CHAPTER 18
UNIVERSITY OF MASSACHUSETTS AT AMHERST

College of Engineering
Department of Mechanical and Industrial Engineering
Engineering Lab
Amherst, MA 01003-3662

Principle Investigators:

Robert X. Gao (413) 545-0868

gao@ecs.umass.edu

John E. Ritter (413) 545-0632

ritter@ecs.umass.edu

Donald Fisher (413) 545-1657

fisher@ecs.umass.edu

Sundar Krishnamurty (413) 545-0297

skrishna@ecs.umass.edu

Janis Terpenny (413) 545-0707

terpenny@ecs.umass.edu

LATERALLY EQUALIZED, SELF FEATHERING SCULLING OARS

Designer: P. Walsh
Supervising Professor: Janis Terpenny, Ph.D.
Department of Mechanical and Industrial Engineering
University of Massachusetts
Amherst, MA 01003-3662

INTRODUCTION

The purpose of this project was to facilitate access to recreational rowing for users who have difficulty operating a conventional pair of oars. The basic design objectives include the oar to be self-feathering and laterally equalized. Additional considerations include existing adaptive solutions within the canoe and the rowing shell.

A crank-arm at the oar grip and a modified oarlock promote the self-feathering function. During the pull stroke, the crank-arm aligns with the direction of pull, moving the oar-blade perpendicular to the water surface. During the return stroke, the user pushes down and forward causing the oar-blade to rotate to a position parallel to the water surface. The oars are joined grip to grip by a flexible universal joint and are forced to move in unison. Consequently, the user's stronger arm assists the weaker arm. The power delivered to the water is the same on either side of the rowing shell.

SUMMARY OF IMPACT

The physical benefits from exercise and success in a physically taxing endeavor may improve the user's self image. The design is simple in concept and readily adaptable to any rowing shell as modifications to the boat end at the oarlock socket. A limitation of this design is that the flexible universal joint impairs the user's ability to turn the shell by rowing on only one side of the shell. Thus, the lateral equalization feature is only useful if applied when a second user steers the shell or when a separate rudder system steers the shell.

TECHNICAL DESCRIPTION

The primary components of the design include the following: an offset grip affixed to the inboard end of the oar shaft, a stepped shaft collar at the oar or oarlock interface, an oarlock with a stop cleat feature and a removable elastomer universal joint between the oar grips. The oars used are standard 2.9-meter delta models manufactured by Alden Rowing Shells.

Figure 18.1. Oars Prototype.

The offset grip feature (Figure 18.2) causes the oar shaft axis to rotate about the oar blade perpendicular to the water during the pull stroke and parallel to the water during the return stroke. The grip itself is free to rotate within the crank-arm. Thus, the user does not need to turn his or her wrist to feather the oar. Rotation of the oar during feathering is constrained to 90° by the interaction of the stepped shaft collar and the oarlock stop cleat (Figure 18.3). The universal joint is an elastomer tube that constrains the oars to move in unison equalizing the energy to each oar. The joint is connected to the grip by means of a detent button within an aluminum tube that slides into the end of the oar grip (Figure 18.2). The inboard end of the aluminum tube is fixed within the elastomer tubing by a friction interface. Materials for the grip or crank-arm assembly, oarlocks and universal joint connection are machined 6061 aluminum and 304 stainless steel. The stepped cleat is constructed of UHMW polyethylene. The universal joint is formed of thick wall natural rubber tubing.

The cost is approximately $425.

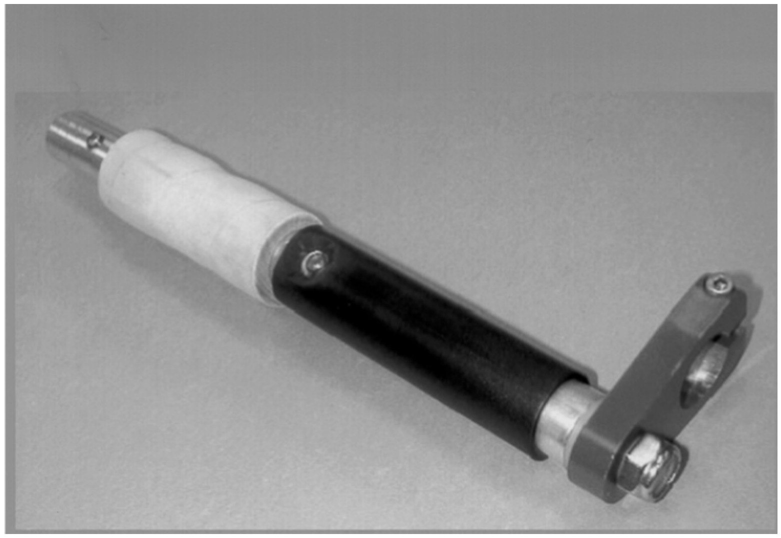

Figure 18.2. Offset Grip/Universal Joint Assembly.

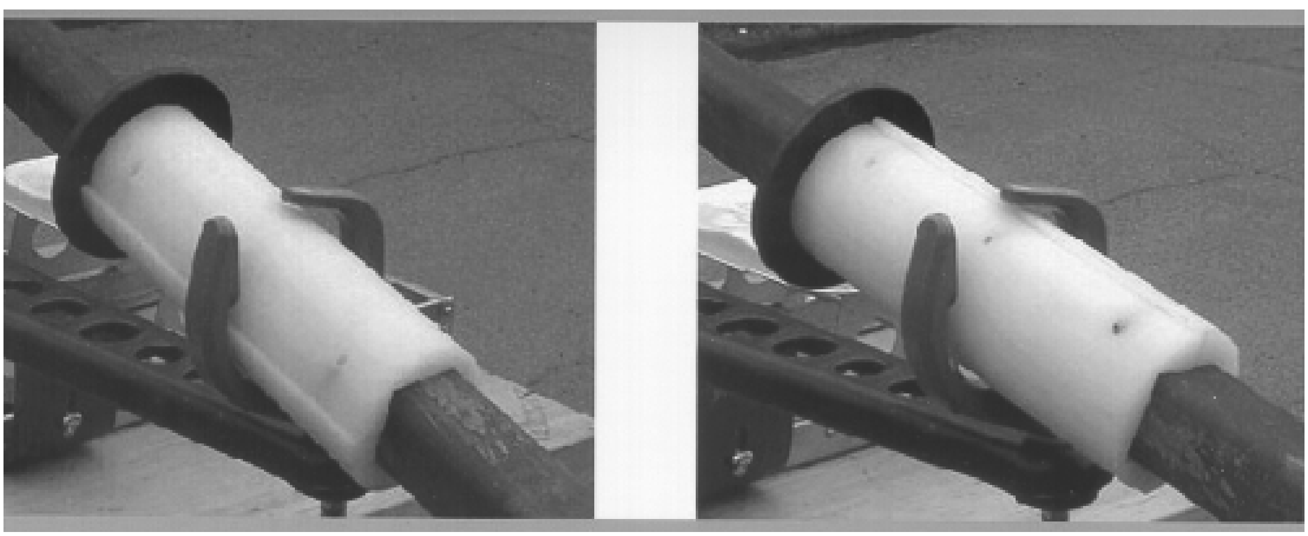

Figure 18.3. Shaft Collar/Oarlock Interface.

PERSONAL STANDING AID

Designers: S. Bousquet, E. Hoffmann, and D. Sirois
Supervising Professor: John E. Ritter, Ph.D.
Department of Mechanical and Industrial Engineering
University of Massachusetts
Amherst, MA 01003-3662

INTRODUCTION

There are several lifting devices available on the market to facilitate standing among the elderly. A current device, often called a transfer lift, uses a large rolling crane structure with a cloth seat. This large device lifts a person by means of hydraulics or motors. These devices are expensive and inconvenient to use in a private residence. The objective of this project was to design a new lift for use in the home.

SUMMARY OF IMPACT

The average cost of a transfer lift is about $2500. In addition to being costly, these lifts are large and cumbersome to use. The new standing aid design is a compact, lightweight and inexpensive device. By virtue of the simplicity in design, it is easy to operate and portable.

TECHNICAL DESCRIPTION

The device is 3′ tall and 2′ wide (Figure 18.4). Two triangular supports are connected by a 2′ long hollow tube, as in a sawhorse design. The Cambridge Engineering Selector software facilitated the material choice of wrought aluminum alloy. A pair of cables runs from the cloth seat to the pulleys on the outside of each triangular support and ends at the cable drums. The motor is connected to the gearbox that powers the cable drums to lift the seat. The tube has a diameter of 1-1/4″. The motor mounting plate is made of a 6″x8″x1/4″ plate with holes pre-drilled to mount the motor. These materials were welded together to create the frame of the lift. The gearbox is made of two 6″x6-1/2″x3/8″ plates with several holes drilled through them for the gear shafts. Co-axle drums were used (Figure 18.5).

The mounting for the outside pulleys was altered to ensure convenient size and storage. Two bars hold the two pulleys on opposite sides of the lift. These bars are held in place by two ¼″ hardened bolts, allowing the pulleys to be removed when not in use (Figure 18.6).

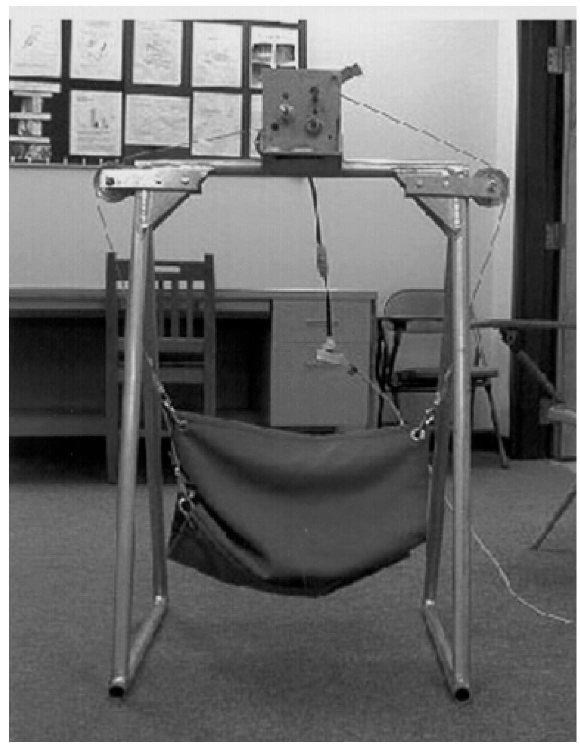

Figure 18.4. Personal Standing Aid.

