CHAPTER 14
UNIVERSITY OF DELAWARE

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Mobile Camera

Designers: Scott Frenck, John Skibicki, Archie Tse, Ross Willson
Client Coordinator: Professor James Richards, Director
Sports Science Laboratory
Supervising Professors: Ralph Cope, Michael Keefe, Robert Allen
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INTRODUCTION

We designed, built and tested a mobile lift, which is depicted in Fig. 14.1, for a camera. This lift will be used by Dr. James Richards, Director of the Sports Science Laboratory in studying human motion. Dr. Richards uses three to four cameras, interfaced with a computer, to analyze the motion of cerebral palsy patients. He can then determine which muscles are creating problems. Presently Dr. Richards has no simple method of moving the cameras to different positions. As he repositions the cameras to different positions high (up to 20') on the walls of his laboratory, considerable time (up to two hours) can pass. However, the cameras must be very still during studies and no alternative was available. The device we designed allows Dr. Richards to move a camera quickly from one position to another when it is not in use and also keeps it very still during its use. The device also allows the camera more versatility in its position, which will let Dr. Richards conduct more accurate studies.

SUMMARY OF IMPACT

Measurement of the "normal" gait pattern is a relatively simple task. Since walking is primarily a planar motion, cameras are set such that two cameras record the motion of the right side of the body and two record the motion of the left side. Markers placed at numerous locations on the subjects appear in two or more of the four cameras. The three dimensional motion of the body segments can then be determined by mathematically combining the simultaneous images from two or more cameras. When a marker is viewed by only one camera, its three dimensional position in space cannot be determined, and that marker and the associated segment which it represents are eliminated from the analysis. This problem arises frequently when measuring gait patterns of children with cerebral palsy. The alignment (or misalignment) of the limb segments and the increase in rotational motion make it difficult to guarantee that the markers will always be contained in the viewing area of at least two cameras. The obvious way to prevent this from occurring is to reposition the cameras so that all markers are in view. While this sounds like a simple solution, moving the cameras around the laboratory presents some unique problems. Once the cameras are set, they must remain absolutely stationary. In addition, each camera must not be in the view of any other camera. The cameras in most gait facilities are fixed to the walls of the laboratory. This method works well unless a camera or two must be moved. Taking a

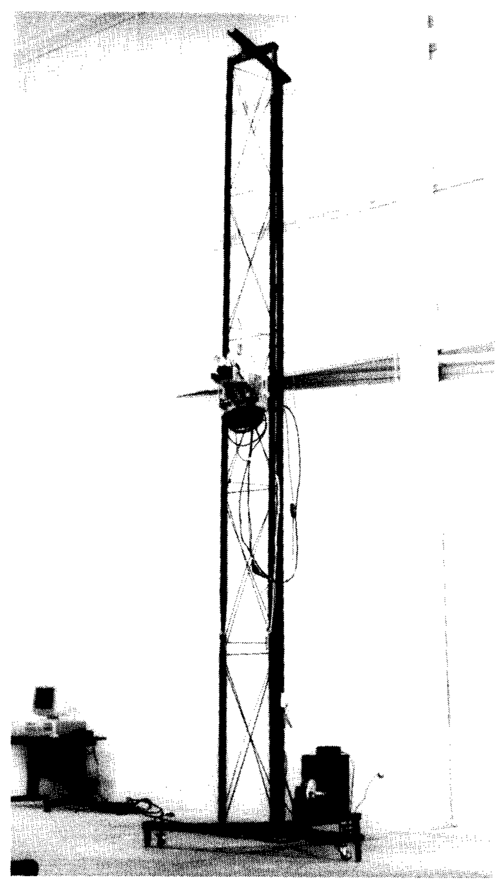

Figure 14.1. Mobile Camera.

camera off the wall and remounting it elsewhere on the wall requires a considerable amount of time, and the patient must be present to make certain that the new location is suitable. Assuming that there is a place on the wall where the camera can be mounted, this process typically requires two to three tries before an acceptable location is found. In the meantime, an hour or more of patient time is lost. The mobile camera mount provides a quick and effective means of instantly relocating cameras and guaranteeing their stability when mounted. This translates into two important benefits: the ability to guarantee marker visibility in at least two cameras, and the ability to minimize the amount of a patient's time spent in setup of the markers and cameras. The flexibility associated with this system of mounting cameras will have a direct positive influence on our ability to measure and analyze atypical patterns of gait. The gait lab staff will be free to customize the camera orientations to the individual patient, and a subsequent improvement in the accuracy and efficiency of the analysis is expected to follow.

TECHNICAL DESCRIPTION

The constraints for our structure were: the system had to be able to be moved in under ten minutes, move the camera as low as five feet and as high as twenty feet, have remote control of the zoom and tilt, and have less movement than the wall. Also the structure had a goal of a cost less than $500 so that it could be reproduced for use with the other cameras.

The system consists of three main parts. First is a base that supports a twenty-foot high tower. The base has retractable wheels and can easily be moved about a room. The tower provides the support for the third part, the camera mount. The tower has tracks that can take the mount from about ground level to a height of twenty feet. The camera mount actually holds the camera and allows it to tilt and zoom. The base is rectangular steel tubing in a "T" shape. The corners of the base are at the points of an equilateral triangle. This prevents wobbling. There are legs at the corners. Next to the legs are wheels that screw down by hand and lift the structure, allowing it to be rolled about the room. There is also a counterweight on the base to help prevent tipping of the structure. The tower consists of three parallel steel poles. These poles are made of stock c-channel. Two c-channels have their open ends facing each other, forming a track. The third pole is placed behind the front two and creates a triangular shape. The three poles are connected to each other with steel trusses made of $\frac{1}{4}$ inch steel rod. The tower rests on the base so that the front face of the tower is at the top of the "T" and the third pole rests on the back of the base. A winch on the base is connected to a cable. This cable runs up the back side of the tower and then down the front to connect to the camera mount. The winch has a disc brake to prevent the cable from going out freely. The camera mount can be divided into four parts: the frame, the clamping system, the tilt system and the zoom system. The frame is rectangular with horizontal bars connecting vertical bars on the side. Connected to the top and bottom of each side are Delrin blocks. These fit into the tracks and provide a low friction surface to make movement easy. Two triangular plates come out of the plane of the back of the frame. At the end of these are axles connected to a plate located in between the two plates. This plate holds the camera.

