CHAPTER 18
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DEPLOYABLE ROBOTIC BASE

Designers: Sam McAmis, Thierry Ku, Minh Nguyen, and William Keese
Supervising Professors: Dr. Don Dekker, Stephen Sundarrao
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INTRODUCTION

The deployable robotic base was developed to assist the user in performing tasks that are difficult to do without another person's assistance. This device can be attached to a variety of power wheelchairs and can be easily removed. The device is deployed via a lifting arm mechanism accessed by the user on the side of the chair. Fig. 18.1 shows the prototype.

SUMMARY OF IMPACT

According to National Health Care Survey in 1994, there are 54 million or 20.6 % of people in the United States who live with some form of disability. There are 1.6 million people who need a wheelchair for mobile assistance. Approximately 96% of wheelchair users have had some form of functional limitation. This robot can then be used to assist the individual perform tasks he or she may not ordinarily be able to do without assistance. Also, this device has the potential for reducing dependence on others.

TECHNICAL DESCRIPTION

This device was designed and developed as a deployable robotic base that can link to a power wheelchair. This robotic base could be attached or detached to the back of the wheelchair and be lifted or released by a lifting arm mechanism. This design project had three main goals: 1) the robot would be able to move in multiple directions easily and be built in such a way that any additional devices, such as lifting arms, could be attached to it for future development; 2) the robot attachment mechanism would be versatile to use on any location on different wheelchairs; 3) the robot could be attached and detached to a variety of wheelchairs.

Fig. 18.1. The Deployable Base Attached to a Wheelchair.

The device is made of an aluminum base with slots on the ends for the lift arm to be inserted. The base has a wheel track system so that the chair can move with the base on the ground. The lift arm is made of square aluminum tubing. A pulley-track system with two dc geared motors is used for the lifting mechanism. Fig. 18.2 shows the aluminum base attached to a wheelchair by the lift arms. Fig. 18.2a demonstrates the device in the deployed position for use. Fig. 18.2b shows the device in storage.

The cost of the parts and materials was about $2000.

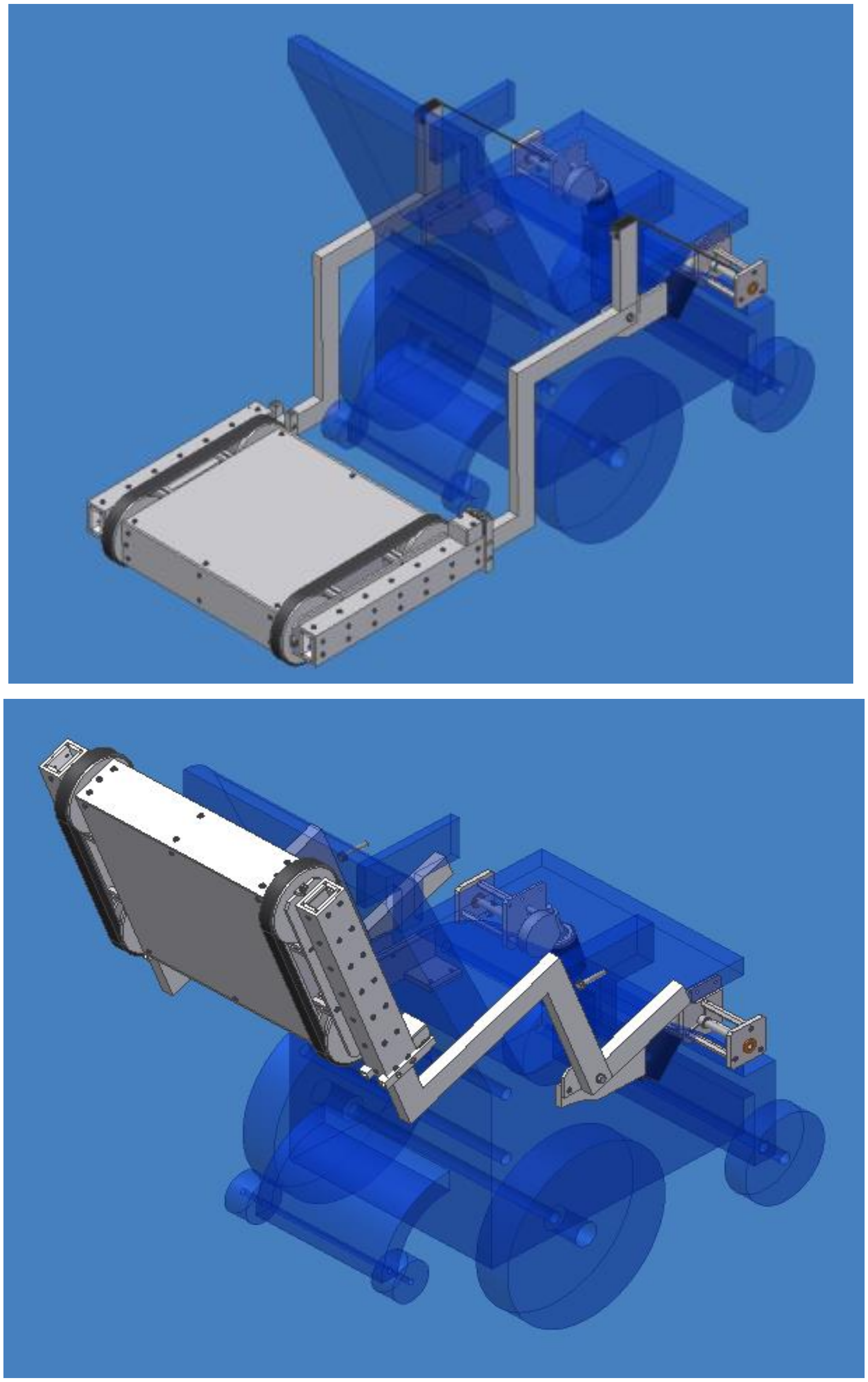

Fig. 18.2. a) Lift Arms in Lowered Position (top) and b) Lift Arms in the Up-right Storage Position (bottom).

PORTABLE LIFTING CHAIR: BED TRANSFER DEVICE

Designers: Arlin Beechy, David Demaree, Mario Simoes, and Ryan Smith
Supervising Professors: Dr. Don Dekker, Stephen Sundarrao
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INTRODUCTION

The purpose of designing a portable hotel bed transfer device is to make it easier for people with disabilities to transfer to and from bed. Hotel beds often measure anywhere from five to fifteen inches higher than the average household bed. This device is meant to be portable for ease of use and transportation within the hotel.

SUMMARY OF IMPACT

This device allows the individual to transfer safely from a wheelchair to a hotel bed with little or no assistance from another.

TECHNICAL DESCRIPTION

The Portable Lift Chair (PLC) is an all-in-one device that is capable of moving an individual weighing up to 250 pounds, in and out of a hotel bed. Its main movements are translational vertically and horizontally, and rotationally. The main components of the design are: 1) a telescopic two-stage lifting column; 2) a DC high torque gear motor, Dayton 1/20 HP, 21 RPM, 12V, 3A; 3) a Torqspline lead screw, 1.5 inches per revolution; 4) a custom seat, made from 3/4″ AL 6061-T651 flat plate; 5) safety handlebars; 6) stabilizing base frame; 7) and sliding top plate.

A seat is attached to a two-stage telescoping lift column which is compact and can be adjusted to a variety of bed heights. Also attached are side rails, made from 0.065″ 1″ OD seamless steel tubing, for arm rests for user safety. An important feature is the transport system at the top of the lift column that gives the user complete 360° rotational freedom. It allows indexing at various angles so that as the user disembarks from the device, it can be securely locked to transfer to the bed safely.

The lead screw at the base of the device provides motorized translational movement. The user can transfer from a wheelchair onto the seat of the PLC; then move close to the bed for ease of transporting to the bed. Fig. 18.3 shows a CAD drawing of this device.

The cost of the parts and materials was about $3500.

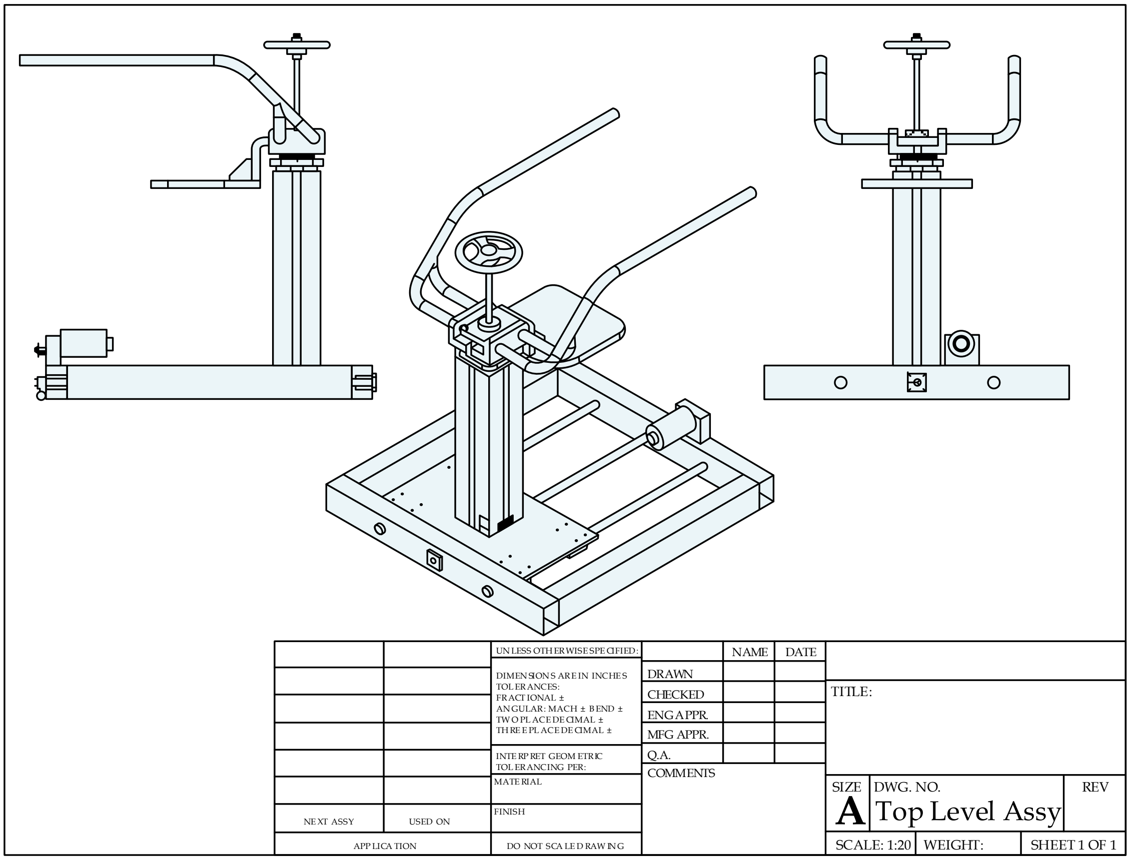

Fig. 18.3. The Deployable Base Attached to a Wheelchair.

THE UPLIFTER: HOTEL BED TRANSFER DEVICE

Designers: Stephen Hoback, Antonio De Armas, and Iris Boci
Supervising Professors: Dr. Don Dekker, Stephen Sundarrao
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INTRODUCTION

The purpose of this device is to provide a portable hotel bed transfer device to make it easier for people with disabilities to transfer to and from bed. A slide board is often difficult to use due to the large difference in height from wheelchair to bed. This device incorporates a four bar mechanism upon which a user can easily sit and be raised to the needed height.

SUMMARY OF IMPACT

This device allows the individual to transfer from a wheelchair to a hotel bed.

TECHNICAL DESCRIPTION

The Uplifter device uses an electrical actuator to efficiently raise and lower the user. The 24 VDC actuator is an enclosed worm gear that drives a rod to a predetermined stroke length. The actuator runs from a converted 120 VAC via an AC/DC converter to provide the necessary torque for the maximum load of 250 lbs. The actuator coupled with a four bar mechanism gives the Uplifter the needed variation in height. To operate the device, the user pushes a limit switch that has two buttons for up and down. This device allows the user to transfer from a standard 19 inch high wheelchair seat to a 30 inch high bed. Fig. 18.4 shows the Uplifter device.

The cost of the parts and materials was about $1000.

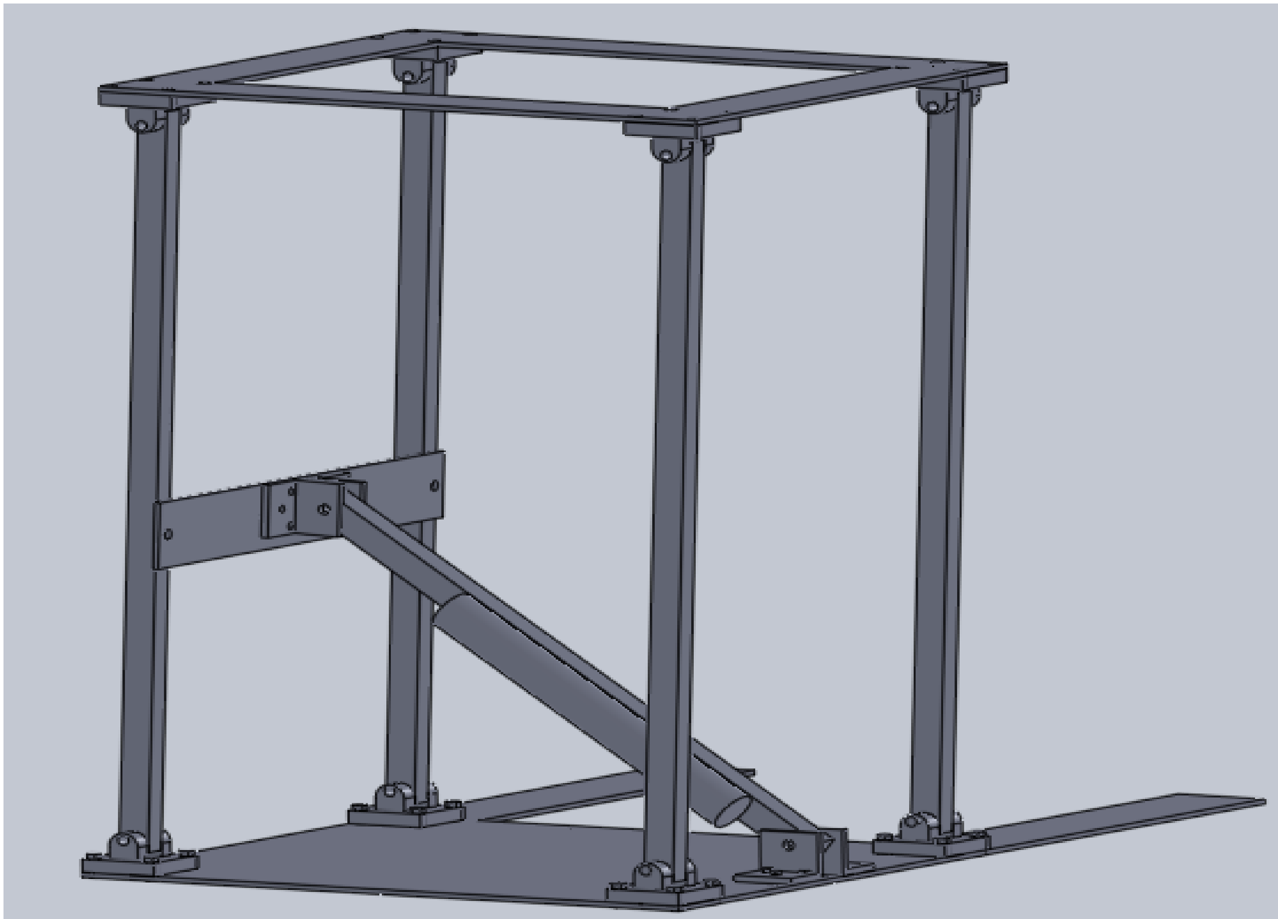

Fig. 18.4. The Uplifter Shown in the Fully Open Height of 30 inches.