The seat is made of a double layer of a canvas and polyester blend for strength and comfort. The cables that run from the gearbox are each split into three sections at the bottom, all with a small carabineer clip. These clips are attached to the grommets in the seat.

A limitation with the prototype is the amount of warping in the metal from welding. This causes a larger amount of friction on the gear shafts than planned, significantly reducing the lifting power of the motor. A possible solution is constructing the motor plate to be thicker. Additionally, the following other suggestions may facilitate client satisfaction and safety. First, the motor should be placed on the ground to prevent it from being in the way of operation. Secondly, the lift should be placed on a set of wheels to aid mobility and to enable an alternate use as a temporary walker. If used as a temporary walker, a set of hand bars parallel to the two triangles near the top for sidebars is recommended. Finally, a slightly larger motor may benefit the lift in the design.

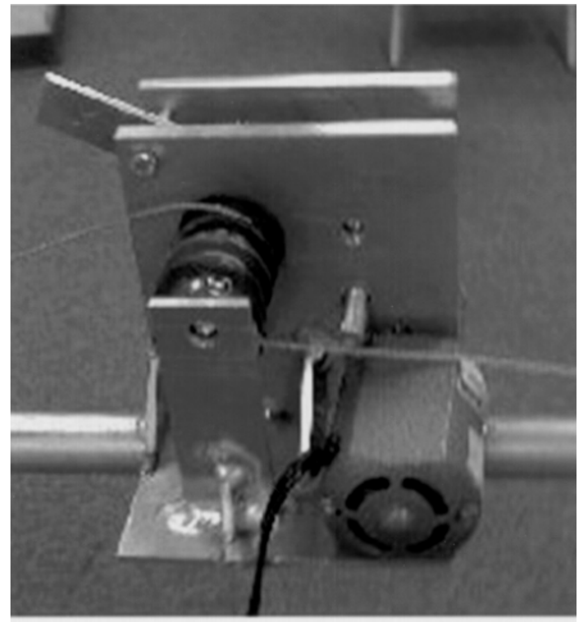

Figure 18.5. Gearbox and Motor Mount.

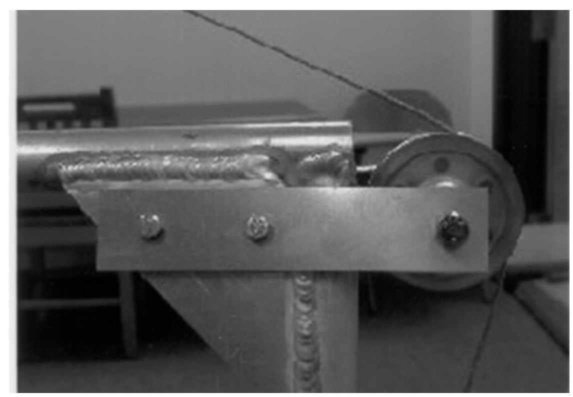

Figure 18.6. Outside Pulleys.

SMART PRESSURE SLEEPING BAG (SPSB)

Designer: Rajesh Luharuka
Client Coordinator: Community Resources for People with Autism, Easthampton, MA 01027
Supervising Professor(s): Robert Gao, Ph.D. & Sundar Krishnamurty, Ph.D.
Department of Mechanical and Industrial Engineering
University of Massachusetts
Amherst, MA 01003-3662

INTRODUCTION

Sleep disorders have often been reported in children with autism. Parents of children with autism often use weighted blankets, gym mattresses and similar products to apply deep pressure on their child while sleeping. Clinical research has shown that applying deep pressure to the body of a child with autism can have a calming effect.

SUMMARY OF IMPACT

Sensory integration is a much-practiced theory in treating children with autism. Temple Grandin's "Squeeze machine" (Figure 18.7) and weighted vests are popular products that provide deep pressure stimulation. However, there are no products currently available on the market that specifically address the sleeping disorder in children with autism. The proposed device will automatically control the pressure applied based on the physiological feedback (GSR) of the child.

TECHNICAL DESCRIPTION

The criteria for the design of the device include the following: safety, low noise level, uniform pressure distribution and high controllability. The device should apply pressure in the range of 0.01 to 0.50 psi. The physiological sensing system should be non-intrusive and robust. For functionality purposes, the device is divided into different modules. (Figure 18.8)

A mummy shaped sleeping bag was used, with a 1-inch thick foam padding replacing the "fill material" in the bag. An extra inflatable outer chamber is provided for pneumatic pressure application. A

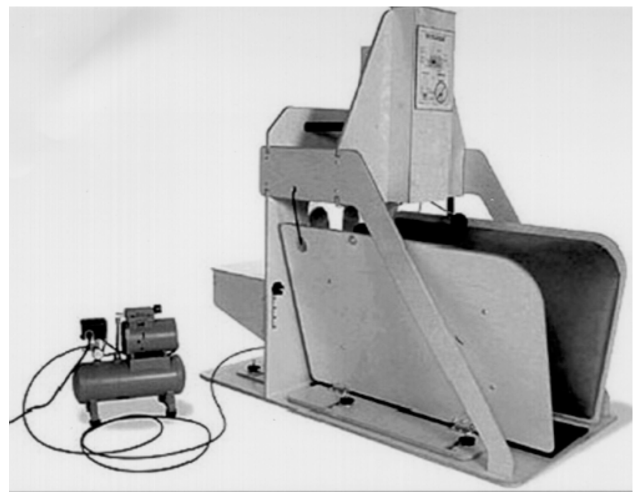

Figure 18.7. Temple Grandin's Squeeze Machine.

Galvanic Skin Response (GSR) sensor monitors the physiological state of the child in the sleeping bag. GSR is the result of changes in electric conductivity of the skin caused by an increase of sweat glands. The GSR of a person is low when one is asleep compared to when one is awake (Figure 18.9).

The control system receives inline pressure and physiological feedback and then processes the signals to control the pressure. The controller maps the physiological signal to the pressure required. The SPSB has a manual control option. A correcting algorithm to fine-tune the pressure to be applied will track the performance of the controller.

The estimated cost of this project is $5000.

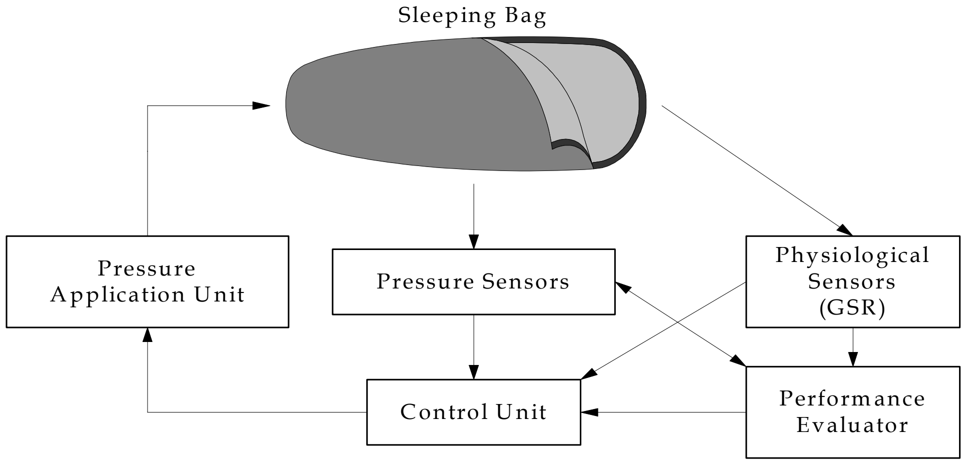

Figure 18.8. Schematic Diagram of the SPSB.

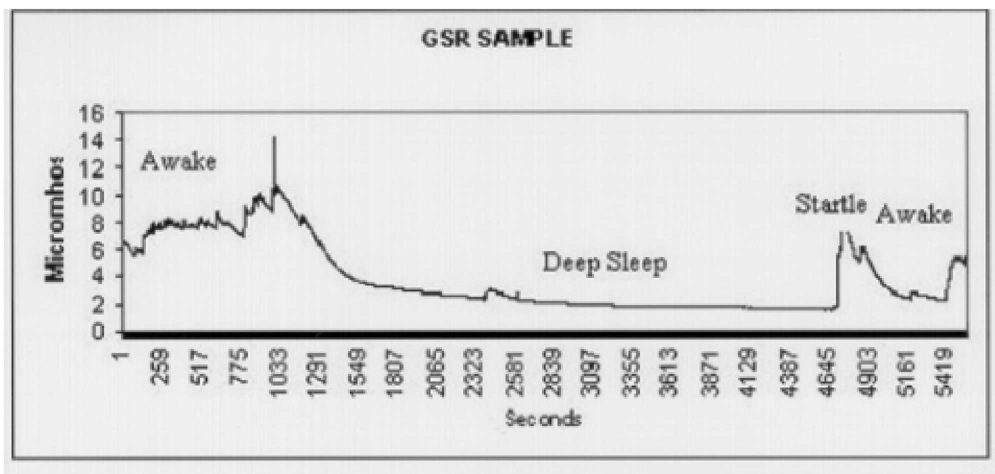

Figure 18.9. Sample GSR Plot of a Subject While Sleeping

WHEELCHAIR CUPHOLDER

Designers: J. Goyette, J. Barnes, and S. Poon
Supervising Professor: John E. Ritter, Ph.D.
Department of Mechanical and Industrial Engineering
University of Massachusetts
Amherst, MA 01003-3662

INTRODUCTION

A beverage cup holder for a wheelchair was designed to enable the user to move a chair freely even when the cup holder is in place. A cup holder that is both aesthetically pleasing and accommodating to several types of beverage containers is necessary.