The clamping system consists of two four-bar linkages and a motor. One four-bar is located on each side of the frame. For clamping, the four moves so that the c-channel is caught between the Delrin and a link. This is driven by a motor. The clamping system does not support the weight of the structure but secures the mount to the tower to limit motion. The tilt mechanism consists of a motor, a lead screw and an anti-backlash nut. The camera is bolted to a plate that has two pivot axles. The axles are located close to the center of gravity of the camera that decreases the load on the motor. The pivot axles go through two triangular support braces. The plate is rotated by a four-bar slider mechanism. The motor turns the lead screw through the nut that rotates at the rear corner of the plate. This tilts the camera through a 90" arc. The zoom motor is attached to the front of the camera mount plate. The motor turns a pulley with a timing belt that goes around the lens.

Qualitative tests demonstrated that the tower could be easily moved around the lab by one person, the average time to properly reposition the camera was under ten minutes, and that vibrations damped out within 1.5 minutes. Most importantly, camera positioning was accurate to within 0.21 pixel, which is comparable to the accuracy without the platform. The approximate cost of the mobile camera is $460.

Automatic Window: A Powering Device for Standard Double-Hung Windows

Designers: Robert Andrews, Ernest Jones, Arthur Valentine
Client Coordinator: David Ward
VME Future Home Institte, Phoenix, MD
Supervising Professors: Robert Wheeler, M ichael Keefe, Robert Allen
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INTRODUCTION

Many disabled people face problems in performing ordinarily simple tasks. Our concern is with the task of raising and lowering a double hung window. There are devices on the market that will open and close a casement window, but none are commercially available for opening and closing a double hung window. Therefore, if one desired such a device in a house equipped with double hung windows, he or she would first have to go through the effort and expense of replacing all of the existing windows with casement windows before such a device was installed. We developed a device that can be used with any reasonably standard double hung window. It consists of a small motor and timing belts, and is successful in opening and closing a window.

SUMMARY OF IMPACT

The Future Home Institute in Phoenix, MD is a historic landmark that serves as a model home for the disabled. Its permanent resident and curator, David Ward, is a quadriplegic. By developing a powering mechanism that can be adapted to the existing double-hung windows in the Future Home, Mr. Ward can open and close windows without assistance. Notably, this goal is achieved without necessitating replacement of the windows.

TECHNICAL DESCRIPTION

The main components of the solution proposed by the design team are a reversible gear motor, timing belts and pulleys, brackets to connect the window to the belts, and a safety encasement. The gear motor is mounted on the wall above the window, and is operated by a toggle switch that is mounted in the wall. The motor drives two output shafts, which extend in each direction parallel to the window. These shafts are supported by bearings that are mounted in the upper right and left hand corners of the window, and drive timing pulleys, which are located at the ends of the shafts. There are also two pulleys mounted slightly below the center of the window. These pulleys are mounted to the wall by L-shaped brackets and adjustable drive tensioners. Timing belts run between the pulleys on either side of the window. There are brackets that screw on to the window and clamp on to the timing belts, so, as the

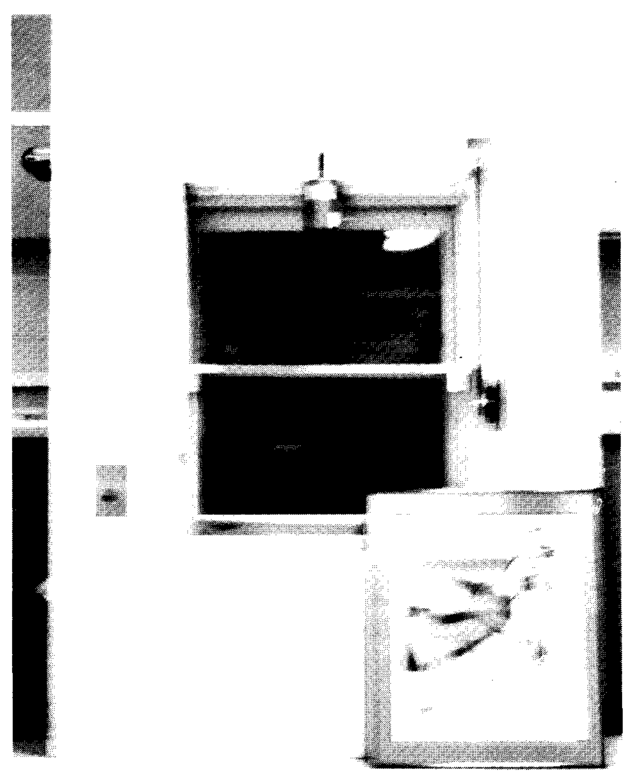

Figure 14.2. Automatic Window.

timing belts are driven by the motor, the window is opened and closed. There are switches located at the top and bottom of the device that cut the motor off when the window is completely open or closed. Finally, the entire mechanism is surrounded by a plywood safety encasement with hinged covers that can be opened to reveal the pulleys and brackets.

The gear motor is a 1/12 horsepower, 115V AC, reversible motor, and it drives two output shafts. It is mounted to the wall by four wood screws. The driven shafts are $\frac{3}{8}$" diameter steel shafts, and are connected to the motor by $\frac{1}{2}$" couplings with $\frac{3}{8}$" sleeves. The shafts are 16" long, and are supported by $\frac{1}{2}$" pillow block ball bearings located 14" from the couplings. The bearings also have $\frac{3}{8}$" sleeves to accommodate the shafts, and are mounted to 1 and $\frac{1}{8}$" wooden blocks between the bearings and the wall which serve as spacers to keep the shafts parallel to the wall.

