CHAPTER 14
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INTRODUCTION
The toothpaste-dispensing and mouth-rinsing toothbrush was developed to allow people with the use of only one hand to brush their teeth in a fast and sanitary manner. This toothbrush was designed so that the entire process of teeth cleaning can be performed using one hand.

The objectives for the function of this product were to allow a one-handed person easily to: 1) apply toothpaste to their toothbrush, 2) brush their teeth effectively, and 3) rinse their teeth and the toothbrush. The objectives for the physical product were that it be: 1) low cost, 2) sanitary, 3) reusable, 4) easy to clean, and 5) simple and quick to use.

Existing toothbrushes are very difficult to use for people with the use of one hand. It is difficult to apply toothpaste from a standard toothpaste tube to a standard toothbrush using only one hand. Also, turning the faucet on and off for rinsing is also difficult while holding the toothbrush. Existing products that apply toothpaste easily to the brush head do not address this problem of rinsing the teeth and brush.

This toothbrush was developed through a design process that began with identifying the problem and understanding the clients' needs and led to extensive market research and the establishment of engineering specifications. Finally, a design was modeled into a working prototype.

SUMMARY OF IMPACT
The toothpaste-dispensing and mouth-rinsing toothbrush (Figure 14.1 and 14.3) allows users to apply toothpaste to the brush bristles and also run water through the brush head with the turn of two gears on the handle that are easy to use with the thumb and pointer finger. This toothbrush is easy to operate for almost all people with a hand disability.
The toothpaste is pushed from the toothpaste chamber with the turning of a gear on the handle as well. The gear turns a pulley, which pulls the base of the chamber up and forces the toothpaste up the neck. By forcing toothpaste back down the neck, the chamber can be refilled.

The toothpaste comes out of a hole in the head of the toothbrush between the bristles. The water flows from the head out of 14 holes between the bristles. The user can set the toothbrush on its flat base and turn the faucet on. The gear screw will pinch the tube and keep the water from flowing through the head. The user twists the gear that forces toothpaste up through the brush head and brushes his or her teeth. When finished, the user releases the water flow up through the head by turning the gear screw that opens the tube up. The flowing water rinses the teeth and mouth, and also rinses the bristles of the brush clean of toothpaste.

The cost of the parts of this toothbrush was $11.
INTRODUCTION
In order to assist people with arthritis, a toothbrush having toothpaste integrated in it has been designed. Frequent travelers may have interest in such compact product, which will prevent leaks in luggage.

SUMMARY OF IMPACT
Without having to use an extra hand to apply toothpaste on the brush, a single hand can be used throughout the oral treatment. The user is able to hold the large handle with good grip in one hand. He or she can next push a single button with this same hand to apply toothpaste on the brush.

TECHNICAL DESCRIPTION
The Toothbrush Combo is a cylindrical apparatus measuring 3 inches in diameter and 19 inches long. It is composed of two main components: 1) the bottom part, containing the mechanical system to push the toothpaste, and 2) the top part divided into: a) the toothpaste compartment, and b) the brush, conducting canal and tube. Those components are held together by two fasteners.

The material used is a type of plastic, UHMV (ultra high molecular weight polyethylene). The bottom part of the device is 8.5 inches long. It contains the mechanical system and six screws holding the system in place. The mechanical system is comprised of different components: batteries, switch, motor, treated rod. Power is generated by two 3CR batteries which are combined and connected to a switch by wires. The switch is a complex part which is then attached to the motor. Between the switch and the motor, contact is made by two parallel aluminum thin plates. The aluminum plates are used to better conduct electricity and also to make the whole system lighter. These aluminum plates are guided by the tip of an L shape rod, which is then attached to a button. The button is situated on the outer surface of the bottom part. It sticks out in order for the users to be able to easily press on it. The rod is controlled by pressing the button to the left or to the right. By doing so, the rod turns and pushes the plates. The plates are pushed towards the motor’s pole. When they get in contact, the motor is turned on. Depending on which side the button is pushed on, the motor can rotate clockwise or counterclockwise. The motor turned on, it spins a treaded rod connected to it. A cap is attached to the treaded rod which can then move up or down depending on the direction of rotation of the rod. While the cap moves towards the top of the toothbrush, it pushes the toothpaste.

The toothpaste is contained in the top part which is 10.5 inches long. The top part is divided in half. The first half is a storage compartment. The second half allows toothpaste flow to the brush. The storage compartment contains the toothpaste. Its capacity is 25 inches cubed. From the outside, the storage compartment has a cylindrical shape. From the inside, it has a square shape. In this compartment, the cap squeezes the toothpaste into the conducting canal. The conducting canal is perforated along the other half of the top component. It allows the squeezed toothpaste to

Figure 14.4. Toothbrush/Toothpaste Combo.
flow inside the top part of the whole toothbrush. Before the canal ends, there is another perforation where a plastic tube penetrates the conducting canal perpendicularly. This plastic tube comes out of the brush situated at the top end of the toothbrush. The transparent plastic tube connects the conducting canal to the brush. From the conducting canal, passing through the transparent tube, the toothpaste comes out of the tube while spreading on top of the brush.

This device is easy to operate. While holding the bottom part with one hand, use your thumb to push on the button. This activates a motor that turns a treated rod. A cap is screwed on that rod and, while the rod rotates in the counterclockwise direction, the cap moves up towards the brush. The displacement of the cap pushes the toothpaste contained in the toothpaste compartment, which in turn is squeezed into the conducting canal. Right before the end of the canal, a plastic tube is inserted perpendicularly to the canal. It allows the toothpaste to flow out of the system. The toothpaste then spreads out on the brush.

The overall cost of this prototype is: $84.

Figure 14.5. Sectional View.
ONE-HANDED JAR OPENER I

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INTRODUCTION

The easy jar opener was developed to address the needs of persons with disabilities who have limited strengths and dexterity. This design was intended for complete operation with only one hand while most jar openers require the use of both hands.

The objectives of this product were to develop a method of opening a jar that: 1) is usable with one hand, 2) requires little strength to operate, 3) is convenient to use, 4) will accept various size containers, 5) is marketable and cost-effective to produce, and 6) has a pleasing appearance.

The one-handed jar opener was developed through a rigorous design process that began with the identification of a problem and culminated in the development of a prototype. During the process, multiple methods of concept evaluation techniques were used.

Most current jar openers, as researched, are opened through a method of using two hands. This two-handed method is either mounting and holding the jar on a base, while pressing a button or turning a lever. The few single handed jar openers found out there are expensive and not easily marketable.

SUMMARY OF IMPACT

Limited dexterity is a broad term that covers arthritis, tendonitis, and an amputated or paralyzed arm that limits the ability for persons to operate many common devices that are usually taken for granted. A jar opener is among the more complicated and challenging devices to operate with a single hand.

When operating the one-handed jar opener, the user is required to raise the top cone with the vertical lever arm. The top lever stays in this upright position to then place a jar on the bright yellow platform under the inverted cone. The vertical lever is then lowered over the jar and fits on snug. The horizontal lever with the black rubber handle is then used to twist the top off, turning to the right. The vertical lever is then raised, again, locks in place, and the jar is removed. The design has a four step easy process.