SUMMARY OF IMPACT

Although trays are available for wheelchairs, there are no cup holders available on the market today. Unfortunately, the trays are not safe for use when the wheelchair is in motion. A beverage container may slide off of the tray, perhaps resulting in personal injury. The design can be easily adapted to other wheelchairs available on the market

TECHNICAL DESCRIPTION

One of the main objectives of the design was to have a cup holder that is visually appealing. Since it is difficult to determine exactly what type of disability the user might have, the cup holder was made to be lightweight and require a minimum level of dexterity (Figure 8.10). The Cambridge Engineering Selector software facilitated material selection and estimated cost. The cup holder was designed to withstand maximum bending and a torsion load of 20 lbs. (Figure 18.11) For most wheelchairs the armrests of the wheelchair are supported by a vertical or a horizontal metal tube of various diameters. Therefore, a universal tubing bracket that allows the user to attach the beverage holder to either the vertical or horizontal piping was used. The tubing bracket was attached to the beverage holder by means of the attachment knob on the mounting device. The material for the cup holder was a polymer that could be injection molded, Styrene Acrylonitrile.

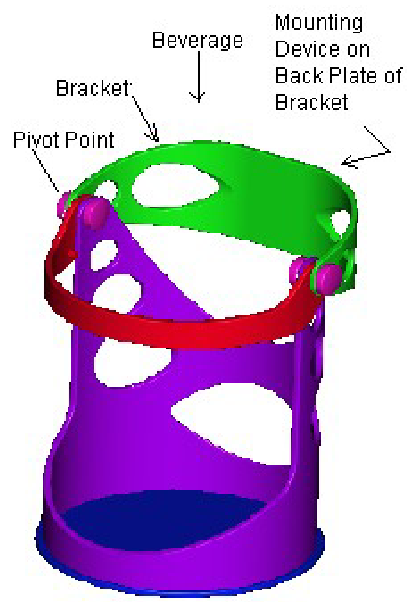

Figure 18.10. Solid Model of the Cup Holder Assembly.

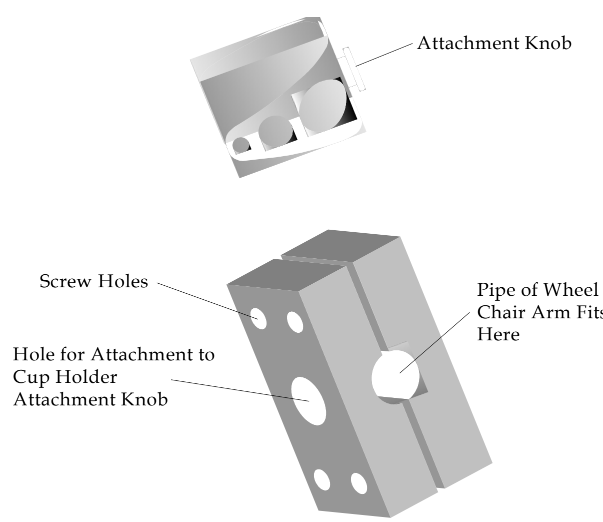

Figure 18.11. Mounting device and Bracket.

Figure 18.12. Prototype of the Cup Holder.

DOORKNOB EXTENSION

Designers: J. Chan, M. Ivy and J. Topor
Supervising Professor: John E. Ritter, Ph.D.
Department of Mechanical and Industrial Engineering
University of Massachusetts
Amherst, MA 01003-3662

INTRODUCTION

An existing doorknob extension design had deficiencies, including mounting difficulties, high cost, and lack of aesthetic appeal. The mounting problem was corrected and the cost was reduced dramatically in this project (Figure 18.13). The redesign was made out of polyvinyl chloride. The 6" long lever arm greatly reduces the effort required to open a door. A U-shaped semi-soft rubber foam grip allows the redesigned doorknob extension to mount on any standard doorknob.

SUMMARY OF IMPACT

A door handle extension helps persons who have limited use of their hands. Converting a doorknob into a lever greatly reduces the amount of effort needed to open a door. It would also benefit most persons in a wheelchair, or on crutches, in opening a door.

TECHNICAL DESCRIPTION

The current doorknob extension design is a rectangular shaped, machined finished metal (Figure 18.13). There are three screws around the periphery that secure the doorknob extension onto the knob. The screws are secured on to a plate behind the knob. The extension can be removed if need be, however, the three small screws and back plate make it difficult. Other limitations of the current design are as follows: First, the extension is not aesthetically pleasing; second, the hand can easily slip off because of the smooth surface; finally, the design has a set radius that accommodates only a small range of doorknob sizes.

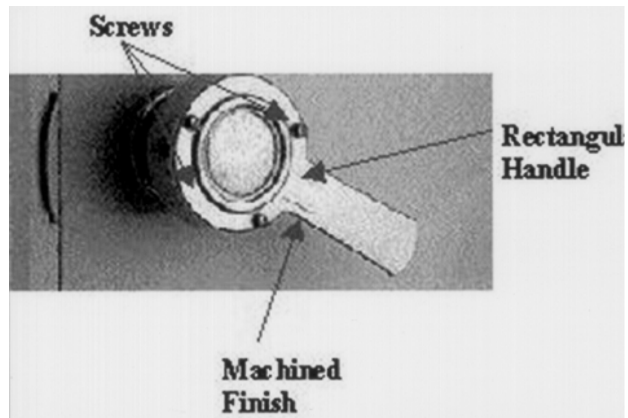

Figure 18.13. Doorknob Extension.

The objective of the redesign was to eliminate the limitations of the existing design. The proposed redesign for the doorknob extension can accommodate all standard size doorknobs. The inner part of the doorknob extension is a rubber, U-shaped foam that will grip to the existing doorknob. Also, only one screw is needed for mounting. This screw is on the bottom and can be easily accessed since no back plate is required. The rubber foam is attached to the inner part of the doorknob extension with an adhesive (Figure 18.15). A ring was added to the end of the handle to keep the user's hand from slipping The doorknob extension material chosen was polyvinyl chloride (PVC) and the process used is injection molding (thermoplastics).

The proposed design would cost about $5 if mass-produced. The existing doorknob extension costs $9.85

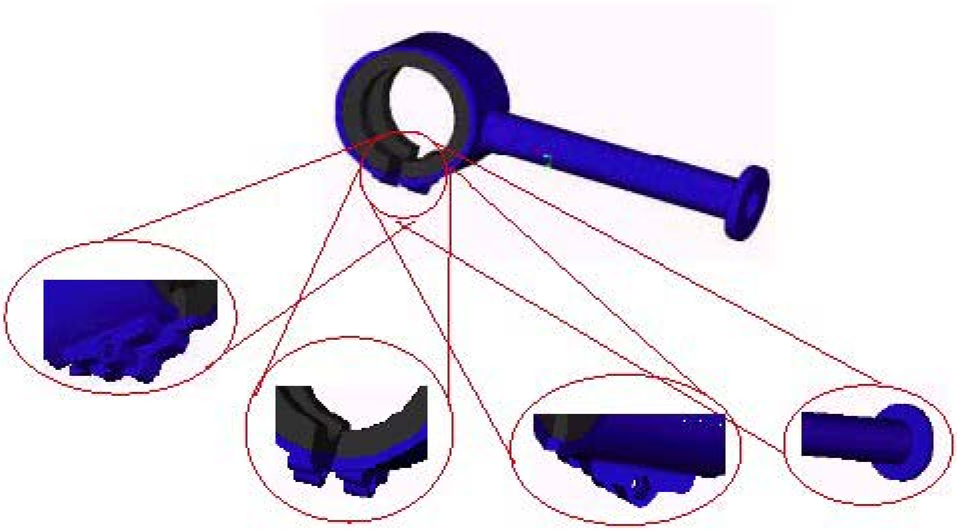

Figure 18.14. Solid Model of the Redesigned Doorknob Extension.

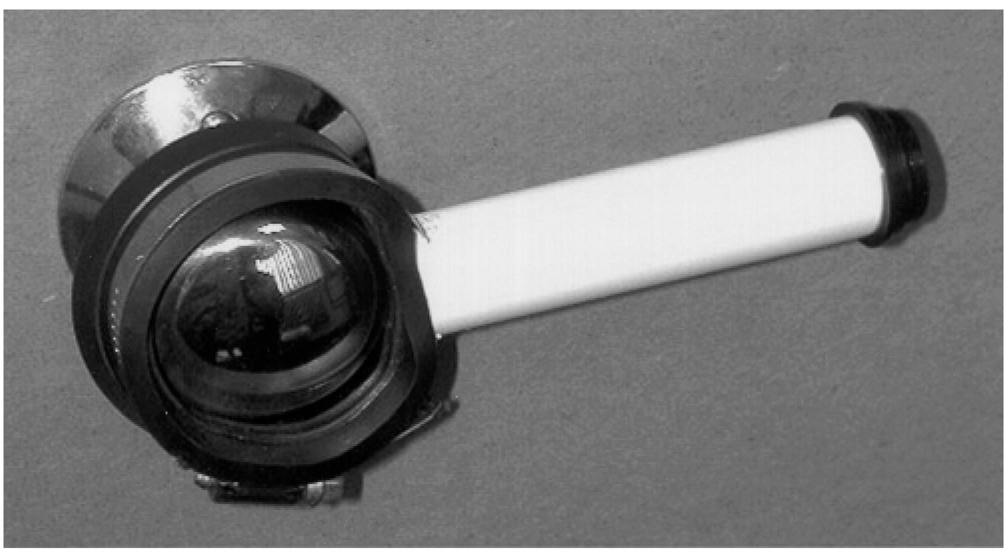

Figure 18.15. Redesigned Doorknob Extension.

PORTABLE INTELLIGENT DEEP PRESSURE VEST

Designer: Jeremy K. Paskind
Supervising Professor: Sundar Krishnamurty, Ph.D.
Department of Mechanical and Industrial Engineering
University of Massachusetts
Amherst, MA 01003

INTRODUCTION

Clinical studies have shown that the application of deep pressure (simulating a hug) around the upper body and shoulders of children with autism has a calming effect. A pressure vest is designed to provide children with autism with deep pressure stimulation around the upper body and shoulders.

