing. The straps were made adjustable using buckles.

The harness was made of denim for strength and durability. It was designed as a vest with Velcro fasteners to make it easy for the child to put on and take off. "D-rings" were connected to the straps using safety clips.

The total cost of this project, including materials and labor is estimated at $500.



Rotating Swing for an Autistic Child

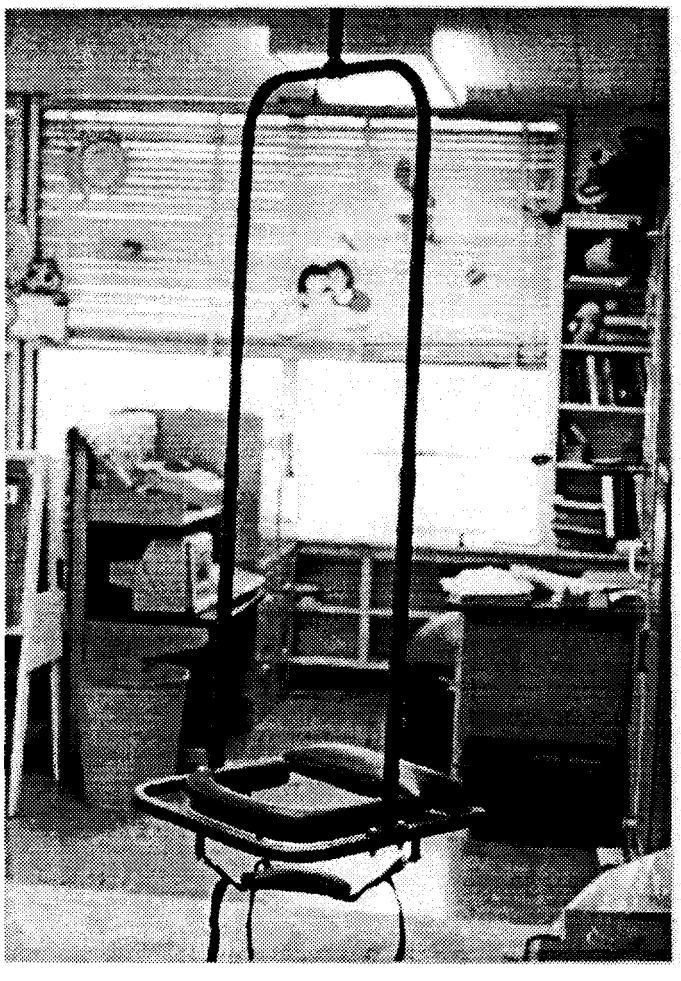
Designers: D. Bennett, M. Crutchjield, and J. Knapp
Disabled Coordinator: M. Dawson, *Las Cruces* Public Schools
Supervising Professor: R. A. Willem, Ph.D.
Mechanical Engineering Department
New Mexico State University
Las Cruces, NM 88003

INTRODUCTION

The main objective of this project was to design a device to rotate a child. The child was previously rotated by his teacher by holding the child and spinning him. The teacher felt a device to rotate the child would be entertaining and therapeutic, besides leaving her free to work with the other children in the class. A rotating swing was chosen since it would best meet the objective of the project and the needs of the child.

SUMMARY OF IMPACT

This project was designed for an autistic child who liked being spun by his teacher. Thus, the swing designed for his needs was ceiling-suspended and can be rotated about its vertical axis. This allows the child to swing in a rotating motion that allows the teacher to work with the other children. After some introduction the child appears to enjoy the swing. It would continue to be a great source of enjoyment because of its versatility and ability to be used by all the children of the class.

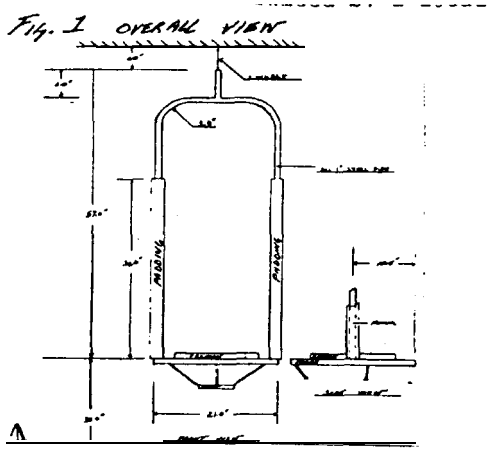


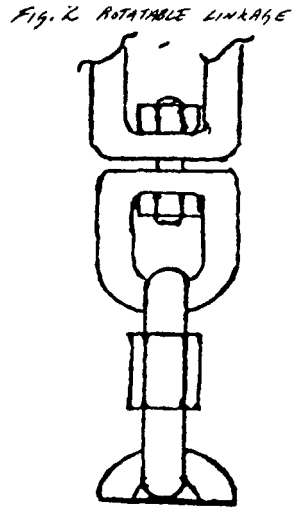
TECHNICAL DESCRIPTION

Figure 1 illustrates the overall design of the rotating swing. This swing is a connected three piece unit consisting of a seat and seat frame that is bolted to a vertical support and all this is suspended from a ceiling bracket by a rotatable linkage.

The vertical support was constructed of 3/4 inch steel pipe. One-quarter inch flat stock flanges (Figure 2) were used to connect the vertical support to the seat frame. The support and frame were connected via four 3/8 inch bolts. Figure 3 depicts the rotatable chain linkage. This consists of two threaded links and one rotatable connector. The threaded links allowed the swing to be easily installed and removed from any stationary overhead support. Padded bicycle wrap was affixed to the vertical support for child safety and comfort.

The seat frame and seat were purchased from J. A. Preston Corporation. The vertical support was fabricated by a local metal shop. The linkage was purchased at a local hardware store. Total cost, including machining cost, of swing device was approximately $540.





