CHAPTER 13
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INTRODUCTION
Many wheelchair users are challenged with determining how to comfortably carry personal belongings with them on their wheelchairs. A simple coupling device enables a person, confined to a standard wheelchair, to easily tow a luggage tote. The luggage tote will offer a greater sense of freedom and comfort during daily travels. This system will provide good maneuverability, easy access to the luggage, and the option to detach the tote via a quick-disconnect coupler.

SUMMARY OF IMPACT
The two-part coupling device is designed for use with a standard folding wheelchair, thus not sacrificing the portability of the wheelchair or the luggage tote. The smart device takes advantage of the wheelchair’s collapsing mechanism. When the wheelchair’s handles move toward one another, one can attach the male end of the coupler frame (first part) to the wheelchair handles. Opening the wheelchair locks the first part into position around the finger slots of the wheelchair handles. The female end of the coupler fastens to the luggage tote’s handgrip by using a common plastic tie-strap. In fact, neither the wheelchair nor the luggage tote is permanently altered in any manner.

Figure 13.1. Luggage Tote Attached to Standard Wheelchair Using the Coupler.
TECHNICAL DESCRIPTION

The coupling system consists of two parts. The first part consists of a 3/8" diameter aluminum rod that wraps around the finger grips of the wheelchair handles and spans the distance between them. The aluminum rod provides a sturdy frame for attaching the male end of a Milton Kwik-Change air coupler. The male end is rigidly secured at the center of the aluminum rod, equidistant between the two wheelchair handles. The male end points down to provide a central pivot for the female-end (second part) of the coupler.

The female end of the coupler attaches to the luggage tote’s handgrip by threading a plastic tie strap through a hole in its base and then around the handgrip. The tie strap locks back through itself.

The female end of the coupler has a spring-loaded grip that, when pushed downward, releases the female end from the male end. This action allows the luggage tote to easily separate from the wheelchair. The tote attaches to the wheelchair by simply lining up both ends of the coupler and pushing them back together until they lock.

To allow the wheelchair handles to easily engage and disengage from the coupler frame, the ends of the aluminum rod were angled upward approximately seven degrees. Synthetic caps applied to the rod ends protect the user from sharp edges and make the frame more aesthetically appealing.

The total cost of the project was approximately $20.
STOWABLE BOOKHOLDING DEVICE
FOR A WHEELCHAIR

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INTRODUCTION
This device was developed to enable a person with weak or ataxic upper extremities to read a favorite novel or magazine or to contemplate a crossword puzzle. In addition, it provides an inclined surface for writing as well as the opportunity to read in a more ergonomically correct position. The need for improvement came from the limited number of existing reading devices, which are too heavy and cumbersome. The suggestion for this device originated from a person with multiple sclerosis who is currently losing arm strength.

SUMMARY OF IMPACT
This device attaches to the backrest of some wheelchairs while moving from place to place. The components of this device, when combined, were chosen to accommodate persons with weak upper extremities. The incline adjustment feature accommodates impaired vision as well as differences in the elbow’s range of motion when writing. This feature also allows the head and neck to remain in a more neutral position compared to using a standard, flat desktop. By permitting the book to rest on a surface, the need for isometric grasp no longer exists. The ease of attaching the device to the desktop also accommodates those with weak upper extremities.

TECHNICAL DESCRIPTION
The polycarbonate desktop and the clamps used to attach the desktop, both purchased from DIESTCO, are the principle components of the design. The incline adjustment feature, not found on the researched bookholders, consists of the ratcheting mechanism found on a chaise lounge chair. The hooks that attach the ratcheting mechanism to the desktop are made of austenitized stainless for strength. The hooks’ shape allows for easy attaching and detaching of the bookholder. Velcro tabs secure the hooks to the acrylic reading surface when the device is not being used. Without the Velcro, the ratcheting mechanism would move, causing difficulty when storing and picking up the device.
Rubber dipping on the hooks prevents scratching of the polycarbonate desktop. The black rubber dip also serves to improve the aesthetics of the device.

The bookholder’s weight and bulkiness was minimized by using a 1/4” piece of acrylic with a 1/4” lip to prevent a book or piece of paper from sliding. A thin U-shaped pipe keeps the two ratcheting mechanisms synchronized to prevent an uneven reading/writing surface. Colored contact paper was added to the bookholder’s surface.

The total cost of the project was approximately $210.
INTRODUCTION
This device helps people with arthritis open glass jars sealed with metal twist-off lids. A twist-off lid requires a simultaneous application of two forces: a radial gripping force and a torque, both of which are difficult or impossible to perform by many people with arthritis.