SUMMARY OF IMPACT

One current product on the market that addresses deep pressure stimulation is a weighted vest. These vests apply static pressure onto the shoulders of the user at all times while being worn. Other large pressure devices also exist in limited quantity, convenience and economical cost. Each current design has major limitations in terms of effectiveness and/or availability.

The Intelligent Vest combines the portability of the weighted vests with the selective pressure application of the pressure machines. It applies deep pressure instead of static pressure, similar to the "Squeeze" machines.

TECHNICAL DESCRIPTION

Since the vest is to be worn on a regular basis, primarily by young children, one of the most important design considerations is its level of comfort. A bulky or otherwise annoying mechanical operation could render the design useless. Since children vary drastically in size, the design of the vest must be able to be replicated for each individual user, regardless of their physical dimensions. The vest should also be aesthetically pleasing.

The design uses air to fill up the space inside the vest, causing pressure to be applied to the abdomen and shoulders of the child. Common vests can be used, chosen in a variety of sizes to fit the majority of children in need. The system utilizes a diaphragm air pump with two three-way solenoid vales to inflate and evacuate the air from the vest (Figure 8.16).

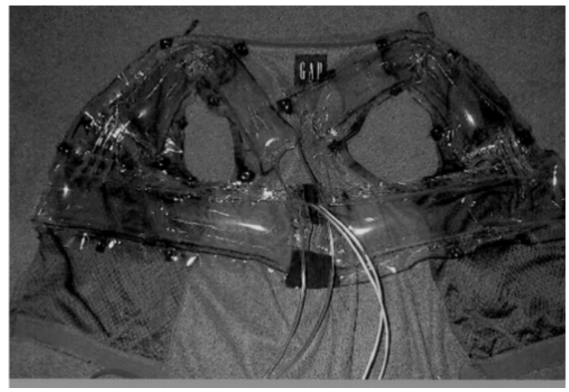

Figure 18.16. Model of Air Containment Tubes.

The "L" shaped air containment tubes are attached to the inside of a standard vest and covered with an additional layer of stretch material for added breathability and comfort. The top portion of each "L" inflates to apply pressure on the shoulders of the individual. At the peak of the shoulder, the tube is almost sealed so as to restrict bulging in this area while still allowing airflow between the two sides. The purpose of this "dead" space is to apply a squeezing sensation to the shoulder area. The bulge, due to inflation, only occurs on the sides of the shoulder, not on the top.

The bottom half of each "L" tube is connected to the other with elastic fabric. The tube then surrounds the torso when worn, just slightly under the armpit of the child. The elastic allows for vest sizing error as well as pressure relief with the child's normal breathing. The pressure in the torso area is a result of the consumption of extra space inside of the vest.

The inflating and deflating processes of the vest is accomplished using a standard medical DC diaphragm pump. Both processes are controlled using two, three-way solenoid pneumatic valves. Each component will be run at 6 volts, a standard voltage available for both the pumps and the valves. The current model used a 120-volt AC current (for simplicity) to run the pump and is manually controlled (Figure 8.17).

The GRS device will be used in the final design to monitor the child's level of excitement and activate the pressurizing vest automatically. A small computer chip will be used to interpret the GSR output and signal for the activation of the pump and valves as needed. Override buttons will be built in to increase or release pressure upon desire of the child.

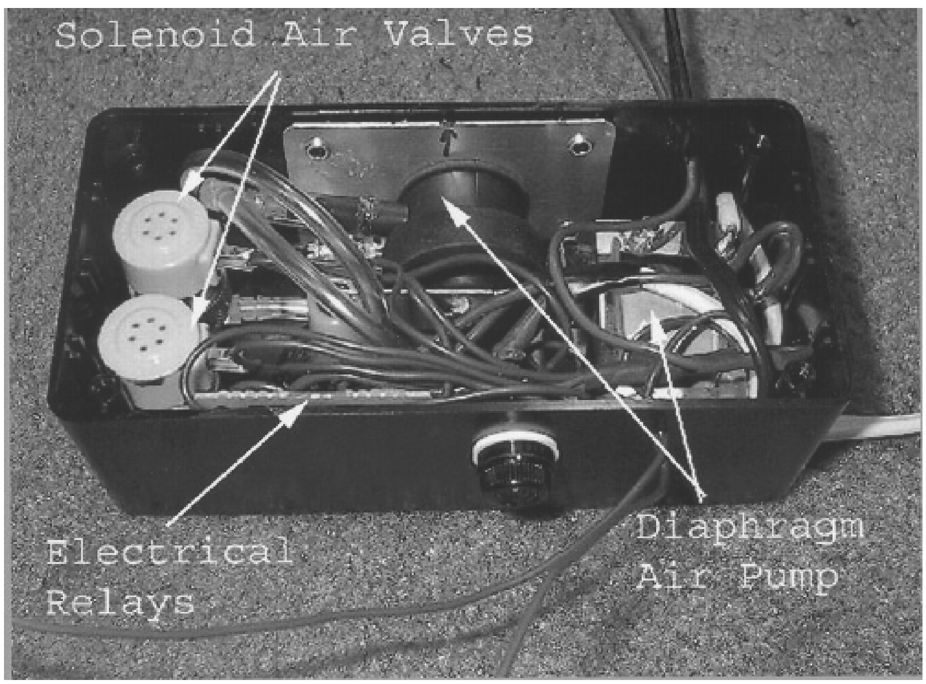

Figure 18.17. Vest Inflation Module.

BICYCLE TORSO SUPPORT

Designers: R. Melnik, S. Ferguson, and D. Fitzgerald
Supervising Professor: John E. Ritter, Ph.D.
Department of Mechanical and Industrial Engineering
University of Massachusetts
Amherst, MA 01003-3662

INTRODUCTION

A bicycle torso support was constructed to alleviate shoulder stress during bicycle operation. Decisions regarding the construction of this apparatus were based upon direct input from the client, a 6'1" male, who weighs 220 lbs. Throughout project development, various body and bicycle measurements were to ensure that the apparatus may be used by individuals of different heights and builds.

The design is a torso support that attaches to the top crossbar of an existing bike frame. This allows the user to rest his upper body weight on the two chest supports instead of using his arms. Wrought aluminum alloy was chosen as the material for the torso support and the optimal process selected for manufacturing of the torso support was extrusion with a series of secondary processes.

SUMMARY OF IMPACT

Shoulder stress after participating in competitive sports may cause severe cartilage and ligament damage. This damage may impede an individual's ability to ride a bike. An apparatus to support an individual's body weight is thus essential. This device can be attached to a client's current bicycle. The torso support directly addresses support to the client's upper body, alleviating shoulder stress.

TECHNICAL DESCRIPTION

The design criteria were that the torso support:

- Be aesthetically pleasing,
- Not deflect more than 0.75" during normal operation,
- Not exceed 10 lbs, and
- Service a maximum weight of 250 lbs.

A device (Figure 18.18) that mounts to the top crossbar of the frame of the bike was developed. Flexibility was incorporated into the design to permit use by various individuals. A shock absorber device is used to offer adjustment by telescoping from the main shaft. A standard quick release bicycle seat clamp is used to lock the torso support at the desired height. Two members extend from the

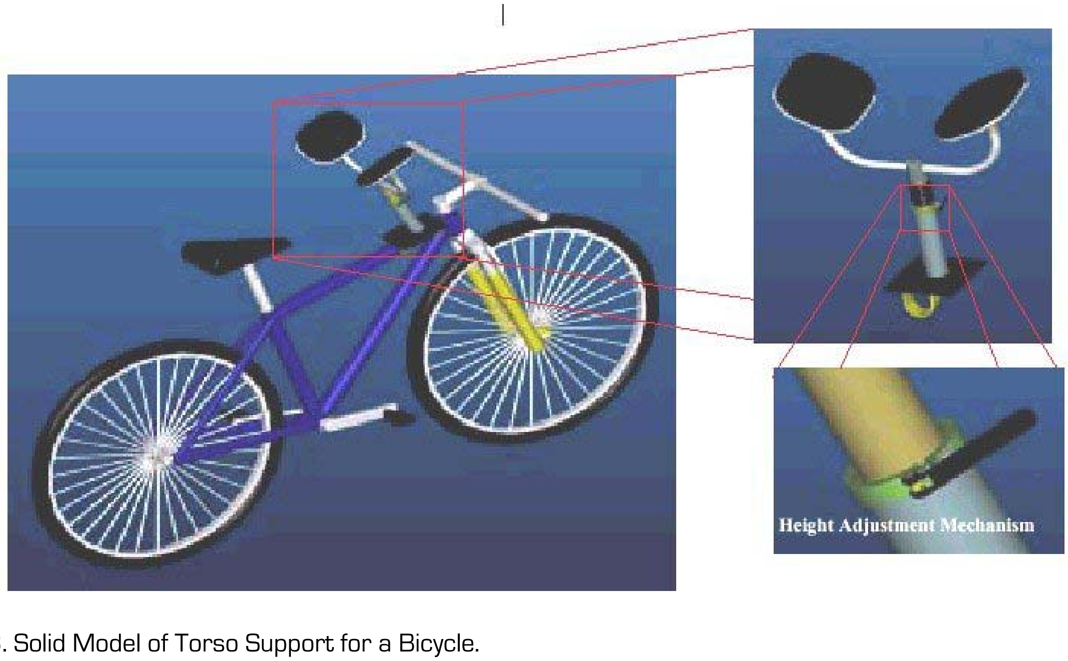

Figure 18.18. Solid Model of Torso Support for a Bicycle.

top end of the telescoping shock absorber. Each member carries one foam padded chest plate that can support the torso. The chest plates are attached using a ball and socket connection to allow for rotation (Figure 18.19).