The motor is operated by a toggle switch with momentary "on"; that is, as long as the switch is being pressed, the motor is in operation. When the switch is released, the motor ceases operation. A switch plate was manufactured to cover the wiring. The system is also equipped with a fuse, which should protect the motor from overheating and the other parts from failing. It is a simple matter to replace this switch with some other manner of control, such as remote or voice activation, to suit the preferences of the customer.

Double-flanged, HTD timing pulleys are attached to the ends of the shafts by set screws. The pulleys are $2\frac{1}{4}$" in diameter, 9mm in width, 60 tooth, and have a $\frac{1}{2}$" bore. The belts are also 9mm wide. The lower pulleys are mounted to a screw adjustable drive tensioner, which can be used to adjust the tension in the belt. The tensioner is mounted to the wall by a large L-bracket. The lower pulleys are identical to the upper pulleys, except they rotate freely on the tensioner shaft. The shaft has a grease port to allow for lubrication.

The window brackets are L-shaped, and are screwed into the upper elbow portion of the lower window. A wooden spacer is used to make the brackets parallel to the belts. These spacers would have to be custom made for each particular window. The long portion of the brackets extends over to the belts. The end of each bracket is hinged, and a horizontal clamp is attached to the top, so the bracket end squeezes the timing belt. Part of the hinged section of the bracket is grooved to accommodate the belt, lessen the shear force, and reduce the amount of pressure that the clamp needs to apply.

Two push-button switches are mounted on the window frame and spliced into the up and down power lines to the motor. They are mounted on small L-brackets in such a way that the window brackets trigger one when the window is completely open, and the other one when the window is completely closed. When these buttons are triggered, the motor will no longer operate in that direction, so failure of the motor, the fuse, and the other mechanical parts can be avoided.

All moveable parts of the assembly are encased in $\frac{1}{4}$" plywood. The design survived many repetitions in testing, and the fuse blew at approximately 30 pounds of applied pressure. We feel that this is a successful and durable design.

The approximate cost of the prototype is $450.

Exercise Equipment for the Elderly

Designers: Mike Doyle, Andrezu Geiger, Tom Shilling
Client Coordinator: Dr. Steven Chavin
Philadelphia Geriatric Center
Supervising Professors:: Irwin Greeenfield, Michael Keefe, Robert Allen
University of Delaware
Newark, De. 19716

INTRODUCTION

Engineering students at the University of Delaware have designed and manufactured exercise equipment specifically tailored for the elderly to exercise the muscles required to get out of a chair. The machine consist of a motorized seat for vertical seat height adjustments and simplified entry/exit of the machine. Also, the seat back is adjustable to provide a forward tilt of up to ten degrees. Once seated, the elderly patient pushes downward on a push bar that accurately represents the positioning of arms on an armchair. The push bar rotates on a fulcrum located just behind the seat and causes a hydraulic strut to extend. The extension of the hydraulic strut provides a resistance to motion of the push bar. However, as the hydraulic strut is compressed, the strut offers no resistance. The resistance force of the push bar varies with velocity at which the push bar is being pushed (i.e., the faster the motion, the greater the resistance). Through continued operation of the exercise machine, patients will exercise and should strengthen the muscles required to lift oneself from a chair.

SUMMARY OF IMPACT

Many elderly suffer from brittle bones and reduced muscle mass, which reduces both strength and mobility. Many of these people have difficulty or the inability to lift themselves from a seated position. The major muscles responsible to move out of a chair are the: deltoid, teres major and minor, latissimus dorsi, and the triceps. The exercise machine provides resistance very much like that of the natural resistance of getting out of a chair. Repeated workouts on the machine will exercise and thereby strengthen the muscles used in getting out of a chair. Once these muscles are strengthened, patients will be able to stand from a seated position much more easily and with more stability, thereby reducing the need of assistance by others and providing more freedom for themselves.

TECHNICAL DESCRIPTION

The exercise equipment was designed particularly for the elderly of the Active Life program at the Philadelphia Geriatric Center. The design requirements were as follows:

1) The machine had to provide a resistance between 0 to 100 lbs., with the increments of resistance to be near or below one lb.

2) The machine should have a range of motion of the user's elbow extension from 90” to 170” to prevent lockout of the elbow joint.

3) The adjustments should not require more than a 75% closed hand since many elderly have arthritis and can not grip tightly.

4) It should have a backrest allowing a back angle between 0° and 10° from the vertical to compensate for curved spines due to osteoporosis.

5) It should be usable for people between the heights of 4'6” and 5'9” tall and between 80 and 200 lbs.

The frame of our machine consists of six main parts. It has two longitudinal beams placed 39” apart and are 46” long. There are also three transverse beams that are welded to the longitudinal beams, and serve specific functions. The first one provides stability. The second one serves as the base for the spine beam and is a 3” size needed to match the spine beam. Finally, the third beam is placed to mount the hydraulic strut. The entire base is made of 1020 CD steel square tubing($\frac{1}{8}$" thick) with all but the center transverse beam being 1 $\frac{1}{2}$" square. Welded to the center transverse beam is a spine beam, and this provides the mounting area for all movable parts.

The first part is the adjustable seat back. It is a plywood base covered with 1” foam padding and black vinyl. It is 24” high and 12” wide for people of various heights. It is adjustable by use of a pin and slot assembly. The slot assembly is an L bracket with five holes to allow from between 0 and 10 degrees of back angle. The pin is an aluminum pin with a large handle so it is easy to grab.

The push bar assembly, mounted to the spine, is the basis of our exercise. The push bar is V-shaped 6061-T6 aluminum tubing with a small horizontal section used to connect to the strut. It is welded so the area where the person pushes the bar is 24” apart. It is connected to the spine beam via a horizontal bar that rotates by use of two flange bearings mounted on the spine beam. The push bar is connected to the spine beam by a threaded rod. Finally, the push bar is connected to the hydraulic strut by the use of 2 eye bolts and a hex bolt. The hydraulic strut is then connected to the base by use of the L brackets and a hex bolt.