PORTABLE WHEELCHAIR LIFTER FOR HOTEL BEDS

Designers: Alex Berrios, Sean Tancey, and Daniel Perez
Supervising Professors: Dr. Don Dekker, Stephen Sundarrao
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INTRODUCTION

This objective of this project was to develop a portable transfer device for hotel beds as an alternative to helping people with disabilities move from their wheelchair to the hotel bed.

SUMMARY OF IMPACT

This device allows the individual to transfer safely from a wheelchair to a hotel bed with little or no assistance.

TECHNICAL DESCRIPTION

The device works as a portable wheelchair lifter, using two hydraulic electric jacks to raise a platform. For transfer, the user drives the wheelchair onto the platform which is then raised until it reaches the correct level.

The lifting plane of the prototype has a width of 30 inches and a length of 48 inches. The device materials used are A36 carbon steel, which gives the prototype a large yield stress (250 MPa) with a minimum amount of deflection. The prototype has a maximum stress of 65 MPa when lifting the user and power chair. The device weighs 335 lbs.

The cost of the parts and materials was about $1000.

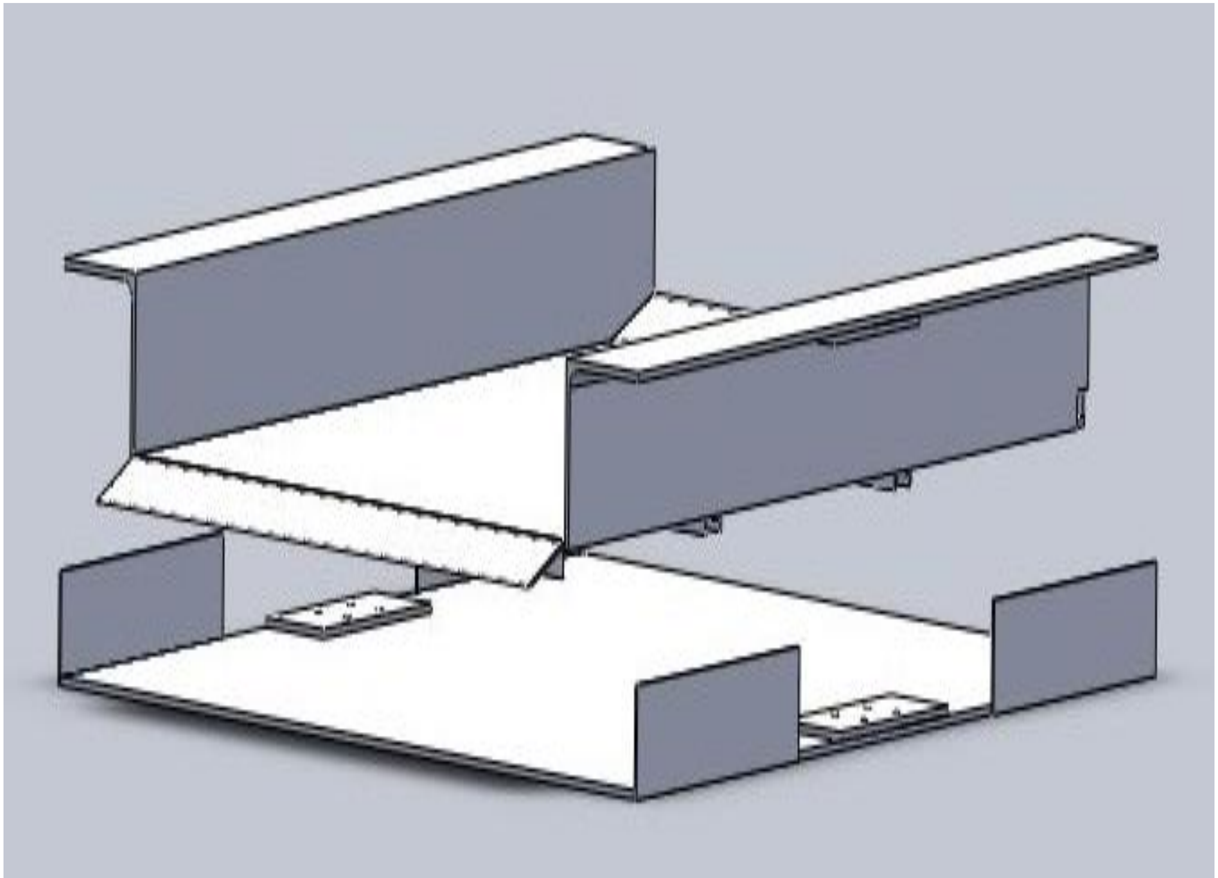

Fig. 18.5. Portable Wheelchair Lifter.

PERSONAL HEATING AND COOLING SYSTEM

Designers: Jay Mckenzie, Rashid Alshatti, Shuen Yasui, and Yanay Pais
Supervising Professors: Dr. Don Dekker, Stephen Sundarrao
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INTRODUCTION

The project goal was to create a personal cooling and heating system that could be integrated into a powered wheelchair. This project is primarily for the use of paraplegics and quadriplegics, who because of spinal injuries, have trouble controlling their own body temperature.

SUMMARY OF IMPACT

By being able to regulate body temperature, the user can enjoy activities that were not possible prior to this device. This device also allows temperature of the user to be monitored and controlled remotely.

TECHNICAL DESCRIPTION

This device uses a thermoelectric cooler as the main component. The 12 v battery on the powered wheelchair, or any external 12 v battery, can be used to power the device. The heating and cooling of the system adjusts automatically based on the user's core temperature utilizing the Peltier effect. The system requires minimal maintenance and is easily adjustable based on the user's environment. Fig 18.6 shows a chart of how the liquid flows throughout the system to cool or heat the user.

The cost of the parts and materials was about $800.

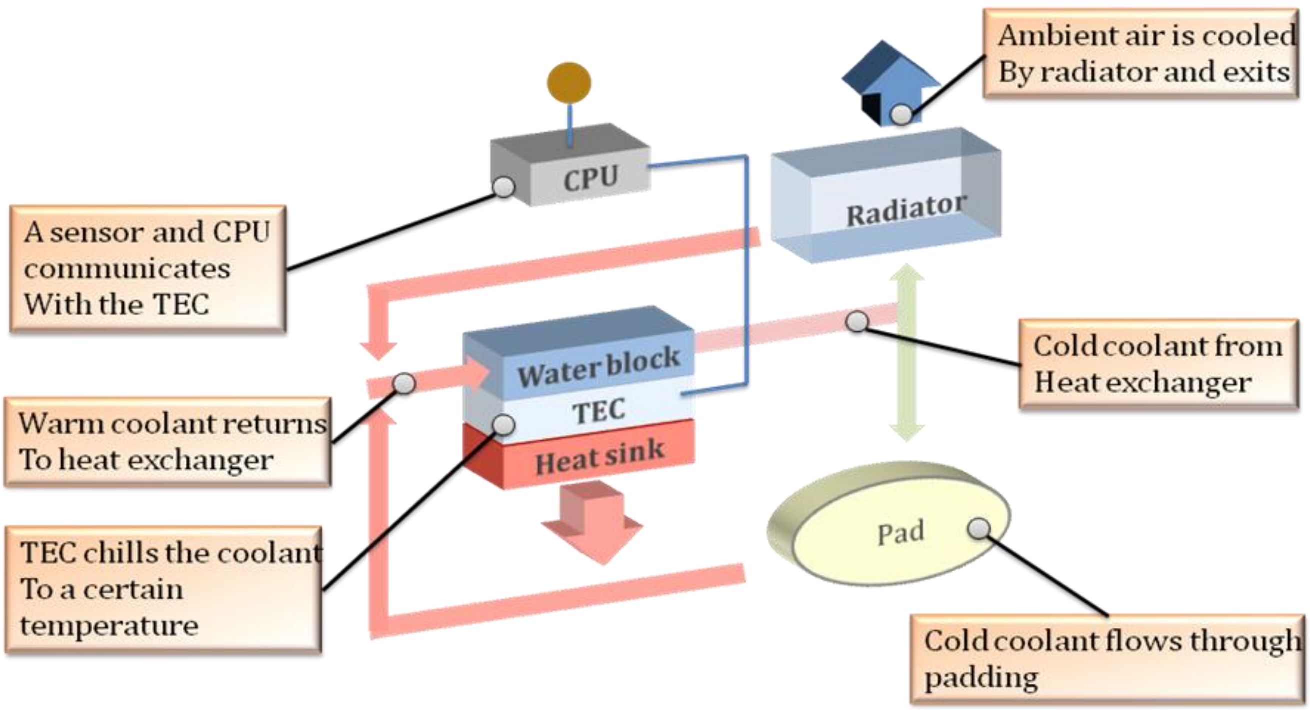

Fig. 18.6. Liquid Flow through the System to Produce Heating or Cooling.

CRUISE SHIP EVACUATION: SPINE BOARD

Designers: Patricia Arredondo, Danielle Grannis, and Steve Lombardo
Supervising Professors: Dr. Don Dekker, Stephen Sundarrao
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INTRODUCTION

This device was developed to decrease the time it takes to evacuate passengers with disabilities from a cruise ship while providing support to the user. Currently a cruise ship has a special team of 30 people who assist passengers with disabilities. In case of an evacuation, at least four members carry the passenger in his or her wheelchair to one of the six master stations located three decks below the rooms equipped for people with disabilities. The life boats hold 140 passengers, 10 crew members, and no wheelchairs. The passenger with the disability is placed unsupported and unsecured on the life boat bench.

SUMMARY OF IMPACT

This design aims to improve the efficiency and safety for all involved in the evacuation of passengers with special needs. This device is a means of carrying the individual and provides seating support in the life boat for the person with disabilities.

TECHNICAL DESCRIPTION

This device is a modified evacuation spine board. It is comprised of three sections: back support, seat, and leg support. Each section is attached with locking hinges which allows the evacuation spine board to be adjusted to various positions to meet the user's needs. The spine board has handles surrounding the perimeter, which provide the safety team with extra grip during transport. The spine board also acts as a flotation device, equipped with an automatic inflatable life vest. In case the lifeboat capsizes, the life vest will automatically inflate once it's submerged in water. This device was developed to be able to minimize the number of physical transitions from personal chair to lifeboat bench, provide comfortable support, offer an alternative independent flotation device, improve evacuation time of the boat, and also possess a maximum of 6 decks.

The cost of the parts and materials was about $700.

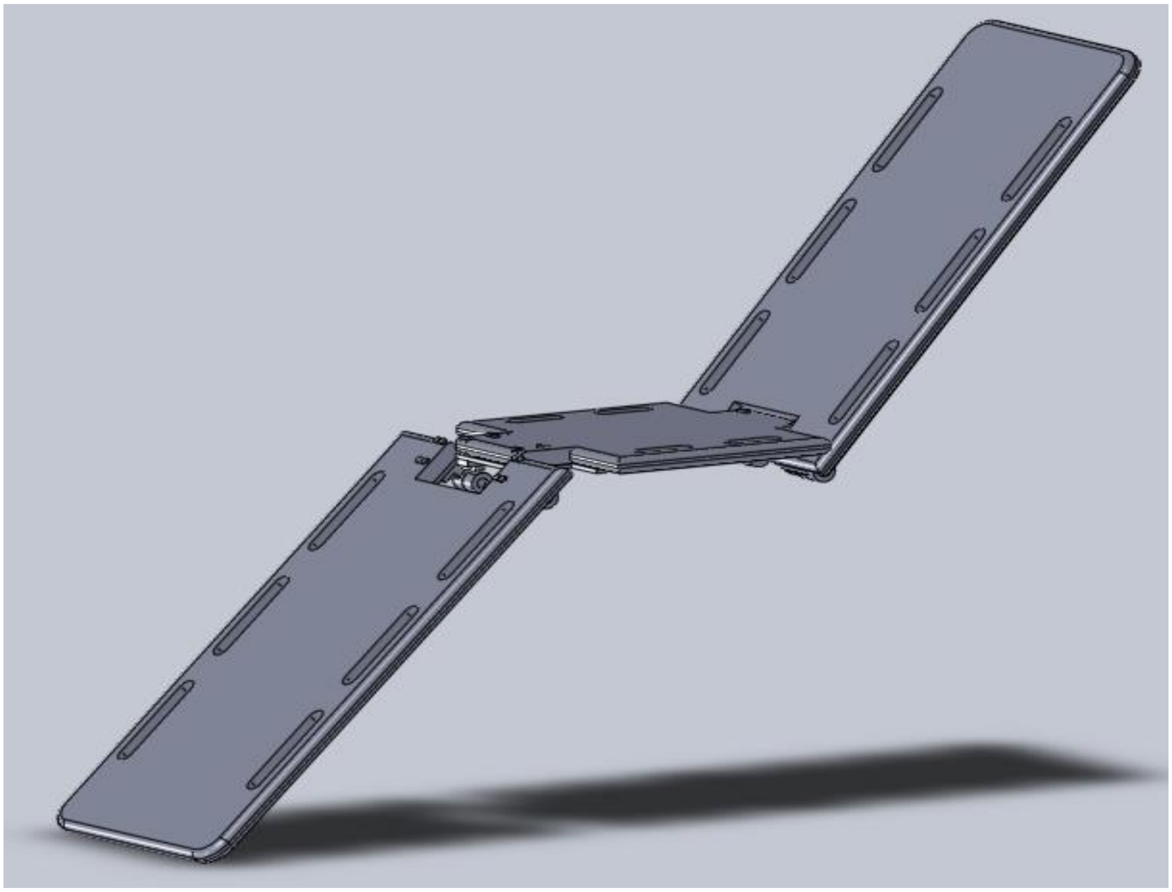

Fig. 18.7. Modified Spine Board for Boat Evacuation.

CRUISE SHIP EVACUATION DEVICE

Designers: Andrew Knapp, Diego Herrero, and Viktor Skowronek
Supervising Professors: Dr. Don Dekker, Stephen Sundarrao
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INTRODUCTION

This design is for a mechanical machine to assist in moving people with disabilities up and down cruise ship stairwells. Currently a cruise ship has a special team of 30 people who assist passengers with disabilities. In case of an evacuation at least four members carry the passenger in his or her wheelchair to one of the six master stations located three decks below the rooms equipped for people with disabilities. The life boats hold 140 passengers, 10 crew members, and no wheelchairs. The passenger with the disability is placed unsupported and unsecured on the life boat bench.

SUMMARY OF IMPACT

This design aims to improve the efficiency and safety for all involved in the evacuation of passengers with special needs. This device is a means of carrying the individual and provides seating support in the life boat for the person with disabilities.

TECHNICAL DESCRIPTION

The Vertical Evacuation Rail Transport System (V.E.R.T.S.) consisted of a track similar to that of a rollercoaster, motor actuated wheel system, and a worm gear assembly. The track was a smooth piece of machined steel alloy that followed the interior of the stairwell. A U-Grooved wheel and a motor actuated system were attached to a platform. The actuator and worm gear assembly assist in moving the device and act as a brake. The user can sit on the composite material platform or chair and be moved down the stairs. The prototype was made to fold up to allow for easier storage and quick deployment in an emergency. Fig. 18.8 shows this chair design.

The cost of the parts and materials was about $350.