Performance indices were derived to maximize strength while minimizing mass and deflection under full load. Using these performance indices, the Cambridge Engineering Selector (CES) software was implemented to select an optimal material that would also be consistent with those used in current bike manufacturing. The material selected was wrought aluminum alloy. The CES Process Selector was also used to determine the manufacturing process, extrusion.

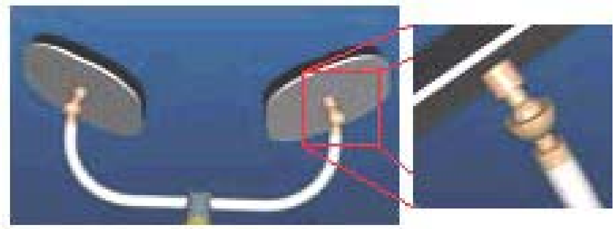

Figure 18.19. Ball and Socket Connection.

The cost was $85 per completed assembly.

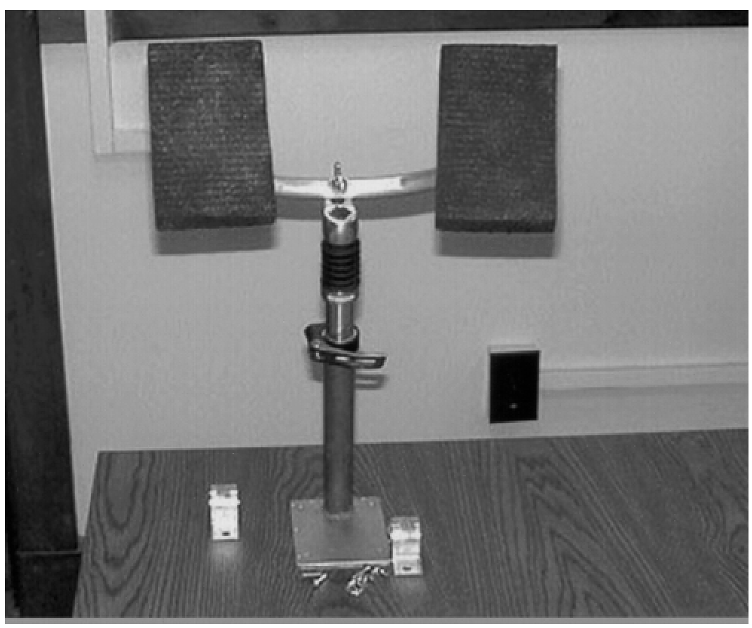

Figure 18.20. Prototype of Torso Support for a Bicycle.

ADJUSTABLE TOILET SEAT

Designers: J. Cashman, J. Sullavan, and A. Huseinovic
Supervising Professor: John E. Ritter, Ph.D.
Department of Mechanical and Industrial Engineering
University of Massachusetts
Amherst, MA 01003-3662

INTRODUCTION

Existing raised toilet seats (RTS) for individuals with disabilities function well, but can be expensive, difficult to use, and unattractive. In addition, existing RTSs have several flaws in their design. By increasing the functionality of the existing RTSs, a new RTS was designed. Based on engineering analysis and use of the Cambridge Engineering Selector (CES) software, a new design was developed.

SUMMARY OF IMPACT

Most of the current RTS designs do not allow for height adjustment. The designs that do have adjustable height features use screw systems and adjustable legs, which are clumsy and inefficient

In this new design, an RTS is made of high density polyethylene (HDPE). For a production run of 100,000 units or more, injection molding would be the best manufacturing process. The new design uses simple seat raisers that can be snap fitted to the toilet seat to adjust height.

TECHNICAL DESCRIPTION

The following specifications were implemented into the design to maximize function and robustness:

- Total weight less than 5 lb,
- Minimum life span of 20 years,
- Maximum load on the seat of 450 lb, and
- Varying heights (1, 3, and 5 ").

The objective of this redesign is to develop a RTS that is lightweight, inexpensive, sturdy, and aesthetically pleasing (Figure 18.21).

The design has four seat raisers to adjust the height of the toilet seat and ensure stability (Figure 18.22). The raiser is snap fitted into a channel on the bottom side of the toilet seat. Three different raisers were designed for three different heights (1", 3", and 5"). Finite element analysis was carried out using COSMOS/Works® software on the critical components of the proposed seat design with a load of 2000 N (440 lb person) acting on the seat, with the top area of the raisers. The analysis clearly showed that the model is designed with an overall Factor of Safety 2.11, confirming the HDPE material choice.

The weight of the seat is about 3.5 lb. As previously mentioned, injection molding was the selected process of production. Additional details that should be considered in improving the RTS are as follows:

- Adhesive rubber pads on the bottom of the raisers to minimize shifting,
- Additional raisers to achieve greater variations in height adjustment,
- A splashguard to fit on the bottom of the RTS, and
- Colors to maximize the aesthetics of the RTS.

The cost of each unit is about $20.

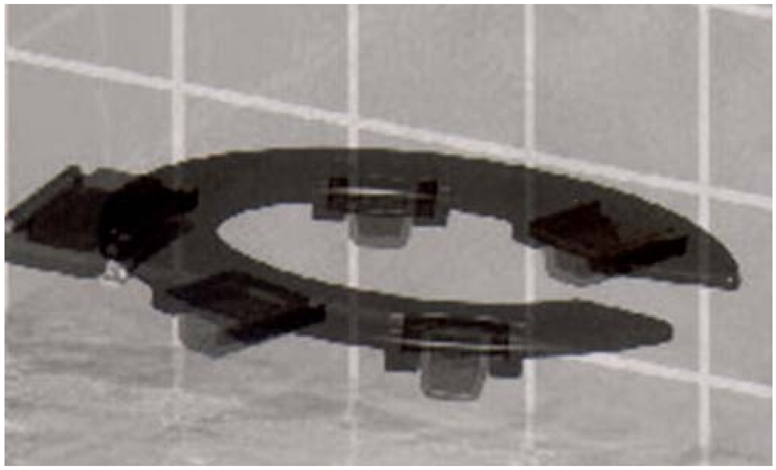

Figure 18.21. HDPE Adjustable Toilet Seat.

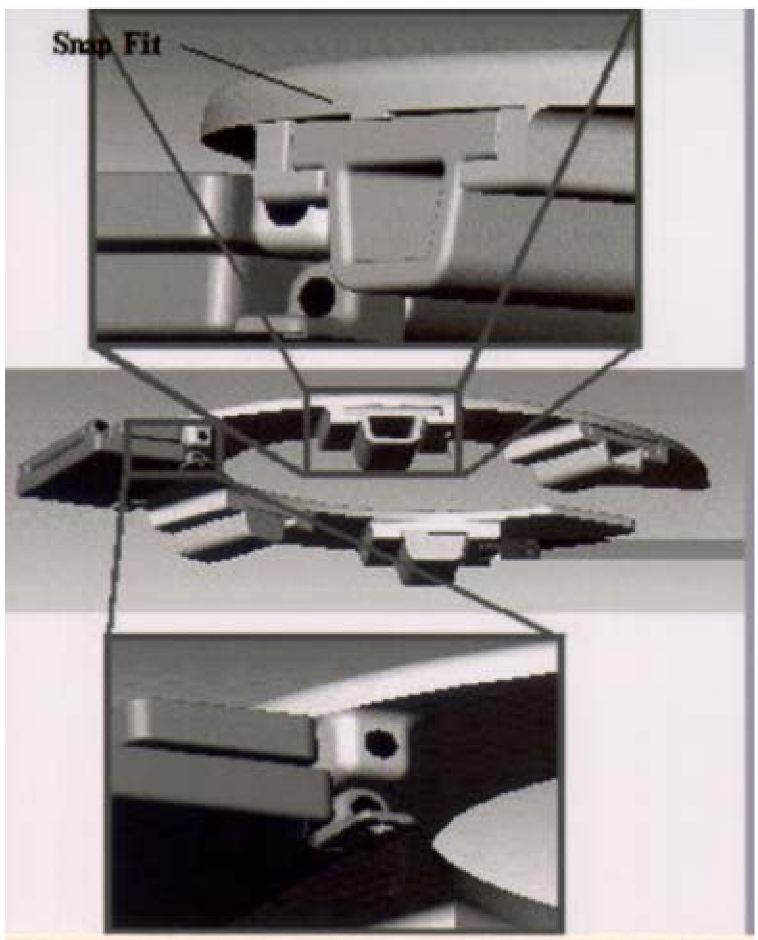

Figure 18.22. Raiser and Seat Attachment Assembly.

QUICK-RELEASE FOLDING CRUTCH

Designers: B. Jones, K. Connoy, and E. Warren
Supervising Professor: John E. Ritter, Ph.D.
Department of Mechanical and Industrial Engineering
University of Massachusetts
Amherst, MA 01003-3662

INTRODUCTION

The main disadvantage of the standard underarm, laminated wood or aluminum crutches is the fact that they are awkward to use and to store. The only full height, collapsible underarm crutch design available on the market today is telescopic in nature and retails for about $180. By comparison, standard crutches retail for about $20 to $30.

An aluminum crutch was designed that could be folded into thirds to allow the user to fit it into a gym bag. By constructing the folding crutch out of standard extruded aluminum tubing and using only off-the-shelf items, the increase in cost as compared to that of standard aluminum crutch is relatively small, while the value added is quite substantial.

SUMMARY OF IMPACT

A standard underarm, laminated wood or aluminum crutch cannot be easily stored. All current collapsible, underarm crutches are telescopic and expensive. An inexpensive, collapsible and storable crutch is in order.

TECHNICAL DESCRIPTION

The objective of this project was to design an aluminum crutch that could be folded into thirds. This value addition was to be implemented without any compromise to the stiffness of the standard underarm crutch (Figure 18.23).