The motorized seat consist of the following. It is a 15"x15" plywood base seat with 2” padding and covered with black vinyl. It is then bolted to two aluminum supports which are bolted around the spine beam. This is done by use of two threaded spindles in the front and the back of the spine beam. Also on the spindles and between the aluminum supports are two SWK roller bearings (two on each side) which allow the seat to roll up the beam, yet are placed on the aluminum supports so that there is no motion horizontally. The entire seat assembly is driven by use of the back spindle, which is a 5/8" threaded hole. It is a driven nut, which is driven by a 5/8" threaded rod which is connected to a motor at the bottom of the vertical spine beam. Finally, switches are mounted to allow the seat to travel forward and backward. Shut off switches are placed to stop the chair at 16” and 22” from the ground.

Test of the motorized chair showed that there was an occasional binding problem due to the excessive side rocking of the chair, although this was later fixed. It handled a force of 210 lbs., yet showed that the motor was quite loud. The push bar proved to be quite operational.

Final cost of the Machine was $360.

Wheelchair Umbrella

Designers: Patricia Fish, Jeffrey Mangin and Maurice Ragland
Client Coordinator: Dr. Timothy Brooks, Dean of Students
Faculty Advisors: Drs. Ralph Cope, Michael Keefe, and Robert Allen
Department of Mechanical Engineering
University of Delazoare
Newark, DE 19716-3140

INTRODUCTION

The goal of this project is to design a cost efficient, rain protective device for motorized wheelchairs. The design is automated, detachable and has the ability to keep the user dry from the knees up. As of this date, there is no existing solution to this problem. The prototype is a spring-loaded mechanism that raises, lowers, opens, and closes the device. The vertical motion is achieved through compression springs placed inside two sets of telescoping poles. The poles are attached to an enclosure box. Contained within the box are two fan arms that are attached at either end of the box through pins. The fan arms open through torsion springs placed on the pins and inside the fan arm. These torsion springs open each arm out to a right angle, where a proximity switch is placed on the right corner of the box to stop the rotation. A nylon water resistant fabric was placed between the fan arms providing the rain protection. (See Fig. 14.3). The device is closed via cables that are attached to the fan arms and run down through the telescoping poles to a spool. Another proximity switch is placed at the top of the stationary pole to stop further retraction. The device is powered by a motor wired to a 12V battery and is triggered by a toggle switch.

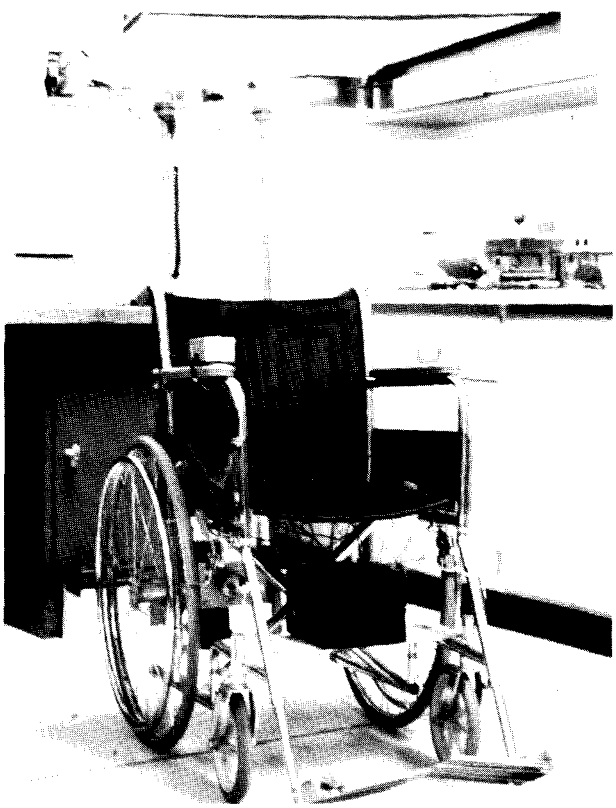

Figure 14.3. Wheelchair Umbrella.

SUMMARY OF IMPACT

There are over 250,000 people in this country who use wheelchairs. Of that number, approximately 50 percent are confined to their wheelchairs. Advances in science and medicine for disabled people have increased, but have failed to address a problem that plagues many wheelchair-bound people in this society, particularly wheelchair-bound college students. Disabled students in motorized wheelchairs typically have limited upper-body strength, not sufficient enough to support an umbrella. Thus, a means of protection in inclement weather is necessary. With this device, a disabled person will be able to venture outdoors during inclement weather without an assistant and without getting soaked. This device compacts down behind the wheelchair when not in use. It is easily removable and storable. All parts are corrosion resistant.

TECHNICAL DESCRIPTION

The frame of the device is constructed of 6061-T6 aluminum. The fan fabric is made of rip-stop nylon. Two fan arms, which open up to 90” to the enclosure box, are used to hold the fabric. One is positioned higher than the other to create a slope for the water to run off. Inside the enclosure box are pulleys that direct the cable and torsion springs that open the fan arms (See Fig. 14.4). Two modifiable supports are used to connect the device to the wheelchair. Four support poles angle in to the stationary poles. These poles are long enough so that when the enclosure box lowers it does not interfere with the wheelchair. Two telescoping poles slide inside the stationary poles with adjustable height settings. (See Fig. 14.5). The approximate cost of this prototype is $335.