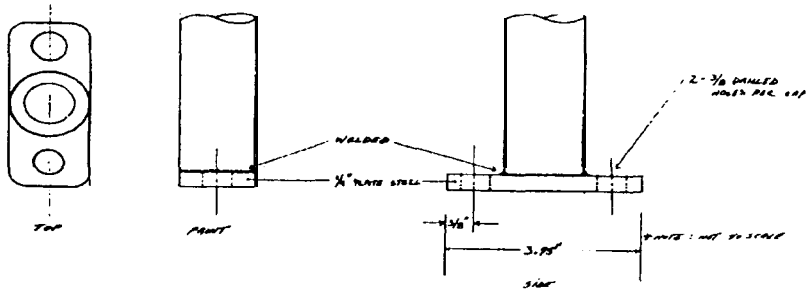


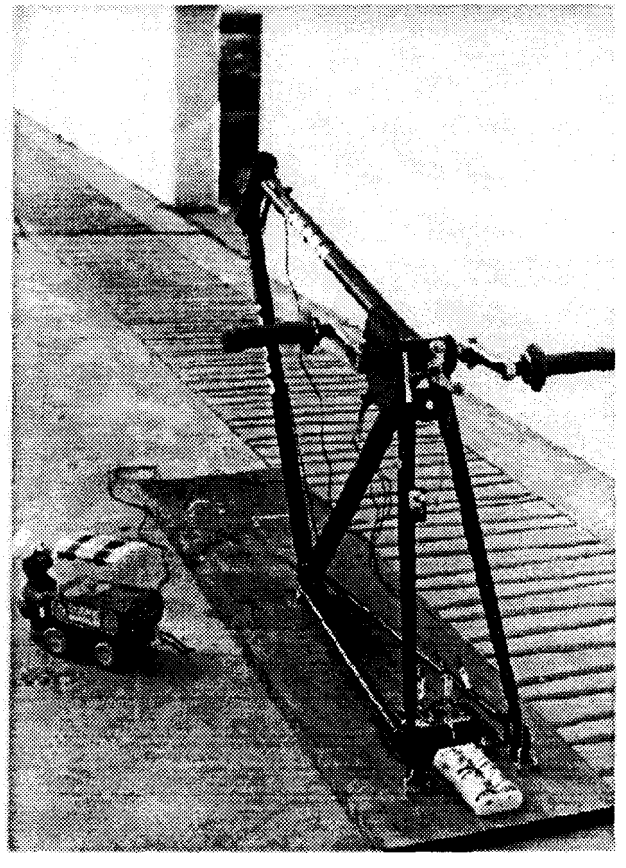
Fig. 3 Bottom Cap

Child's Upper-Body Muscular Development Apparatus

Designers: Morgan Kirby, *Jacky* Peterson, *Bret Smith*
Disabled Coordinator: Caroline Leland, Las Cruces Public Schools
Supervising Professor: R. A. *Willem,* Ph.D.
Mechanical Engineering Department
New Mexico State University
Las Cruces, NM 88003

INTRODUCTION

Some children, including those with Down's Syndrome, are muscularly underdeveloped, particularly in the upper-body. This condition can impair a child from performing normal everyday functions like eating, writing, and playing. Several devices are available for lower-body muscle development. The few upper-body exercising devices available do not maintain a child's interest. The primary goal of this project was to design a device that would enhance upper-body strength. The secondary goal of nearly equal importance was to make the child feel the device was a toy or game rather than an exercise machine to keep the child's attention.



SUMMARY OF IMPACT

Due to time constraints, it was only possible to develop a prototype that demonstrated feasibility of the concept. It is anticipated that another student group will pick-up this project at a later time and carry it to completion.

TECHNICAL DESCRIPTION

The concept of the design is to provide a hand pedaling motion to utilize all parts of the upper-torso. The principal components are an adult sized bicycle frame and a three-piece crank set from a child's bicycle. The frame provides a base in front of which a child can sit or stand and hand pedal the cranks.

To provide variable resistance to motion, an adjustable braking device is used. The brake consists of one side of a two piece bicycle caliper brake. A steel bracket with a threaded hole was welded to the crank housing and a screw was run through a clearance hole on the caliper piece and threaded into the bracket thus allowing the brake to rotate. The original sprocket was replaced by a solid steel disk that was welded to the crank arm. This provided a surface to which the rubber brake pad could be applied. The brake is adjusted by a 24 gauge guitar string attached to a lever arm opposite the brake pad. The other end of the string is wound around a worm gear type guitar tuning key that is mounted to a bracket welded to the bicycle frame. As the tuning key is turned, the string pulls the lever arm down. This allows the brake to rotate and apply pressure to the disk.

To reward the child for operating the exercise device a switch is triggered that would allow power to an electronic toy as long as the child maintains a minimum crank rotational velocity. To do this an optoisolator was implemented into the design. The optoisolator sends a light beam across the slot which when broken at a high enough frequency will close a switch allowing current to pass through it. To break the light beam the disc was machined so that it has 120 equally spaced teeth along its perimeter. The optoisolator was positioned on the bicycle frame by a bracket so that the disc teeth passed through the optoisolator slot as the disc was rotated by the crank arms. It was determined that a frequency of 120 beam interruptions per second was adequate to trigger the switch. This translates to 1 revolution of the crank arms per second, which is reasonable for the child to accomplish.

Each time the disc teeth break the optoisolator light beam a square wave is generated that is sent to a lm2917n-8 frequency to voltage converter. This is contained in an integrated circuit shown in figure 1. Also contained in the integrated circuit is a comparator that completes a third circuit when two potentials across it are balanced. The converter feeds the comparator a voltage that is proportional to the square wave frequency, and therefore also proportional to the disc angular velocity. When this voltage matches a second voltage across the other side of the comparator, which is set by the potentiometer, current is sent to a third leg. It is by adjusting this potentiometer that the trigger speed for the toy is set. The third leg contains a reed relay, which is a switch pulled closed by an electromagnet when current flows through it. The original switch on the toy is replaced by the reed relay that is connected to the toy by a tether. The toy is turned on when the relay is engaged. The power required to operate the toy and the optoisolator is four C-size batteries.

The toy chosen for this design is the 'Cookie Wagon', an adaptation of the Cookie Monster from Sesame Street. The toy consists of a plastic replica of the Cookie Monster pushing a cookie cart. When the toy is operated, the cart moves by two wheels hidden underneath while the Cookie Monster's legs move back and forth and fake cookies pop up inside the cart. The cost to develop the project to this point has been about $150.