SUMMARY OF IMPACT
The device will remove lids of diameters ranging from 2 to 4 inches. This device can be stored on kitchen countertops. Overall dimensions of the final product are approximately 12" in height and 9" in diameter. The device is electrically controlled, requiring a light downward force to activate a pressure switch for removing the lid. No complicated hand motions are necessary and direct contact with the jar is not required. Currently, only a few electric jar openers exist on the market and they require the user to grip or hold the jar during operation.

TECHNICAL DESCRIPTION
The main component of the device is a five-point chuck. Two thin circular plates are stacked along a common axis and rotate relative to one another. This relative rotation moves the contact pads in a radial direction. The driving plate has a spiral groove cut to a blind depth on one side of the plate. This feature, along with the slotted cuts in the slider plate, allows the contact pads to move radially and applies the required radial force. When the contact pads grip the lid or container, both plates rotate to apply the required torque.

To hold the jar and remove the lid it is necessary to have two chucks, one located under the container and one located on top of the lid. The bottom chuck assembly connects directly to the electric motor. As the bottom chuck assembly rotates and grips the jar, rotation is continued and transferred to the upper chuck assembly, through the container, causing the upper chuck assembly to grip the lid and remove it. Once the lid is removed, the device rotates in the opposite direction to release the container and lid from the chuck assemblies.

The contact pads’ surfaces require a soft rubber coating to increase the friction coefficient between the lid material and the container. To ensure the proper radial force to the lid and container, the slider plate is held in place by friction pads similar to a disk brake assembly on an automobile. When the static friction force is less than the rotational torque applied by the motor, both plates will rotate.

The device shown in the figures is a prototype of the chuck assembly. This prototype was manually tested on an unopened metal lid container and successfully removed the lid. Further construction of the prototype is required to test hands-off operation but results obtained thus far show promise for future success of the concept.

Total cost of the project was approximately $510.
Figure 13.7. Lidded Jar Engaged with Chuck.

Figure 13.8. Components of Jar Opener.
ADJUSTABLE SWING ATTACHMENT FOR A CHILD’S BICYCLE SEAT

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INTRODUCTION
A device was designed to attach a typical child’s bicycle seat to a playground swing to enable children with physical disabilities to swing. The bicycle seat provides the support needed for maintaining a sitting position while on the swing for children without the necessary postural support. This swing attachment would also represent an excellent choice for young toddlers without disabilities.

Keeping the seat fully universal, making the attachments simple and easy to put on and remove, and ensuring the safety of the child were the main goals of this project.

SUMMARY OF IMPACT
This project promotes accessible playground recreation for children with physical disabilities.

TECHNICAL DESCRIPTION
It was necessary that the design be simple, allowing for easy attachment and removal to the swing and seat.

A back piece was made of 1/8 inch aluminum plate with five slots for straps. The strap on the top of the seat prevents the plate from slipping during attachment. On the left and right sides there are straps that securely loop around the side of the seat and the chains of the swing with safety locks. On the bottom of the aluminum plate there are two straps that attach using snap locks.

The bicycle seat has three screws that hang from the bottom of the seat to attach the seat to the bicycle. These same screws, along with three wing nuts, are used to attach the bottom plate, which is also made of 1/8 inch aluminum. The front of the plate has a slot for a strap that hangs down to loop around the swing seat and attach to the straps that hang from the back plate.

While these straps hold the swing to the seat independently and prevent the bicycle seat from slipping on the swing seat, if the straps failed for any reason the device must still catch the seat if slippage occurs. Therefore, the back end of the bottom plate is bent down toward the front at a 60° angle. This design still allows easy placement of the bicycle seat on the swing while maintaining this safety feature.

The total cost of the project was approximately $62.
Figure 13.9. Bicycle Seat as Seen from Front and Behind.
INTRODUCTION
Some wheelchairs can not negotiate rough terrain due to narrow wheels. For example, in the sand, one-inch wide wheels will dig in instead of propelling the wheelchair. Many wheelchairs have similar problems traveling over rocky terrains, snow, ice, and mud. Therefore, most wheelchairs are limited to asphalt surfaces.

SUMMARY OF IMPACT
The goal of this project was to develop an “All Terrain Vehicle Accessory for Wheelchairs” (Figure 13.10). This design will best suit electric wheelchairs due to the power needed to operate the device. The two main design criteria were to increase the contact area between the wheel and the ground and increase the traction characteristics of the wheel. In addition, this device must ensure easy operation, taking in to account the physical limitations of many wheelchair users.

TECHNICAL DESCRIPTION
This design was built around a manual wheelchair due to the high cost of electric wheelchairs, usually exceeding $2000 per unit.

The wheelchair sits atop the platform with each of the two wheelchair drive-wheels turning in place via a pair of rollers under each drive-wheel (Figure 13.11). These drive-wheels will engage the clamp-assembly that consists of the drive-wheel fitting, shaft, and sprocket (Figure 13.11). Each platform-wheel is connected to a shaft and a sprocket. Therefore, each side of the device consists of two platform-wheels with sprockets and the clamp-assembly. These three sprockets are connected with a chain—forming the triangular sprocket-chain assembly (Figure 13.12). Each side is independent of the other, which enables steering.

