CHAPTER 20

UNIVERSITY OF SOUTH ALABAMA

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A Child's Recreational Alternative to a Powered Wheelchair

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Disabled Coordinators: Robert Perry, Rehabilitation Engineer
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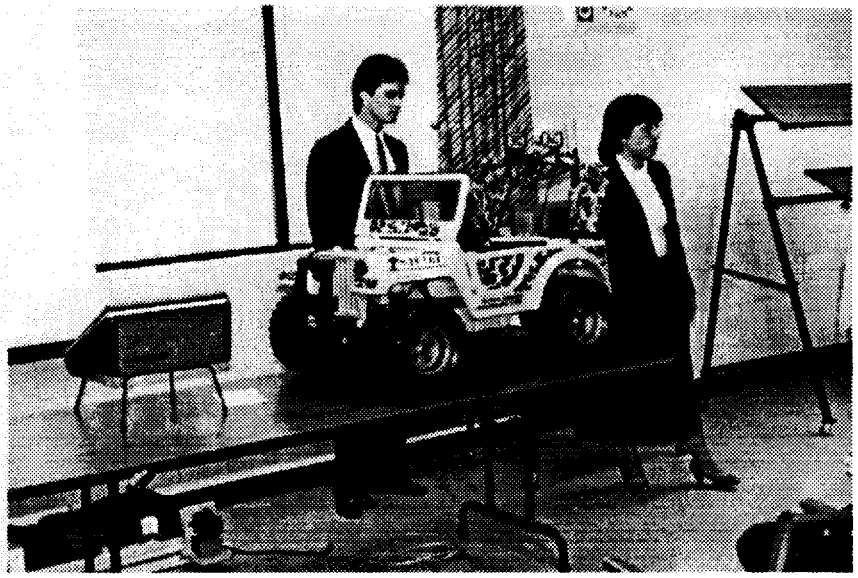
INTRODUCTION

To allow for outdoor activity a three year old cerebral palsy client a recreational alternative for a powered wheelchair was requested. The available powered riding toys for handicapped children do not meet the client's needs. Therefore, in cooperation with the United Cerebral Palsy (UCP) Center of Mobile, Alabama, a commercially available electric-powered toy jeep has been modified. The seat in the jeep has been replaced with a base to attach therapeutic posture seating. The steering wheel and foot pedal have been replaced with a gated joystick and electronic control system.

A motor and linkage to turn the front wheels have also been added to compensate for removal of the steering wheel. Other modifications include a second joystick that allows the supervising adult to override control of the car if necessary.

SUMMARY OF IMPACT

While this vehicle was constructed to meet the specific needs of the client, the design concepts could easily be adapted to a range of children. For example, the seat attachment base allows the attending therapist to prescribe the best posture seating for each child. The UCP Center staff has expressed an interest in modifying jeeps for the center and other young clients. The adapted electric-powered toy jeep allows the client to interact with the outdoor world.



TECHNICAL DESCRIPTION

An outdoor recreational alternative for a powered wheelchair has been constructed in cooperation with the United Cerebral Palsy Center of Mobile, Alabama. The main components of the modification of the Power Wheels toy jeep are outlined below

Seating

An attachment base for therapeutic posture seating has replaced the stock car seat. This base is constructed on 2x8 lumber and 1" diameter tubing. The plastic car body is sandwiched between the cross boards so that the plastic is not subjected to point loading. While this attachment base was built especially for the client's posture seat, this design could easily be adapted for other seating configurations.

Other Support

A swing-away tray was included for joystick arm support. Foot support was provided by a multi-layer wooden platform added to the floor of the car. Layers of the platform may later be removed when increased leg room is needed. The safety harness supplied with the posture seating will be used for restraint.

Joystick control

A gated joystick was located for right-dominant hand control. The joystick returns to neutral when released and power to the motors is disconnected. A second joystick has been included to allow the supervising adult to override control of the car when necessary. Depressing the fire button on the second joystick transfers control of the car to the supervisor's joystick until the fire button is released. The fire button of this auxiliary joystick energizes a four pole double throw (4PDT) relay located between the four output leads of the main joystick and the rest of the control circuit.