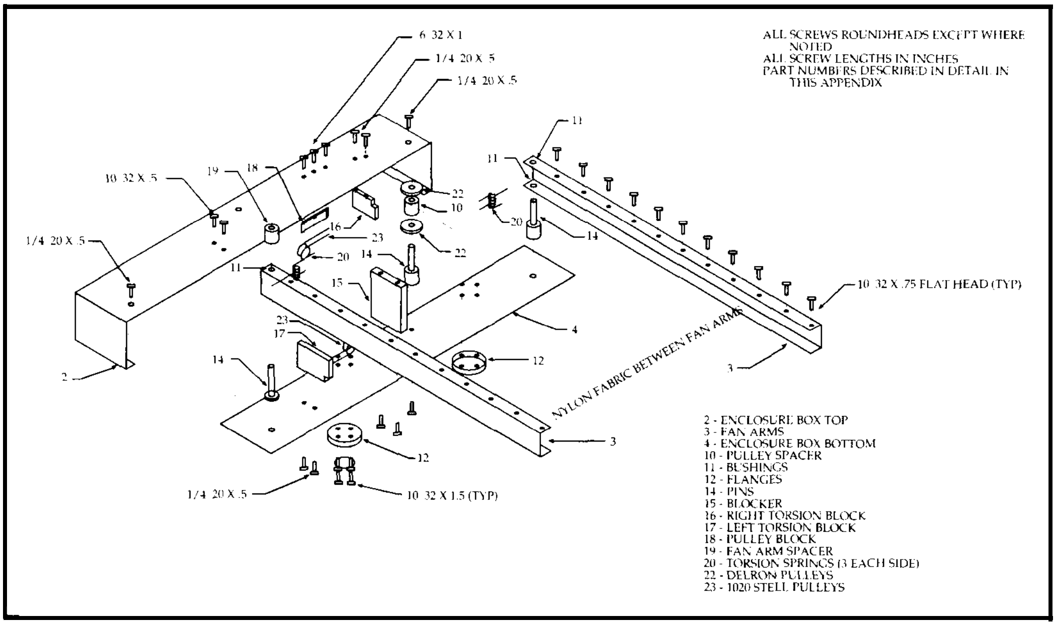

Figure 14.4. Box Assembly.

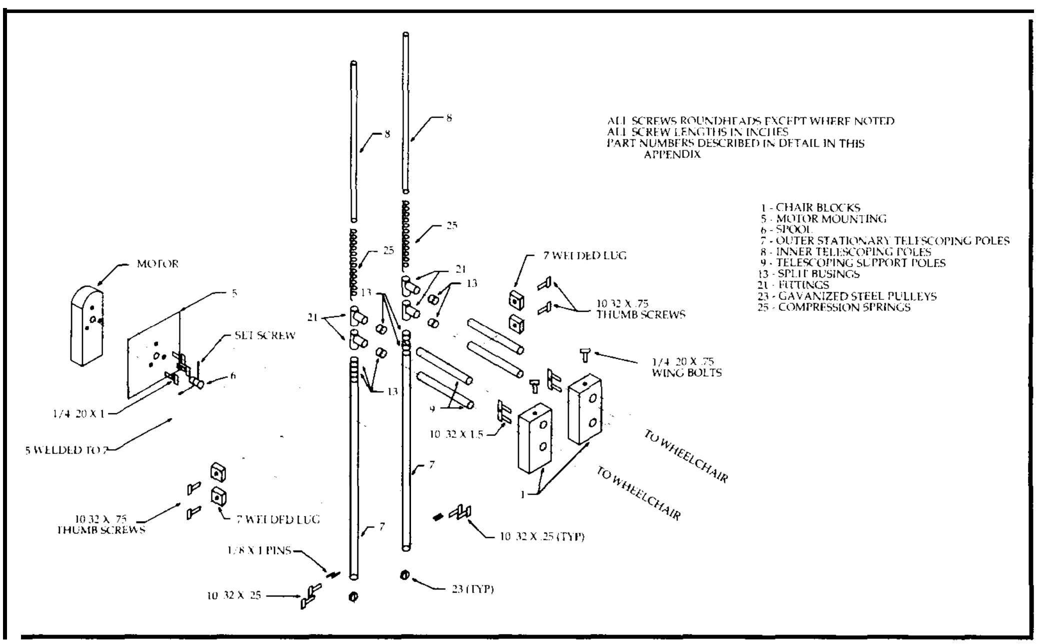

Figure 14.5. Support Assembly.

Flexible Sink

Designers: Jack S. Garhart, Pamela A. McLean, David T. Spangler
Customer: Joseph E. Koskol, P.E.
E.I. Du Pont De Nemours & Company (Inc.)
Supervising Professors: Ralf Tschirschnitz, Michael Keefe, Robert Allen
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INTRODUCTION

We designed and built a sink capable of moving vertically. The device consists of three main components, a cable cylinder, a tracking system, and flexible tubing (Fig. 14.6). The system is powered by hydraulics in which water enters the cylinder allowing the sink to move along the tracking system. The user only has to turn a switch in order to set the sink in motion.

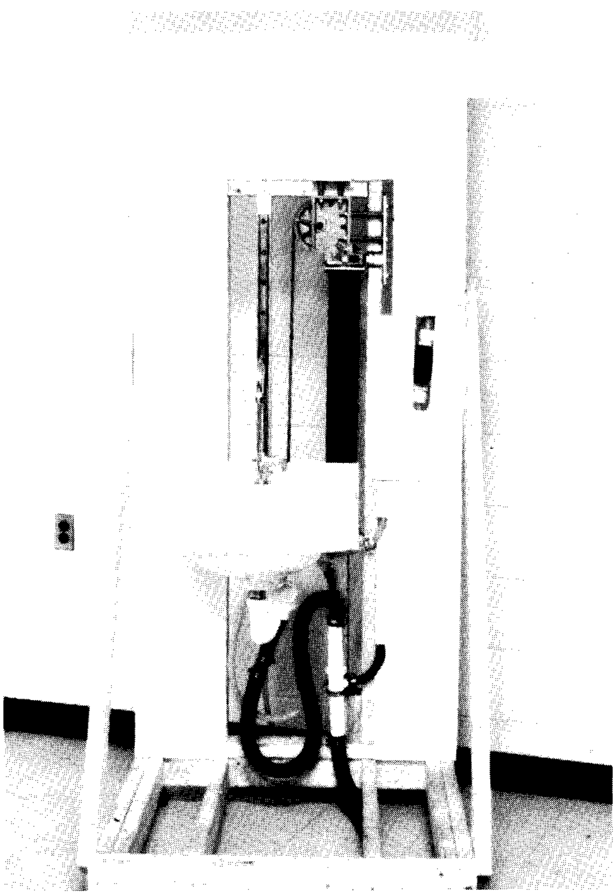

Figure 14.6. Flexible Sink.