TECHNICAL DESCRIPTION

The one-handed jar opener consists of two levers, one vertical and the other horizontal. Each lever has a specific motion and task to execute. The vertical lever raises up, and locks in place, and then is easily lowered, pulled by the springs that are attached to the base. The upward motion of the lever requires about 5 pounds of strength. Coming down, the lever needs about 3 pounds to keep it steady and not come down harshly onto the top of the jar with the force of the springs. This covers the jar. Then the horizontal lever twists the top off.

The jar opener accommodates jar of approximate diameters of 4 to 6 inches.

The cost of the parts for the prototype was $76. The estimated cost for market sales is about $40.00.
Figure 14.6. One-handed Jar Opener.

Figure 14.7 One-Handed Jar Opener with Jar.
ONE-HANDED JAR OPENER II

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INTRODUCTION
The one-handed jar opener was designed and created to minimize the effort required to open the common household jar and to make opening the jar possible for those with only one arm or hand. Existing jar opening devices fall under three categories, those that: 1) require the use of two, full-strength hands, 2) require the jar to be held in place by the user with at least one strong hand, and 3) are completely automatic. The problem with the first two categories is that neither product is designed so that someone with one arm or hand can operate them fully, and the third category is often extremely expensive.

In response to this, the one-handed jar opener was designed to be fully functional with the use of only one hand, while remaining low in cost. In addition to these parameters, it was also designed to remain as small and lightweight as possible.

SUMMARY OF IMPACT
Lack of hand strength and the inability to manipulate everyday objects can be detrimental to a person’s ability to function. The one-handed jar opener accomplishes the goal of allowing those with severe hand disabilities to painlessly and effortlessly open jar lids with the use of only one hand.

With the advent of a low cost, one-handed jar opener, the lives of those with limited hand strength will be much less frustrating. With the absence of difficult, painful, and sometimes impossible tasks such as opening jars, the quality of life for those with hand disabilities will therefore be increased.

TECHNICAL DESCRIPTION
The one-handed jar opener is a wooden frame that will be permanently attached to a household countertop via bolts or adhesives. The frame itself is made out of a 10” x 6.5” x 3/8” particleboard base, with two 3” x 14” x 3/8” particleboard legs. These are held together by four 1 ¼” wood screws. The cross beam at the top is ¼” thick steel, with a 5/16” counter-threaded hole in the middle. A 5/16” counter-threaded bolt is fed through this hole, and brazed to the slotted adaptor and gear mechanism. Inside the slotted adaptor, a 1” spring is inserted in order to maintain downward force while in use. The gear mechanism is an existing product on the market, modified by taking off the existing handle, and using a metal pin to hold it into place. The base consists of a PVC cone with slots in the bottom to lock down to the pegs sticking out of the base plate. This cone is coated with a rubber material in order to provide adequate friction.

When the crank handle is inserted into the eyehole of the bolt, it is then rotated counter-clockwise. This advances the thread until the gear mechanism touches the top of the jar, which has been centered on the base cone. Once it reaches this point, the sides of the gear mechanism close onto the lid and then lock down. At this point, all rotational motion is then used to unscrew the lid. Because the threads are still advancing, the gear mechanism is allowed to travel upwards with some resistance (from the spring), but does not have any rotational freedom of motion.

The total cost of parts for the jar opener was $40.
Figure 14.9. One-handed Jar Opened Exploded Assembly View.
INTRODUCTION
Safely operating a motor vehicle with a back or lower extremity handicap can be difficult. Current available solutions focus on either permanent modifications to a vehicle, or devices that are laborious to install and remove on a temporary basis. Research shows that there is no current solution for the situation where one person using a vehicle has a handicap that requires modified controls, and another person who shares the same vehicle does not. The design shown in Fig. 14.10 was developed using multiple concepts for each function, selecting their positive aspects, and combining them into one design.

SUMMARY OF IMPACT
The Quick Release Throttle and Brake Aid is designed for the person who shares a vehicle with someone. This product allows the vehicle to be converted from hand controls to normal feet controls in less than ten seconds without requiring extraordinary strength or flexibility. This device allows both people to operate the vehicle safely in the method that is most convenient for them. The design consists of a lever that is permanently installed, and a removable connecting lever, both made from 6061-T6 Aluminum. It is simple, lightweight, and very safe and easy to operate.

TECHNICAL DESCRIPTION
The assembled device is shown in Fig. 14.10 as it would be fully installed in the vehicle with the connecting rod in place.

The Connecting Rod (Fig. 14.11) consists of two hollow tubes, the Insert and the Adapter. The Insert slides into the Adapter, and has multiple holes to allow for length adjustment. These holes allow the device to fit into most small cars and station wagons without vehicle specific Connecting Rods. The Insert has a slot that connects to the permanently installed Lever, and the Adapter has a similar slot that slides over the brake shaft.

The throttle is controlled by a cable connected on one end to a device similar to a brake from a bicycle and on the other end to the top of the accelerator pedal. The car is accelerated simply by squeezing the Accelerator which is mounted on the handle of the Lever. The brake is controlled by simply pushing on the Lever, which causes rotation about
the mount bolt, forcing the connecting rod to depress the brake pedal. When the lever is released, the force of the brake pedal returns the lever back into its starting position.

This prototype was installed on a 1994 Ford Taurus in order to evaluate the design. It was backed up for ten feet, turned a corner, and then was accelerated to thirty miles per hour using the hand controlled accelerator. The vehicle was then stopped using the hand controlled lever in less than the target of five feet.

A prototype costs were approximately $50.00.

Figure 14.12. Installed Prototype Showing Connecting Rod.

Figure 14.13. Assembled Prototype in Final Color with Handle Grip.
JAR BEAST
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INTRODUCTION
While there is a broad market for devices that aid in the opening of jars, only a select few existing products permit the removal of jar lids with the use of only one hand. This design project resulted in the final rendition of Jar-Beast™, a durable product that works efficiently and dependably, and is easily usable with one hand.

SUMMARY OF IMPACT
The Jar-Beast™ quickly and reliably opens jars. With a few turns of its handles, it can open almost any jar while requiring the user to use only one hand. The Jar-Beast™’s attractive and modern design will look great in any kitchen.

TECHNICAL DESCRIPTION
The base of the Jar-Beast is constructed of a combination of masonite (a plastic-coated fiber board) and billet aluminum, and measures 16.4” long, 12” wide, and 0.9” thick. The base’s sheer size and weight allows for excellent stability when removing jar lids.

The jaws that grip the jar and hold it in place are self-centering in design. This was achieved by mounting the jars on an inverted turnbuckle whose opposing-thread screws are brazed together in the center. The resulting assembly is one whose jaws move at the same rate to and from a central point when the user turns a single handle, as shown in Fig. 14.14.

To compensate for slack in the threads of the turnbuckle, as well as provide extra support for taller jars, the jaws are constructed of 2” high by 3” wide aluminum blocks that are welded to the turnbuckle. Each of the jaws has a V-shaped groove for gripping jars of various sizes. To further enhance gripping power, the V-faces on the jaws are coated with a non-stick rubber surface. With all the design features implemented, the resulting jaw assembly allows jars to be efficiently and dependably secured into place, all while requiring little physical input from the user.

The 6”-diameter lid-removing funnel is made of 24-gauge (0.024” thick) stainless steel. The funnel’s thick metal construction ensures that the funnel will not buckle, deform, or crack if the user tightens the funnel onto a jar lid excessively. The inside of the funnel is coated with the same non-slip rubber
material that coats the V-surfaces of the jaws. The funnel allows for the opening of a wide variety of popular jar sizes, and the rubberized coating provides adequate friction for the efficient removal of the jar lid when the funnel is rotated.