The crutch pivots about two pins (P) that have threaded ends secured with a lock-tight nut. The release mechanism is a push button or detent pin mechanism (Figure 18.24). The button is pushed down against the spring, which pulls the detent pins out of their respective holes, thus unlocking the middle frame from the lower frame. The lower

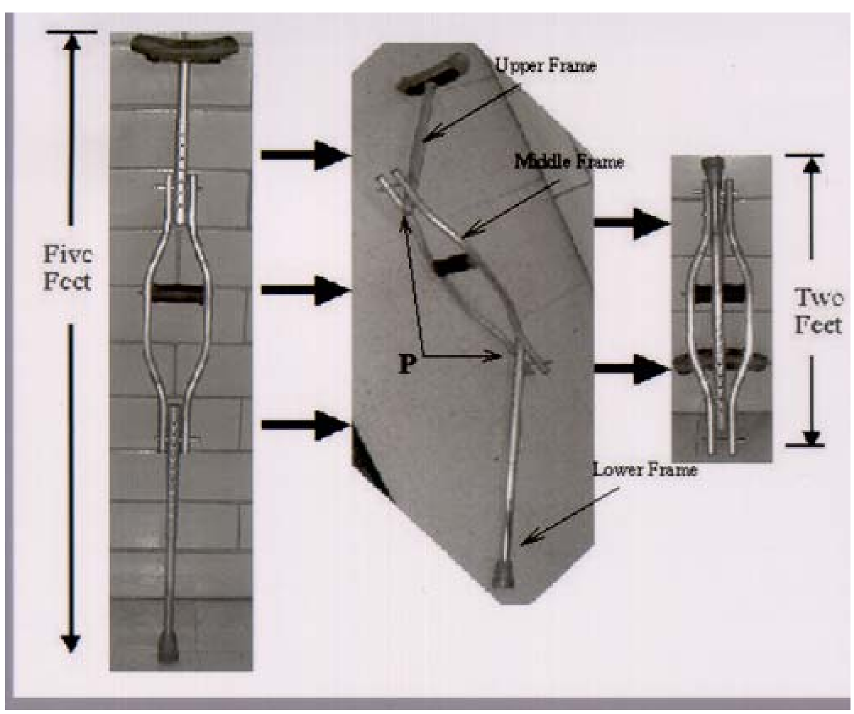

Figure 18.23. Folding Crutch.

frame is then free to pivot about the pin and, subsequently, be folded. The push button requires little effort to retract the detent pins fold the crutch. When the crutch is unfolded, the detent pins are simply pushed back into their holes, locking the crutch into an upright position. The same mechanism is used for the second fold between the middle and the upper frame.

The prototype design was as stiff and reliable as the standard aluminum crutch, while having the distinct advantage of convenient storability.

The fold-up aluminum crutch costs less than $10.

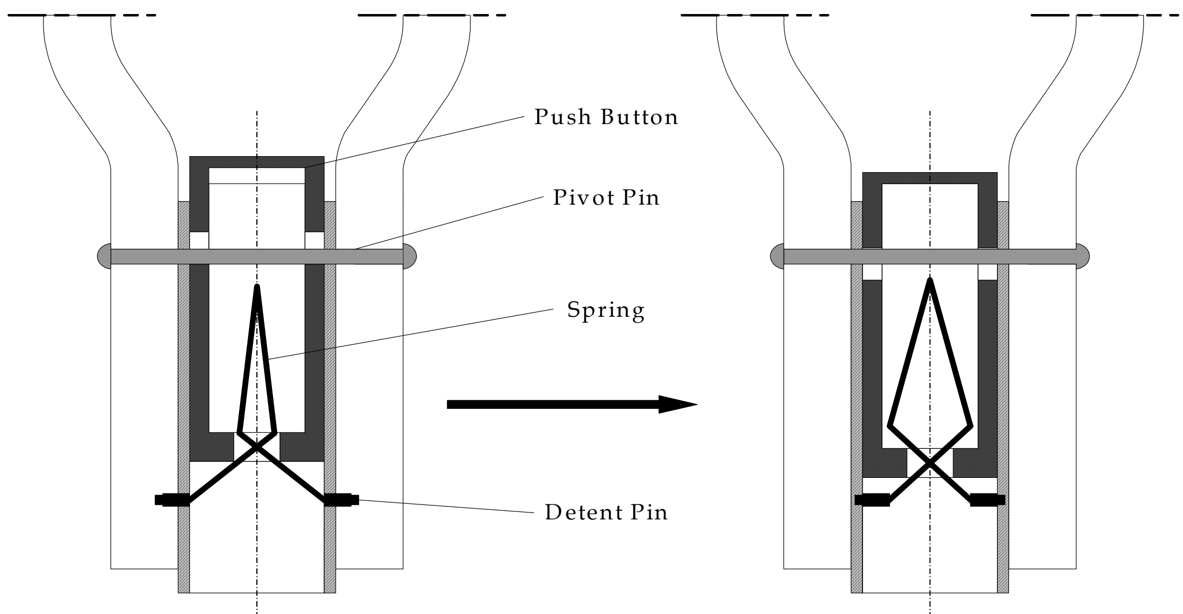

Figure 18.24. Locked and Unlocked Position of the Release Mechanism.

ONE-HAND DISHWASHING AID

Designer: Kirk P. Pitta
Supervising Professor: Janis Terpenny, Ph.D.
Mechanical and Industrial Engineering Department
University of Massachusetts
Amherst, MA 01003

INTRODUCTION

Currently, there are no products available that assist individuals with one hand in cleaning dishes. Due to the concepts available for washing glassware with one hand, the project focus was narrowed to accommodate plates. The selected design configuration is a holder for two commercially available brushes.

SUMMARY OF IMPACT

This design will enable people with one functioning hand to wash plates without experiencing shoulder pain. In addition, the device may be able to accommodate other dishes or utensils if they fit between the brushes. The device represents the beginning of a solution to washing dishes without a dishwasher. However, there are some improvements that could be made to the device. The next step would be to incorporate the design with solutions for other types of dishware to provide a more complete solution. For example, the design could be integrated with a version of a glassware design used by bartenders (Figure 18.25).

TECHNICAL DESCRIPTION

After review of several design alternatives, the brush holder (Figure 18.26) was selected because it accommodates a large range of plates, is easy to use, is simple in design, and is low in cost. Force analysis demonstrated that the design could withstand the expected loads from cleaning plates. This loading situation was modeled as a cantilever beam in bending. Finite Element Analysis verified the hand calculations from a force body diagram. In addition, force analysis was conducted on the suction cups. This proved that the suction cups could withstand an expected loading without dislodging.

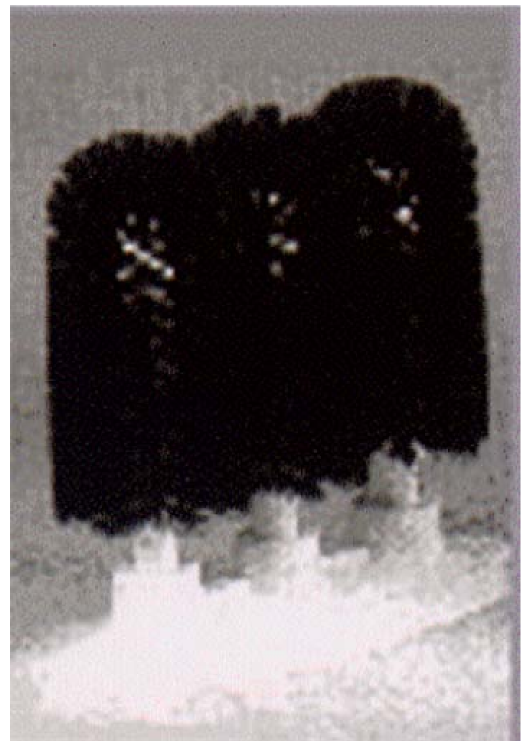

Figure 18.25. Bartender's Glass Cleaning Device.

Selection of materials included consideration of cost, weight, stiffness, and resistance to water. The CES software facilitated the material selection process. Six grades of lower-grade engineering polymers were selected along with ABS in the event that a consumer desires to clean the device in the dishwasher. Ranges for the variables of tolerance, roughness, and aspect ratio were specified. The process of thermoplastic injection molding was selected by CES in order to use multi-cavity molds in a high production environment (Figure 18.27).

The cost per unit is $8.87.

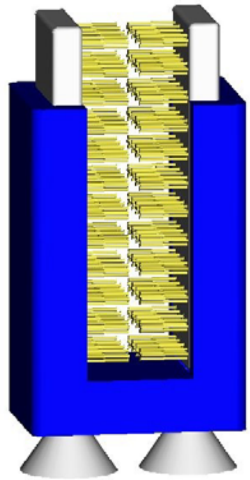

Figure 18.26. Brush Holder Device.

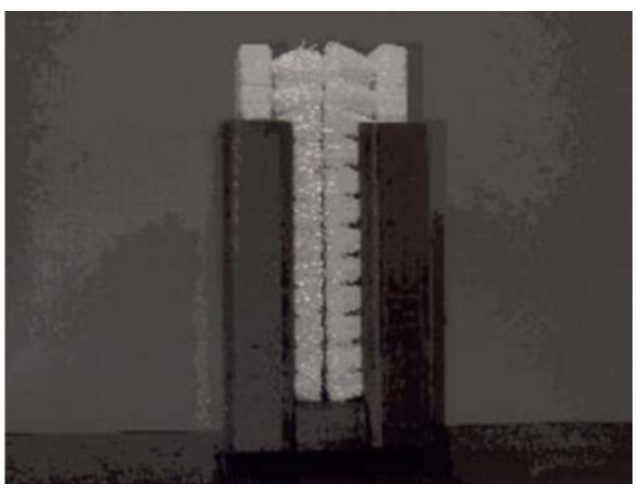

Figure 18.27. Prototype of the Brush Holder Device.

ONE-HANDED BOTTLE OPENER

Designers: G. W. Matsumoto, N. H. Veilleux, and R. D. Yazbeck
Supervising Professor: John E. Ritter, Ph.D.
Department of Mechanical and Industrial Engineering
University of Massachusetts
Amherst, MA 01003-3662

INTRODUCTION

A one-handed bottle opener was designed for an individual with a weak or amputated hand. From a material and processing analysis using the Cambridge Engineering Selector software, a design was developed that uses wrought austenitic stainless steel as the material and stamping as the manufacturing process of choice.