To propel the device, the user operates the wheelchair normally, except that the power from the wheelchair’s motor is transmitted to the sprocket-chain assembly, then to the platform-wheels, thus propelling the device.

The tires used were 3.5 inches wide and 10 inches tall—satisfying the design goal of increased contact area between the tires and ground. Also, these tires possess a tread pattern similar to ATV tires—addressing the design goal of increased traction.

The disadvantages and improvement methods are as follows:
Weight. The materials used to build this device, mostly wood and steel, are heavy. The overall weight of the device is roughly 100 pounds. To decrease weight, the design could incorporate lightweight alloys. However, this would increase costs.

Size. The dimensions of the device are 3 feet wide by 3.5 feet long. This size makes movement through standard doorways cumbersome.

Gear ratio. The gear ratio reduces the velocity by one-half. That is, the platform speed, which is the true speed, is one-half the wheelchair speed. This gear ratio also increases the torque needed to propel the device. To solve this problem, multiple gear ratios, similar to those of a 10-speed bike, could be integrated.

Steering. The current steering mechanism does not allow for easy turning. The front platform-wheels should roll free and pivot 360 degrees to facilitate steering. As a result, the sprocket-chain assembly would only involve the clamp-assembly and rear platform-wheels.

The total cost of the project was approximately $700.
INTRODUCTION
Although there many wheelchairs have a reclining feature, transport chairs lack this feature. Usually, they are the most inexpensive of the transport devices. Therefore, such amenities were never implemented. Many nursing homes and hospitals that use transport chairs often purchase the most economical, yet very uncomfortable, chairs. The lack of transport chairs without reclining features coupled with the discomfort of patients without good postural support provided the impetus this project’s conception.

SUMMARY OF IMPACT
The goal was to develop a transport chair that is safe, reliable, and able to provide adequate comfort for patients. Nursing homes and hospitals would show interest in this idea since the product evolved from an existing chair. The design is practical, taking little time to implement on any transport chair. This design provides comfort and simplicity for patients at a reasonable price.

Interviews with elderly patients regarding this idea resulted in positive feedback. They explained that existing chairs are too straight and that an option to change position would be welcomed.

TECHNICAL DESCRIPTION
The design consists of a simple “pin and pivot” assembly. At the back of the chair there is a pivoting point that allows the patients to recline. This pivoting point has a screw consisting of a ½” nut and bolt. At the front of the chair there is a pin assembly that allows patients to choose the angles at which they want to recline. The pin assembly consists of a 3” x 2.5” x ½” steel plate with a number of holes; a 7/8” diameter L-shaped beam that connects to the pivot on the back, and another hole for the pin at the front. This frame’s dimensions are 15” in the back and 16 ½” at the base.
Figure 13.14. Reclining Apparatus.
FREE WEIGHT BENCH SPOTTER

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INTRODUCTION
This Project was specifically designed to act as a “spotter” to assist a weight lifter who has paraplegia with a set of bench presses. A bench press is performed while laying face up on a flat bench and pushing a weighted barbell straight up and then down using both arms. A full set may include several of these repetitions. Good form includes lowering the bar to about an inch above the chest before pressing the bar back up. When alone, a person may need a little assistance to finish the set. When help is not there, the person may not have the stamina to finish the last repetition, leaving the bar on the person’s chest, resulting in possible injury, especially for a person with physical disabilities. This device entails lowering or lifting of the support brackets so the counter weights will lift just as the bar touches the person’s chest. The system engages when the bar comes in contact with the chest. The system adjusts to the user’s body size.

SUMMARY OF IMPACT
This device was designed with the intention that a person could work out alone and still depend on a spotter for those important last repetitions, resulting in a more efficient workout. This system doesn’t lift the weight off of the lifter’s chest, but gives the assistance he or she may need to finish the set. The device will eliminate short-changing of a set by allowing the one more repetition a lifter may need to improve his or her strength and upper physique. Not only will this device work for people with disabilities exercising alone, but also able-bodies people who want to work out alone.

TECHNICAL DESCRIPTION
The counterweights used will take 50 pounds off the total load being pressed, which is adequate, and will travel down a hollow tube that runs through the center of the heavy counterweights. A cable is attached from the machine to the center of the barbell, which runs through two pulleys and connects to a small cylindrical weight that runs inside the same hollow tube, below the weights. Since the small counterweight has two pegs on the bottom, the tube must have slots on both sides. The hollow tube will act as a guide for the small counterweight and a track for the heavy counterweights.
The small counterweight removes any slack from the cable before the system is engaged. The heavy counterweights will rest on the pegs after the system is engaged. When engaged, the heavy counterweight will lower as the user presses the barbell. The pulleys will direct the cable so that as the weighted end is being pulled down the other end attached to the barbell will be pulled up.