The funnel is attached to a threaded rod via a bearing assembly which, when turned, allows the user to adjust the funnel to an appropriate height according to the jar they want to open. The bearing assembly permits the funnel to rotate independently of the rod.

Once the jar is fitted into the jaws and secured in place, the funnel is lowered onto the lid, simulating the downward gripping force a hand would normally exert on a jar lid when opening a jar manually.

The jar lid is then removed by rotating the funnel using the attached handle. Finally, the funnel is retracted, revealing the jar with the fully loosened lid sitting on the top of the jar.

Total cost to construct the prototype Jar Beast™ was $78. However, it has been estimated that, with more cost-effective selection of materials and fine-tuning of design for ease of manufacturing, the production Jar-Beast™ could be made to sell for roughly $40.
JAR AND CAN OPENER

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INTRODUCTION
The purpose of our device is to loosen jar or can lids for easy removal. Other devices encountered are either expensive, ineffective, or too complex and prone to breakage.

SUMMARY OF IMPACT
In prototype form, this project works rather well by loosening various sized jars to the point where they are easily opened by the slightest twist.

During a redesign the movement of the twisting arm should be made smoother, as this was one of the aspects with room for improvement. Perhaps by adding tracks with wheels to allow for smoother up and down motion one can accomplish this without compromising the basic design.

TECHNICAL DESCRIPTION
Currently, this design is 18 inches high, 10 inches long at the base, and 11.25 inches wide. The cone slides up and down the center of the base while the lever arm extends eight inches. The redesign of incorporating tracks would allow for a much straighter and uniform movement of the cone. Such modifications would not affect the function, but would improve the effectiveness of the device in removing jar lids.

A few special parts were used including:

1) The rubber lined cone
2) The brass connecting joint
3) The back of the base containing the vertical track

These three parts are the main working components of our device and though they could be modified, they serve an important function and must be incorporated.

The cost of production was kept as low as possible. Figures 14.18 and 14.19 show a CAD view of our device. The cone assembly slides vertically over the base.
jar and the handle shown is used to pivot the cone while it grips the jar lid, loosening it for removal. Excluding screws and brackets, a total of eight parts make up our design. These CAD drawings were created in Pro-Engineer Wildfire.

Shown in Figure 14.20 is the operation of our device. The jar is in place and mild pressure is exerted downward as the lever arm is turned, taking the lid off the jar.

Parts costs come to about $20 dollars per jar opener, excluding assembly costs.
EASILY ADJUSTED BIKE SEAT

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INTRODUCTION

A trend often noticed in biking is the improper pedaling position of recreational riders. This problem is prevalent in seniors and other disabled riders. Many of them have difficulty adjusting their bike seats to proper riding position. Using a bike at the improper position often causes lower back pain and cramping, defeating the purpose of bike riding as a low-impact cardiovascular workout.

The only current solution on the market was a product called the Gravity Dropper™. This product is geared for competitive mountain bikers. The seat drops three inches with a pull of a trigger in order to give the rider an advantage going downhill. Their product does an excellent job at this, but their concept does not allow for variable adjustments. This project’s objective was to find a way that a bike seat could be easily adjusted to any height that the rider chooses.

SUMMARY OF IMPACT

The adjustment can be attached to any bike with a few easy connections. Getting on and off the bike will be easier, because the seat can be lowered before one gets on and then raised when the rider is in position. The rider can adjust the bike, while riding, to a position where they feel most comfortable, making the ride more enjoyable. This product helps to eliminate some of the annoyances that keep some people from riding bikes.

TECHNICAL DESCRIPTION

The unit was designed with two aluminum clamps at either end of the device. The top clamp connected the gas piston to the seat post. The bottom clamp connected the piston to the bike frame. This was in order to keep the piston in the proper position so the maximum force is applied to the seat. The device is activated by a lever arm, which depresses a button located on top of the piston. The lever is pulled down by a wire, which is connected to a button at the handlebars, similar to that of bike brakes.
The design was made to be universal for all bikes with similar post diameters. The piston is aligned parallel to the post so that the seat can move as smoothly as possible. The whole product is made out of aluminum, but is a little bulky. In future designs less material could be used, thus bringing down the total cost as well as making the product lighter.

The product came to a total cost of approximately $60.
EASILY-ACCESSIBLE CABINETRY

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INTRODUCTION
The cross-link system was developed to address the inconvenience experienced by many when accessing items located in lower cabinets. The intent of this device is to bring the shelf out of the casing and raise the shelf up for any person to be able to reach the items stored on top of the shelf. Also incorporated into the universal design are objectives not to affect the aesthetics of the exterior cabinet.

Multiple ideas and concepts culminated to form the final prototype. For simplicity of design a motor was not used, nor were any other parts that require a power source; this product is based purely on a mechanical design.

Currently on the market are cabinets that have shelves that slide out of the cabinet casing, but these products have limitations. These products still make the user bend to retrieve items. Also on the market are hydraulically-lifted shelves for heavy kitchen appliances, but these are expensive and unnecessary for average kitchen use.

SUMMARY OF IMPACT
It can be difficult for an elderly person or a person with back problems to access items stored in the lower cabinets of their home. This cabinet was developed so that individuals who are elderly or who have disabilities can maintain independence. This design is easy to operate for all persons of society, regardless of ability.

TECHNICAL DESCRIPTION
The cross-link system mounts to a shelf on sliding tracks attached to the bottom of a cabinet. Each of two cross-links components are made of two 12.5” by 1” aluminum flat-stock with three 3/8” diameter holes in them. One hole is located at each end and the third is in the center of the piece of flat stock. The links are connected to each other by a pin-joint with a bolt through the middle hole of the links. The links are then connected to the upper track by two additional bolts through a hole on each link. The track is made of 2” aluminum bent stock that is 13” long. There is a 3/8” hole 7/8” from one end that is used to connect the link to the track. There is also a sliding slot even with the hole that is 5.25” long slot that connects to the other link by a bolt. The other side of the bent stock has two 1/8” holes which are used to mount the track to the sliding shelf on the bottom of the cabinet. The link attached to the slot on the upper track is connected to the lower track at the 3/8” hole by a pin-joint. The link that is connected to the 3/8” hole on the upper track is connected to the slot on the lower track by a long

Figure 14.25. Half of Cross-Link System.
Figure 14.26. Shelf in a Lowered Position.
bolt that then connects to a mirror image of the cross-link system.

Two chains that are connected to the long bolt by S-hooks are anchored to the back of the cabinet by eye-bolts. As the user pulls the door open, the chain becomes taut and the long bolt in the lower tracks’ slots move along the tracks causing the links to come together and the shelf to lift (Fig. 14.25 and 14.26). A spring is used to decrease the amount of force needed to move the cross-links. When the cabinet is completely opened, a 20” piece of aluminum slides into place between the casing and the shelf. This locking system keeps the chain taut and the shelf at its full height. To close the cabinet, the locking device has to be disengaged. As the cabinet is pushed back into the casing, a spring helps the process be smoother. As the chains become loose, the links move back into their original place and the shelf lowers. Cables attached to the back of the cabinet keep the chains away from the sliding tracks.

This product enables usage on most current cabinetry. The length of the cross-links and tracks can be machined to fit any cabinet.