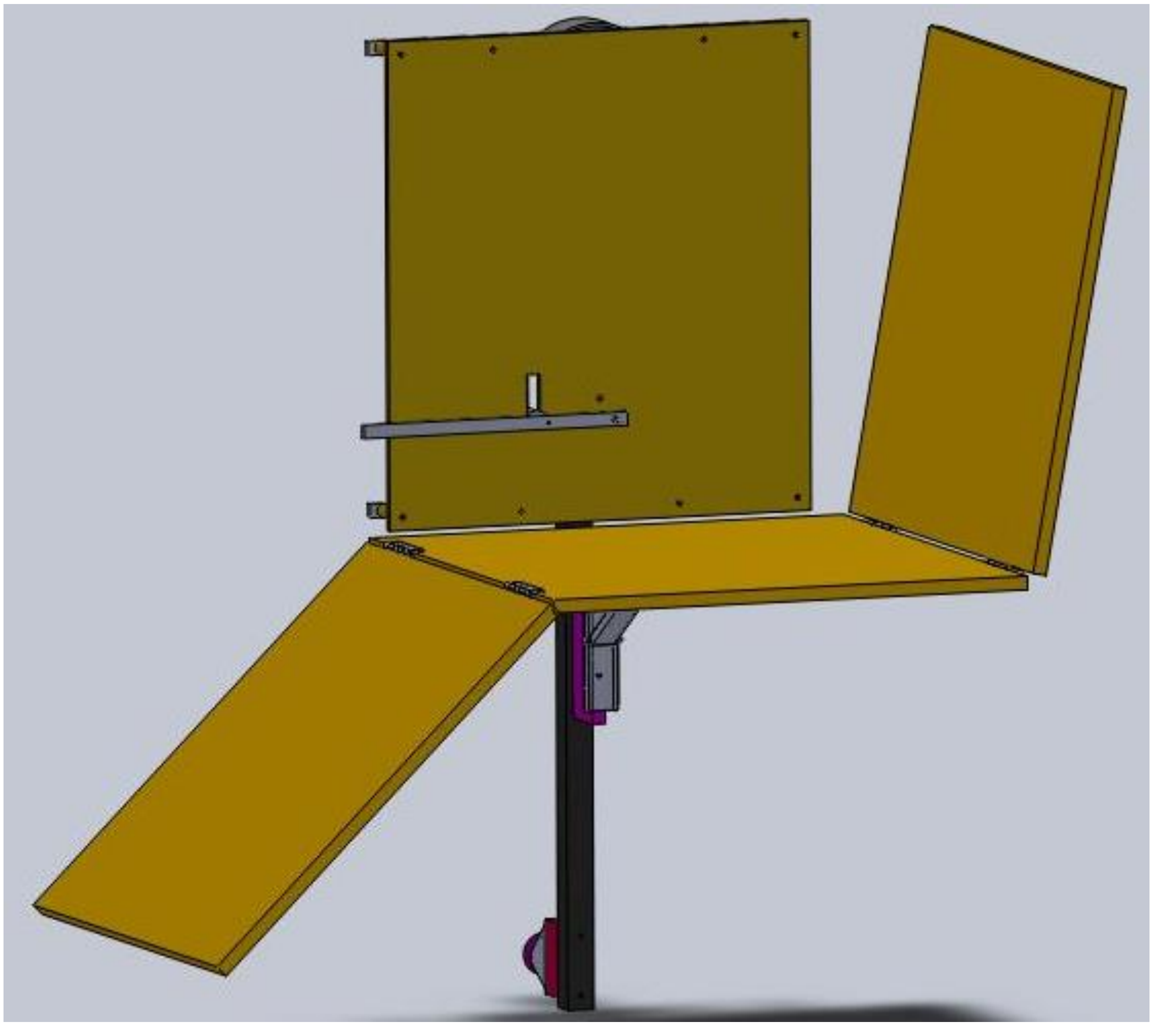

Fig.18.8. The Vertical Evacuation Rail Transport System Boat Evacuation.

CRUISE SHIP EVACUATION CHAIR

Designers: Joseph Gundel, Justin Barnhart, and Chris Iacono
Supervising Professors: Dr. Don Dekker, Stephen Sundarrao
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INTRODUCTION

This chair allows the passenger with a disability to be transported to the lifeboats and to be supported appropriately in the lifeboat at sea. Currently a cruise ship has a special team of 30 people who assist passengers with disabilities. In case of an evacuation at least four members carry the passenger in his or her wheelchair to one of the six master stations located three decks below the rooms equipped for people with disabilities. The life boats hold 140 passengers, 10 crew members, and no wheelchairs. The passenger with the disability is placed unsupported and unsecured on the life boat bench.

SUMMARY OF IMPACT

This design aims to improve the efficiency and safety for all involved in the evacuation of passengers with special needs. This device is a means of carrying the individual and provides seating support in the life boat for the person with disabilities.

TECHNICAL DESCRIPTION

The chair frame is made of 6061 aluminum tube. Aluminum is strong, lightweight, and corrosion resistant – 6061 is commonly used in marine environments. The NPS 3/4 SCH 80 pipe was bent into U-bends, each 18″ wide, with one 36″ long, and the other 18″ long. The seat is 18″ x 18″, ½″ aluminum plate with four large triangles removed to help reduce weight. The weight of the frame is less than 25 lbs. and holds a 250 pound load.

A 1″ thick mincel foam cushion was sewn around the back, seat, and foot rest, providing support for the evacuee in every location. The mincel foam is lightweight, water resistant, mildew resistance, and buoyant. The foam was covered by a canvas duck cloth material, wrapped and sewn around the frame. Medical grade Velcro straps were used to secure the passenger to the chair.

A three part system was incorporated to secure the chair in the life boat, consisting of four aluminum pegs, a non-slip surface on the bottom of the base plate, and a seat belt attached to the chair. Fig. 18.9 shows the chair design.

The cost of the parts and materials was about $700.

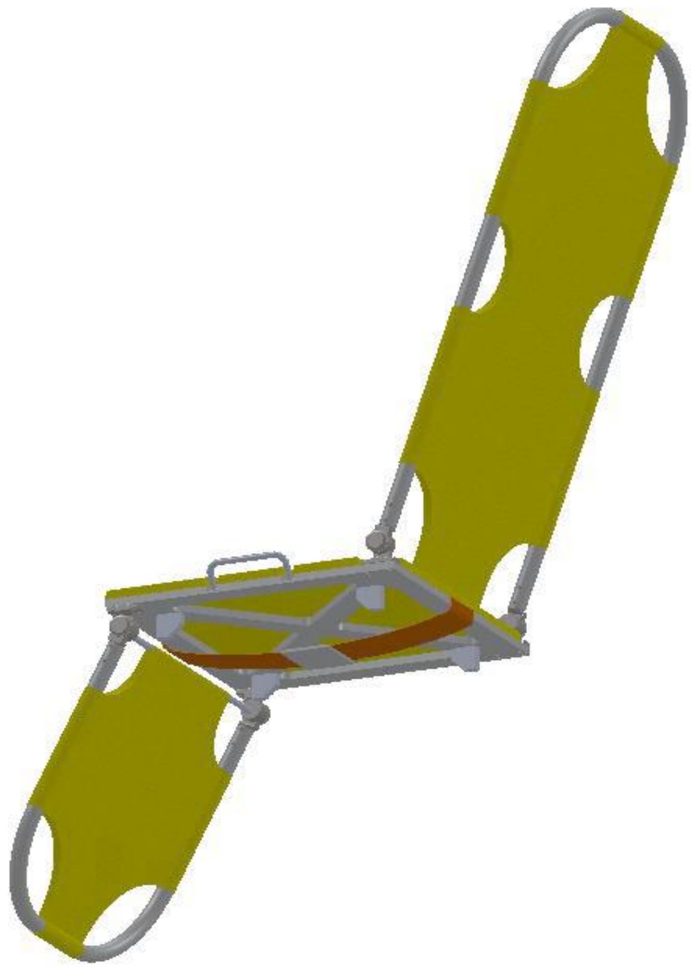

Fig. 18.9. Cruise Ship Evacuation Chair.

WHEELCHAIR LIFT FOR A YACHT

Designers: Nick Knickerbocker, Blake Palmer, and Tegan Strautmann
Supervising Professors: Dr. Don Dekker, Stephen Sundarrao
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INTRODUCTION

The objective of this project was to create a vertical lift system for a 46′ Carver 444 CPMY, capable of moving an individual with disabilities in a wheelchair safely to the second level of the boat.

SUMMARY OF IMPACT

This lift system allows a person with disabilities to gain access to a boat, that otherwise was not possible. Additionally, this system protects the user from the elements during transport.

TECHNICAL DESCRIPTION

This device is designed for a 46′ Carver yacht, which is white with stainless steel trim. The design used conventional elevator techniques, which included a winch and cable system. Due to the shape of the boat, a tract system was incorporated to provide extra stability and safety.

The design includes a winch/pulley system with a custom platform and detachable railings (2″ x 2″ x 3/16″ square stainless steel tubing). The base platform, 48″ x 54″, was designed to allow a standard power wheelchair to transfer on to it with ease. The floor of the platform was diamond plate aluminum, fortified with a steel foundation (2″ x 2″ x 3/16″) to withstand a load of up to 1000 lbs. All components were made of stainless steel, with the exception of the aluminum base plate, which was coated in order to resist the corrosive effects of salt water. The foundation of the base plate has a protective rubber coating to prevent damage to the fiberglass hull.

Two custom made roller brackets allowed for connectivity of the carriage to the wall of the boat. The brackets were stainless steel with a 2″ in diameter nylon roller. The nylon rollers were chosen for their low coefficient of friction and high modulus of elasticity, and were designed to encompass two ball bearings (5/16″ x 11/12″) rated for loadings higher than 1000 lbs. The winch that drives the system was rated for loads up to 3000 lbs.

The cost of the parts and materials was about $1700, and with boat modifications, the cost approximates $6700.

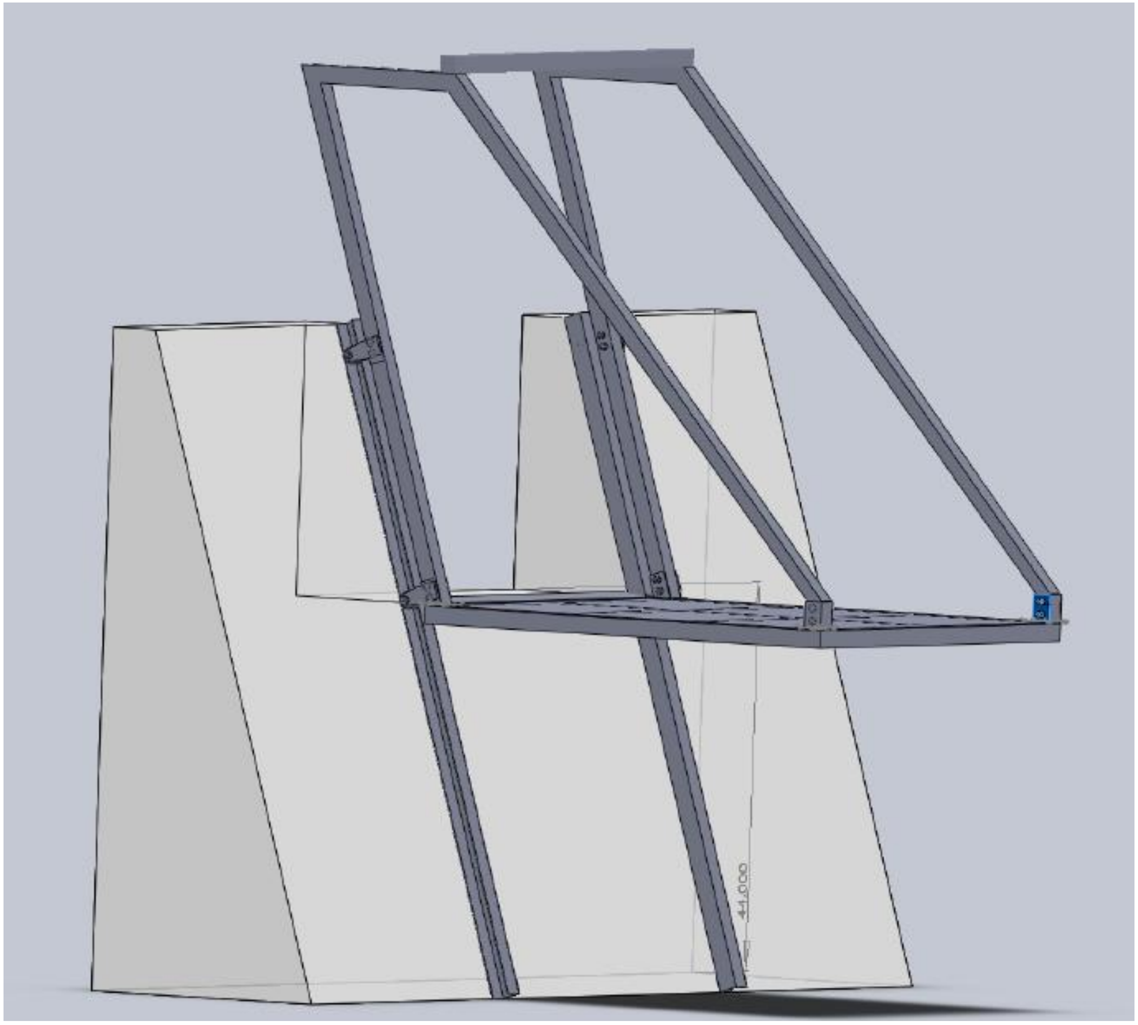

Fig. 18.10. Cruise Ship Evacuation Chair.

HYBRID VEHICLE RETROFIT: A FEASIBILITY STUDY AND DESIGN REVIEW

Designers: Robert Cole, Scott Fregeau, and Jason Ramsay
Supervising Professors: Dr. Don Dekker, Stephen Sundarrao
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INTRODUCTION

The goal of this study was to determine the feasibility of converting current gas automobiles into hybrids for energy savings.

SUMMARY OF IMPACT

This device has the potential for minimizing the energy lost by automobiles under braking.

TECHNICAL DESCRIPTION

The device from this project is different from the Regenerative Braking in electric and hybrid cars and the Kinetic Energy Recovery Systems (KERS) in Formula 1 cars, which are used to capture braking energy and store it in a usable form for powering the vehicle.

This device utilizes existing technology for the generative motor system:

The energy is captured through a generator/motor:

1. It is mounted in a cavity next to the front of the motor
2. There is an overflow reservoir where the radiator normally mounts
3. It is powered via a belt with a modified pulley

The batteries have a large storage capacity for proper cycling

A controller is used to manage:

1. The drag of the generator on the belt
2. The power supply to the motor
3. The generator/motor engagement
4. The amount of power to and from the batteries

The only component to be constructed from raw materials was the vehicle-specific mounting bracket.

The cost of the parts and materials was about $3400.

ROCKING WHEELCHAIR

Designers: Chris West, Juan Guartatanga, & Momo Kajiwara
Supervising Professors: Dr. Don Dekker, Stephen Sundarrao
Department of Mechanical Engineering
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INTRODUCTION

This design was inspired by a 15 year-old girl who was not able to breathe on her own due to a trachea disorder. In order for her to breathe without a ventilator, she needed to be in a constant rocking motion. There are not many wheelchairs currently available that can transport a person and rock at the same time. In addition, the user for this device tried a wheelchair that is on the market now, but it required a large force to rock and was not practical for her.

SUMMARY OF IMPACT

This device provided a viable rocker to assist this young woman's breathing.