As the user performs repetitions, before the heavy counterweights are engaged, the small counterweight travels up and down with each press of the barbell. Just as the user begins to press the bar, the pegs on the cylindrical weight will reach the bottom of the counterweights, which are supported by two spring loaded brackets at the upper part of the mechanism. When the lifter decides he or she might need a spot for the last repetition, he or she can engage the system by lowering the barbell down to make contact with the chest. When the barbell is low enough, the small counterweight will pull the heavy counterweights off the support brackets. With nothing to hold the support brackets in place, they will snap open, allowing the heavy counterweights to pull down on the cable, which pulls up the barbell until the lifter fully presses the weight.

Figure 13.16. Counter Weights on Support Brackets.
PORTABLE SLIDE DEVICE

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INTRODUCTION

The objective of this project was to design and build a device to allow children with physical disabilities to use a slide. The complete design consists of three components: a bicycle seat, a catch-net and an attachment clamp. Using a bicycle seat allows for more applications of the components because adults can transport the child to the playground using the same piece of equipment.

SUMMARY OF IMPACT

With the Handy Slide Attachment, children will have access to playground slides and receive stimulation for growth and development. Furthermore, the device requires adult operation, providing the child with adult attention.

TECHNICAL DESCRIPTION

The design consists of three elements: a bicycle seat, a clamping device, and a catch-net apparatus. The components are easy to transport and uncomplicated to use. The safety catch-net with the clamp is only necessary to use if the slide ends above the ground level.

The procedure of usage is as follows:

1. Attach the clamp to the bike and store the net in a bicycle-basket for easy transport.
2. Ride the bicycle to the slide with the child already strapped into the seat.
3. Remove the child and seat from the bicycle by unscrewing three seat knobs. Place the seat with child at the bottom of the slide.
4. Remove the clamp and safety catch-net from the bicycle.
5. Insert the flat plates on the clamp into the yellow brackets on the safety catch-net.
6. Pull the trigger on the clamp and stretch it out until the metal plates lie flat against the outside of the slide. Make sure the long arm of the clamp is placed underneath the slide. See Figure 13.19 for clarification.
7. Tighten the clamp by pumping the handle until the net is secure and fastened. If the net is loose, then the clamp is not tight enough.
8. Attach the two 40” cords from the top of one post on the net around under the support beam of the slide and back to the opposite post. This prevents the net from rotation caused by impact. See Figure 13.19.
9. Double check that the harness and helmet on the child is fastened and all limbs are inside seat.

10. Pull the seat up the slide as far as desired and release. The net will prevent the seat from falling off the edge of the slide.

11. Upon completion, remove the clamp by pressing in the handle and pulling away from the slide.

12. Reattach the equipment to the bicycle, then remove the child and seat from the bottom of the slide and attach to the bicycle again.

The device is recommended for use on plastic slides and restricted to single straight slides. Able-bodied children can use the slide device as well.

The bicycle seat attaches to an adult bicycle. The weight of the child should not exceed 40 lbs. The seat provides good neck stability, leg support, and a 5-point harness for safety. Furthermore, the seat's width is the same as most standard plastic slides. The seat's stability helps avoid tipping over the slide's side, even with movement of the child. If the child cannot control his or her arm motion, mittens with Velcro wristbands should be attached around the seat handlebar.

The safety catch-net consists of two solid aluminum rods, each 23 inches in length, with metal plates welded to the bottom of the rods. In addition, the rods have holes drilled axially at each end, large enough to insert bungee cords. The net measures 18" X 24" and constructed of a thick mesh material. Bungee cords are sewn along the perimeter of the net, inside the seam. The cords along the wider length of the net are wrapped around the aluminum rods, where as the cords along the short portion of the net are inserted into the metal rods. This assembly provides a stiff structure able to catch the seat. The cords provide elasticity to dampen the impact when the seat hits the net.

The clamp is designed to have one-handed operation for speedy tightening. To tighten the clamp, one squeezes the clamp’s pistol grip handle. Because the clamp cannot be over-tightened, the risk of marring the slide is eliminated. The clamp unlocks by merely applying pressure to the trigger. The clamp, made of a resin material, possesses good durability and low weight. For easier assembly the rubber work pads are removed from the clamp and riveted to the metal plates.

The total cost of the project was approximately $124.
INTRODUCTION
The Door Opener was designed to aid wheelchair users in turning a lever door handle and opening the door from a distance.

SUMMARY OF IMPACT
This project was short to meet the objectives because of specification errors. This device has a limited use, only fitting one kind of doorknob. During a test, the Door Opener succeeded in grabbing and turning a door lever handle, but could not open the door since specification errors exist. Yet, performing several iterations in the near future to modify the model would ensure proper operation.