The materials that were chosen are capable of sustaining a 15 pound load. Aluminum was found to be the optimum material for the cross-links due to its light weight and strength needed for the load. Since the cross-links needed to be attached to the bent metal stock, it was decided that these tracks also be made of aluminum. This allowed for the two pieces to be easily attached using bolts.

The prototype (Figure 14.28) constructed is a down-size of the actual product. The cost of the parts for the prototype was $50.11. The estimated the cost for the full size product in mass production to be $48.00.
AUTOMATIC MOTORCYCLE CENTER STAND

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INTRODUCTION
A motorcycle center stand was designed to assist riders as they stop and go on their motorcycles. Many motorcyclists with lower limb disabilities are unable to ride because they have difficulty stabilizing the motorcycle. Also, people of smaller stature may not be able to make ground contact with their feet. A motorized center stand stabilizes the motorcycle when necessary with minimal effort to the rider. Patents for similar devices exist in the market today but require alterations to be made to the motorcycle. This design is unique in that it mounts onto the frame using existing fasteners.

SUMMARY OF IMPACT
Motorcycle riding can be for leisure or out of necessity. Many people have either no use or limited use of their legs and so they may not be able to participate. Motorcycles can weigh up to 800 pounds without the rider. When riders start and stop their motorcycles, they need to use their legs to prevent the motorcycle from falling to one side or the other. This motorcycle support could make motorcycles more accessible to those with disabilities ranging from loss of legs to arthritis. Using this system, they could enjoy the opportunity to ride a motorcycle. In addition, riders without disabilities can use the system for added convenience.

TECHNICAL DESCRIPTION
The automatic center stand consists of a steel crosspiece that mounts underneath the motorcycles exhaust. It is welded to two brackets on each side of the motorcycle. One of the brackets is attached to the frame using two motor mount bolts. In order to accommodate the thickness of the bracket, the original bolts were replaced with slightly longer ones. The bracket on the other side is affixed using the original kickstand position switch bolts and a U-bolt around the frame. A section of steel square tubing is welded perpendicular in the center of the crosspiece in order to mount one end of a linear actuator.

The linear actuator is the device used to automate the stand. The other end of the actuator is mounted to another section of steel square tube that is welded to the motorcycles center stand. Both ends of the actuator are mounted on clevises that allow it the freedom to rotate as it extends and retracts. The
motorcycle’s original center stand needed to be modified in order for it to serve its new function. Standard center stands lift the motorcycle’s rear tire off the ground. Therefore, the legs of the stand were shortened to an appropriate length such that it just makes contact with the ground. Wheels were attached to the stand so that during rolling starts and stops the bike’s support could slide relative to the ground. Two inch diameter rubber wheels were mounted on the outside of the stand. Finally, a switch was wired from the actuator and mounted between the handle bars so that it could be easily activated by the rider. In experimental trials, the design proved successful. After installing the automatic center stand, it was tested for a week under varying road and weather conditions. It completely eliminated the need for the motorcyclist to use his feet during starting and stopping.

The total cost of parts and supplies was $81.

Figure 14.31. Stand Without Motorcycle.
ADAPTED BRAKE AND THROTTLE

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INTRODUCTION
The Adapted Brake and Throttle (ABAT) is a design that enables a person without function of either leg to drive an automatic transmission car. Existing solutions are expensive permanent fixtures, or are not simple enough to operate. In order to meet the goal of a portable and cheap system, easily-manufactured and pre-existing parts are utilized. Broken or worn parts are, therefore, replaceable without hassle.

What sets ABAT apart from similar portable devices is its squeeze throttle action. Both braking and throttling are accomplished by low effort force. The device fits most compact and mid-sized cars, allowing a comfortable driving position.

SUMMARY OF IMPACT
With the ABAT, a person with disabilities is able to drive any number of cars, because the non-permanent assembly can be installed in five minutes, and removed in two minutes. The straps only need to be special-fit to the brake pedal beforehand. A second car or complex electro-mechanical system for the disabled person is not necessary.

TECHNICAL DESCRIPTION
The ABAT boasts a squeeze throttle action, a bar that engages the throttle when pulled up through a direct link cable. The base is a hinged steel plate, which straps to the brake pedal. Bolted to the base is a steel rod, which the cable passes through. A steel base cap tops off the rod and is removable when fastened with wing nuts. Two steel rail guides are bolted to the base cap and allow the squeeze throttle to slide. A wooden dowel is screwed in between the top of the two rails, where the force to operate the brake is applied.

Total cost of the concept is $22, cut from a steel rail, a rod, and steel stock. An all aluminum production version would weigh much less, and would cost about $30 for a concept. The projected cost of

Figure 14.32. Adapted Brake and Throttle.

Figure 14.33. Adapted Brake and Throttle in Car.
materials for production is $10 per aluminum ABAT.

Figure 14.34. Client using Adapted Brake and Throttle.
INTRODUCTION
Waking up at a particular time to a standard alarm clock is difficult for people who are hearing impaired. Alarm clocks for people who are deaf exist, but they primarily consist of a pad that vibrates, which is placed under a pillow. The problem with this is that, if the pad is moved during the night, then the clock may fail to wake the person. An alarm clock with a vibrator that goes directly into the pillow ensures waking up on time.

SUMMARY OF IMPACT
This design is the same size as a standard alarm clock. It was created with younger children in mind. The alarm clock is encased in a pillow shaped like a ladybug. The vibrating unit is attached by wires to the primary pillow, which encases a vibrating device. The vibrations begin lightly when the alarm goes off, and eventually become more intense. It is easy to use and effective in waking people from their sleep.

TECHNICAL DESCRIPTION
The alarm clock consists of two units. The first unit is the base unit. The base unit consists of a modified standard alarm clock. It has a digital display and the typical functions of standard alarm clock. The alarm sound function has been rewired to a resistor which amplifies the voltage being sent to the vibrator. The second unit is the vibrating pillow. This is located directly inside the pillow.

Because the vibrations become intense, this alarm clock could also be used by heavy sleepers, who have trouble waking up to sound. The parts used in this design are easily manufactured. Production is simple, and could be produced in mass.

The cost of this design is approximately $35.
Figure 14.37. Pro-Engineer drawing of Clock Prototype.

Figure 14.38. Circuit Diagram of Alarm Clock.
ASSISTIVE AUTOMOBILE BRAKING AND ACCELERATION SYSTEM

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INTRODUCTION
Drivers with lower limb injuries face difficulty in operating automobile pedals. Hand-operated pedal control systems are a typical solution to this problem. Existing products employ rigid bars that attach directly to the brake and gas pedals which the driver must push or pull while steering the vehicle. This can be cumbersome and have a negative impact on the overall driving experience. There is currently nothing on the market that resembles this product.

SUMMARY OF IMPACT
The system is universal and can be adjusted to fit on any automobile steering column. Only the driver’s arm strength is needed to work the levers that operate the hydraulic cylinders on which the system is based; no external pumps or power sources are needed. By allowing the driver the use of hand controls to operate the pedals, the driving experience can be both comfortable and enjoyable. Aluminum and steel are the primary construction materials, while PVC reinforced hose is used to transmit the hydraulic fluid between cylinders. These robust materials ensure product longevity and reliability. Drivers who have trouble operating standard braking and accelerating systems will be able to drive independently.