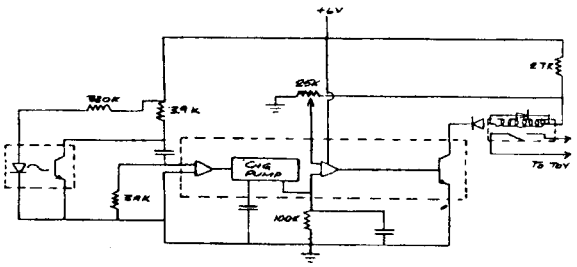


Fig. 1. Circuit diagram.

Picture Communication Device

Designers: S. Hobbs, J. Johnson, and E. Manzanares
Disabled Coordinator: M. L. McKay, Las Cruces Public Schools
Supervising Professor: R. A. Willem, Ph.D.
Mechanical Engineering Department
New Mexico State University
Las Cruces, NM 88003

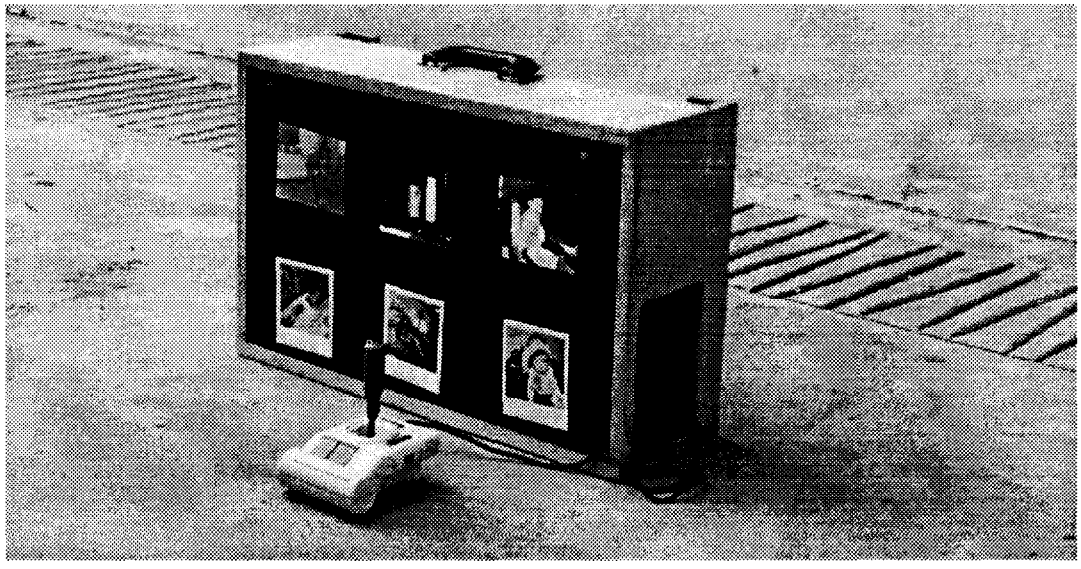
INTRODUCTION

The recipient of this device is an 18 year old boy with severe cerebral palsy. Like many people with severe cerebral palsy, the recipient's mobility, motor functions and speech are severely limited. The only way he can communicate with people around him is through his sight and with a side-to-side sweeping motion of his right arm. It is desired to give the recipient greater control over things he wants: does he want to watch T.V., listen to the radio, sit, etc. The goal of this project was to develop a selection device that made use of the recipient's limited motor functions.

SUMMARY OF IMPACT

This project was undertaken to improve the recipients communication abilities in school as well as in his home environment. The device needed to take advantage of the recipients side to side sweeping motion, be portable and self contained. It was desired that the selections (pictures) be easily changed when moving to a different environment.

Due to the recipient's severe condition, an extended period will be needed to work with the recipient in the use of this selection device; however, the device appears to be well suited to his limited abilities.



TECHNICAL DESCRIPTION

Located on the front of the device's cabinet are six pictures with six corresponding red LEDs, Figure 1. A joystick is used to indicate the desired selection by indexing to the corresponding LED.

A 23 x 17 x 7 inch wooden cabinet serves as the frame for hanging the picture boards and housing the electronic components. It is also utilized for storage and transportation of the additional picture boards and joystick. As a result, this device is totally self contained within the cabinet and portable.

Six pictures are attached to a 1/8 inch black Plexiglass board by corner tabs. The color black was chosen to provide contrast to the red LEDs. A total of six picture boards (36 pictures) are included to provide versatility in home and school use. Any size picture can be used to accommodate the needs of the recipient. These pictures are easily interchanged by teachers and family. A modified Archer joystick is used to take advantage of the recipient's side-to-side sweeping motion to index the LEDs. Two micro-switches were wired in parallel to provide the required voltage output regardless of joystick direction.

Output voltage from the joystick is interpreted by digital electronic components to perform the indexing operation. A timer is included to turn off the circuitry after 15 minutes of inactivity. All electronic components are driven by three AA batteries with a total output voltage of 4.5.

The total cost of this project was $300.00.