TECHNICAL DESCRIPTION
The Door Opener is built with steel; lighter material such as carbon fiber or aluminum is recommended.

The system consists of three main parts: hook, body, and clamp. A hook grabs the lever door handle and rotates about the axis of the main body to turn the door handle. The body supports the hook and rotates horizontally to open the door. The clamp allows the entire body to attach to the wheelchair. Wheelchair users place this device on their right-side armrest of wheelchair. A 5-cm-long thread between the main body and clamp allows height adjustment for doorknobs not located in the standard position. This thread permits users to raise and lower the main body by 2.5 cm in each direction.

The total cost of this project was $210.
Figure 13.21. The Hook, Body, and Clamp Comprise the Door Opener.
INTRODUCTION
Many persons with physical disabilities lack sufficient ability to safely maneuver themselves into and out of the bathtub. Other persons, too, sometimes slip while in the tub, causing serious injury. A device was designed for installation on an existing tub to assist a person in moving into and out of the tub.

The design consists of two basic parts. The first, the tub mounting, consists of two plates positioned to hug the tub wall. These two plates then attach to a base plate where the motor and two reduction gears are mounted. An arm attaches the shaft from the second gear to the chair. Finally, a protective housing encloses the mechanism.

The device is designed to slide onto the tub wall. Then, by means of a switch, the chair rotates into or out of the tub, depending on the switch position. The device plugs into any grounded wall outlet.

SUMMARY OF IMPACT
This provides a reasonable alternative to people in need of assistance in entering and exiting the bathtub.

TECHNICAL DESCRIPTION
The design involves three distinct parts. The first part includes the mechanical assembly of the reductors, motor, shaft, and chair. The second consists of an electronic control circuit to maneuver the chair. The third is a housing that safely contains the moving parts and electronics.

The first step in the mechanical configuration was to select a motor capable of providing the horsepower required to lift a person. After examining several design possibilities, a GE instant reversible motor rated at ½ Hp was selected to provide the back and forth motion. Also, to limit the electronics needed, an AC powered motor rated at an amperage/voltage consistent with that provided in a normal wall outlet was chosen. Because the motor rates at 1800rpm, a reducing unit increases the torque and decreases the rpm. Several commercial units were examined; however, the reduction ratios and costs were not acceptable. Therefore, an original reducing unit was built.

The unit requires two steps to obtain the required reduction ratio of 800. Two worm gear combinations, one at a reduction of 40 (small gear)
and one at 20 (large gear) accomplish the task. Considerable care was taken in the machining of the worm gear mounts to obtain precise distances. Pillow blocks hold the shafts in place and support the forces applied by the gears. The first reduction, the 40 ratio, attaches to an extension of the motor output shaft. At the end of the 40 reduction the output turns 90 degrees and enters the 20 reduction. The 20 reduction turns the output 90 degrees back in the original direction. Also, the gear attaches directly to the main shaft, which rotates the chair. With this arrangement the motor will spin at 1800 rpm when turned on, but by the time the output reaches the chair the rpm is reduced to 2 with a considerable increase in torque.

The control system for this device consists of a switch causing the chair to rotate in either direction and two stops at each end of the arc. The worm gears eliminate the need for a mechanical stop. The nature of the gears allows only the motor to turn them. Whenever power to the motor is shut off, the chair will stop immediately, even in the middle of its arc. The chair will not fall if power suddenly ceases. With this consideration in mind, only two circuits are required; one for rotation clockwise and one for counterclockwise. The two circuits activate through a three-way switch where the middle position is off. In addition, two limit switches positioned at the second gear shut off the circuit at the desired location, causing the chair to stop. By activating the switch in the opposite direction the chair will return until hitting the other limit switch. The limit switches, attached to the structure by clamps, allow for easy chair-arc adjustment for differing tub geometries. A fuse added to the power line from the switch to the plug protects the user from an electrical hazard in case water leaks into the control unit.

The housing was built to hold the mechanism on the tub wall as well as protect the user from mechanical and electrical hazards. The two basic components include a sheet metal box and a plastic control box. The sheet metal box totally encloses the motor and gears, allowing only the shaft and chair to protrude. Also, holes for the power cord, control cord, and fuse were made.

The box, sealed with silicone gel, attaches to the base-plate by brackets. On the bottom of the base-plate two “hugging” plates (not pictured) are attached. These plates attach directly to the chair shaft supports to allow for more stability. The control box attaches to the housing by a 4-foot-long waterproof cord. The cord is attached and sealed to the control box, which contains the control switch. The control is left free so that the user can operate the chair easily from all positions. Prolonged contact with the water is not recommended for the control case. However, the control case is waterproof and should not present a hazard.