TECHNICAL DESCRIPTION

This design begins by modifying a manual wheelchair. The cross braces were replaced by a four bar mechanism to provide the rocking motion. The range of the rocking motion is +20 degrees from the horizontal plane. The chair can be locked in any position within the full range of motion.

The device specifics include a frame to hold the four bar mechanism fabricated out of ¾" square steel tubing, hung between the two halves of the chair by a linkage system. The attachment of the links to the frame was with a self-locking 5/16 shoulder bolt. The four bar links were made out of 6061 Aluminum with PTFE (Polytetrafluoroethylene) plain bearing were pressed into the links for smooth movement. A seat was mounted to the top of the frame. See Fig. 18.11 for the final design.

The cost of the parts and materials was about $1000.

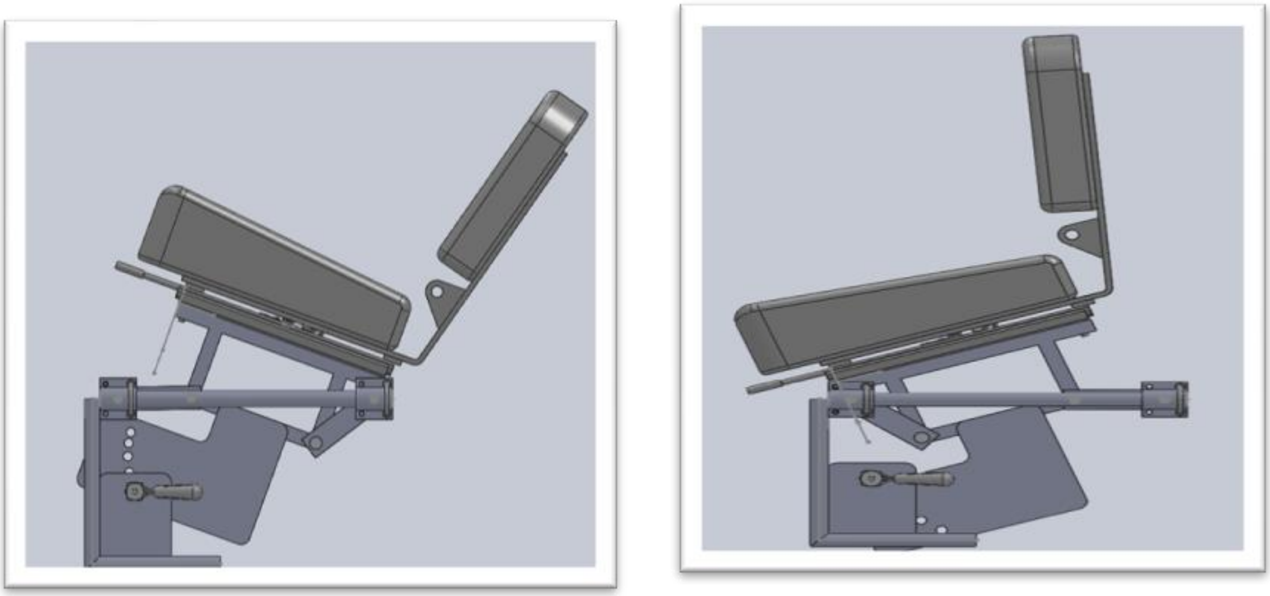

Fig. 18.11. The New Wheelchair Design: a) at -20° (left) and b) at +20° (right).

NON-INVASIVE LAPROSCOPIC SURGICAL DEVICE

Designers: James Doulgeris, Ben Nelson, Brandon Kruse, Grahm Roach, and Erin Moree
Supervising Professors: Dr. Don Dekker, Stephen Sundarrao
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INTRODUCTION

Laparoscopic, also known as abdominal, surgery is one of the most common surgical procedures in the United States. With over 4.7 million surgeries performed annually, it is imperative that this procedure continues to evolve and introduce new technologies as it becomes available. In the past, these procedures were generally performed by making a six to twelve inch incision down the center of the patients' body. The abdominal cavity was then exposed and the surgeon performed the surgery in this fashion. Recovery from these procedures could take anywhere from a few weeks to several months.

At present, there are two forms of laparoscopic surgery, the multiple incision and the single incision surgeries. The multiple incision surgery is the more common technique, where two small incisions, between 5 and 12 millimeters, are made in the abdomen. A third, slightly larger incision is made around the belly button to allow the insertion of a camera to provide visibility within the abdominal cavity. By making two incisions on opposite sides of the abdomen, surgeons are capable of using a technique known as triangulation. Because of triangulation, these surgeries can be finished in about 1.5 hours and only require a week and a half for recovery.

The newest version of laparoscopic surgery, which was first performed in 2007, is known as single incision surgery. A new instrument known as the Single Incision Laparoscopic Surgery, (SILS) port allows the insertion of all cutting tools from this one port. This type of surgery provides surgeons with a minimally invasive surgery that leaves only one hard to notice scar. However, without triangulation, the surgery also takes at least 4.5 hours, a three hour difference between the multiple incision surgeries.

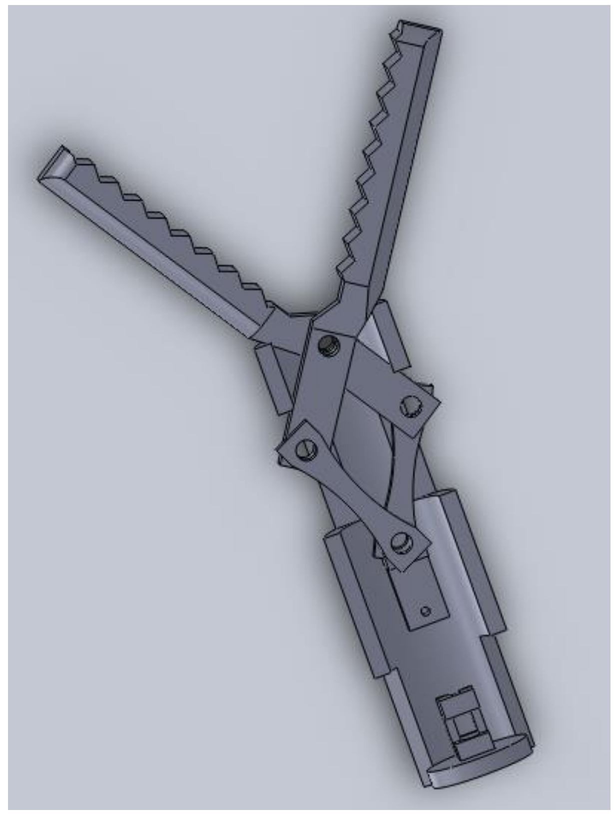

Fig. 18.12. An Internal View of the External Head Including Part of the Delivery Holster.

SUMMARY OF IMPACT

There is an obvious need for improvements to both the multiple and single incision surgeries. As with most medical procedures, the introduction of a scarless surgery would be preferred; however, doctors would be happy with modifications to improve the single incision surgery. During single incision surgeries and the use of the SILS port, the surgeon has limited visibility and without the use of triangulation, the surgery is not only longer but causes harm to the patients' abdominal wall. This device uses triangulation to enhance surgeon visibility and reduce patient scarring.

TECHNICAL DESCRIPTION

The problem of triangulation is resolved by an expanding detachable cutting head tool. This tool is the best representation of a non-invasive surgical tool that, when used in conjunction with the SILS port, provides the surgeon with the triangulation the SILS port prevented. Additionally, two versions of a cable free tool were created: Design 1 is the external cable detachable cutting head tool, and Design 2 which is the cable-free detachable cutting head tool. Both designs were created to closely resemble the current laparoscopic surgical tools on the market today.

Design 1, the external cable, uses a cable system to lock the cutting head to the rod as well as actuate the cutting head when it is in the body. As seen in Fig. 18.12, there is one cable casing running from the handle to the cutting head. This cable casing contains two cables, one used for actuating the cutting head and the other to work the cam used to lock the cutting head onto the rod. When in use, the beveled tip on the handle/rod is used to create a small puncture in the abdomen of the patient. The rod is then slowly inserted further into the abdomen, having the progress viewed on the camera on the SILS port. This tool operates very similarly to those laparoscopic tools in use today. The major benefit of this external cable model is the fact that the rod shaft has been reduced from a 5 millimeters diameter to that of 1.6 millimeters, the same as an 18 gauge needle. With the smaller shaft, no incisions are needed to provide entrance for the tool into the abdomen. This means that no scar will be made by the insertion of the new rod through the abdominal wall.

Design 2, the cable free model, when assembled looks almost exactly the same as the tools being used today. As with the external cable design, the rod diameter is only 1.6 millimeters, again ensuring that no incision must be made to allow the insertion of the rod. However, instead of being actuated by a cable, an inner shaft is used to control the head. As seen in Fig. 18.13, there are two shafts that make up the rod portion, an inner rod measuring 1.2 millimeters and the outer rod measuring 1.6 millimeters in diameter. Each rod has a few notches carved in it; the outer shaft is used to lock the rod to the cutting head while the other actuates the head.

Both designs provide a laparoscopic surgical tool that articulates in the same manner as those on the market today with the added advantage of moving to a single incision surgery with triangulation. Though each tool is slightly more expensive than the current model, because our tools are disassembled, the handle/rod can be re-sterilized and used for multiple surgeries.

The cost of the parts and materials was about $1500.

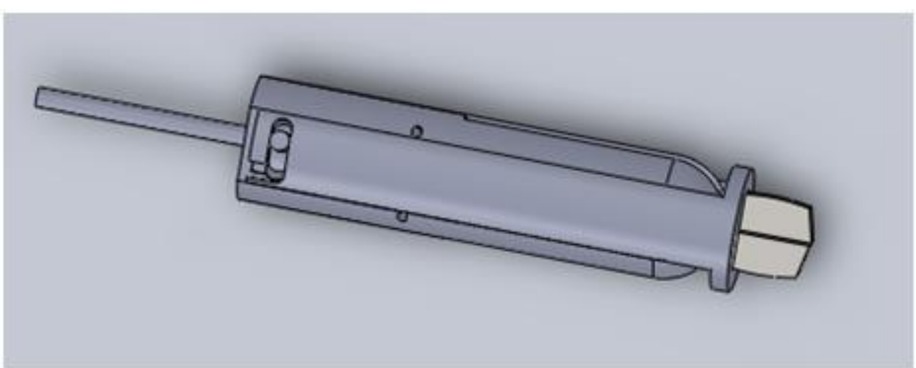

Fig. 18.13. External View of the Cable Free Model Cutting Head.

UNIPORT: SINGLE-INCISION SURGICAL PORT

Designers: Kent Wheeler, Danny Segal, and Asad Ahmad
Supervising Professors: Dr. Don Dekker, Stephen Sundarrao
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INTRODUCTION

For many years, surgeons have been exploring minimally invasive techniques to decrease the complications of traditional abdominal hysterectomy. Although two-thirds of all hysterectomies in the United States are performed through a large abdominal incision, a minimally invasive hysterectomy provides a faster recovery, less scarring, less pain, a quicker return to normal activities, and fewer complications. Most minimally invasive gynecologic surgeons view conventional laparoscopic hysterectomy as a great option for patients. Notably, the conventional procedure still requires several small incisions and ports, each of which increases the potential of complications from bleeding, nerve injuries, or port-site hernias and hematomas. The scarring due to the multiple incisions in turn diminishes the cosmetic outcome desired by most women.

SUMMARY OF IMPACT

The next frontier and the next logical step in the development of minimally invasive surgery have recently been realized. This new laparoscopic approach is most commonly referred to as single-incision laparoscopy or laparoendoscopic single-site surgery (LESS). These procedures involve a single umbilical incision and the use of one specialized port through which three to four laparoscopic instruments can be passed. The most significant benefits to patients are the minimization of scarring and complications. Often the incision can be completely hidden within the natural creases of the umbilicus. This is most likely the most attractive benefit to women qualified for single-incision laparoscopy. However the further reduction of potential morbidity associated with the use of multiple laparoscopic trocars may be an even more important advantage to patients.

TECHNICAL DESCRIPTION

The goal was to replicate the triangulation that a doctor is accustomed to with traditional laparoscopic surgery, which lead to designing a new multi-channel port.

The procedure is still so difficult to perform that surgeons are reluctant to offer the option to any but the best possible candidates. The SILS™ port design that is currently being used at Tampa General Hospital is a great device that makes the benefits of single-incision laparoscopy available to patients. But the design of the SILS™ has its drawbacks as it is a first generation product. The SILS™ port is a solid form with holes from top to bottom. Being a solid form, whenever one instrument is manipulated the entire device is moved – resisting the surgeon's movements and interfering with the manipulation of other tools in the port.

The design team designed the UniPort. It addresses many issues that the original SILS™ port and other mechanisms of single incision laparoscopy do not address. Once fully assembled, the UniPort has a larger port and tool aperture maximizing the 30mm incision needed for the single incision procedure. Relocating the tool insertion position to the outside of the incision area allows for increased tool motion and a reduction of interference between the tools being utilized. The UniPort's design features appreciably reduce the high level of stress the SILS™ port produces. Because of the limited range of motion and instrument interference, the surgeon is often forced to bend the port site for a SILS™ port to get better entry angles and easer visibility. To address this disadvantage, the UniPort's tool pivoting point is located above the incision sight and has a thinner membrane for the tools to move within the incision. In conclusion, the UniPort eliminates some of the issues with the range of motion and the instrument interference thus the UniPort does not need to be manipulated to better suit the surgeon. The goal for the UniPort is to become an all-inclusive product that is the pinnacle of single incision laparoscopic procedures. Fig. 18.14 shows the design.

The cost of the parts and materials was about $550.

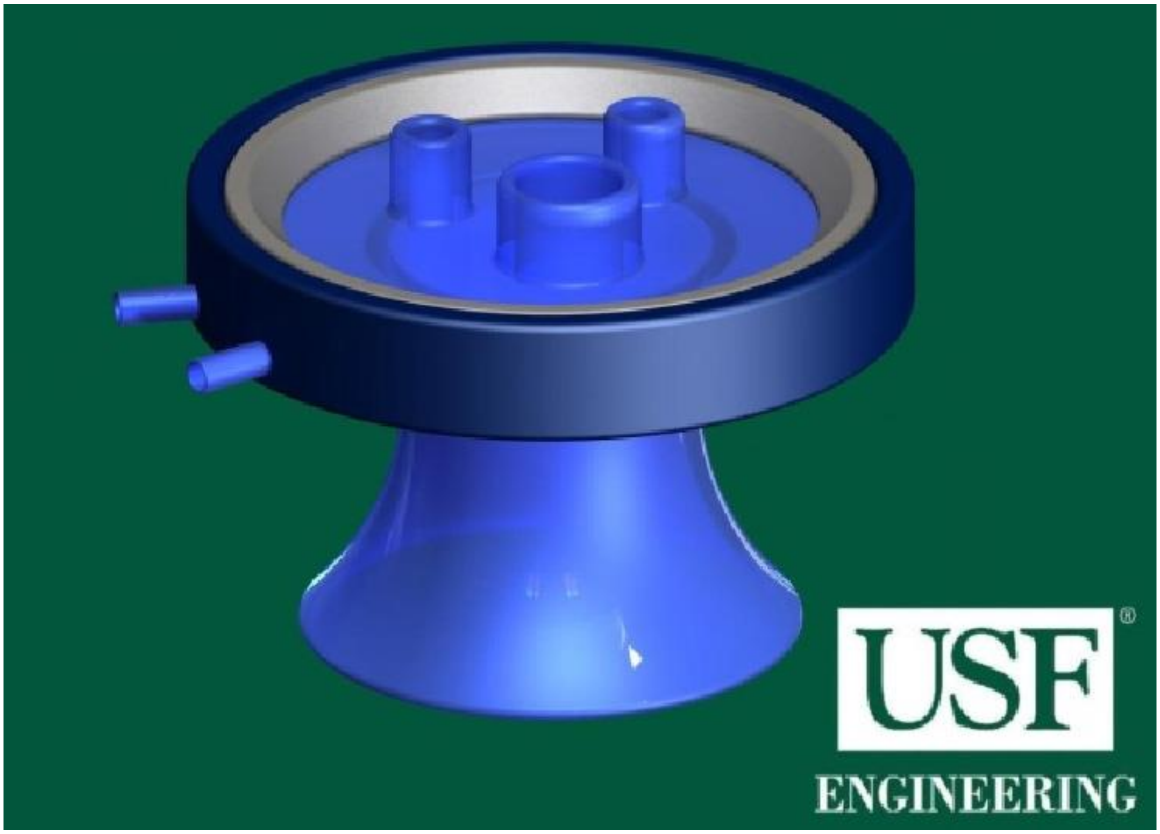

Fig. 18.14. Computer Modeled Picture of the UniPort.