TECHNICAL DESCRIPTION
The Assistive Braking and Acceleration System consists of several key components, such as a control module clamped around the steering column and an actuator module that lies in the foot-well of the car. Figure 14.39 displays the system in its entirety.

The driver operates the device by pulling (or pushing) either one of two handlebars that push on master hydraulic cylinders. From a neutral position, pulling the handle activates the brake master cylinder, while pushing the handle activates the gas master cylinder. Hydraulic fluid is then pushed through individual PVC-reinforced hoses to the appropriate slave cylinder down on the actuator module. The actuator module consists of a wood frame attached to a quarter inch thick, rubber foot-mat that sits in the foot-well. The two slave cylinders rest on top of the wood frame, one for the brake and gas pedals respectively. These are placed such that the pistons in the cylinders will push directly against the pedals. The foot-mat which holds the frame and cylinders in place, sits against the rear of the foot-well to keep the cylinders from moving backwards when activated.

The control module is fastened to the steering column by an octagonal shaped clamp, comprised of two steel sheets, that fastens together using 4 bolts in the horizontal direction. Each half of the clamp is made from a 1/8” thick, 2”x12.5” sheet of steel, bent into the appropriate shape. Two steel tabs are welded to the bottom of these with coaxial holes drilled through them to support the axial torsion bar. Two handlebars are attached to the ends of the torsion bar, and are perpendicular to its long axis; both are approximately 12” long. Also attached to the bar are plungers that push on the master cylinder pistons as the bar is rotated. The left clamp half has the master cylinders mounted to it. This
leaves the bulkier side of the clamp closest to the door opening for easier installation.

The two master cylinders are both made from 2” diameter, machined aluminum; both have 1” diameter aluminum pistons. Each cylinder is welded to its own 3/8” thick aluminum plate. Another 1/8” sheet of steel is welded on the side of the left clamp half, and each aluminum plate (with its cylinder) is bolted to this steel plate.

Two heavy-duty, reinforced PVC plastic hoses, one for each cylinder, connect the master cylinders on the control module with the slave cylinders on the actuator module and are rated to withstand more than 300 psi; both hoses are 0.5” outer diameter, 0.25” inner diameter. Fig. 14.40 shows the control module and the connecting hoses.

The actuator module starts with a commercial grade foot-mat as a mounting surface for the wood frame. It also serves to keep the frame stable and stationary. The simple wood frame is constructed of 2x4 spruce wood timbers. On top of these are the two slave cylinders. The brake cylinder is 1.5” diameter machined aluminum with a 0.5” diameter aluminum piston. The gas cylinder is 1.5” diameter machined aluminum with a 3/8” diameter aluminum piston. These are fastened to the wood frame with metal U-brackets and positioned so that the pistons are in line to make contact with the pedals.

A 20 lb maximum operating force is required to operate either of the two handles; both have a 60 degree range of motion from the neutral position. There is a 9:1 mechanical advantage when pulling either of the handles, resulting in a 50 lb force exerted on the pedals by the master cylinder pistons; both pistons are allowed a 6” stroke length during operation. Regarding the PVC hose and all cylinders combined, an approximate total of 1.77 cubic inches of hydraulic fluid is needed for optimum performance. As with any hydraulic system, the absence of air pockets within the cylinders and hose is critical; only then, through fluid suction, will all pistons return to their initial positions.

The total cost of the materials used is approximately $62; the aluminum stock used for the cylinders constitutes the bulk of this figure.
AUTOMATED WHEELCHAIR STORAGE SYSTEM

Designers: Kyle Kremer, Brian Mullen
Sascha Ruemenap, and Dan Santos
Collaborators:
John Deere, PTC, Georgia Tech, Univ. of Illinois, Univ. of Maryland, Bentley College
Supervising Professor: Prof. Sundar Krishnamurty
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INTRODUCTION
The objective of this engineering project is to modify the existing John Deere Gator (Figure 14.42), a small utility vehicle used for hunting, fishing, and on golf courses etc. The location to store the wheelchair was first determined through a selection decision matrix. With the chosen location, the device to move the wheelchair from the point at which the user leaves the wheelchair, to the storage location, needed to be designed. Research was done on different ways to complete the required tasks: pick and place (e.g. lifting, rotation, and translation), attachment, and folding of the wheelchair. Concepts were then generated, evaluated, revised, and finally a concept was selected for the design. The final design is a pole located behind the driver with a rodless linear actuator that sits atop a gear, which is attached to an electric motor, and acts as a turntable. Attached to the actuator is an arm perpendicular to the pole. At the end of the arm, away from the pole, the attachment device for the wheelchair is located. The attachment device is one track, in which one of the wheelchair wheels is rolled into and then locked into place.

SUMMARY OF IMPACT
This design is a major component in making the Gator accessible to wheelchair users. The design allows for the storage and unloading of the wheelchair and interfaces with another design project, that of a seat transporter so that the person using the Gator does not need any help getting into, getting out of the gator, and storing and retrieving the wheelchair. With this design, in conjunction with the seat transporter, a new market has been opened for the John Deere Gator while also expanding the choices and freedoms for those with disabilities.

TECHNICAL DESCRIPTION
The design of the pick and place mechanism was designed in three steps: determining the location,
standing on its wheels and parallel to the side of the Gator.

The best way to transport a wheelchair to the selected storage location from outside the Gator is using a linear actuator to lift the chair. The linear actuator sits on top of two bearings and a turntable, which is directly connected to a pneumatic rotary actuator that turns the whole assembly.

There is an arm which extends from the linear actuator and connects the pick and place part of the design to where the wheelchair attaches to the device.

The wheelchair attaches to the device via a track which one of the wheels is rolled into. Then a locking mechanism slides down the post and locks the wheelchair into place. This locking device makes it safe for the user to move out of the chair, folds the chair, and latch the chair so it stays folded. With the wheelchair in place, the pick and place device can be activated.

Figure 14.44. Linear Actuator from Danaher Motion.

Figure 14.45. Turntable Assembly with Bearings.

Figure 14.46. Rotary actuator from Rotomation.

Figure 14.47. The wheelchair attachment mechanism. Showing the track, locking
ASSISTIVE TOOTHPASTE DISPENSER

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INTRODUCTION
A project was developed to aid a person with a hand disability in brushing his or her teeth. Two of the major product types researched (using the Thomas Register and the USPTO Patent Database) are disposable toothbrushes with the toothpaste in the handle and toothpaste dispensers with motorized pumps. Using design practices such as the 6-3-5 method, a House of Quality (QFD) matrix, a customer questionnaire, and the TRIZ method, a new option, a mechanical toothpaste dispenser was developed with the aim of balancing cost efficiency with functionality.

SUMMARY OF IMPACT
The assistive toothpaste dispenser allows a person with only one hand or limited manual dexterity to easily put toothpaste on his or her toothbrush, without requiring use of a specialized toothpaste or toothbrush. Furthermore, the product may be useful to persons without disabilities. It provides a sanitary, semi-permanent stand for toothpaste and a temporary stand for a toothbrush during use.

TECHNICAL DESCRIPTION
The entire housing of the dispenser prototype was created from aluminum and the components were subsequently welded together. The roller assembly was also manufactured from aluminum with the exception of the large wheels, which were cut out of fiberglass. When the wheels are turned, the rollers turn in opposing directions, squeezing out toothpaste while advancing down the tube. Tracks along the walls guide the rollers. The rollers themselves are covered in a rubber shrink wrap to promote this action. The result is a controlled amount of toothpaste leaving the tube to be used on the toothbrush below it.