The total cost for the project was approximately $1110.
INTRODUCTION
A device was designed for storage of personal belongings and provision of a desktop on a walker. This accessory is designed for easy operation and low cost.

SUMMARY OF IMPACT
A need exists for walker attachments that will permit walker users to have more freedom and independence. An attachment that allows for storage and provides a desktop will facilitate these needs. Walker users have utilized such devices as fanny packs, pouches and purses, which have not been designed specifically for this application.

The design offers collapsibility, along with easy removal and attachment to and from the walker. This aspect permits the walker to collapse without damaging the storage/desktop unit.

TECHNICAL DESCRIPTION
The storage/desktop unit consists of three main parts: the locking box, the linkage and the support/clamping unit. The box has inside dimensions of 15” X 11½” X 1½” for storage of personal belongings. The box has an attachment to allow the box to lock into a forward angle of approximately 2 to 5 degrees along with a slight lip around the entire top. This ergonomic design lends itself to ease in reading, writing and discourages objects from rolling off the distal edge.

The linkage consists of a ground, the support/clamping units, a slider and links. The storage/desktop unit uses the linkage to move from a vertical to horizontal position so the walker user can walk without impeded motion.

The support/clamping units are high-density polyethylene blocks formed to fit around the legs of the walker. They are held in place with sunken cap screws. The units have 70° slots in which the linkage fits, with wing screws to secure the linkage in place.

The criteria for a successful design were: low weight, unobtrusiveness, ease of use, and a locking box. The storage/desktop unit required low weight so the walker would not tip over when in static loading or dynamic motion. Consequently, the components were mostly made of plastic to ensure the low weight. After testing, the lightweight design withstood 10 pounds of static loading without tipping the walker.
To move the storage/desktop unit from the vertical to horizontal position, and vice versa, the unit had to be unobtrusive to the frame of the walker. Therefore, to not interfere with the frame, the linkage sits at an angle of approximately 70°.

The design needed easy attaching/detaching so the storage/desktop unit would not get damaged while in transporter storage. The unit also required easy removal because the existing models are time consuming when attaching/detaching. This ease-of-use requirement was essential because users often have other motor and strength challenges.

The box/desktop had to lock or the contents would come out when tipped to the vertical position, spilling the contents. A spill would require the user to bend down to get items. However, since the user already requires a walker for support, bending down poses an additional and unnecessary safety concern.

Total cost of this project was approximately $110.
INTRODUCTION
Many people who spend a great deal of time in a wheelchair complain of a rough ride. This project addresses this problem by placing an independent suspension between the rough ground and the wheelchair seat.
SUMMARY OF IMPACT
The cracks and rough edges in concrete slabs transmit jolts directly to the wheelchair operator. A prototype was developed to test the basic idea of attaching an independent suspension to each of the large wheels to soften the connection between the operator and the ground.

Initially, air-filled tires similar to a bicycle seemed a sufficient solution. Unfortunately, the softer air-filled tires puncture too often. Solid tires, which also lasted longer, avoid this problem.

TECHNICAL DESCRIPTION
To lessen the price of the project a new wheelchair was not purchased. Billions of disabled persons use the standard wheelchair. In this design, the solidly mounted axles allow a vertical (Y) travel of approximately 3.5 inches. By solidly connecting the axles to a vertical square cross section bar able to slide inside of another tight fitting square section tube that is welded to the frame allows for the Y-direction travel (see Figure 13.26). The tight fitting square inside of a square eliminates the X and Z direction of rotation about the vertical tube. Without this square inside of a square the wheel would wobble and change direction. By mounting a spring-surrounded shock absorber (commonly found on the rear of motorcycles) to the frame above the seat and to the mobile box section, a suspension was created. An easy modification would allow the suspension to bolt to most similarly designed wheelchairs, allowing the interchangeability between manufacturers and different wheelchair designs. The spring, compression, and damping rates require adjustment to match the user’s weight (decreased for a lighter person and increased for a heavier person).

The total cost of this project was approximately $65.
WEARABLE PORTABLE VIBRATING ALARM FOR
PEOPLE WHO ARE DEAF

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INTRODUCTION
The objective of this project was to design a device to alert deaf individuals to the presence of audible warnings. In most emergency situations, especially ones in which time is critical, audible warnings alert a person to the presence of the emergency. Examples are: the honking of car horns, people shouting, gunshots, and train whistles. In case of fire, a person who is deaf can fail to hear the alarm; unless he or she is in the presence of people who hear the alarm, the person may not know about the fire until too late.

The unit consists of a commercially available lapel microphone and a small box with a clip, similar to a pager, that attaches to the waist of the user. The box contains a pager vibrating motor and the circuitry necessary for activation. When the microphone detects a noise above a preset decibel level, the device activates, causing vibration that lasts approximately 1 second longer than the duration of the input sound. The longer duration of vibration guarantees very short duration sounds, such as gunshots, will be felt.