THE DESIGN OF A DOOR OPENING MECHANISM FOR POWERED WHEELCHAIRS

Designers: Matthew Conrad, Steve Gonzalez, Kyle Johns and Patrick Vitello
Supervising Professor: Dr. Don Dekker, Stephen Sundarrao
Department of Mechanical Engineering
University of South Florida
Tampa, Florida 33620-5350

INTRODUCTION

Wheelchair users are often faced with door entry situations that do not comply with the ADA regulations, these standards can provide information for designing a proof of concept door opening mechanism. The standards of interest within these guidelines are: a 5 pound force maximum for opening doors, a 32 inch minimum door entrance width, and a 24 inch minimum maneuvering clearance on the pull side of a hinged door.

SUMMARY OF IMPACT

The prototype design proved to be a feasible concept for a power wheelchair mount door opening system. The prototype demonstrates the range, motion, and power required to accomplish such a task. This device will allow users of power wheelchairs to open doors and pass through the doors without the assistance of friends.

TECHNICAL DESCRIPTION

The Overall Assembly is composed of five different sub-assemblies. Each Assembly functions to solve an issue involved with the process of mechanically opening a door. The Utility Shaft serves as a base for mounting these sub-assemblies. The lead screw assembly solves the issue of positioning the system on the door knob while also providing a means of opening the door once the knob of the handle has been turned. Once the lead screw sub-assembly extends out to the door, the gripper assembly is responsible for attaching to and detaching from the door knob. The gripper assembly also applies torque to the door knob in order to solve the issue of turning the handle. Once the handle has been turned by the gripper assembly and the door has been opened by the lead screw assembly, the rail assembly is used to hold the door open while the wheelchair and the system pass through the door. The advantage to splitting up the several functions of opening the door into different sub-assemblies is that each assembly is specialized and can be designed for that single function. Fig. 18.15 shows the design.

The cost of the parts and materials was about $3100.

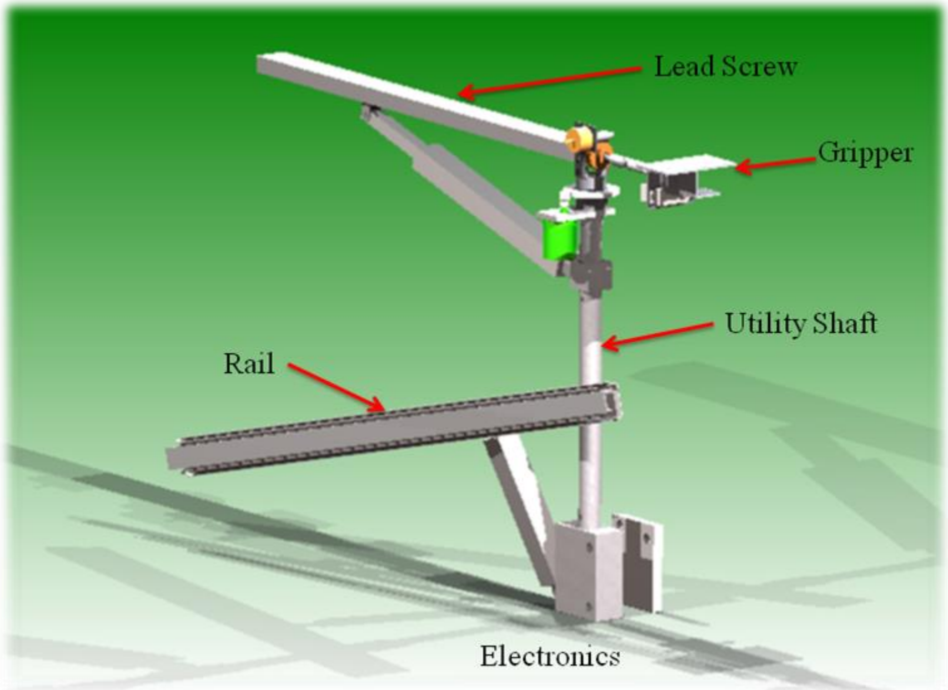

Fig.18.15. Overall Assembly of Prototype.

PORTABLE DOOR OPENER

Designers: Stephen Helms, Lauren Kintner, Jennifer Gilbert, and David Leppert
Supervising Professors: Dr. Don Dekker, Stephen Sundarrao
Department of Mechanical Engineering
University of South Florida
Tampa, Florida 33620-5350

INTRODUCTION

In most office or school buildings, the front doors and main entrance doors have handicap access, but many other doors do not. These doors also usually have some sort of damper system to close the door. This closing action presents a problem for wheelchair users trying to go through the door. This device can open these doors without heavy, bulky machinery being attached to the wheelchair, provided the user has enough upper body strength and can partially open one of these doors.

SUMMARY OF IMPACT

This device allows a person in a wheelchair to open heavy doors and go through the door without help. It is lightweight and fits most doors. A person in a powered or manual wheelchair can use it. Little power is needed from the power source of an electric wheel chair with a 12 volt power supply or a portable battery in the case of a manual wheelchair. This design has proven successful in implementing a portable door opener for a door with a damper system.

TECHNICAL DESCRIPTION

This device is constructed of aluminum to reduce the weight of the mechanism. A bar clamp is used to hold the mechanism in place while the door is extending and retracting. A lead screw is used to open and close the scissor mechanism controlled by a two-way toggle switch. A controller for the lead screw is connected to the powered wheel chair's battery. It can also be connected to a portable 12 volt battery so that it can be used with a manual wheel chair. The lead screw is supported by a wooden support that is also used as part of the door support. A rubber grip pad is installed at the other end of the scissor mechanism to hold the device to the door without slipping while it is opening and closing. Figs. 18.16 and 18.17 show the device.

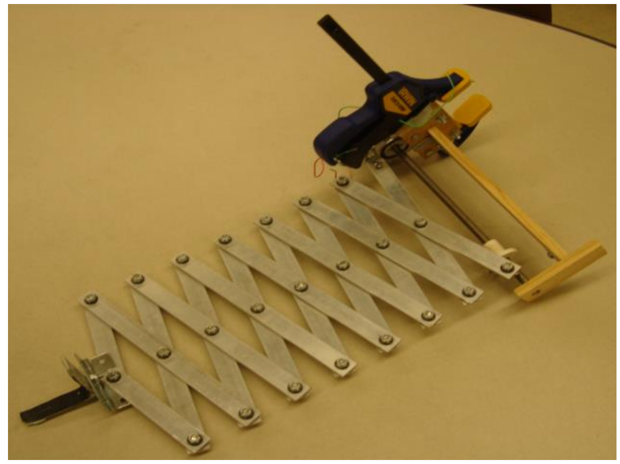

Fig. 18.16. Photo of Completed Assembly: Extended position.

The cost of the parts and materials was about $590.

Fig. 18.17. Photo of Completed Assembly Clamped to Door Frame.

MANUAL WHEELCHAIR DOOR ASSIST DEVICE

Designers: Matt Causin, Matt Kennedy, Paul Mitzlaff, and Kirk Van Portfliet
Supervising Professors: Dr. Don Dekker, Stephen Sundarrao
Department of Mechanical Engineering
University of South Florida
Tampa, Florida 33620-5350

INTRODUCTION

The aim of this device is to assist those individuals in a manual wheelchair to pull open any sort of door they would encounter in everyday life. The intended audience is those persons who are capable of normal upper body movement and grip strength. The difficultly comes once the door handle has been grasped and the wheelchair user attempts to back away while holding the door with one hand and maneuvering their wheelchair with the other hand. This device was developed to allow the user to stop several feet in front of the door, apply their brakes, and reach out with the device to grasp and open the door. This allows them to be out of the swinging area of the door while it opens therefore making it much easier for them to navigate through the door. The device consists of a clamping mechanism at one end and a ratcheting handle at the other end of a 3 ½ foot half inch tube. This design will be very useful to anyone in a manual wheelchair that may encounter any type of common door knob in their daily lives and feel comfortable in that fact that they will be able to open it easily.

SUMMARY OF IMPACT

There is a need for a device which can open most types of doors while sitting in a manual wheelchair. One of the challenges, which people in wheelchairs encounter, is trying to pull open a door. The manual wheelchair tends to roll forward when one pulls backwards. This design will help manual wheelchair users overcome this obstacle. The door opening device will allow users to open a door while staying outside the range of motion of the door. They can then move through the doorway.

TECHNICAL DESCRIPTION

The device can be operated without any motors or batteries to reduce cost, save weight and increase reliability. The device is designed to be collapsible, allow the user to approach a door straight on and stop at a distance of 4 feet from the door, require a gripping force of more than 5 to 8 pounds to actuate most doors, not require the user to lean forward more than 12 inches in order to grip the door handle, be weather resistant and durable, and be aesthetically pleasing. The device should also be able to grip all round door handles, and also operate a variety of lever type door handles.

The design provides a vertical clamping force between two points with a minimum distance of 3 inches between its jaws. This device allows a person to wheel straight up to the door rather than from the side of the door. It is completely made from weather resistant materials. This device has a universal door handle gripper at one end of a 40 inch aluminum tube and a ratcheting handle at the other end. A stainless steel cable connects the gripper to the ratcheting handle after being directed through two holes and around a pulley as shown in Fig. 18.18.

The cost of the parts and materials was about $1700.

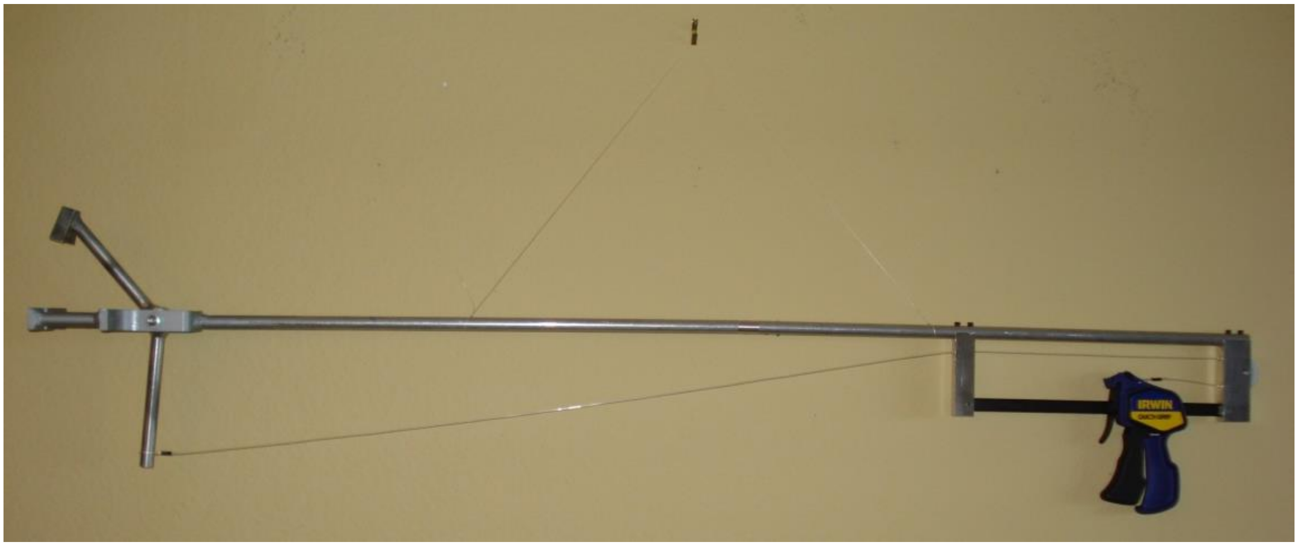

Fig. 18.18. Picture of Prototype.

WHEELCHAIR CLEANER

Designers: Jose Cruz, Richard Scott, and Johanlis Clintron
Supervising Professors: Dr. Don Dekker, Stephen Sundarrao
Department of Mechanical Engineering
University of South Florida
Tampa, Florida 33620-5350

INTRODUCTION

The goal of this project is to design a wheelchair cleaner that will simplify the task of cleaning one's wheelchair.

SUMMARY OF IMPACT

An issue with wheelchairs is the user's ability to clean the wheelchair properly without reliance on another individual for assistance. Innovative ideas that remove the need of a second person to help the wheelchair user will reaffirm their sense of independence, as well as provide simple solutions to make everyday life easier and more convenient. A simple method to easily clean an individual's wheelchair will allow them the freedom and independence to keep a healthy lifestyle. Wheelchair users will find it more convenient to engage in outdoor activities where the wheelchair will collect dirt and other debris from being outdoors. Users can go indoors without the worry of tracking in dirt and unwanted particles.

TECHNICAL DESCRIPTION

The concept of the design for this wheelchair cleaner was focused primarily on cleaning the wheels. This system uses solely the power of the wheelchair to activate the mechanism. The only outside source of power is the external water supply pumping water through the system. Additional advances could be made to keep a supply of water in a tank for a manual pump. Fig. 18.19 shows the design.

The base of the wheelchair cleaner acts as a support for the wheelchair and the user to comfortably set themselves upon the rollers for cleaning. At the location of each hole, each set of rollers for both the front and rear wheels will be placed to allow the wheel to contact the rollers. The wheel will only contact the rollers during the time of operation. The lengths of the rollers and their corresponding holes on the base will be dimensioned to allow the rear wheels to pass the rollers designated for the front wheels. This will allow for a smoother transition of the user onto the rollers and decrease any unbalancing that may occur when disengaging from the cleaner.

The design of the wheelchair cleaner, in its prototype state, can be implemented in many ways. It would be ideal as nursing homes or other locations where there are many wheelchair users that would need an effective machine to assist in keeping their wheelchairs clean. Daily activities and especially recreational activities will become more prevalent in the lives of individuals restricted to wheelchairs, as the burden of cleaning and maintaining the chair will become extremely quick and simple, and will no longer impede on the individual's lifestyle.

The cost of the parts and materials was about $900.