At a reasonable cost to the user, this design is reusable, in contrast to disposable toothbrushes.

Additionally, because our dispenser is a purely mechanical system, it is simple enough that it requires no complex set up or special care due to electronic parts.

These characteristics make the dispenser easy to use, easy to assemble, and affordable.

While the prototype works, it is only a proof-of-concept. Injection molded plastic would be the ideal material to create the marketable product. This is partially due to the high tooling costs of aluminum. Not only would it be less expensive and faster to injection-mold all parts out of plastic, but a large metal structure would surely drive away many potential customers. An additional benefit of using plastic would be reduced friction and, therefore, less required force. Using an injection-molding estimator (Professor Kazmer, Univ. of Massachusetts-Amherst), the estimated cost is $7.04/part, including processing, materials, and tooling. This is based on an analysis of potential customers and a conservative estimate of a production volume of 20,000 in the first year. The price to consumer would be less than $15.00.
Figure 14.49. Roller Assembly.
INTRODUCTION
A toothpaste dispenser was designed to assist those with hand disabilities. For the most part, the designs for combination toothpaste/toothpaste dispensers are designed for people who travel and not for an individual with disabilities.

SUMMARY OF IMPACT
The main goal of the Improved Dispenser was to design a dispenser that can be used with, and maintained with, one hand. Additionally, the design is easy to operate for people who have trouble with coordination. The Improved Dispenser will make the task of brushing one’s teeth easier and less frustrating. In addition, people who have suffered a temporary ailment, such as a broken hand or finger, will also benefit from an easier application of toothpaste.

By designing a toothpaste dispenser that works with the tube style toothpaste container, customers will not be forced to buy a single brand of toothpaste. The Improved Dispenser is also made from components that are reliable and easy to replace, making it a long-lasting solution.

The Improved Dispenser was designed so that it could be practical for everyday bathroom use. To do this is electric solutions were not used for safety purposes. In addition, batteries were not used to save users from constantly having to spend money to replace them. The most practical solution was a manual device.

TECHNICAL DESCRIPTION
The Improved Dispenser is made of five main components: 1) the base, 2) the roller, 3) the gear, 4) the rack, and 5) the ratchet. The base in the prototype was made of three separate machined aluminum pieces out of convenience. In reality, the base would be a single plastic piece. The base itself is nine inches long, three inches wide, and the three inches in height. The base floor holds the toothpaste tube and also secures the rack. The side walls are a quarter of an inch thick and slotted. The slots serve the function of holding the roller and setting the roller height so that it is offset from the base floor that the toothpaste tube rests on. The offset is equal to the thickness of an empty toothpaste tube. This allows the roller to be able to roll out all the toothpaste. The front side of the base has a piece that serves the function of holding the toothpaste tube in place, and preventing it from moving forward or being bent upward. The bottom of the base is made of a material with a high coefficient of friction. This allows the base not to slide on the bathroom counter when force is applied the ratchet.

The roller is made of one shaft that consists of two different diameters. The first diameter is equal to the diameter of the gear hub (1/4 inch). The gear fits onto this portion of the shaft. This diameter also allows the roller to slide in the slotted side of the base walls. The ratchet is attached to the roller and allows for the user to turn the roller and gear with a high ratio of mechanical advantage. As the roller turns, the gear being set on the rack allows the roller to move in the horizontal direction, and as a result, the roller larger diameter (1 inch), applies force to the toothpaste tube. When all the toothpaste is dispensed, the ratcheting direction can be switched so that the tube can be taken out and a new tube can easily be placed underneath the roller.
For the prototype, the roller, gear, and rack were all comprised from aluminum, but for the final design would be made from plastic. By making these pieces plastic one will be able to cut down on cost while maintaining functionality. Plastic gears and rack are commercially available, and when bought in bulk, very inexpensive. In addition, the final design would also include a manufactured ratchet opposed to a commercially available ratchet. The projected final cost and prototype cost were:

<table>
<thead>
<tr>
<th>Material</th>
<th>Prototype Cost</th>
<th>Projected Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Brass Gear</td>
<td>$12.15</td>
<td>$0.98</td>
</tr>
<tr>
<td>Brass Rack</td>
<td>$27.48</td>
<td>$1.90</td>
</tr>
<tr>
<td>Ratchet</td>
<td>$10.30</td>
<td>$3</td>
</tr>
<tr>
<td>Aluminum</td>
<td>$10</td>
<td>$2</td>
</tr>
<tr>
<td>Total Cost</td>
<td>$59.63</td>
<td>$7.88</td>
</tr>
</tbody>
</table>

From the projected material cost of $7.88 and manufacturing cost the estimate of the overall price for Improved Dispenser would be $24.40. This figure is already $3 less than the major competitor. Going into production and possibly making minor modifications would allow the Improved Toothpaste Dispenser to be more affordable than the current solution.
INTRODUCTION
The PG Propulsion Wheel allows wheelchair users to more easily navigate up inclines or over obstacles that they encounter in their homes and in their everyday lives. The wheel is equipped with a gearing system, so the users can exert less force to propel themselves.

The objectives during production were to make the system modular. The user should be able to switch back to their existing wheel, if needed. The method of propulsion was kept the same, to maintain consistency in the users’ lives. Another objective was to maintain the relative width of the wheelchair. It is already difficult for people in wheelchairs to navigate through doorways and other small passages. The last objectives were to allow the wheelchair to be easily transported and keep the product relatively inexpensive.

There is no existing system that is directly comparable to the PG Propulsion Wheel. Current proposed designs have the gearing system on the backside of the wheel. These products are not modular and the wheelchair cannot be folded up for easy transportation.

Electric wheelchairs are another option for people with limited arm strength. Electric wheelchairs can cost anywhere from $2,000 to $10,000. They are also bulk and hard to transport. Other people opt to buy threshold ramps that help them get over thresholds from room to room. These can cost $50 to $60 a piece, which can add up and become costly.

SUMMARY OF IMPACT
For wheelchair users with weaker arms it is difficult to navigate on inclines or over obstacles, such as bumps in pavements or thresholds between rooms in homes. The PG Propulsion Wheel gives wheelchair users an option that allows them to exert less force to mobilize their wheelchair. The wheel does not add width or change the method of propulsion of the existing wheelchair.
behind the wheel. By allowing the sun to rotate with the propulsion of the wheelchair and keeping the outer ring stationary, the planetary gearing system works properly.

The bracket is attached to the wheelchair by a quick-release attachment. The assembly is designed to be attached using the quick release axle of the user’s existing wheelchair. The central axle may be the only universal feature on manual wheelchairs. The PG Propulsion Wheel is designed to be mounted by inserting the axle through the center of the sun. The mounting of the wheel is also designed so that it is able to be taken off whenever the user needs to use an ordinary wheel.

The planetary gearing system used can provide a mechanical advantage ranging from 2:1 to 10:1. The mechanical advantage can be decreased by increasing the size of the sun and decreasing the size of the planets. For the prototype, a mechanical advantage of 7:1 was fabricated, in order to demonstrate the concept visually.

The design has shown that the design idea is practical. The force needed to move the rim is substantially less. The decrease in force needed is gained at the cost of speed. Tests on inclines demonstrate the minimal force needed to ascend the incline.