SUMMARY OF IMPACT

Currently, existing bottle openers require the use of both hands to effectively open a bottle. Although one-handed bottle openers are available on the market today, they require permanent attachment to a wall or kitchen counter. The goal of this project was to create an innovative design that would require only the use of one hand while still being inexpensive and portable. With a one-handed bottle opener the user slips the bottle opener on the bottle with one hand and then with the same hand supplies the force necessary for the cap release.

TECHNICAL DESCRIPTION

Design criteria for the one-handed bottle opener include that it be able to withstand the bending forces necessary to pry a cap open, be small and lightweight, and be inexpensive. Additionally, since it will be exposed to liquids the material must have good corrosive resistance.

The operation of the bottle cap opener is simple (Figure 18.28). The user simply positions the bottle opener in the same way as a standard two-handed opener by allowing the "lip" of the bottle cap to be above the notch (Figure 18.29) while the first bend stage rests on top of the bottle cap. Once positioned, the handle acts as a counterweight to allow the bottle to remain in its required position of operation. The user simply applies a force on the plastic-coated handle with his or her fingers while using their thumb to apply a minimal force on the other end to ensure that the notch of the bottle opener is always under the "lip" of the cap. Once the bottle is opened, the opener remains in the hands of the user instead of falling on the floor (Figure 18.30). The moment required to pry the cap off a bottle was determined from wheatonsci.com to be 1.01 N-m. Given the established moment and the length of the bottle opener, a force of 15.3 N was needed. Also, in order to achieve a stiff and robust bottle opener with a quality feel, a maximum deflection of 5 mm was specified during its operation.

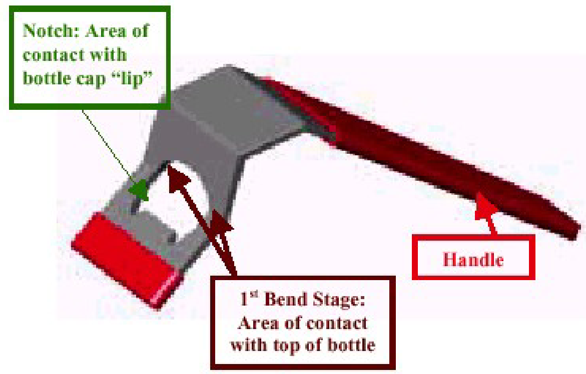

Figure 18.28. Solid Model of One-Handed Bottle Opener.

The plastic coating on the handle allows for an easier grip and enhances the aesthetic appeal of the opener. It is available in multiple colors.

On cost analysis, stamping was found to be the most cost effective process to produce the bottle opener at a volume of 100,000 units. The final material selection was decided to be wrought austenitic stainless steel. The weight of the one-handed bottle opener was calculated to be about 50 gm (Figure 18.30).

This design costs about $1.00.

Figure 18.29. Solid Model of Bottle Opener.

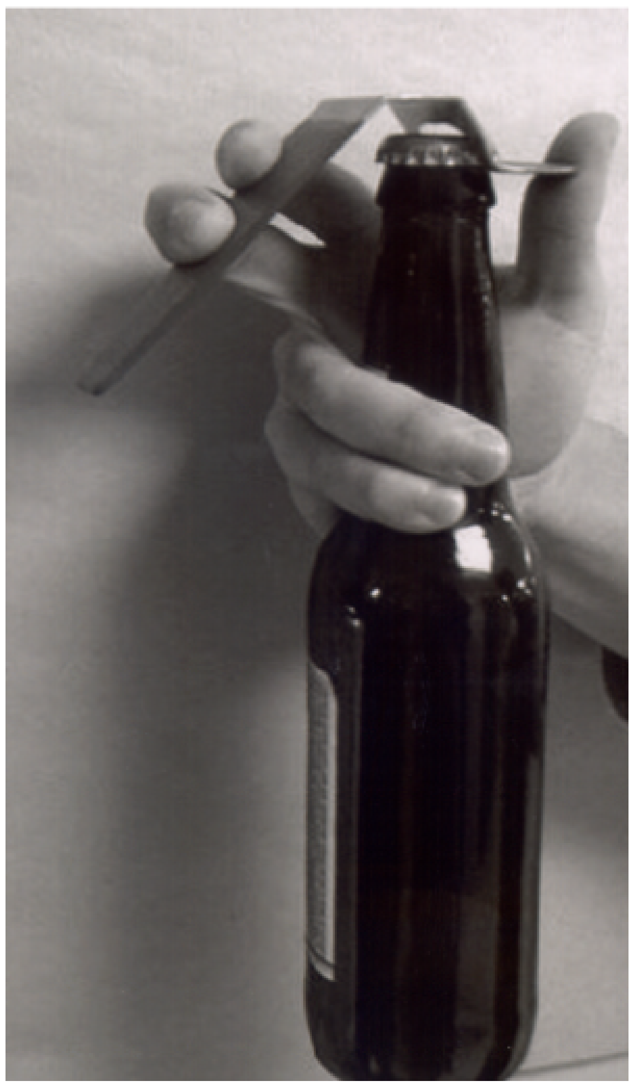

Figure 18.30. Prototype in Use

BAK-PAK

Designers: M. Baldwin, H. Gelinas, and T. P. Shoman
Client Coordinator: Ms. Tara P. Shoman
Supervising Professor: John E. Ritter, Ph.D.
Department of Mechanical and Industrial Engineering
University of Massachusetts
Amherst, MA 01003-3662

INTRODUCTION

During prolonged sitting without any type of back support, the spinal cord posture deteriorates due to muscle fatigue caused by incorrectly contracted muscles and ligaments. Pressure on the intervertebral discs of the lower lumbar spinal column increases by 30% in the sitting posture. A lumbar support was designed to decrease muscle fatigue and strain on the intervertebral discs (Figure 18.31). This support system was to be compact and portable.

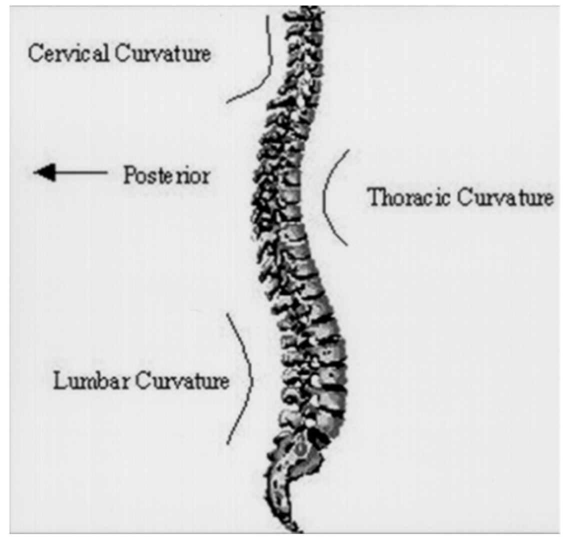

Figure 18.31. Vertebral Column.

SUMMARY OF IMPACT

Some factors that are detrimental to the spinal column include sitting in poorly designed chairs and reading and writing at a table that force an incorrect back and head posture. Irreparable postural damage can be caused by poorly designed school furniture. Most desks and chairs in a classroom are not designed to reduce lumbar pressures. Thus, a lumbar support is necessary not only for someone who has a lumbar back disorder, but also to prevent anyone from developing poor posture or back pain.

TECHNICAL DESCRIPTION

The support system must be able to keep its shape to ensure proper posture. This was accomplished by making the product out of a durable material with a high stiffness value. Another criterion was that the support system be carried inconspicuously when not in use. This was accomplished by making the support system lightweight and compact so that it fits in a purse, school bag, or briefcase.

This support system has been designed to be hidden in a backpack. An adjustable strap was provided so that the lumbar support system can be secured to a wide range of chairs. This adjustable strap goes around the chair, snaps together and then can be tightened. Polypropylene was chosen as the material for the lumbar support insert based on various performance indices using Cambridge Engineering Selector software. Injection molding was found to be the most suitable process for manufacturing the

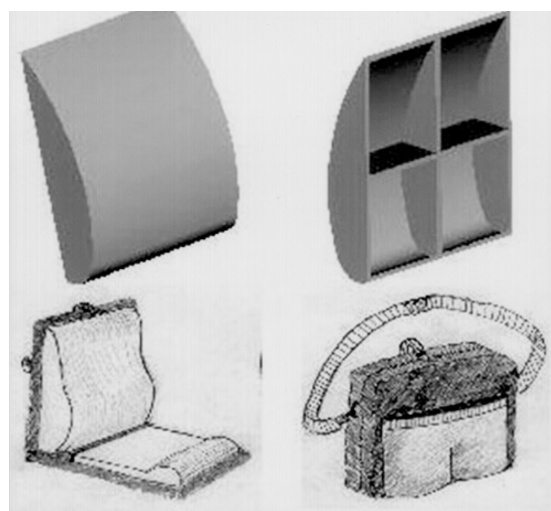

Figure 18.32. Solid Model of Lumbar Support Insert and Sketch of Backpack.

lumbar support in batch sizes of 10,000 (Figure 18.32 and Figure 18.33). Future designs of the lumbar support could include a foam pad adhering to the lumbar support to give added cushioning.

The cost of the support system was estimated to be about $21.

Figure 18.33. Prototype of Lumbar Support Insert.

HEADSTAND

Designers: J. Wohlander, J. Daley, and R. Koller
Supervising Professor: John E. Ritter, Ph.D.
Department of Mechanical and Industrial Engineering
University of Massachusetts
Amherst, MA 01003-3662

INTRODUCTION

Various conditions may require patients to remain inactive, immobilized or even bed-ridden for several weeks. One operation that necessitates that the patient be immobilized for a period of time is used in some cases of retinal detachment. In the operation, a gas bubble is injected into the eye and is used to reattach the retina by pushing against the area of the retinal tear. The patient is instructed to lie face down for about four to six weeks for the gas bubble to float to the back of the eye in order to repair the damage. A Headstand was designed for the patient to lie face down and still enjoy certain activities such as eating, playing cards, watching television and so on.