SUMMARY OF IMPACT

Some handicapped individuals have difficulty using conventional sinks, even ones that are especially designed for them. The reason is most sinks are of a fixed design and height. People with different handicaps have certain needs in the height and positioning of a sink for maximum effectiveness of the sink's facilities. Therefore, a mechanism such as this would solve their problems and make life a little bit easier. The customer had certain needs that had to be met. The sink was to move a total distance of two feet. This means that the sink starts off at a height of 29 inches off the floor to accommodate a person in a wheelchair and then increases to a maximum height of 53 inches. The movement also needed to be facilitated with minimal to no strength on the part of the user. The user would only have to flip a switch or valve in order to move the sink up and down.

TECHNICAL DESCRIPTION

The main design constraints are ones associated with an ordinary bathroom:

1) limitation of sink size

2) range of possible heights of a sink for the handicapped

3) safety considerations

4) availability of flexible plumbing to accommodate movement

5) size limitation of sink movement mechanism so that it would be able to fit behind the sink and within the boundaries of an ordinary bathroom in terms of

height and width (height = 8 feet and length = 31 inches).

Also, we had limited funds to build the mechanism.

The components of the Flexible Sink are described in detail below. The tee controls the water flow at the beginning of the process. After the water source is turned on, the water travels through the flexible tubing and its first obstacle is the tee. The tee splits the water flow into two directions:

1. towards the faucet

2. towards the three-way valve

The three-way valve is the switch that determines the up or down motion the sink will travel by controlling the direction of the water flow in and out of the cylinder. The cable cylinder controls the movement of the sink. There is a piston located inside the cylinder with a cable attached to it. As a result of the applied water pressure, the piston pulls on the cable. If the switch is in an upward position, water enters the cylinder through the flexible tubing forcing the sink to move up. If the switch is in a downward position, the water will drain from the cylinder causing the sink to lower itself by gravity.

The tracking system allows the sink to go up and down using linear motion. The system consists of a track on which two linear roller bearings travel causing the sink to move only in a linear path. The tubing used to connect the water source to every component of the mechanism was reinforced PVC tubing. This tubing was necessary in order for the sink to be able to move to different positions. As the sink lowers, the water drains from the cylinder to the same drain used by the sink.

An aluminum plate was machined in order to connect the sink to the cable cylinder and the tracking system. In order to attach the cable from the cylinder to the plate, a bracket was built and attached by machine screws.

The mechanism had to be able to withstand different loads. This was tested by having the sink travel up and down under three types of forces:

1. having the sink travel alone

2. having the sink travel with a full tub of water inside

3. having the sink travel while water is flowing into it from the faucet.

All three tests were successful with no difficulties. The sink was also run up and down more than 400 times simulating one year of residential use.

The final cost of the flexible sink was approximately $800.

Improved Tactile Sensing System (T.S.S.): Investigating the Tekscan Software/Sensing System

Student Designers: Brian Burd, Vince Cichocki
Client Coordinator: David Nagey M.D., Director, Division of Maternal Fetal Medicine, Department of Obstetrics and Gynecology, University of Maryland
Supervising Professor: Professor Robert Allen
Department of Mechanical Engineering
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Newark, DE 19716

INTRODUCTION

As part of an effort to limit human birth injury, the objective of this research effort is to make improvements on an existing Tactile Sensing System (TSS). The TSS analyzes clinician-applied forces on the fetal head during human birth. The TSS consists of four piezoresistive silicon sensors that are mounted individually to the fingertips of the clinician. In particular, this previous research focused on a delivery known as shoulder dystocia that is considered an obstetric emergency. This condition occurs in up to 2.0% of deliveries and is characterized by the impaction of the anterior fetal shoulder against the maternal pubis symphisis as shown in Fig. 14.7. The clinician must apply greater forces than normal to the neonate during delivery which can result in a fractured clavicle and/or damage to the brachial plexus nerve. Our customer, David Nagey M.D., questioned the reliability and accuracy of the current TSS since only fingertip forces were measured. From this basis, we began to seek a better method to measure these hand forces. The search led to the investigation of a software package called F-scan by Tekscan Inc. This package showed promise since it was reported to be able to measure normal forces applied over a large area. We thought that it would enable us to measure palm and finger forces in the hand. Detailed testing of this package became the focus of our research.

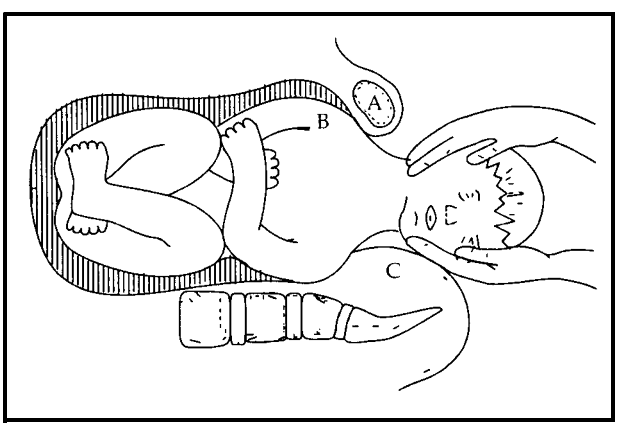

Figure 14.7. The Fetus in the Birth Canal when Shoulder Dystocia occurs.

SUMMARY OF IMPACT

With over 8,000 injuries to children occurring annually at birth in the United States, we need to limit the number and extent of these physician-induced injuries. The key in doing so is to understand the mechanisms by which obstetricians apply excessive force to the fetal head, as depicted in Fig. 14.7. By measuring these hand-applied forces in situ and correlating them with injury, we can establish safe limits of force and force rate to be exerted. If obstetricians are trained to recognize these force levels, injuries may be diminished or avoided altogether.

TECHNICAL DESCRIPTION

F-scan is a thin, piezoresistive sensor that is composed of a series of conductive ink strips arranged to form a matrix as shown in Fig. 14.8. Current Tekscan technology does not have a sensor made specifically to fit the palm of the hand. However, we were able to adapt the foot sensor to meet our needs. The foot sensor was wrapped around a 4 inch piece of PVC pipe to approximate the size of a newborn head and still provide a firm, smooth surface for the sensor. The PVC pipe was attached to an extensometer we built and calibrated for a range of 5 lb to 25 lb. The extensometer (Fig. 14.9) allowed us to track how hard we pulled against the F-scan sensor/PVC pipe combination.