Plans for an actual model of the PG Propulsion wheel include nylon gears. These would keep the weight of the existing wheelchair relatively similar. Nylon gears would also minimize any noise that the gears would make.

The total cost of materials to produce the prototype of the PG Propulsion Wheel was $211. The material cost does not include the cost of the wheel or the rim.
INTRODUCTION
The long-cane is a widely used and accepted travel aid of people with visual impairments. An enhanced long-cane travel aid with an embedded electronic collision warning system was developed to reduce risk of injury from walking into suspended or overhanging objects.

SUMMARY OF IMPACT
A user of the traditional long-cane can feel the nature of a path and can detect holes, bumps, curbs, steps and obstacles on the ground. However, suspended or protruding obstacles above waist height cannot be detected with a traditional long-cane. Embedding a microprocessor controlled ultrasonic sensor system into a long-cane will make travel safer for the user and advance the state-of-the-art of mobility aids research.

TECHNICAL DESCRIPTION
A miniature ultrasonic obstacle detector using an embedded DSP capable microcontroller and piezoelectric transducers is embedded into the body of a long-cane. A coded ultrasonic pulse is sent out to bounce off all obstacles up to four meters ahead of the user. Two receiver transducers capture the reflected signals which are decoded using correlation techniques. The two receivers form a synthetic aperture that discriminates obstacles that pose a collision hazard. The range and elevation of obstacles detected in the danger zone are calculated from the geometry of the sensor array, the time of flight information, and the angle of tilt of the cane. The information is transmitted at 900 MHz to a wireless receiver and microcontroller which indicate the range of the obstacle to the user in a voice message.

To achieve pulse compression, a binary code sequence, a 13 bit Barker code, was embedded into a carrier signal by shifting the phase of the signal 180° between ones and zeroes. As shown in the figure, a transmitted pulse with an embedded binary code sequence can be detected even if the energy content of the reflected signal is low and the signal is buried in the noise. The technique can also differentiate between obstacles spaced closer than

\[
c(l) = \sum_{i=0}^{N-1} e_i \cdot x_{i+l}, \quad l = 0, 1, \ldots N \quad (14.1)
\]

where:
- \( c(l) \) is an element of the result of the cross correlation vector,
- \( N \) is the number of samples in the signal,
- \( e_i \) is an element of the zero-padded correlation vector,
\( x_{l+1} \) is an element of the compensated signal vector, and

\( l \) is the lag.

The vector resulting from the cross correlation shows a peak or local maximum for each received echo. The timing of a peak is proportional to the distance to an obstacle. The peaks in the vector from one receiver are matched to corresponding peaks in the vector from the second receiver. The fixed spacing between the receivers determines the maximum arrival time difference that an echo returning from a particular obstacle can have.

Fig. 14.58 shows the geometry of the two receivers. The simpler, vertical arrangement of the receivers is shown in black. The blue shows the receivers at an angle of 34° as they would be in the long-cane.

There will be no difference in arrival times when the obstacle is centered in front of the receivers. The difference in arrival times at the two receivers can be calculated for the vertically oriented receivers as:

\[
\Delta t = \frac{d}{c} \sin(\theta)
\]  

(14.2)

where:

\( \Delta t \) is the difference in arrival times,

\( d \) is the distance between the receivers,

\( c \) is the speed of sound in air, and

\( \theta \) is the angle between the line perpendicular to, and bisecting, the line connecting two receivers and the line from the bisect point to the target.

There is a finite range of \( \theta \) for the censor embedded long cane to respond only to obstacles that pose a collision threat not detectable by traditional use of the long cane. The first set of peaks that collaborate within that range trigger a warning.
INTRODUCTION
The Single Hand Jar Opener is intended to allow the user to loosen jar lids with one hand while remaining relatively light, simple and portable. Considerations of the target audience, composed primarily of those who are elderly and those with limited use of one hand, dictate a specific set of engineering requirements. First, the device must be entirely operable with only one hand. The device must operate with little or no grip strength. The operation must be simple and the device must be portable.

SUMMARY OF IMPACT
The Single hand Jar Opener widens the group of people who can open jars. It allows anyone with the use of one hand to successfully remove jar lids. People with limited use of both hands (including limiting grip strength/ability) can effectively use the device. It is also useful for those who have only occasional difficulty with jars and others who seek an efficient lid-removal tool.

The prototype shown here represents the early development of the design. It demonstrates the overall effectiveness of the concept at meeting the design requirements and highlights some of its primary advantages over alternative concepts. The opener is simple to use, is self-adjusting and requires only one handle and one motion for all aspects of its operation. It lays flat for convenient storage and requires no electricity for operation. As a prototype, it does not represent a mass producible design; additional modifications will be necessary prior to the introduction to market. An anti-roll device should be fitted to the opener to maintain a parallel orientation between the opener rails and the surface on which the jar rests. It would be composed of a rectangular base frame and telescoping uprights running through the side rails.

As is intended to prevent twisting and not to support the opener, it would be auto-adjusting and would not require any attention from the user and would contribute only slightly to the collapsed height. The effective lid size range would be increased by allowing for adjustment of the length/tension on the jar lid slider spring. A better handle would make the opener more comfortable. Changes in materials and manufacturing techniques for increased production would also reduce the weight.

TECHNICAL DESCRIPTION
The Single Hand Jar Opener device is intended to converts linear motion from the user into rotational motion on the lid. The prototype is shown in Fig. 14.60. It is composed of two sliders, a lower jaw and an upper opener track. A fixed back stop forms the other half of jaw. The sliders run in the side rails which form the frame of the device. A scissor mechanism transfers the user’s force from the handle to the sliders. See Fig. 14.63 for part arrangement.
To use, the device may be removed from convenient storage via the handle; which extends the scissor mechanism, pulling the sliders together, preparing them to accept jars. The device is then placed on the jar, centering its lid the on the transparent top piece. As the handle is depressed, force is transmitted through the scissor linkages to the sliding plates. The bottom jaw slider moves against the jar, forcing it against the fixed backstop. The top slider moves in the opposite direction of the bottom slider contacting the jar lid. As the force is increased, the spring is compressed until the normal force generated on the lid is sufficient to stop slippage, at which point lid rotation is initiated. When sufficiently loosened, the device is lifted by the same handle causing the sliders to retract, which frees the jar. The lid may then be removed. The handle is depressed with the device off of the jar to return it to the storage position.

As produced the prototype has dimensions of: 21 ½” x 7 ½” x 4” in the compressed position and weighs 9 3/4 lbs. It can be produced from commercially available aluminum at an approximate $46.00. Design changes for mass production could approximately cut the costs in half.
CONEHEAD JAR OPENER

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INTRODUCTION
The Conehead Jar Opener is designed to aid in the opening of tight jar lids. This device is applicable to a wide variety of people of different ages and abilities. The Conehead is designed to adjust to the many different shapes and sizes of jars. The opener can help anyone with a missing arm, hand, and/or fingers, anyone with a disease such as arthritis or tendonitis, or anyone who does not have the strength to open a tight jar lid.

SUMMARY OF IMPACT
The design is lightweight and mechanical. The proof of concept had some materials-related problems that could be solved with tighter manufacturing tolerances and improved selection of materials. Those problems aside, this design provides a sufficient mechanical advantage to tackle the design challenge.

TECHNICAL DESCRIPTION
The Conehead Jar Opener has five main parts which work together to perform the final objective of opening a jar: 1) the base plate, 2) the vertical column, 3) the lockdown lever arm, 4) the cone; and 5) the rotating base.