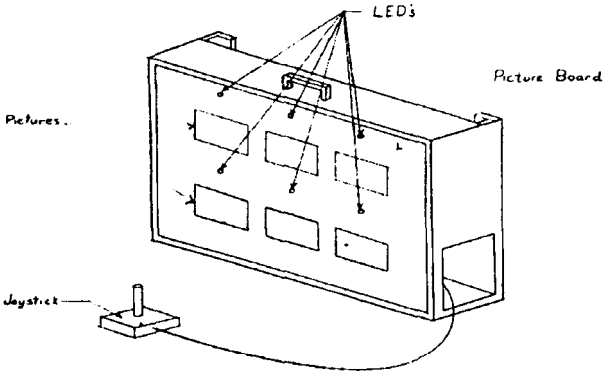
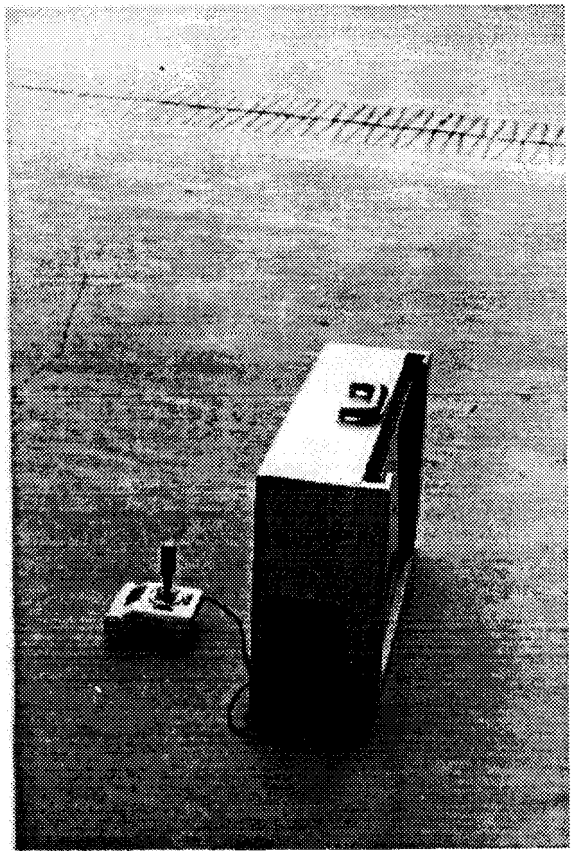


Fig. 1.



Reading Material Support and Stand

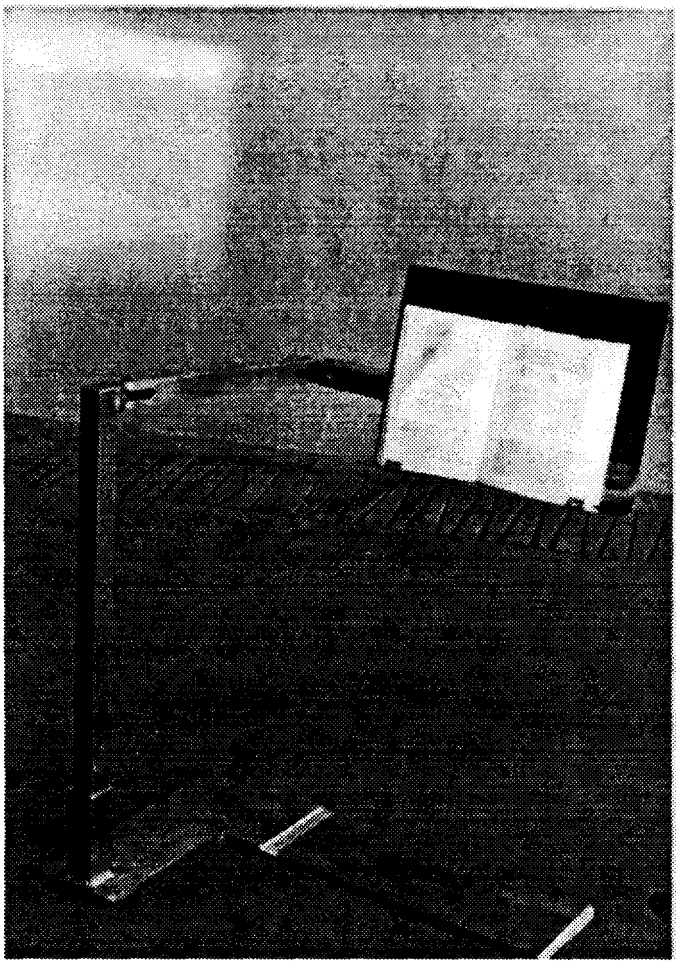
Designers: C. Balish, A. Al-Buraih and J. Dees
Supemising Professor: R. A. Willem, Ph.D.
Mechanical Engineering Department
New Mexico State University
Las Cruces, *NM 88003*

INTRODUCTION

This reading aid was built to assist our client in reading at home. The client injured her neck in an automobile accident, and experiences pain when she holds a book up at eye level or bends her neck to read a book on her lap. Therefore, the reading support was to hold a book at a certain height and distant so the client may read at home. The primary challenge was to design the device at a low cost while maintaining compactness and ease of use.

SUMMARY OF IMPACT

The person for whom the device was designed has a neck problem. The design allows her to sit in her comfortable chair and read without having to hold the reading material. The reading material is placed on a holding device and adjusted to her satisfaction. This allows her to read in the comfort of her house without experiencing any neck pain. Also, she said that it will help her to maintain a good reading posture along with allowing her to read more often. She is very pleased with the design.



TECHNICAL DESCRIPTION

The photograph of the device shows how the various components are assembled. The major components of the device consist of; 1) an L shaped base, 2) three interconnected moving bars, 3) a supporting pole, 4) a reading material support. The whole device is made out of aluminum except for a small piece of steel used to fabricate the middle moving bar. The device was designed to allow for the user to adjust the reading material up and down, side to side, and to rotate for exact positioning. Using three arms gives the user the capability to position the reading material at the optimal position for reading.

To maintain a book open to a particular page, a spring load Plexiglass plate is attached to the front of the reading material support and presses the book against the support (see photograph). The bracket for attaching the reading material support to the outer-most horizontal arm (not shown in the photograph) allows the support to be rotated about two axes as well as adjusted vertically over a small range. The use of three horizontal bars (2 long, 1 short) provides for greater mobility of the arms and allows the two long arms to be folded compactly against one-another for storage. Also, the vertical support pole fits into a socket welded to the base plate and can be removed from the base by pulling upward. Therefore, the total device can be quickly disassembled into three pieces: the base plate, the support pole and arms, and the reading material support. Further disassembly of the arms from one another and the support pole can be done by removing three cap screws.

Since the device is so easy to use, it readily is pushed away to allow for easy access in and out of the chair. The device was designed to satisfy all the client's requirements and as many wishes as possible while still maintaining an economy of means. The approximate cost of producing this design was about $500, which includes the material and fabrication cost.