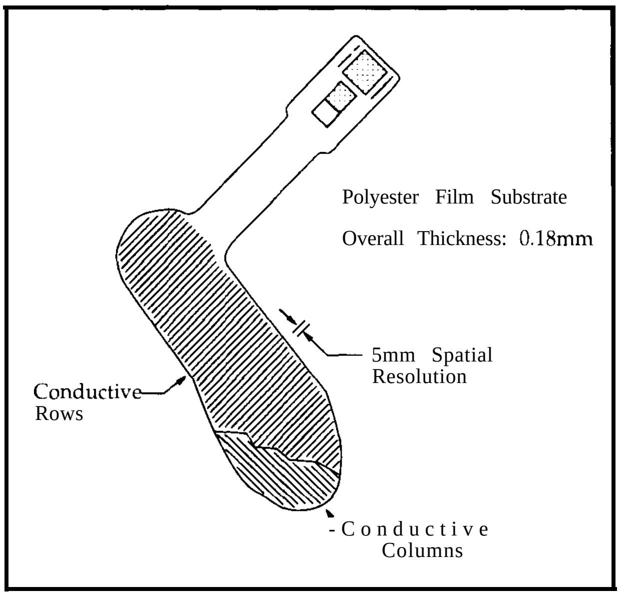

Figure 14.8. The Foot Sensor Device.

Our initial evaluation was to check the accuracy of the F-scan sensor. Tekscan literature states that the sensors are accurate to within ±10%. We tested the sensor both in the flat position, and wrapped around the PVC pipe. The sensor was loaded with known loads in the five to thirty five pound range and the results were recorded. The percentage error between applied load and recorded load varied from less than 1% to as much as 43.8% on individual tests. The error in the recorded readings seemed to fall in both the high and the low range as compared to the applied load. Even though the individual tests were often way off, the average percentage error for a large number of trials fell around the 10% mark guaranteed by Tekscan. The calibration testing results lead us to conclude that the stated accuracy of ±10% is not generally true for individual readings, but is usually within the 10% for the average of a larger sampling of data. Our application would make difficult the collection of large sampling of data.

In spite of the calibration problems encountered, we still used the F-scan software to do some additional testing. The intent was to use it to find relationships rather than looking for specific numbers. We were interested in the relationship of how applied force is split between the palm and fingers when applied to the fetal head. Pull simulation tests were performed with the sensor/PVC pipe/extensometer setup already described. The pipe was pulled against the extensometer and the results recorded. The tests showed that gripping styles differ, and it is impossible to grip the pipe exactly the same way each time. Also, the sensor readings showed a larger force than the extensometer showed. This is due to grip force that is unintentionally applied when pulling the extensometer to the desired deflection. The general relationship found was that the fingers are responsible for a larger part of the hand applied force than the palm, but the contribution of the palm is significant.

The cost of this research was $118 for sensors. The software package was loaned at no cost.

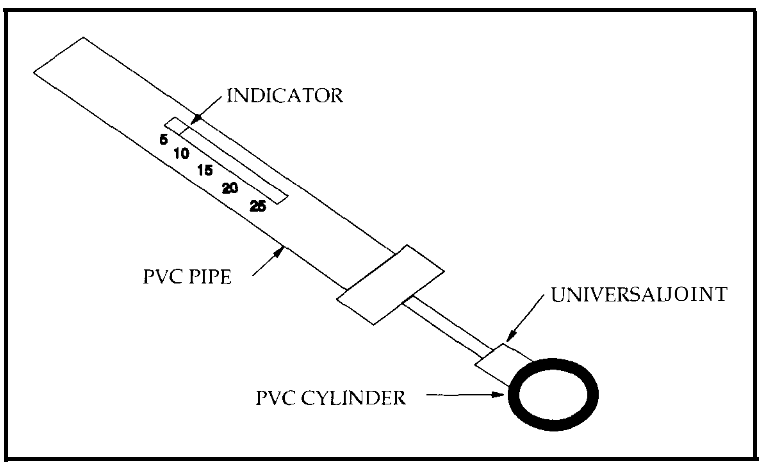

Figure 14.9. Extensometer.

Computer Desk for the Handicapped

Designers: Tom Yocum, Vince Cichocki, Bill Eberle
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INTRODUCTION

A computer desk for the handicapped has been designed for the students at the A.I. DuPont Institute in Wilmington, Delaware. The desk consists of a modified standard office furniture desk. The desk comes supplied with a wide opening for easy wheelchair access at various angles. In addition, the desk has a large top for the storage of all computer components. For additional storage, file drawers and shelving are provided. The lifting mechanism consists of a single vertically standing hydraulic cylinder. It is operated with a hand pumping action and released with a push button. The cylinder is attached to the desk via designed brackets. Also, the cylinder is mounted on a support frame that prevents tipping. The support frame comes equipped with locking swivel castors for mobility. The desk unit is also attached to the support frame using four safety legs. Refer to Fig. 14.10.

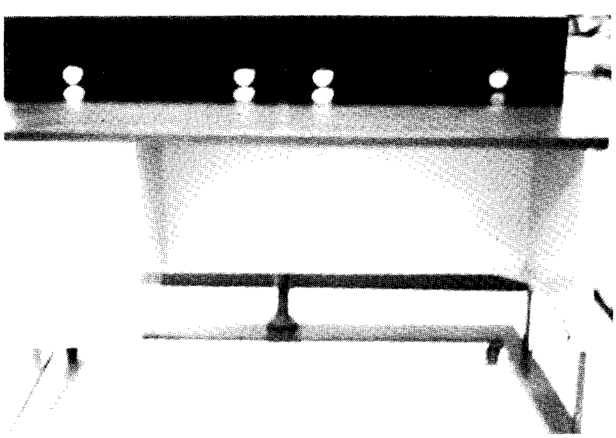

Figure 14.10. Computer Desk for the Handicapped.