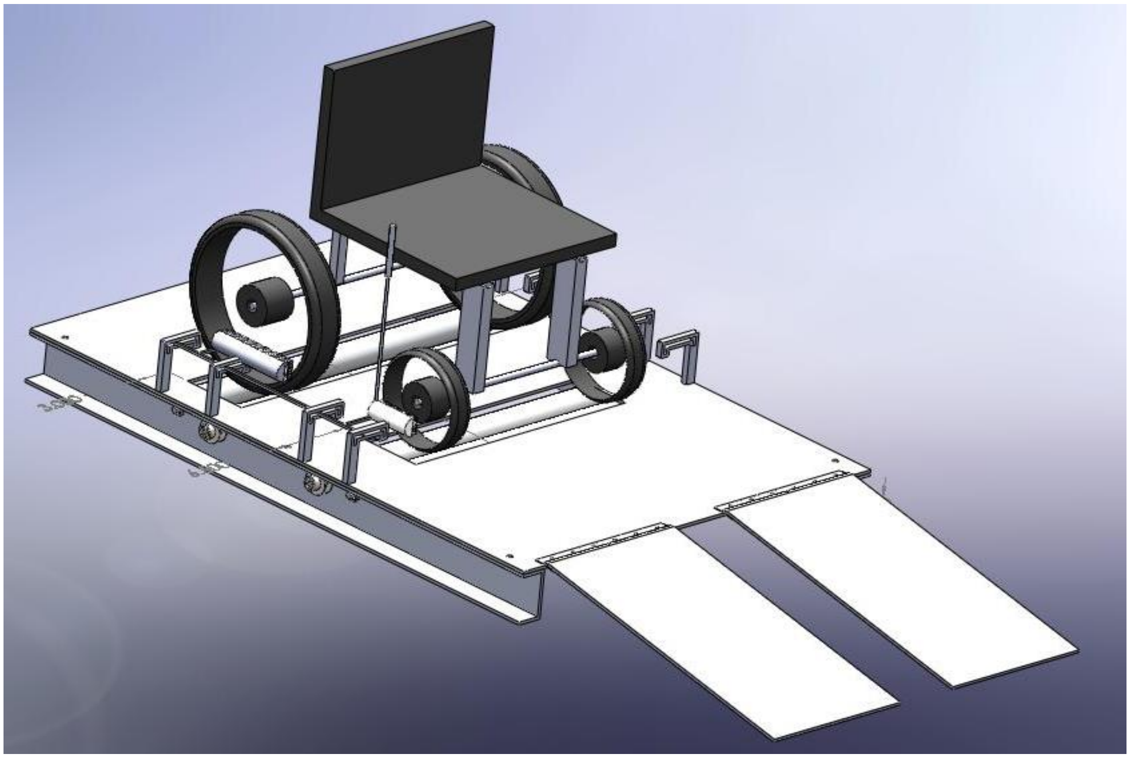

Fig. 18.19. Conceptual View of the Wheelchair Cleaner.

PORTABLE DEPLOYABLE RAMP FOR ATTACHMENT TO A POWERED WHEELCHAIR

Designers: Trenton Jawors, William Krichman, and Brian Scheirer
Supervising Professors: Dr. Don Dekker, Stephen Sundarrao
Department of Mechanical Engineering
University of South Florida
Tampa, Florida 33620-5350

INTRODUCTION

The problem was to design a mobile platform that can deploy from a power wheelchair to be utilized by the user to overcome four to five inch curbs.

SUMMARY OF IMPACT

There are many locations where wheelchair ramps are unavailable and the users cannot proceed to their destination without trying to surmount a curb or other obstacle. This ramp will allow the wheelchair user to have the ability to go places that are currently inaccessible.

TECHNICAL DESCRIPTION

The ramp, the RM500, consists of four major components: the ramp, geared motor, fork arm, and controller. Most of these components are commercially available sizes and specs. Since the design has such few components and utilizes aluminum for the main body of the unit; it is also lightweight. The main component is the ramp which is composed of six pieces. There are two U-channels that act as drive paths for the wheels of the wheelchair. They are also nearly stock sized, with the exception of having some of the sides of the channel removed. This means it requires very little machining to get to the final size. These two channels are held together by three hollow rectangular tube bars. The final component serves multiple purposes; it has a slot that allows the fork to lower and raise the ramp and it also helps keep the ramp rigid. All six pieces are welded together.

The overall length of 36 inches keeps the angle of incline below eight degrees. A finite element analysis in SolidWorks, using the Von Mises criteria, indicates that the ramp can support 500lb static loads. The total weight is 20.82lbs and not expected to slow the wheelchair while towing the ramp on the back. The overall width is designed not to exceed the width of the powered wheelchair, as to not interfere with the user's ability to navigate through narrow walkways.

The ramp is lowered and raised using a fork connected to the driveshaft. The fork is composed of aluminum and the shaft is made out of steel. The shaft features a slotted and key design for easy assembly as well as safe operation. The fork design was inspired by commercially available forklifts and how they lift palettes. However, the RM500 only has one fork located in the center of the wheelchair and lifts the ramp from its center. This was meant to aid in use, because lining up two forks required much more precision from the operator. Fig. 18.20 shows the design.

The cost of the parts and materials was about $880.

Fig. 18.20. Ramp Master 500 CAD (top) and Prototype Attached to a Wheelchair (bottom).

CURB TACKLER: WHEELCHAIR RAMP

Designers: John A. Bruegger, Carlos E. Carballo, James R. Ritter III, and Nick J. Vukelja
Supervising Professors: Dr. Don Dekker, Stephen Sundarrao
Department of Mechanical Engineering
University of South Florida
Tampa, Florida 33620-5350

INTRODUCTION

This project focuses in the design of a mechanical ramp that allows a power, rear wheel drive wheelchair, to overcome a curb of at least 5 inches tall. Other basic design requirements that were taken into consideration were: the width of the wheelchair should not be altered, access to the wheelchair should not be impeded and lastly, the length of the ramp should allow an angle of attack not larger than 10 degrees.

SUMMARY OF IMPACT

The ramp will enable the user to overcome curbs, steps, and other obstacles at least four inches in height.

TECHNICAL DESCRIPTION

This particular design consists of two eight-inch wide ramps for the wheels to travel on. They are hinged at the middle with an off center pin for strength and to allow for clearance between the frame rails of the ramp when it's closed. This clearance was essential to the prototype to allow room for the connecting links to be screwed to the frame rails being that it is initially going to be made out of wood.

With the connecting links neatly folded between the ramp's faces all of the connecting link pins will align within the clearance we created from the offset pin. As you can see, we initially over designed the hinge in the middle of the ramp face. After running strength equations we determined the hinge could be greatly reduced.

First Prototype: Although rough in design, the first prototype was beneficial. After deciding on one particular design concept we proceeded to create the first prototype. It was difficult to determine if it was even possible to design the hinges to retain the proper axis of rotation to enable rotation about the vertical axis. It was also difficult to determine an acceptable range of motion without contacting any other surfaces. Modeling the CT1 design and physically building the small scale model provided additional ideas on how to improve the joints and reduce the overall dimensions of the future device. For example, instead of the joints being mounted on the surface of the connecting links with PVC, which were easily dislodged and bulky, we decided to incorporate the joints into the links themselves. This design allowed for greater control, tighter tolerances, and prevents the occurrence of pins slipping out. It also makes the pins concentric with reference to one another in the center of the device, ensuring the same rotation in both directions, which CT-1 did not exhibit.

Second Prototype: The new pin design, within the connecting links, greatly reduced the bulky appearance of CT-2 and reduced the dimensions, however the materials used for the model still limited certain design aspects. Fig. 18.21 shows the CT-2 design.

The cost of the parts and materials was about $1500.

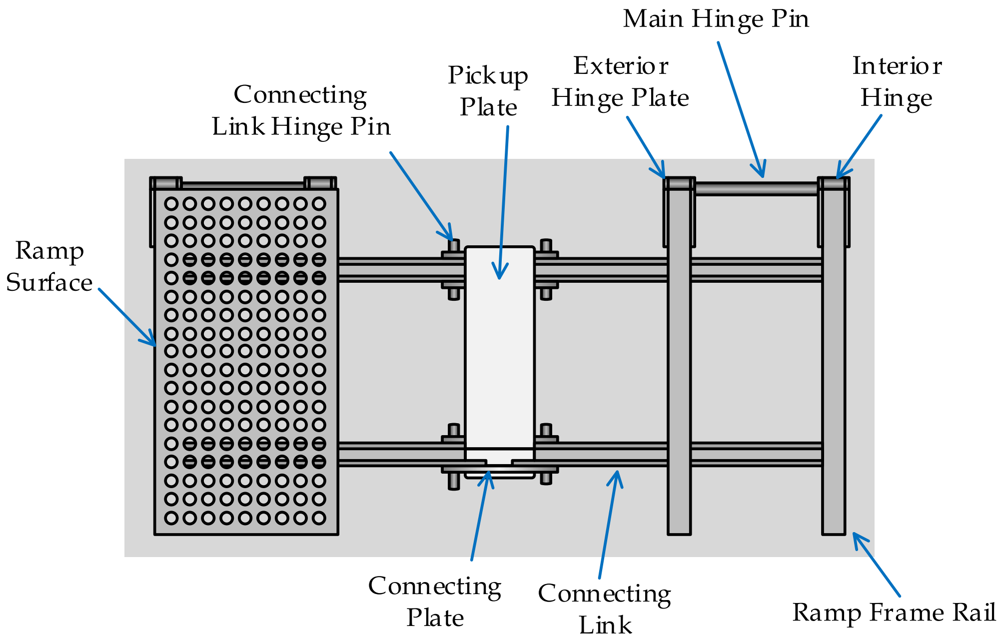

Fig. 18.21. Drawing of the CT-2 Ramp.

DEPLOYABLE WHEELCHAIR RAMP

Designers: Eric Tridas, Hamad Alosaimi, Kenji Music, and Victor A. Macias
Supervising Professors: Dr. Don Dekker, Stephen Sundarrao
Department of Mechanical Engineering
University of South Florida
Tampa, Florida 33620-5350

INTRODUCTION

The objective is to build a ramp that can be deployed from a power wheelchair to be utilized by the user to overcome four to six inch curbs. This design consists of motorized ramps attached to a shaft with linear bearings to ease the rotation of the shafts. The shafts, with the ramps attached, will be rotated by heavy duty DC motors with gears, sprockets, and chains. This overall design is effective and simple for its task with the capability of adapting to different wheelchairs. In addition, it will be user friendly since it will be easy to maintain.

SUMMARY OF IMPACT

There are many locations where wheelchair ramps are unavailable and the users cannot proceed to their destination without trying to surmount a curb or other obstacle. This ramp will allow the wheelchair user to have the ability to go places that are currently inaccessible.

TECHNICAL DESCRIPTION

The ultimate design chosen was the variable length ramp arm design. There are three main parts of the system: the ramp/joint assembly, the member/linear bearing assembly, and the drive train system. The ramp/joint assembly consisted of the ramps and the joint that controls the motion of the ramps. The ramp required two degrees of freedom, one to allow for the chair to ride over it and the other to fold the ramps up. This folding motion is controlled by a DC motor. The member/bearing assembly consisted of an aluminum rod and a linear bearing. This bearing would be mounted on a plate and connected to the final component of the system, the drive train. The drive train consisted of a DC motor and several gearing and chain components.

This design employed beams that have the ramps attached to their ends. These members are supported by linear bearings mounted to a drive train on each side of the wheelchair. The motors powering the drive train allow the members to be moved to any angular position by rotating the linear bearings they were mounted to. When in use, the ramps would be lowered into position onto the curb. As the wheelchair moves forward friction prevents the ramps from sliding further so it remains in position. The members attached to the ramps are able to slide freely, allowing for the length between the pivot point on the gearbox and the end supporting the ramps to change in length. An elastic band is used to keep the members fully extended with respect to the linear bearings. This prevents unwanted sliding motion as the members are rotated.

As the wheelchair rides over the ramps the motors are deactivated and the angular position of these members changes due to the linear motion of the wheelchair. This motion allows the ramps to remain attached to the wheelchair yet still allow for the wheelchair to ride over the ramps. After the wheelchair finishes climbing the ramp the ramps are rotated 90°, leaving their final position perpendicular to the ground allowing for space conservation. When this is complete the members rotate until they too are perpendicular to the ground. The motors used to control the angular position of the members as well as the motors to control the tilt of the ramps are controlled by momentary switches.

Fig. 18.22 shows the device in action.

The cost of the parts and materials was about $1000.

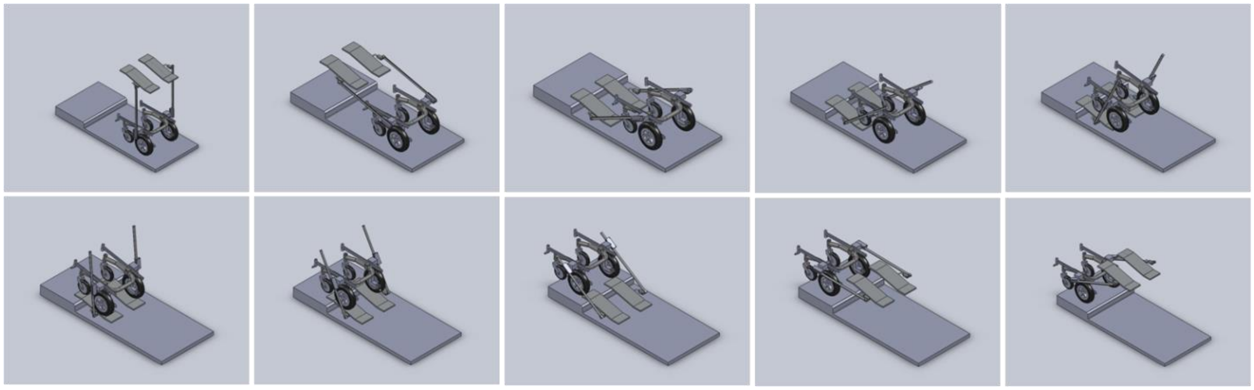

Fig. 18.22. Function of the Proposed Ramp System.

THE DELEVATOR: BOAT WHEELCHAIR LIFT

Designers: Michael Bair, Adriana Chacon, Mario Kikic, and Evgeny Shakurov
Supervising Professors: Dr. Don Dekker, Stephen Sundarrao
Department of Mechanical Engineering
University of South Florida
Tampa, Florida 33620-5350

INTRODUCTION

This team went to the Tampa Florida Aquarium to look at the current design of the ramp being used to board the Ecotour boat. The currently used device operates and completes the task of enabling people to get on the boat however it does not allow persons in wheelchairs to get on the boat because the current ramp is not wheelchair accessible (it is very steep and narrow).

The purpose of this project is to design a device that would allow wheelchair users and other mobility impaired individuals to board a tour boat at the Florida Aquarium. This design would be an improvement over an existing solution, which does not accommodate people with mobility impairments. The design would provide a stable mechanism and a familiar environment for the users. Moreover, safety features, environmental corrosion, and other key elements such as material and component selection were addressed.

SUMMARY OF IMPACT

This device provides access to a tour boat for persons with disabilities. This design solution employs a familiar system which is essentially an elevator that lowers the person down to the level of the boat and allows them to drive onto the boat with ample maneuvering space.

TECHNICAL DESCRIPTION

The design has a platform within an enclosed space that can go up and down with a winch through a railing system attached to the dock. This enclosed space is composed of hand rails to provide safety and comfort to the user. The platform would sit perpendicular to the dock until the mechanism is needed. When functioning, the platform would rotate so that it levels with the dock's surface and then descends until it reaches the boat. Rising motion would occur in a similar way. Fig. 18.23 shows the elevator and winch systems. Fig. 18.24 shows the device.

The cost of the parts and materials was about $5000.