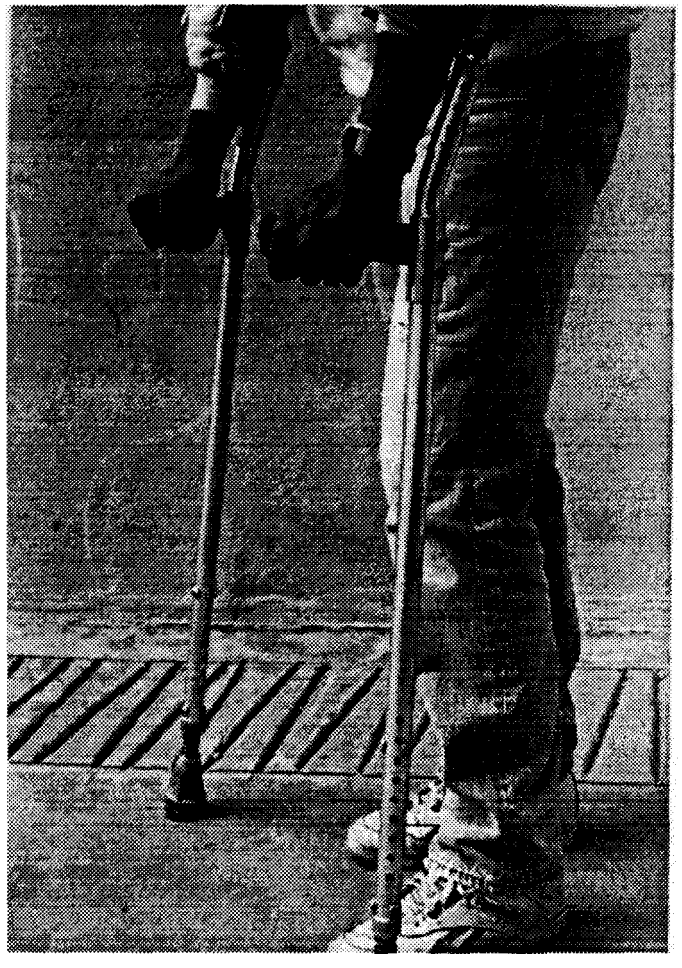
Shock Absorbing Crutches

Designers: M. Williams, D. Marquez, P. Tran
Supervising Professor: R. A. Willem, Ph.D.
Mechanical Engineering Department
New Mexico State University
Las Cruces, NM 88003

INTRODUCTION

Crutches are designed to aid people with leg impairments to walk. Typical crutches, however, are not designed for jogging. When a handicapped person jogs on crutches, impact forces and compressive stresses are generated throughout the crutch and the person's arms. These repeated stresses over a short period of time can cause a severe strain in the person's arms, especially in the joints of the wrist and elbow.

Therefore, the goal of this project was to design a set of shock absorbing crutches for a person with an amputated leg who likes to jog. Comfort and the alleviation of these stresses were the foremost priority in this design.



SUMMARY OF IMPACT

The project was undertaken to assist a female amputee who is also a student at the university. She wanted a pair of crutches that would allow her to jog in relative comfort.

The recipient of the crutches finds them completely satisfactory in meeting the project's objectives. Not only do they reduce the impact forces and compressive stresses, but their shock absorbing spring system and rotating handle can be adjusted to the most comfortable position with little difficulty.

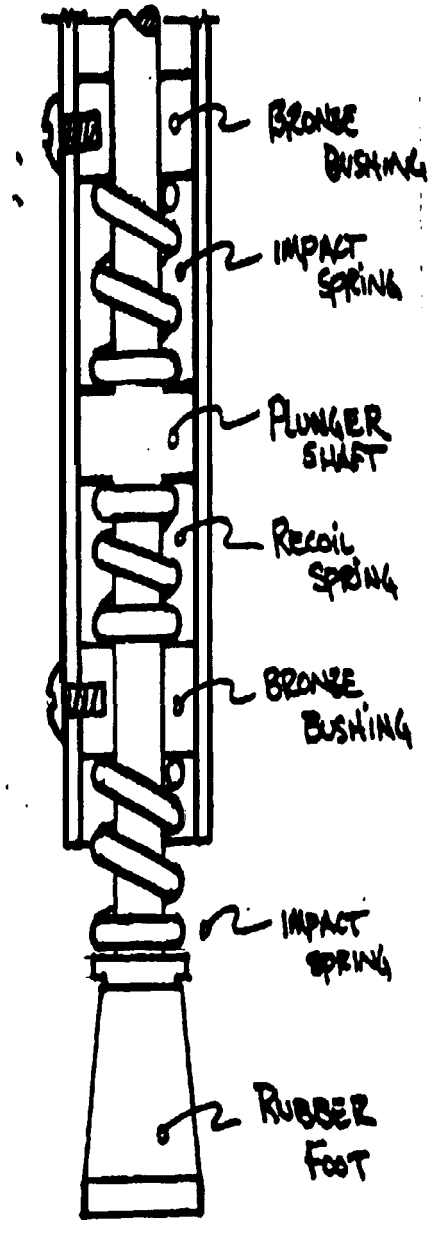


Fig. 7. Crutch Modification (Spring Section).

TECHNICAL DESCRIPTION

To solve the problem at a reasonable cost in a reasonable length of time, the approach of modifying an existing pair of crutches was taken. The components in the final design include: the modified crutches, the plunger, which was made in the machine shop, the three kinds of springs, which were ordered from Associated Spring Co., the stoppers, the endcaps and a few pins and bolts to secure the assembly.

The crutches were modified so the handles could be rotated about the axis of the crutch. This was done after a conference with an athletic trainer. Her advice was that the handles turned slightly inward should be more comfortable because it is a more natural position.

The shock absorbing system that was used is shown in figure 1. It was decided to use a system of three springs, two landing springs and one for the recoil to equilibrium. These springs turned out to be all of different lengths and stiffness and work in a combination. The decision to go with the spring system was made after a careful consideration of all the options. A small shock absorber would be expensive and difficult to install and maintain and would dissipate rather than return energy to the user. Therefore, the spring and plunger system was implemented because it was simple, inexpensive, and returned energy to the user.