SUMMARY OF IMPACT
Since this device is intended as a lifesaving device, the impact cannot be measured in conventional ways. If instrumental in saving even one life, the device has done its job. Since most of the components that make up the device are inexpensive (the most expensive component is the microphone), the may be used widely.

TECHNICAL DESCRIPTION
The unit consists of a microphone and a box that contains the circuitry and vibrating motor. The microphone, an Optimus Ultra-Miniature Tie-Clip Microphone, bought for $35, contains its own power supply and amplifier.

The circuitry in the box is based around a hex unbiased inverter chip, with each of the inverters capable of acting as either an amplifier or a switch. The actual switch is a transistor. Transistor based operational amplifiers draw too much current, rendering them incompatible with this design. The first two RC circuits act as amplifiers; put in series so the second one amplifies the output of the first. Each consists of a 0.1uF capacitor connected in series to a 4.7kOhm resistor. This is connected in parallel to a 100kOhm resistor and an inverter. The RC circuit brings the inverter current into the range at which it acts as an amplifier. The next assembly is a comparison amplifier, which only lets a voltage above the specified threshold through. The threshold is set by picking the ratio of the two resistors connected in parallel before the third inverter. The diode following the third inverter clips the negative voltage, allowing only positive voltage through. The next assembly, consisting of a 100kOhm resistor and a 22uF capacitor in series, is a pulse stretcher, which determines how long the device would be turned on after the input voltage is cut off.
The device drew 3V, supplied by two AAA batteries connected in series.

The motor, a small (6mm diam. X 14.4mm) pager motor, is coupled in parallel with a diode to prevent back current and connected in series with a resistor that cuts the 3V input voltage to an approximate 1.5V level.

The circuit was assembled using wire wrap sockets and pins, which were then clipped in length in order to fit in the box. The box, a standard Radio Shack project box, has two drilled holes, one for the microphone jack and the other for the switch. The back of the box has a pager clip attached to mount the device to the user’s belt.

The user should wear the lapel microphone on the back of his or her collar to prevent his or her own speech from setting off the device. The proximity of the microphone to the mouth when worn in the front significantly magnifies the apparent amplitude of the wearer’s own speech.

The total cost of the project was approximately $125.

Figure 13.28. Inside the Vibrating Sound Alarm.
PORTABLE BACKPACK HANDS-FREE
OXYGEN SYSTEM

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INTRODUCTION
This project assists persons who need to use oxygen on a daily basis. For many people oxygen use requires them to carry heavy oxygen tanks wherever they go, usually using a cart that they pull. The heavy tanks make mobility difficult. This backpack design incorporates two lightweight oxygen tanks that a person can carry on his or her back for greater mobility. The backpack adjusts to fit most people.

SUMMARY OF IMPACT
This device will enable oxygen users to remain active and have both hands free while they go about their daily activities. The lightweight design will not inhibit the users from being active.

TECHNICAL DESCRIPTION
The backpack consists of three major components: the backpack itself, the lightweight oxygen tanks, the regulator, and air hoses.

The backpack is designed to carry the oxygen tanks. The slim, tight fitting design transfers the weight of the oxygen tanks to five points on the carrier's body, distributing the weight and providing more comfort. The backpack, constructed from heavy canvas for increased durability, has a back panel reinforced with flexible plastic and padded for comfort. The flexible plastic aids in the distribution of the weight, adding to comfort. The weight is distributed to the shoulders, the hips, and across the chest. The two shoulder straps have padding. The adjustable buckle across the chest serves as one of the pressure distribution points. The waist strap is oversized to carry a majority of the weight. This design positions the weight of the tanks as close to the center of gravity of the carrier as possible.

The oxygen tanks’ slim design enabled fitting of two at once, resulting in longer usage time. Each tank weighs 6.5 pounds and measures 3 7/16 inches in diameter and 17 inches in height. Each tank provides 1 1/2 hours of oxygen at a rate of 2 liters per minute. The regulators control the oxygen flow to the 2 liters per minute, the standard rate for oxygen users.

The total cost of the project was approximately $1548.
Figure 13.30. Portable Oxygen System.
AN ORIENTATION SENSING FLATWARE COMPANION

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INTRODUCTION
The orientation sensing flatware companion device assists those who could not easily control eating utensils through normal feedback, such as sight and touch. Instead, an audio signal provides the feedback.

The flatware companion works with ordinary flatware, fitting to any spoon or fork, thereby allowing the user the option to use flatware already owned. With the flatware in place, the companion device provides a large easy-to-grip handle and a buzz when the device tilts too far in any one direction. The device uses eight original tones, one for each general direction of tilt. Once the operator learns which tone is associated with which direction, the operator dynamically adjusts the spoon orientation by responding to the audio feedback.