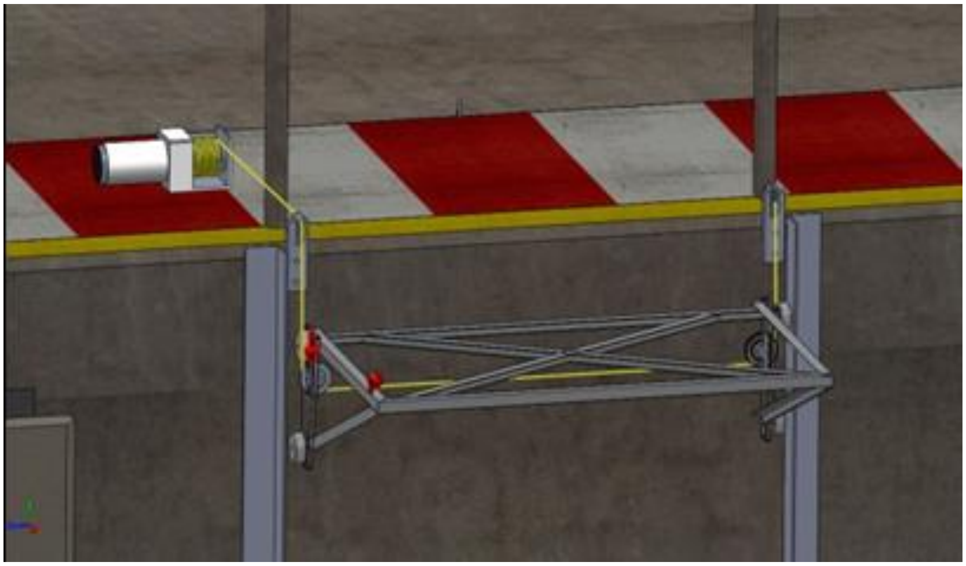

Fig. 18.23. Winch and Elevator Mechanisms.

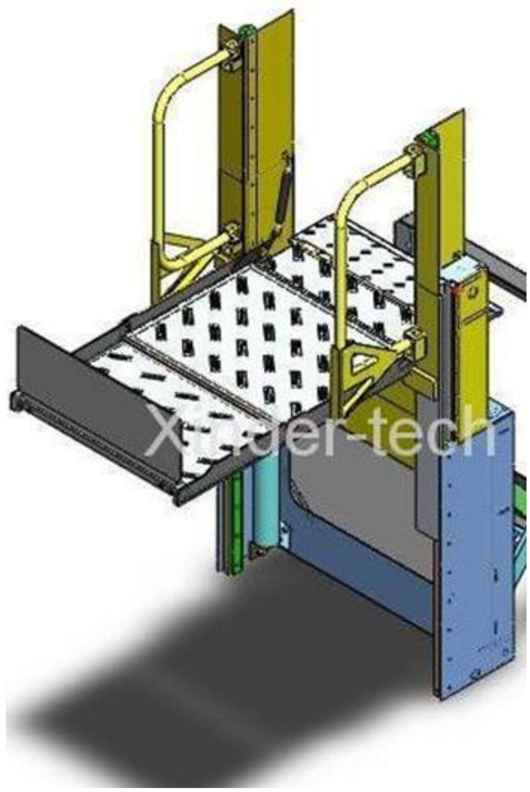

Fig. 18.24. The Concept of a Delevator Mechanism.

ECOTOUR BOAT ACCESS FOR PASSENGERS WITH DISABILITIES

Designers: Mycah Jewell, Jantzen Maynard, Jeremy Reedy, and Shane Worsham
Supervising Professors: Dr. Don Dekker, Stephen Sundarrao
Department of Mechanical Engineering
University of South Florida
Tampa, Florida 33620-5350

INTRODUCTION

The Tampa Aquarium has gone to great lengths to make their entire facility accessible to people with disabilities. However, passengers must navigate metal stairs in order to board the aquarium's tour boat. A solution to the limited access to the Ecotour Boat would allow people, who have limited mobility, to explore the environment of Tampa Bay on the boat (See Fig. 18.25.).

A site visit to the Tampa Aquarium's tour boat clarified the accessibility issues of the tour boat. Several constraints were noted during the site visit such as space confinements, range of motion, and stability of the device. The design should allow wheelchair users to safely transfer from the dock to the boat deck or vice versa without having to disembark from the wheelchair. It also needs to have a range of motion that can work with varying tide levels. All of these issues have been addressed with the chosen design.

Fig. 18.25. Ecotour Boat Access.

SUMMARY OF IMPACT

This device provides access to a tour boat for persons with disabilities. This design solution allows a person to drive a wheelchair onto the boat with ample maneuvering space.

TECHNICAL DESCRIPTION

This design uses rotary motion to accomplish the transfer of the passenger from the dock to the boat desk. The device uses a single degree of freedom to rotate the passenger platform from the loading position to the unloading position. The device is designed for long life and a high lifting capacity. Cost of the device and safety of the passenger were also key considerations in the design. Fig. 18.26 shows the device.

The design is simple as it uses a single motion to lift and extend. The passenger is transferred to or from the boat in one single fluid motion. The transfer time is less than one minute. This time includes loading the passenger, transferring to the boat, and unloading the passenger. The device is also easy to use. The passenger rolls on to the platform and the ramp closes behind. Once the passenger is on board, the device moves to the desired location, the opposing ramp is lowered, and the wheelchair can roll off onto the boat deck. A single controller will be implemented to operate the device.

In order to keep the platform stable during operation, a gearing system was added to the lifting arms that extend out to the basket. The gearing system keeps the basket floor parallel to the ground at all times which ensures that the basket will not tilt under any loading condition. When the model was tested, it was shown that if a person was located offset from the center of the basket, the basket could tilt as much as fifteen degrees. This was a major hazard that needed to be resolved and thus the gear system was implemented.

The device will be rated at a 600 pound capacity. With the safety factor load of 900 pounds, the device should be able to last for approximately 100 million cycles. This is anticipated to be vastly more cycles than the device will ever see. Aluminum was used throughout since it is lightweight and corrosion resistant. The sprockets are stainless steel and the pillow block bearings, that support the shafts, are a plastic material with excellent corrosion resistance.

The motor is a 5 hp unit. It is geared down approximately 320:1 in order to get the output torque needed to operate the device. The drive train also includes a worm drive gearbox. This was added to keep the motion of the basket controlled at all times. If power is lost, the basket will stop where it is and not be dropped.

The cost of the parts and materials was about $6000.

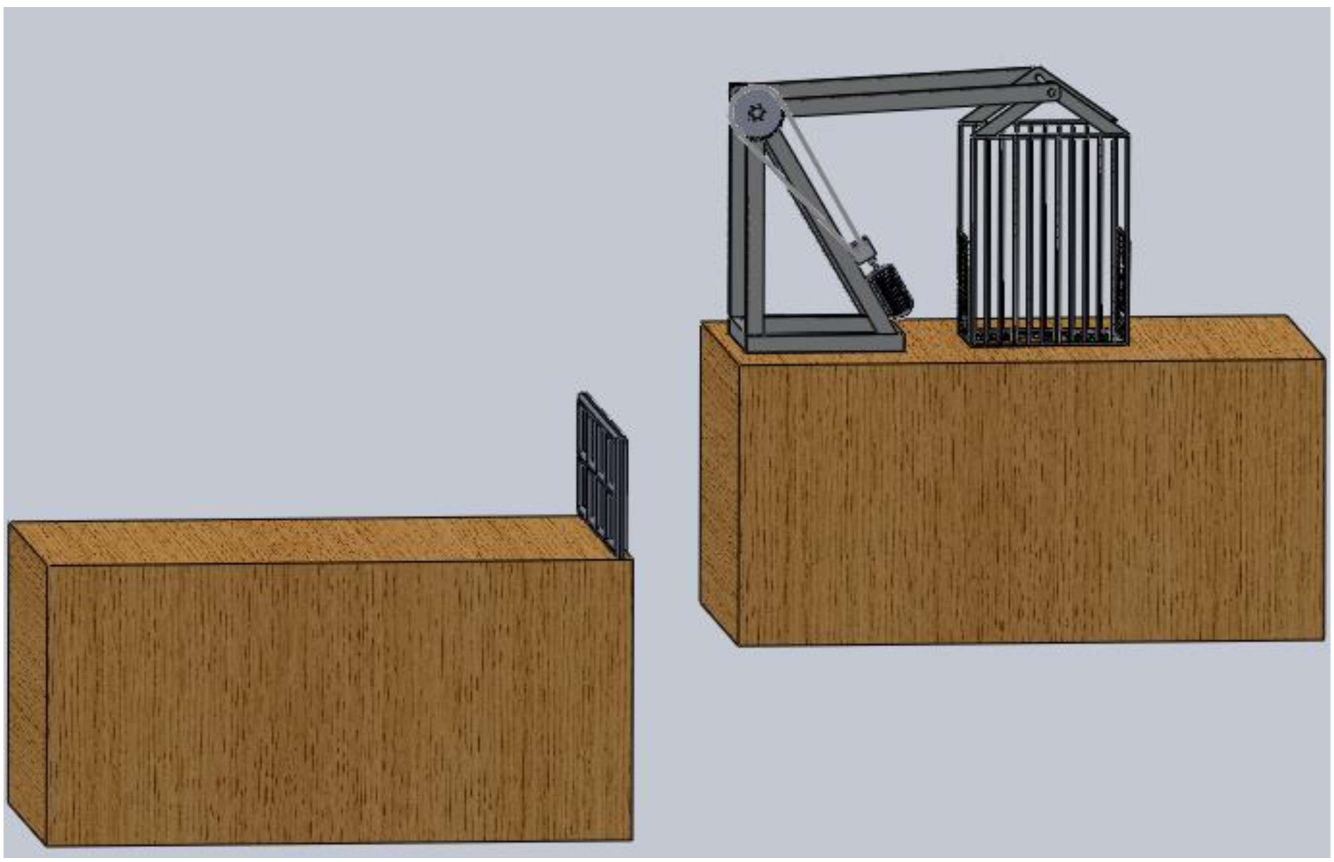

Fig. 18.26. Rotary Lifting system for the Ecotour Boat.

SUNBRELLA: UMBRELLA HOLDER FOR MANUAL WHEELCHAIR

Designers: Ivan Espinosa, Christopher Jones, Kevin Lotero, Jeremy Stano and Lenny Valles
Supervising Professors: Dr. Don Dekker, Stephen Sundarrao
Department of Mechanical Engineering
University of South Florida
Tampa, Florida 33620-5350

INTRODUCTION

The project that was chosen was the umbrella holder for a manual wheelchair user. This project involves designing a lightweight, detachable accessory that is capable of holding an umbrella for a disabled person who uses a manual wheelchair. This person must use their arms to propel the chair forward, thus rendering them incapable of holding anything for any sustained period of time.

SUMMARY OF IMPACT

This project came to us from a young lady at USF named Shauna Bisson, who has been having trouble going to and from class in the rain. She needs both hands to power her wheelchair, and has no way to hold an umbrella. She carries her books and homework in her lap, and they all became soaked anytime it rained. Most people take for granted the fact that they can just walk outside with an umbrella and be covered, whereas Shauna doesn't have this option. Something as simple as an umbrella holder can make the lives of many disabled individuals much easier. Since Shauna and her schoolwork both need to be covered by the umbrella, the umbrella holder needs to be widely adjustable so it can cover any part of the chair.

TECHNICAL DESCRIPTION

The design needed something sleek, attractive, and simple. Our first challenge was to determine how our prototype could be attached to any wheelchair. The solution was a slip that went over the back of the chair which is kept in place by the weight of the user. We were worried about wind being a factor in our design, and the slip basically eliminated that concern. Another problem that Shauna mentioned to us was the fact that when she was getting in and out of her chair, she would need the umbrella to be higher. This would make it much easier for her to move around, and the heightened umbrella would keep a greater area dry. This problem was solved by adding an extendable rod to the back of the seat attachment. When the rod is lowered, the umbrella sits directly above the user, however when it is extended, it sits well above the user, allowing more freedom of movement. Finally, we needed a way to attach the umbrella. After doing some research, we found an umbrella holder for a golf bag. This part was able to be adjusted in every direction, which is what is desirable our prototype. The umbrella holder is mounted directly to the end of the extending rod.

There are many benefits to the design of our prototype. Most notable however, are the size, style, and ease of use. We basically wanted our prototype to be an "accessory" to the wheelchair, so that the person using it doesn't feel like they have a giant weight on their back. The small size and style both contribute greatly to this factor. It's easy to use since one only needs to pull up on the holder to extend it, and then turn the handle to adjust it in any direction. Also, the umbrella sits right in the holder, so there is no need to clamp or fit the umbrella perfectly. The holder fits a wide variety of umbrellas as well, so the user can have their own personal style incorporated with the holder. Another benefit to our design is the fact that it can fit any size chair. The seat slip is adjustable to fit a wide variety of chairs, so the user need not worry about if the holder will fit their wheelchair. Another major benefit to our design is the fact that the umbrella holder is easily transportable. The user can decide when to attach the holder, and not have to worry about bolting anything. The seat slip takes a few seconds or less to fit over the chair and it's attached. The user's body weight actually holds the umbrella holder in place, so it won't come loose in the wind or on rough terrain. Since the seat slip is comfortable, the user won't even notice the holder is attached. Fig. 18.27 shows the device.

The cost of the parts and materials was about $175.

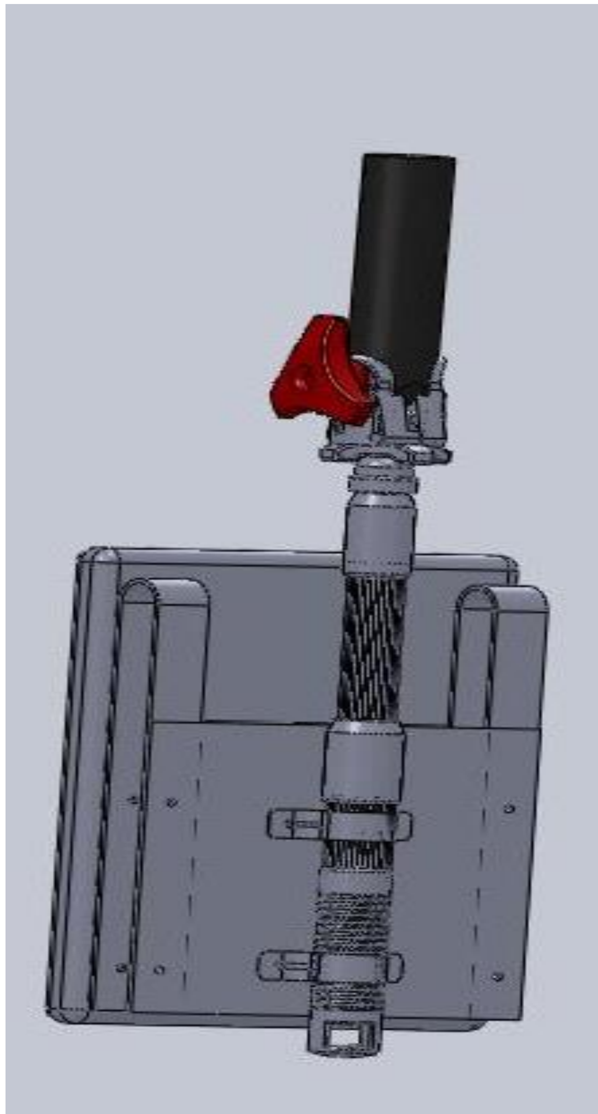

Fig. 27. View of the Wheelchair Umbrella Holder.

WHEELCHAIR UMBRELLA HOLDER

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INTRODUCTION

To assist in making an umbrella more accommodating to a manual wheelchair user, the design pursued was an umbrella holder. This device is made possible through the use of a utility arm specifically designed for manual wheelchairs. This non-powered robotic arm easily unfolds from the back of the wheelchair when needed and folds back to be stored away when not in use. This utility arm is not limited to holding an umbrella, but also beverages, a table tray, or similar items. This addition permits the user to access items such as food, books, or even a laptop.

SUMMARY OF IMPACT

Since the use of a manual wheelchair requires the use of two hands, other tasks become limited, difficult, or impossible to perform such as holding an umbrella or drink, using a laptop, or other similar task. Therefore, a utility arm is of great benefit, to those using a wheelchair, by allowing these once nearly impossible tasks to become an option. This aims to promote even greater freedom and versatility for the user.