After the crutches were fabricated and given to the client, she concluded that the plunger rotated when the foot of the crutch was placed on an uneven surface, which made her unstable. This problem could have been foreseen, but wasn't. To eliminate this problem the crutches were then modified by the addition of two slots and a pin. The crutches seemed to work very well after that.

After everything was manufactured and put together, the cost totaled approximately $700. Broken down this is about $200 for the crutches, $150 for the springs and the rest for the manufacturing of the plungers and stoppers.

Desk for an Adult Quadriplegic

Designers: E. Ruiz, L. Garcia and M. Offolter
Supervising Professor: R. A. *Willem,* Ph.D.
Mechanical Engineering Department
New Mexico State University
Las *Cruces,* NM 88003

INTRODUCTION

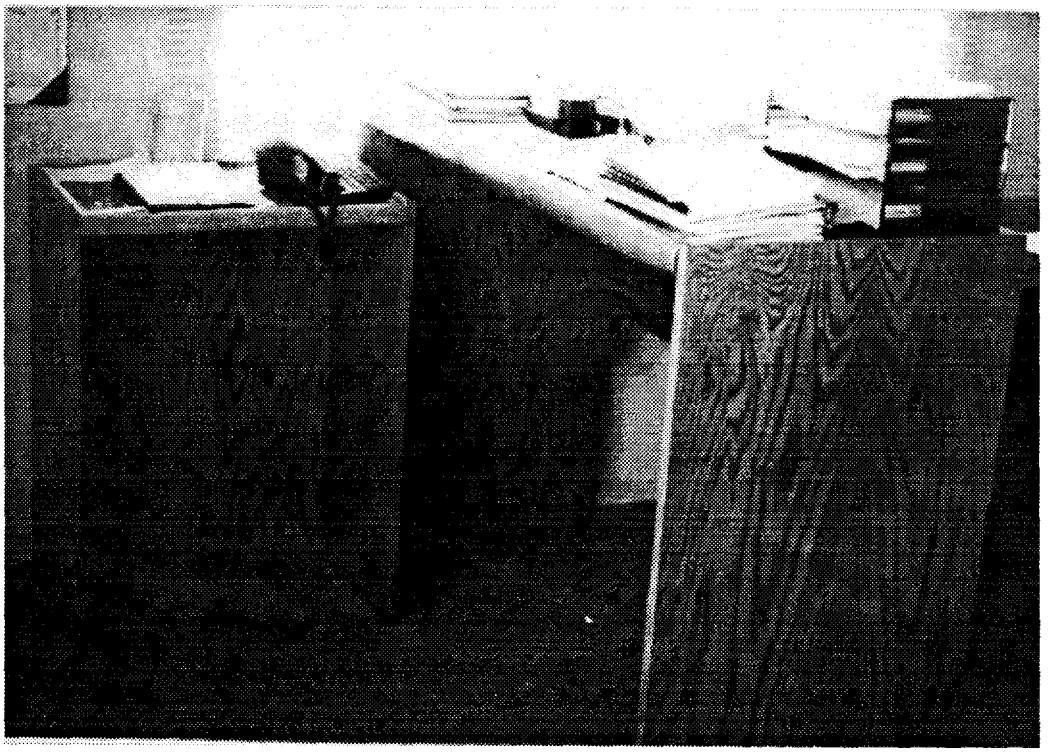
Being constrained to a wheelchair, an adult Quadriplegic finds the use of a standard 30" high desk cumbersome. Due to the height of the wheelchair, one is forced to work alongside the standard desk. This limits the work area to the range of one arm and the use of only one arm. In designing a desk the particular needs of the individual were considered. The range of motion of the individual determined the size of the work area. The width and height of the wheelchair determined other dimensions pertinent to the design.

The goal of this project was to design a desk to accommodate an adult male employed at New Vistas as well as his attache case. The desk would be designed to function as a work area for his particular use and range of motion.

SUMMARY OF IMPACT

The client's needs were for a desk with more usable work area, a border around the edge to limit the possibility of objects falling, and to accommodate his attache case.

The final design is a two piece desk. One piece is a work area while the other accommodates his attache case and storage of other items. The client finds that the desk meets his needs very well. It is likely, however, that the principal desk (work area) will be lowered by an inch or so to accommodate the client better.

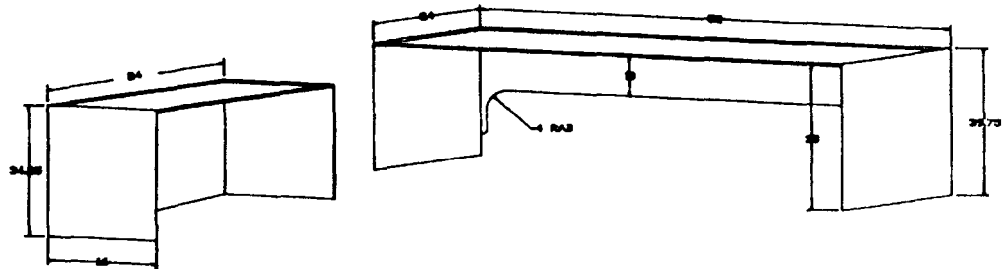


TECHNICAL DESCRIPTION

The principal components in the fabrication of the desk were the side panels and desk tops. The side panels are a fiber core with an oak veneer. The desk top is particleboard with a plastic laminate. The desktop has a 1 1/2" solid oak lip that protrudes 1/4" with a chamfer. The face of the lip is upholstered with a foam insert.

The assembly of the desk is a simple box design. The top inserts into the side panels into 1/4" deep dado that are bored 3/4" thick. The panel and desktop are then fastened by screws. The dadoes are bored to allow a 1/2" reveal on the top side of the desktop. The wood finish is stained and lacquered. The two pieces of the desk are independent of each other to accommodate the function flow of the room that the desk occupies, and to allow it to be moved easily.

The total cost of the project, labor, and materials, is $536.00.