SUMMARY OF IMPACT
The flatware companion device helps individuals not able to feed themselves to become more independent. For example, the device may help a blind person who has lost the sense of touch in his or her hands to eat without assistance.

The flatware companion device works with all flatware, thus requiring some adjustment and calibration. This adjustment requires the assistance of someone more dexterous than the intended users. Also, the device requires a learning period for the user. The operator must learn the specific audio feedback associated with a particular direction of tilt.

Figure 13.31. Flatware Companion with Spoon.
TECHNICAL DESCRIPTION

The orientation sensing flatware companion device has physical and electronic components. The physical components consist of the base, flatware holder, and handle. The electronic components are the circuitry and the sensors.

The base is a block hollowed out into a “C” channel to house the electronic components. The flatware holder has two parts: one attaches the base to the handle and the other levels the device. The leveling device calibrates the sensor orientation to the orientation of the spoon via two threaded pegs. The pegs press-fit into the base and have contacts that control the angle of the flatware. Threading the pegs on or off controls the heights of the contacts.

The electronic components consist of two buzzers, the driver circuit for the buzzers, and the tilt sensors.

The tilt sensors were made by inserting a metal slider into a length of drinking straw with copper contacts placed at both ends. When the device tilts, the slider moves to one end of the straw, acting as a switch. When the slider completes the circuit at one end, a tone is generated. Placing different resistors in series with each of the contact leads creates the four individual tones. Two buzzers combine the audio signals to create four additional tones, resulting in eight distinct sounds.

The total cost for the project was approximately $7.

Figure 13.32. Flatware Companion Circuit.
STOWABLE COLLAPSIBLE CANOPY FOR WHEELCHAIRS

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INTRODUCTION
The objective of this project was to provide a wheelchair user protection in adverse weather conditions. The design was to be a universal design easily adaptable to a multitude of wheelchair designs. Also, the wheelchair must close with the canopy attached. The user may have limited functionality in operating the canopy, mandating simple two-step deployment and storage.

SUMMARY OF IMPACT
No known devices provide the same versatility and ease of use as the Protective Canopy. Other marketed models require extensive assembly that often cannot be performed by the user.

The Protective Canopy allows an individual to easily rotate and deploy the canopy. The operation has two simple steps. The ratcheting knobs rotate to the locked up position. The canopy top then rotates over against the stops and locks in place. To stow the canopy, the rotator knobs turn to the locked down position and the canopy top rotates back.

The canopy permits easy removal of the entire mechanism from the chair by loosening wing nuts that secure the clamps on the wheelchair handles. The Protective Canopy also allows for collapsing of the wheelchair while remaining affixed to the wheelchair.

TECHNICAL DESCRIPTION
The device consists of two aluminum rods on each side of the wheelchair with ratcheting mechanisms between the rotating upper rods and fixed lower rods. The lower two rods fix to the chair with clamps machined from aluminum and secure together with a wing nut assembly. The left and right sides of the canopy have waterproof nylon fabric between them to provide protection. Small intermediate bars spanning between the sides provide additional support and allow the fabric to maintain the desired shape.

The total cost for the project was approximately $60.
Figure 13.35. Deployed Canopy Mounted on a Wheelchair.
COMPUTER PORT EXTENSION FOR IMPROVED PORT ACCESS

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INTRODUCTION
This project was designed for people not able to reach the rear panel of their computers. This problem may result because the person has a disability or because placement of the computer makes access to the rear panel difficult.

Computer manufacturers have consistently placed the ports and jacks for accessories at the rear of the computer case. Using a computer feature, or software, that requires these accessories is difficult, untimely, or even impossible if one cannot reach the rear port. For instance, a personal computer on a desktop, located under a monitor and against a wall, is difficult to reach behind. Likewise, reaching the back of a mini-tower type computer case built into a desk may be impossible without removal of the computer.

SUMMARY OF IMPACT
This device ensures PC users effective and efficient utilization of tools their PC may need. Examples of tools a user may need include headphones, a digital camera, a video camera, a microphone, or a joystick.

TECHNICAL DESCRIPTION
The computer port extension, an assistive device for computer users, brings useful computer ports closer to a computer user. The device has (4) 1/8” audio jacks and (2) data ports. The audio jacks are female and used as one headphone jack, one microphone jack, one audio-in jack, and one audio-out jack. The data ports consist of one DB9, 9-pin male port and a DB15, 15-pin female port. The entire unit, only slightly larger than a common computer mouse, allows for placement anywhere on a user’s desktop. Approximately 4 feet of bundled wire connects the unit’s jacks and ports to plugs inserted into the rear of the computer. All wiring and connector shells have shielding to minimize interference. All connections are soldered.

The total cost of the project was approximately $100.
Figure 13.36. Computer Port Extension.