The initial task was to develop a utility arm that could hold an umbrella; however, the idea expanded when additional uses of the utility arm became apparent. This structure was designed for non-powered wheelchairs. The benefits of the utility arm design include its light weight, slender, non-corrosive, structure that does not impede on the user's ability to maneuver the wheelchair. Furthermore, the utility arm is easily accessible and easy to use.

TECHNICAL DESCRIPTION

The first design consideration was to create a device which required no power supply. This consideration reduces the overall cost of the device while also adding no additional weight. Since rainstorms can be unpredictable, the focus was on creating a device which could be stored on the wheelchair at all times, while also being easily deployed. Specifically with manual wheelchairs weight factors are often of significant concern as additional weight adds more work for the user, thus creating a lightweight device was of high importance.

The final design is lightweight, compact, easily deployable, non-powered and versatile, made of aluminum box beams and c-channels. One end of arm has an adjustable locking hub, rated to support more than one hundred pounds. This joint allows the device to easily move and lock into position. The prototype is very compact and glides easily in varying positions. Figs. 18.28 and 18.29 show the device.

The cost of the parts and materials was about $335.

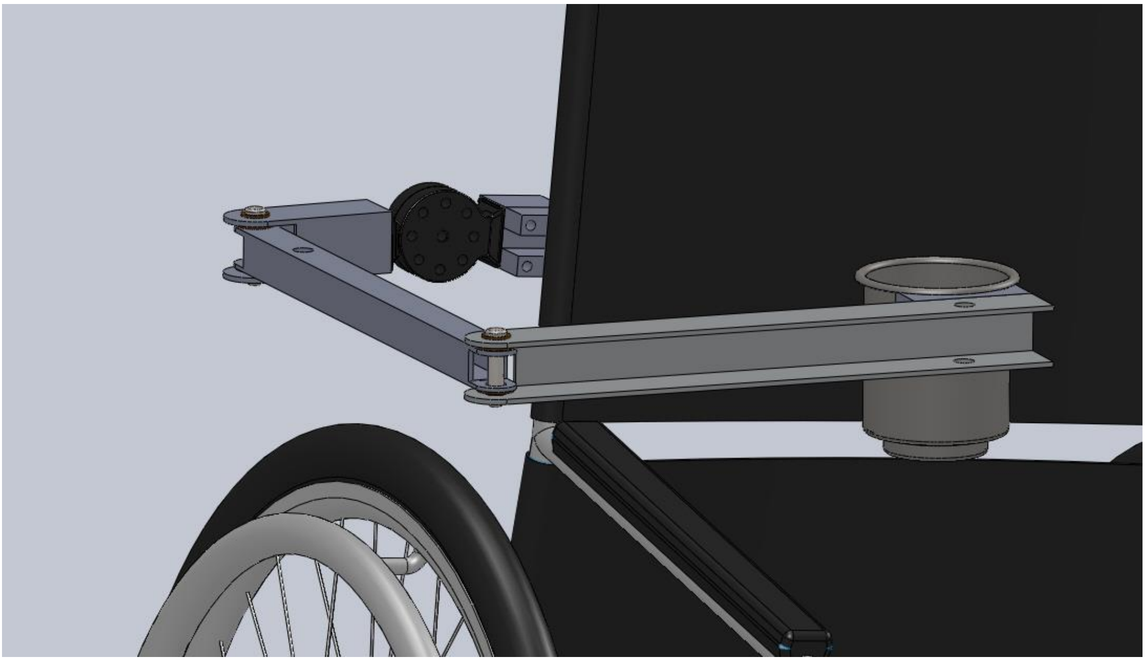

Fig.18.28. Conceptual View of the Utility Arm.

Fig. 18.29. Photograph of the Utility Arm.

PORTABLE CUPHOLDER SYSTEM

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INTRODUCTION

This report addresses the design process of a device that could assist people who suffer from quadriplegia to pick up a drink from a table and tip it, since they are not able to do this by their own means. Instead, they need to rely on the assistance of somebody else. The proposed design focused mainly on facilitating the lifting motion of the person and the improvement of his or her range of motion in a natural manner. The design consists of two separate systems: one that allows 3 degrees of freedom of movement and other that permits holding the cup in a mechanical hand. This design is highly versatile, adaptable and simple. It provides a smooth and natural motion of the arm, but at the same time it provides enough force to assist the user when lifting the cup. It is important to consider that this design still has room for improvement, looking forward to enhancing the quality of life of people who suffer from quadriplegia. The main goal is to offer them a stylish innovative solution that fulfills their expectations.

SUMMARY OF IMPACT

According to the University of Alabama National Spinal Cord Injury Statistical Center every 41 minutes a person in the United States sustains a spinal cord injury. There are about 11,000 new cases of spinal cord injury reported in the United States each year. The total number of people with spinal cord injuries in the United States is estimated to be between 250,000 to 285,000. 52% of spinal cord injured individuals are considered paraplegic and 47% quadriplegic. Finally, the average age of a spinal cord injured person is 31. These people are quite young, and want to move on with their lives and be able to do activities without having to depend so much on other people. This project can help them improve the quality of their lives and provide them the chance to live their lives as comfortably as they can. This device offers a simple, practical and innovative means for the user to pick up and tip a cup in a smooth and natural manner. In addition, this product ensures a stylish (not too bulky) look, comfort and a user-friendly mechanism.

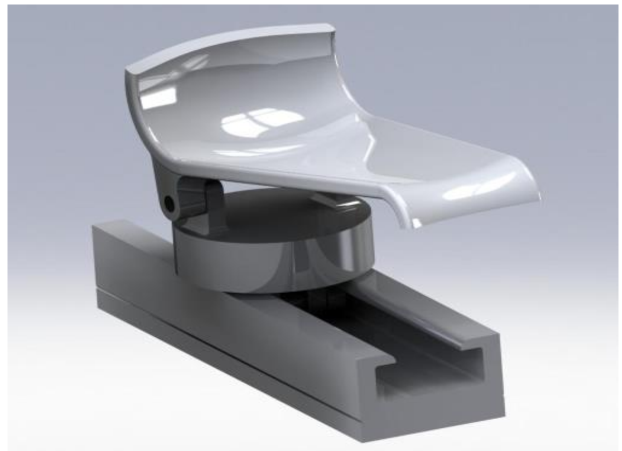

Fig. 18.30. Part of the Prototype that Allows the User to Reach the Cup.

TECHNICAL DESCRIPTION

The system's functions were established, taking into account the previous requirements, and they are defined as follows, (1) Reach the Cup, (2) Grab the Cup, (3) Take the Cup to the Mouth and tilt the Cup, and (4) Take the Cup Back

(1) To perform this function the device has a support base that allows three degrees of freedom. The base lets the person move his/her arm forward and backward, rotate it and lift it, guaranteeing the range of motion necessary to reach the cup. The base moves along a rail through two bearings in order to produce the linear motion needed. Fig. 18.30 shows the device.

(2) The mechanism employed to grab the cup consists on an arm pad that is attached to the person's forearm, and a T-shape beam that moves along a rail. The beam pulls a thumb finger backward to let the mechanical hand grab the cup. The user must employ his or her left hand to actuate

the mechanism by pressing a lever that pushes the beam backward, and releasing the lever to allow the finger to return to its position and press the cup firmly towards the mechanical hand.

(3) Once the person is holding the cup in the mechanical arm, they need to take the cup to his or her mouth. In order to perform this step, the person has to move his/her arm backward along the base's rail. At this point, a torsion spring will provide most of the force to assist the person to lift the cup without much effort. The person will be able to control the velocity of the lifting movement and the cup's position. These features ensure a smooth simple and natural motion of the arm. Fig. 18.31 shows this mechanism.

Finally, after taking a sip the person can slowly put his arm down in a movement analogous to the lifting motion, but employing less effort.

The device is highly adaptable; since it consists of two separate modules. The user has the choice to use only the elbow support module, giving him or her more freedom to maneuver by his or her own means. The prototype can lead to an attractive and affordable commercial rehabilitation device that could help thousands of people with disabilities to perform a very common yet difficult task for them.

The cost of the parts and materials was about $1030.

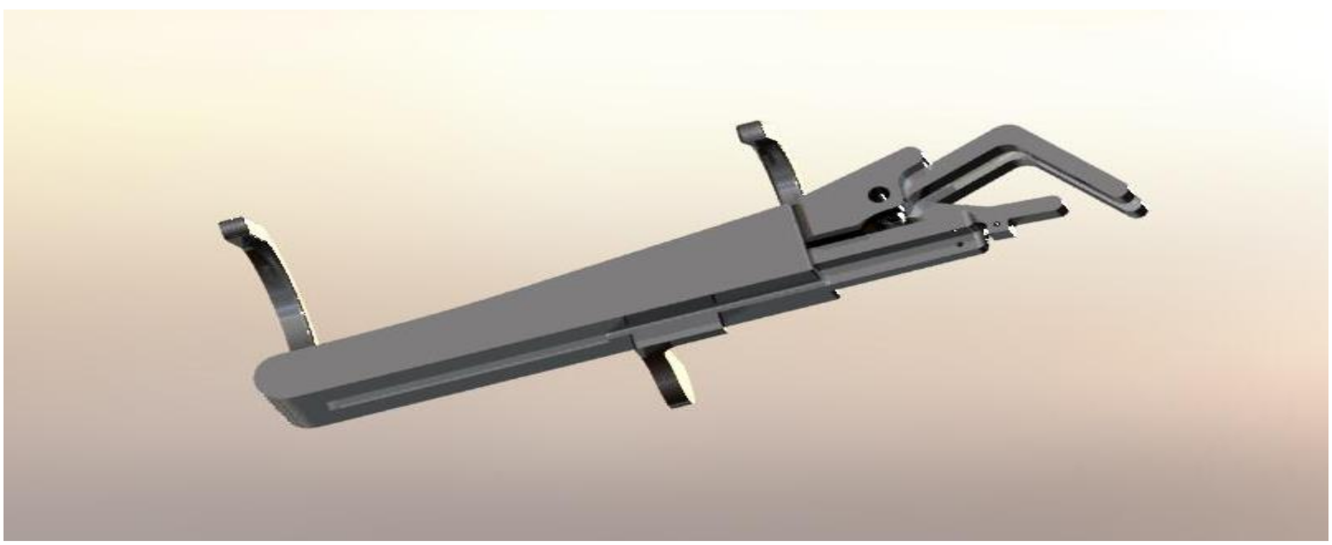

Fig. 18. 31. Part of the Prototype that Allows the User to Take to Cup to the Mouth.

DRINKING AIDE

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INTRODUCTION

The drink aid aims to mimic the drinking capability of a human arm. The device can pick up a drink cup from a table and lift the drink to the individual's mouth, in a well-controlled manner. The drink aid accommodates as many individuals as possible, can be attach to most powered wheelchairs, and does not hinder the comfort of the user or the functions of the wheelchair.

SUMMARY OF IMPACT

Currently a person with quadriplegia has to drink out of a straw or requires the assistance of others to be able to drink. This is awkward and difficult for some drinks such as coffee or beer. Over all, the drink aid device aims to empower the user and offer a better quality of life.

TECHNICAL DESCRIPTION

When taking a drink from a cup, the hand provides grip, which secures the cup, and the wrist provides control over the cup's fine motions, tilt and rotation. Therefore, the drink aid design incorporates a robotic claw and pan-tilt device that mimic these biological functions in a simplified manner. In addition to fine motions, a drink cup must experience a large displacement from the table to the user's mouth. The human elbow and shoulder provide a pivot point and support, respectively, for the drinking motion. However, a gear-motor supplies power and a range of motion similar to that of an elbow. Structural tubing provides extended support for mounting the gear-motor, which is attached to the back post of the wheelchair. Therefore, the design fixes the elbow joint as a source of rotation. Overall, the final design simulates a natural drinking motion while providing simple control and function. Acting like a hand, the robotic claw in Fig. 18.32 provides grip during the drinking process. A servomotor attached to the claw allows for control over opening and closing motions.

Fig. 18.32. Robotic Claw.

The motion of a person's wrist is represented by a pan and tilt mechanism in the design. Because of the anatomy of the human wrist, mechanically copying the wrist's exact motion and control is unrealistic for the short time period of this project. However, two motions exhibited by the wrist were chosen for application in this robotic arm. The vertical up and down motion and the side to side motions provide control over the tipping of a drink container. With the use of the controls of the pan and tilt, the user is able to drink from an open cup, and not solely from a cup with a lid or through a straw, as was done previously. Fig. 18.33 shows the pan and tilt device and its location on the arm.

The hand and wrist provide fine control over drinking motion, but the elbow joint provides the strength and large range of motion that brings a beverage to a person's mouth. Because the elbow requires the most force, when compared to the hand

and wrist, the mechanism to replace the elbow needs to be powerful. In addition, the elbow is a compact joint that does not allow much room for an effective moment arm. Therefore, selecting an appropriate mechanism to substitute for the elbow provided a challenge. However, a readily available component was available for use, an electric motor with a gearbox. (Fig. 18.34 shows the motor and its location on the arm.) The gearbox's transmission ratio can be selected for a particular torque and speed. When drinking, one does not want the cup to fly towards the person's face at high speed; therefore, a high gear ratio was chosen to reduce the maximum operation speed. Low speed is also required for ease of control and smoothing the motor's motion.

The design includes two "arm" pieces. These arms connect the electromechanical devices and create a more natural looking device. These arms mimic the human arm (forearm and upper arm). They are made of aluminum tubing, which is light weight and strong. The forearm is made of square tubing and acts as a connector from the motor to the wrist device. It will add the needed height to make the drink device reach the user's mouth. The upper arm is made of tubing bent at a 90° angle. This will enable the device to be attached below the arm of the wheelchair and then be routed around the user. This bar is used on the rear mounting bracket to attach to the wheelchair. The upper arm adds stability to the design, and allows the design to be more versatile for different body types.

The cost of the parts and materials was about $300.

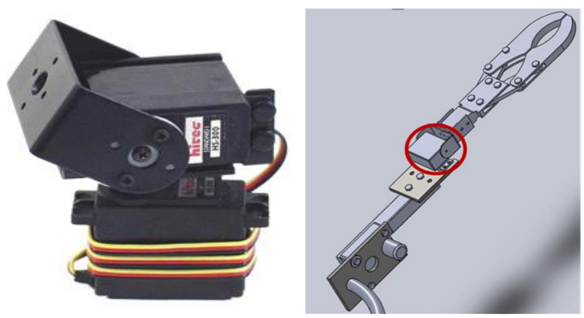

Fig. 18.33. Pan and Tilt Device, and Location.

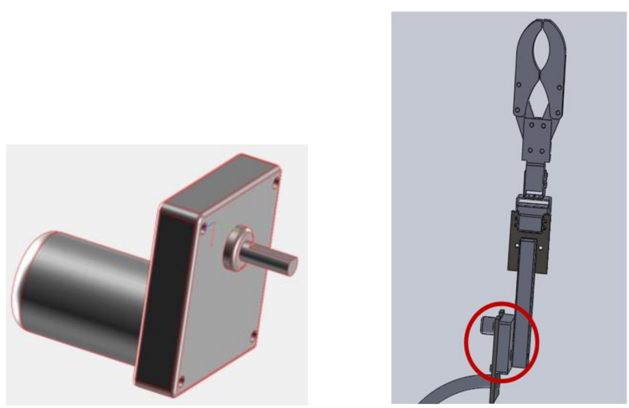

Fig. 18.34. DC Gearmotor, and Location.