Automatic Swinging Unit

Designers: D. Knab, D. J. Ortiz, N. Yusoff
Disabled Coordinator: Debbie Taylor, Las Cruces Public Schools
Supervising Professor: R. A. Willem, Ph.D.
New Mexico State University
Las Cruces, NM 88003

INTRODUCTION

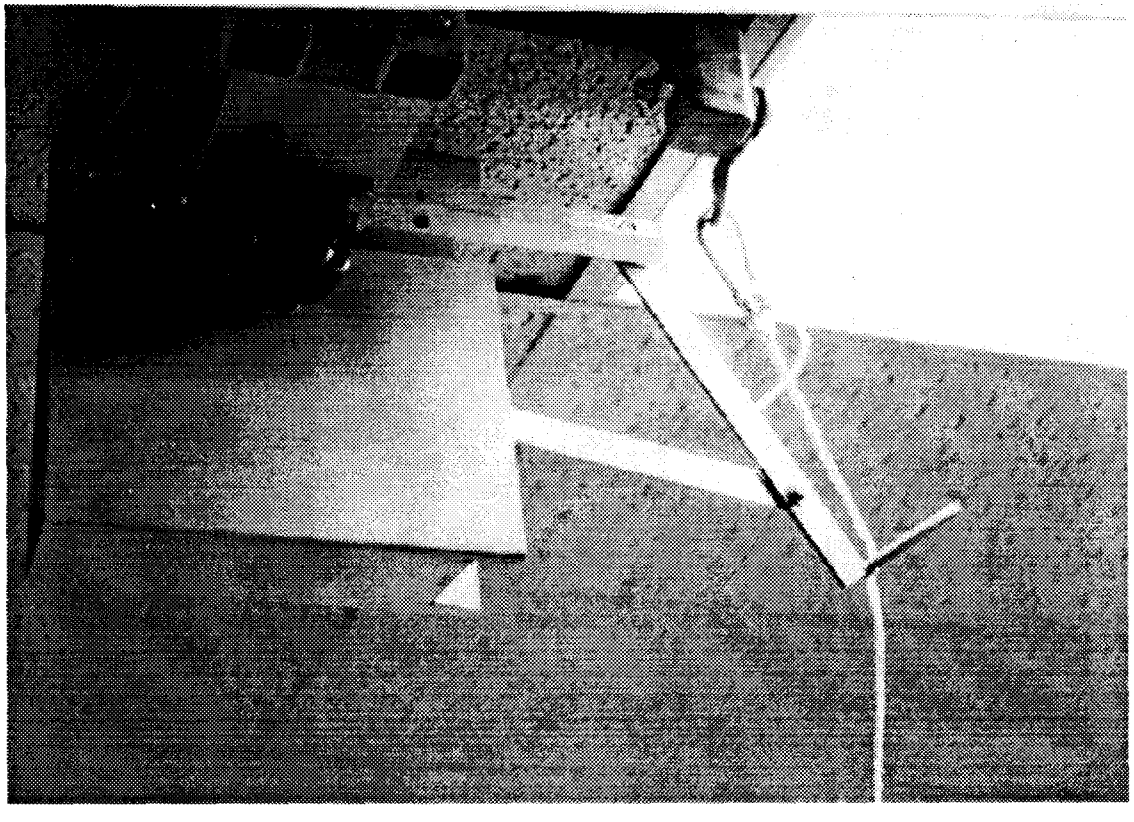
Handicapped children normally require a great deal of individual attention from their classroom teachers. A teacher of the handicapped can provide better student care if devices are available to assume some rote tasks. The device developed in this project serves this purpose.

Some physically handicapped children need physical motion such as swinging in a hammock might produce. However, with all the demands present in a classroom for the handicapped, often a teacher finds it difficult to take the time to swing a child. The swinging unit developed here will automatically swing a hammock for a preset period of time thus freeing the teacher to do other things.

SUMMARY OF IMPACT

The children that will be using this device are all fairly small and most cannot walk unaided. The children enjoy movement of any kind, especially the hammock. However the teachers cannot spare the time to sit and push the child in the swing and take care of all the other children also.

The device will free the teachers from the pushing task and still allow them control of the swing's use and elapsed time for each child. The device worked well on our test run.



TECHNICAL DESCRIPTION

The unit mounts onto the fixed strut that the swing is mounted to as well. Two 1/2" bolts connect the unit to the strut for easy removal. The apparatus weighs less than ten pounds.

The aluminum four-bar linkage allows a rocking motion output from a rotary motor input. The rocking motion spans approximately +/- 25 degrees. The motor (Dayton, model 2A800B) used is rated at 100 In lb. of torque and runs on 110 VAC at 60 Hz. The control box is mounted on the adjacent wall and consists of a speed controller to set the optimum speed, a master (emergency) on-off switch and a timer to allow the teachers to set the running time. The timer allows setting up to 60 minutes of elapsed time. The cost of making this unit is $450.00.