SUMMARY OF IMPACT

The treatment for retinal damage was discussed with a renowned specialist in the field of retinal trauma and surgical repairs. According to him, there is no recovery period enhancement product available on the market. Based on his recommendations, a headstand was developed. It offers a realistic solution to the problem of providing some everyday freedoms to the patient without jeopardizing the patient's chances for a full recovery.

TECHNICAL DESCRIPTION

The specifications for the design of the Headstand were as follows: low weight, little deflection under full load, low cost, aesthetically pleasing, and adaptable. Hollow tubing with a circular cross-section was selected for the primary structural component. To make the Headstand adaptable to the wide variety of the bed styles and sizes available on the market, the Headstand was designed to accommodate height adjustability from 19" to 32". The use of round tubing also enabled variable height adjustment with the addition of a telescoping section that locks into position using spring-loaded ball pins.

Figure 18.34. Solid Model of the Headstand.

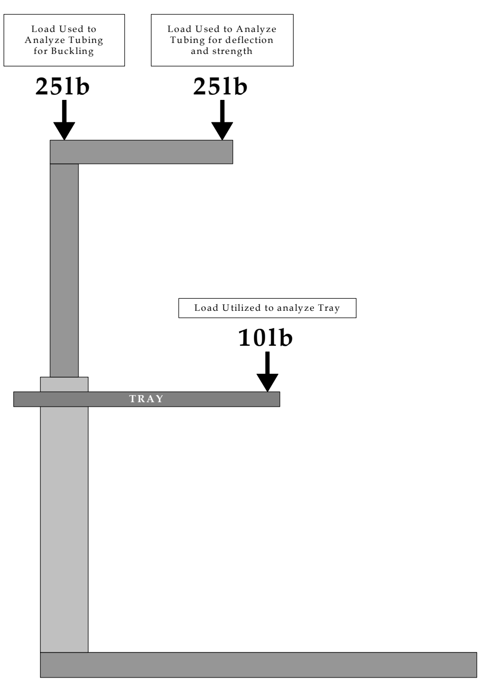

Figure 18.35. Diagram.

The components of the headrest portion of the product were sized according to data gathered for average head sizes of adult males. To reduce stress concentrations and to allow more free space for head placement, the two headrest support shafts were arranged in Y-neck fashion. A padded Velcro strap was chosen for the head-supporting band that mounts between the two head supporting bars (Figure 18.34).

An activities tray was included. It mounts between the patient's head and the floor. The tray provides a small work area where patients may lay out a book or magazine, write letters, or play cards. The height of the tray is adjustable and the tray could also be removed. For stability, the legs should be positioned at 45-degree angles to either side of the headrest and should extend twice (e.g. 16") as far in the same direction as the headrest (Figure 18.35) A polymer coupling device was used to join the various sections of the tubing.

Wrought aluminum alloy was selected as the tubing material to meet the requirements of high strength to weight ratio, low cost, and availability in tubular form. The material selected for tray and the connecting components was epoxy/glass fiber composite (Figure 18.36).

The cost of the headstand is around $18.

Figure 18.36. Headstand Prototype.

SIT-SKI BRAKE DESIGN FOR A CROSS-COUNTRY SKIER

Designers: T. Choiniere, J. Jablkowski, and C. Torrao
Supervising Professor: John E. Ritter, Ph.D.
Department of Mechanical and Industrial Engineering
University of Massachusetts
Amherst, MA 01003-3662

INTRODUCTION

A Sit-Ski is designed to enable people who are paralyzed below the waist to enjoy cross-country skiing. In current skis, the user must use ski poles as a braking device. This mode of breaking is inadequate even at an average slow speed. Thus, there is a need for an alternative breaking system. A new design, a center braking system is proposed, which can be attached to the existing frame of the Sit-Ski.

SUMMARY OF IMPACT

A braking device for the present Sit-Ski has been designed to provide a reliable cost efficient braking mechanism for a cross-country skier with disabilities. People with one functioning hand may also use the proposed braking device. The brakes stop the Sit-Ski without rotating the skis, regardless of which arm exerts more force.

TECHNICAL DESCRIPTION

The objective of this project was to design an efficient braking device that can be added to existing Sit-Skis and that could also be used by individuals with disabilities. The brake must stop the skier without causing the Sit-Ski to rotate. The braking system should be stiff so that there is minimum deflection (Figure 18.37).

The brake was designed to act between the skis to avoid any rotation of the Sit-Ski when applying the brake. Two separate lever arms are available on either side of the Sit-Ski and these lever arms join behind the skier to act in unity. Having a triangular shape where the wider edge digs into the snow provides an ample stopping force (Figure 18.38).

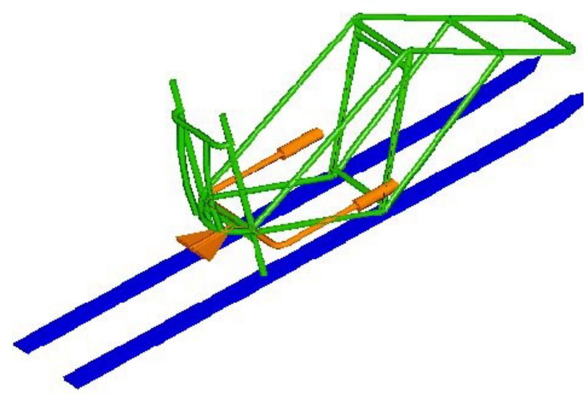

Figure 18.37. Solid Model of the Proposed Braking System in Sit-Ski.

The braking system was attached to the Sit-Ski with two sheet metal clasps. Since the lever arms of the braking mechanism have significant bends, it will be subjected to high bending and torsion stresses. Thus, the material must be tough, strong and lightweight. The Sit-Ski frame is made out of wrought aluminum alloy tubing. Thus the braking system should be constructed out of the same material for ease of construction, cost, and aesthetics.

A prototype was built and tested on a Sit-Ski (Figure 18.39). Aluminum tubing with an outer diameter of 5/8" was used to build the braking mechanism. The total length of one lever arm is 10". These arms have two 90-degrees bends with a bend radius of 2". The triangular aluminum brake is welded to the tubing arms.

The total cost would be about $14 based in mass production.

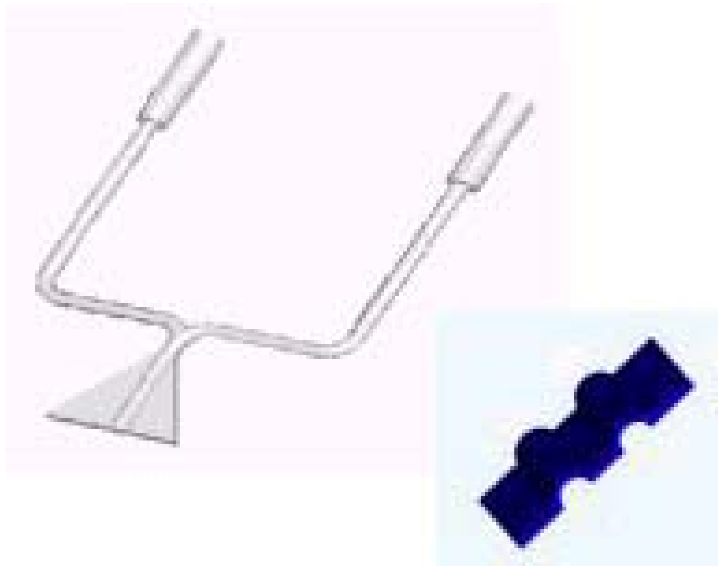

Figure 18.38. Sketch of the Braking Mechanism and Clasp for Attaching the Brake to the Sit-Ski Frame.

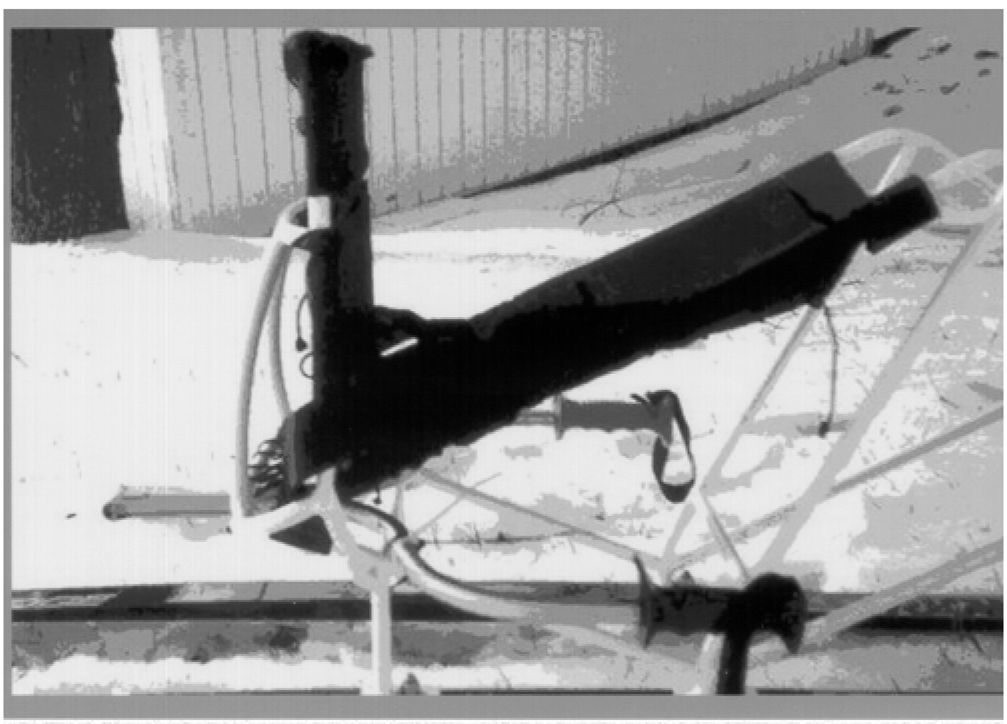

Figure 18.39. Prototype of the Braking System Tested on a Sit-Ski.