The base plate, which stabilizes the entire device, is equipped with four rubber pads on the bottom which prevents the jar opener from slipping. The base plate is 12” long, 12” wide, and is 3/8” thick. It is machined from 60-61 aluminum.

The vertical column connects the base plate to the lockdown lever arm. This column in 12” tall, which allows larger jars to be opened. It is also 1” thick enabling it to withstand the torque needed to open a jar.

The lockdown lever arm is a unique part to the Conehead Jar Opener. The lever arm can move up and down, enabling any size jar to be opened. As the lever is pulled down, it locks down on the jar, creating a strong normal force on the jar. The lever

Figure 14.64. Conehead Jar Opener.

is an 8” long, cylindrical shaft made of stainless steel.

The cone (4) is responsible for gripping the lid of the jar. Once the lever has been locked on the jar, the cone grabs the lid with its internal rubber lining. The cone shape allows the device to adapt to the many different shapes and sizes of jars. The internal rubber lining creates a strong friction force enabling the jar lid to be stationary as the rest of the jar is rotated. The cone is made of thick plastic. The length of the cone is 8”, while it is has a 6” handle on top allowing the user to get a good grip on the device.

The rotating base is where the jar is placed. It has a connected lever arm which, when turned, creates a mechanical advantage for the user. The rotating base has a rubber surface which creates a friction force on the bottom of the jar. The rotating plate is made of 60-61 aluminum.

A “directions” section would be available with the packaged device stating the following: Place the jar on the rotating base. Pull the cone over the jar pressing down on the lid, thus locking the cone on the jar. Then rotate by pulling the lever on the
rotating base plate in a clockwise direction. Lift the cone off and the jar will be open.

An approximate cost is $23.

Figure 14.65. Designers and Conehead Jar Opener.
INTRODUCTION
Tooth decay is one of the most prevalent diseases in the United States today coming in second only to the common cold. In their efforts to avoid this disease, Americans spend $2 billion a year on dental products such as toothpaste, toothbrushes, and mouthwash. Such products are essential to keeping our teeth clean. However, people with limited manual dexterity may find the simple task of applying toothpaste onto the brush to be quite challenging. Examples of those affected may be those who have carpal tunnel, arthritis, or a broken arm or hand.

SUMMARY OF IMPACT
Temporary or permanent disabilities in the hands or arms affect millions of Americans. By combining the paste and brush into one easy-to-operate device, the Pastebrush makes brushing teeth a simple one-handed task. Simply grasp the brush and give the dial a quarter turn and paste is applied to the bristles. With its ergonomic grip and smooth operability, the Pastebrush is easy to use for anyone with a disability in a hand or arm.

Looking for the perfect travel companion? With its compact size and all-in-one capability the Pastebrush eliminates the need to pack a toothbrush and toothpaste when traveling. Also, the twist n' lock cap allows the user to insert any type of paste. Snap-on, replaceable brush heads allow for easy replacement of the bristles when they become worn.

TECHNICAL DESCRIPTION
The overall design of the Pastebrush is shown in Fig. 14.67. It is comprised of six parts, the most complicated of which is the ball valve that is used to start and stop the flow of paste through the brush head. The spring, with the stopper mounted on top if it, serves as the driving force that moves the paste. The stopper has a conical shaped depression on the top with a slope of five degrees below the horizontal. This angle allows the paste to be taken from the sides of the main tube and brings it towards the center.

The cap, on the bottom of the brush, is designed so that it can be easily manipulated using only one hand. J-shaped grooves cut into both sides of the cap allow the pegs from the main tube to be locked into place by the compression force from the spring. A key part of the design involves the brush head itself. In order for paste to flow from the main tube to the bristles the brush head must be hollow on the
inside with a hole coming up though the center of the bristle area. In the prototype model the head of an Oral-B Crossaction electric brush was used as is shown in Fig. 14.67 and again in Fig. 14.68. Brush heads on the production model shown in Figs. 14.69 and 14.70 are designed to be replaceable for maximum brush usage.

As is shown in Fig. 14.57 the Pastebrush is also equipped with ergonomic grips to make grasping it easier, and allowing for a better overall grip when brushing. A performance evaluation was done to see how our final product stacked up against our initial target values. These values were as follows: two brushings per day, one to two pea-sized amounts of paste per brushing, and a total of 82 to 165 brushings. The final design of the Pastebrush is 8” long and 7/8” in diameter. This allows it to hold 81 to 162 brushings worth of paste for an adult and a child respectively. The number of brushings is based on the dentist-recommended allotment of one pea-sized amount of paste for a child and twice that for an adult.

Current products on the market only hold 30 brushings worth of paste. Based on an average of two brushings per day, these brushes would only last two weeks. The Pastebrush on the other hand can hold six to twelve weeks’ worth of paste for an adult and a child respectively. Our design far exceeds that of our closest competitors. The Pastebrush can be refilled and the brush heads can be replaced, while the competitor’s brushes can do neither. The projected selling price of the Pastebrush could be as low as $3.45. This number is based on a 15% profit margin and the competition’s selling price of $3. Due to the quality of its design and added features such as ergonomic grips, refillable option, and twist n’ lock cap the Pastebrush could easily sell for $5. This is still a third of the price of the average electric toothbrush.

The final cost of producing the prototype was $27.24. However, this number is slightly inflamed as it includes the price of PVC cement, Plumber’s Goop, and an Oral-B Crossaction brush of which only the head was used. Without those materials, the cost was $12.59. It should also be mentioned that the ball valve used in the prototype was purchased at Home Depot for $4.97 and is made of chromed brass. All of the parts on the production model are designed to be injection molded except for the spring.
UNIVERSAL TOOTHPASTE DISPENSER

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INTRODUCTION
A device was designed to aid people with one functional hand in brushing their teeth. It incorporates a motor to provide power to dispense the toothpaste.

SUMMARY OF IMPACT
With our product, brushing one’s teeth is made easy for both people with one functional hand and the use of both hands. For people with the use of one hand, however, it is a vast improvement from any other the current devices on the market today.

TECHNICAL DESCRIPTION
The device is a mechanical toothpaste dispenser that uses an electrical motor to dispense the toothpaste. Upon the depression of the button, the motor is activated, powering the gears. The gears then rotate a screw, which drives a plunger upwards. This plunger is located inside the toothpaste canister. It is forced to move upwards as it is prevented from rotating by the square design of the toothpaste canister. This moving plunger provides an increase in pressure within the canister, driving the toothpaste out of the top. The toothpaste travels through the affixed nozzle and enters the tubing. The tubing transports the toothpaste and delivers it directly above the button, and onto the toothbrush, which is depressing the button.

The whole process detailed above happens simultaneously. That results in an efficient dispensing of toothpaste. The motor used provides approximately two Newton-meters of force. Through the gearing, that torque is magnified 3.5 times, with the resulting torque that is delivered to the shaft is seven Newton-meters. The button used is a standard doorbell that completes the circuit and actuates the motor.

The prototype is primarily constructed using aluminum. This would prove costly to produce. However, in the model for production, it would be made out of injection-molded plastic and would be much less expensive than the prototype. It would cost approximately $15 for the final model, while the prototype cost about $30 to make.
Figure 14.73. Exploded View of Dispenser.

Figure 14.74. Prototype of the Universal Toothpaste Dispenser in Use.