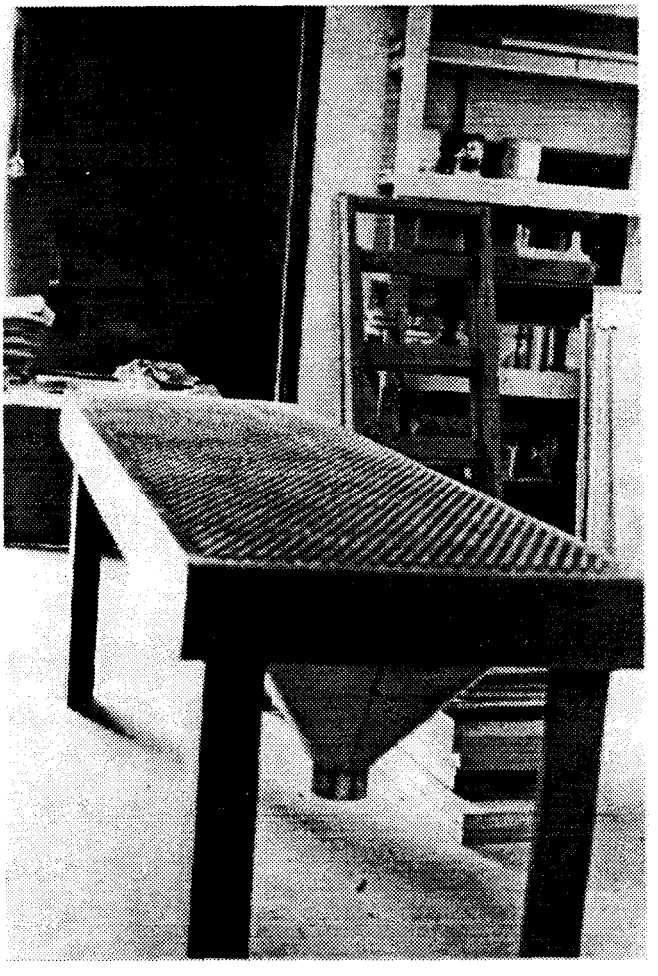
Dust-Collecting Table

Designers: P. Wierenga, A. Valencia, A. Abdulmajid
Disabled Coordinator: Jim Thompson, Las Cruces Public Schools
Supervising Professor: R. A. *Willem,* Ph.D.
Mechanical Engineering Department
New Mexico State University
Las Cruces, NM 88003

INTRODUCTION

The Las Cruces Public School System has a vocational educational program specifically for handicapped students. Among the various parts of this program is a wood-working, furniture-refinishing unit in which students engage in a variety of work including refinishing furniture for the school system on a contractual basis. This kind of work requires a large amount of sanding usually with power sanders that create much dust. Reducing the amount of dust in the air is important for all the students but particularly for those with Down's Syndrome who have a tendency toward lung weakness.

The Dust-Collecting Table developed in this project provides a multistation sanding table in which air is drawn downward through a metal grating in the top of the table. The table is shown in the photograph without the vacuum hoses and dust collector attached.



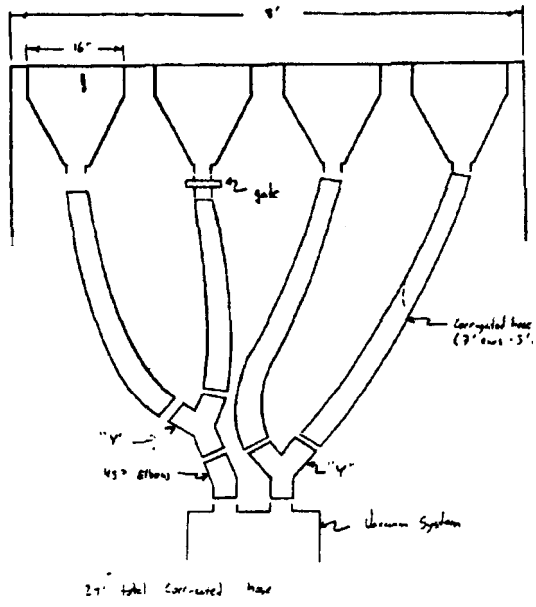
SUMMARY OF IMPACT

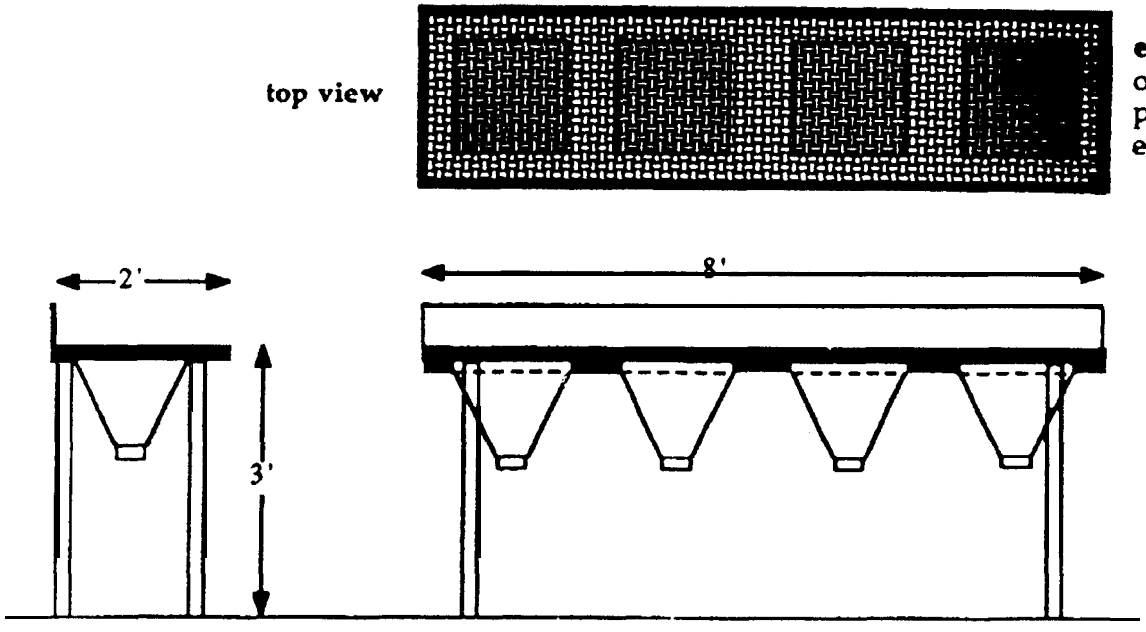
The Dust-Collecting Table was developed particularly for the benefit of two Down's Syndrome students in this vocational program. When articles are sanded on the table, the large vacuum-cleaner type of vacuum device is very effective in drawing the dust into the system. Whether sanding at the table or not, all students have benefited from the reduced levels of dust in the workshop.

TECHNICAL DESCRIPTION

Some basic details of the system are shown in the figures on this page. The table is 8 ft. long, 2 ft. wide and 3 ft. high. The plywood top has four large 16 X 16 in. holes and is covered with an expanded metal grating. The metal grating has been painted with a plastic compound that prevents damage to the wood piece being sanded and to the hands of the person sanding.

Sheet metal converging sections under the table guide the air drawn through the grating into corrugated hoses attached at their lower ends. The dust is separated from the air in an industrial, 1 HP dust collecting unit. The entire system cost approximately $650.





** expanded metal coated with plastic coating to prevent scratching wood

Sanding Table