SUMMARY OF IMPACT

The work performed by Tom Yocum and his group on the wheelchair-accessible computer stand is exceptional. The desk is large and spacious and adjustable to an infinite number of height settings. The handicapped students and their teachers really enjoy using it. The ability to get a student's legs under the shelf bearing the computer is invaluable in trying to get them into a working position. Thanks very much for helping them make this possible.

TECHNICAL DESCRIPTION

The computer desk was designed for to accommodate a range of wheelchair-bound users. The particular application for this desk was a classroom where handicapped students of different ages and sizes use the desk. The main design requirements of the desk were:

1) The desk had to be conveniently adjustable over a range that would allow anyone in a wheelchair to fit under the desk comfortably (24 to 38 inches).

2) The desk must have access to computer components by the user.

3) There should be file drawers for storage.

4) The desk should be mobile.

5) There should be shelving along the back of the desk for additional storage.

Our computer desk has two main parts. The first part is the desk unit itself. The desk is a standard commercially available office desk with an extra wide opening (42 inches). The opening is wide enough to provide adequate side clearance for the wheelchair. The desk top is 30 inches by 60 inches to allow room for all computer equipment such as monitor, printer, keyboard and CPU. The shelving located on the desktop is made of the same walnut finish as the table top.

The second part of the design is the lifting mechanism. It is composed of a hydraulic cylinder made by Arjo Inc. with a load rating of 330 lb. The features of the cylinder are easy lift using a hand operated pump, easy lowering by pressing a button, and the ability to support a cantilevered load. The cylinder is attached to the desk by a cylinder bracket.

The cylinder bracket is composed of A513 mechanical tubing (1 inch by 3 inch). It has an offset Y-shape to conform to the underside dimensions of the desk and is used to support the desk and also to attach the desk to the cylinder. The bracket attaches to the desk by wood screws.

The cylinder/desk is attached to a support frame. This frame is U-shaped, and conforms to the outer dimensions of the desk. It is composed of the same mechanical tubing as the cylinder bracket. The function of the support frame is to carry the desk load and prevent the desk from overturning. For mobility, swivel casters have been attached to the underside of the support frame. The casters have a rating of 210 lbs each. The front two casters have manually applied brakes to prevent desk movement while in use. The support frame and cylinder bracket were assembled by TIG welding.

Another feature of the desk is its safety legs located between the desk and the support frame. They have been incorporated into the original desk legs at each corner of the desk. The original one inch square hollow tube desk legs were cut off even with the desk side frame. Inner legs of $\frac{3}{4}$ inch square bar were added between the support frame extending into the desk legs. Once the desk is adjusted to the desired height, the inner and outer legs are locked together by a T-handle set screw located on each leg. The purpose of the safety legs is to provide stability to the desk while in use and to support the desk in the event of cylinder failure.

Tests were conducted using a total weight of 180 lbs to simulate actual computer equipment on the desktop. Tests were also conducted in the event someone were to sit on a corner without the safety legs engaged. The tests showed the cylinder would support the desk under these conditions without failure. The final test was on the safety legs themselves. The leg was vertically loaded to 300 lbs without slipping.

The material cost for the computer desk was approximately $450.

Rolling Walker

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INTRODUCTION

Our project is a rolling walker intended for use by the elderly (See Fig. 14.11). The walker has two rear legs and one front leg. A soft-tread swivel wheel is attached to the front leg, and a straight wheel is attached to each rear leg. We decided on this design after examining existing designs, and noting the problems associated with them. The typical problems in existing designs are noise, lack of maneuverability, and inability to negotiate rough surfaces. We deemed that our solution improved upon existing designs in each of these areas.

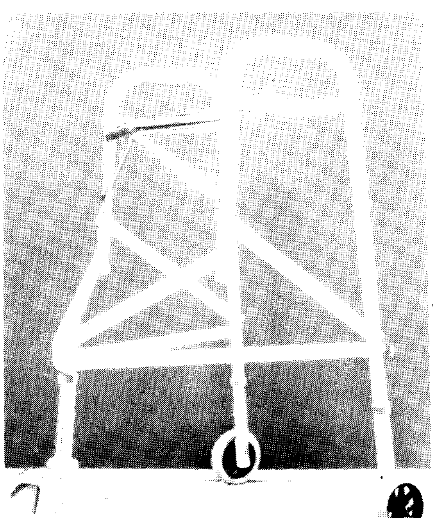

Figure 14.11. Rolling Walker.

SUMMARY OF IMPACT

This rolling walker represents an improved balancing aid for its user. The three-legged design along with the swivel wheel in the front provides easier turning than other walkers. On smooth surfaces, the wheels selected, with soft treads and quiet bearings, decrease the noise level of the walker to a point that is not perceptibly above background noise level. The five inch diameter front wheel also negotiates small bumps and rough surfaces easily.

TECHNICAL DESCRIPTION

This three-legged design is a modification of a four-legged frame. The bottom half of the two front legs are removed, and a single front leg is placed seven inches in front of the shortened legs. Six structural support members are added to the walker to provide stiffness and strength. These members are made of one inch outer diameter, one-sixteenth inch walled aluminum tubing milled to angles that provide flush meeting of the members to the legs. The members are joined by either mechanical fastening or welding. The mechanical fastening technique used consists of a bolt, an angled washer, and a tube fastener inserted into the joined end of the member. The four joints at the front leg are all welded since mechanical fastening is prohibited by the geometry of the members and the front leg. End plugs are inserted at the welded joint end of each member to ease the difficulty of the welding process. The constructed frame provides sufficient stiffness and strength for use in its application.

The front wheel is five inches in diameter, has a soft surface, and a low turning resistance. The rear wheels do not swivel, and have soft treads. All wheels are quiet in operation, and roll easily. The walker is easy to turn, yet provides straight line stability.

The walker is stable when used in the proper manner. The intended mode of operation is with the user standing with at least part of his or her body behind the rear legs. This is deemed as a plausible mode for a considerable number of users. The walker used in this manner provides a stable structure for the user to put his or her body weight on.

The final cost of our final prototype, including a cost for donated pieces, is approximately $120.