Battery Circuit

The car came equipped with two 6 volt batteries. The batteries were wired in parallel to the motors and in series using a diode to the relays.

Drive Motor Circuit

A small DC motor and gearbox assembly is at each of the rear tires. Each drive motor is wired to its battery and the joystick through two single pole double throw (SPDT) relays. When the joystick is pushed forward (backward) both motors are activated and drive the car forward (reverse). When the joystick is pulled left or right the steering motor is engaged and the drive motors are activated in forward.

Steering Motor

A 12 volt windshield wiper motor is used turn the front wheels. The steering motor is connected to the front axle through a pitman arm, tie rod, and steering arm. The steering motor interfaces with the steering control circuit through a contact arm and three limit switches. Mechanical stops were also included to guard against over steering or motor damage should one of the limit switches fail to operate properly.

Steering Control Circuit

The steering motor control circuit components are: four SPDT relays, two 3PDT relays, and three limit switches. The limit switches feedback steering position from the steering motor contact arm. When the center limit switch is engaged the steering motor remains idle until the joystick is moved to the left or right position. When the joystick is moved into the left (right) position the steering motor activates and the front wheels are turned until the left (right) limit switch engages and the steering motor stops. Moving the joystick into the forward or reverse position reverses the direction of the steering motor rotation and the front wheels are turned until centered.

Further work to provide for smooth acceleration should be considered. The joystick circuit activates the drive motors in the same manner that the original foot pedal, The pulse felt as the motors receive full power may not be suitable for all children

The final cost of the project, including the cost of the original toy jeep, was approximately five hundred dollars ($500.00).

A Wheelchair Workstation
An Adjustable Wheelchair Workstation For a Quadriplegic Child

Designers: Virginia Byrd, James Cunard, Ray Kesterson, Lynda Lebel and Geoff Pain ter
Disabled Coordinators: Robert Perry, Rehabilitative Engineer
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INTRODUCTION

The wheelchair workstation provides the adjustability and stability required by the client. These requirements include adjustments of horizontal and vertical position, angle of equipment, and distance from user. The workstation provides a large work area that can simultaneously accommodate several pieces of equipment, including a page turner, typewriter, computer and/or other devices or materials. The user is positioned at the workstation and adjustments are made accordingly.

The support structure of this design is an A-frame keyboard stand. These music stands are lightweight and adjustable yet high strength, with a factory rating of 150 pounds per support tier. Locking casters were added to aid in positioning the workstation without reducing stability.

SUMMARY OF IMPACT

There are many wheelchair trays available for handicapped people with partial use of their arms. These trays do not meet the needs of this quadriplegic client (complete paralysis of the body from the neck down). He also requires permanent respiratory assistance through a tracheotomy. The respirator severely limits his vertical head movement; however the horizontal movement is less restricted.

The client previously used a fixed position lap tray, which could be used to support his page turner, but could not be used for any task that used mouth stick action. He attends fourth grade, and his teacher or an aide must hold his paper for him to write using his mouth stick. His lap tray could not be used with a typewriter or computer to enhance his

communication and learning skills. Two wheelchair workstations were built, one for home and one for school use. The client can use the workstation without requiring his mother to transport more equipment. The classroom workstation also could be used by other students. The school year had ended before the client received his workstations, therefore the workstations have not been implemented in the classroom setting. The workstation for home use has been delivered and his mother feels that it will help him access more activities independently.

TECHNICAL DESCRIPTION

The major design factors are the nature and the extent of the user's physical limitations and the activities to be performed at the workstation. The original request was for an adjustable tray that attached easily to the wheel chair. After investigation, it was determined that the workstation should be separate from the wheelchair for the following reasons:

1. The workstation requires no additional modification to the wheelchair.
2. The workstation allows easy access to the client should he need assistance.
3. The workstation allows more than one activity to be available at a time.

Two alternatives were considered for selection of the workstation components:

1. New design and fabrication.
2. Purchase existing equipment and modify as needed. The decision to purchase and modify was made based on these considerations: availability, aesthetics, cost and time.

The workstation was designed using keyboard stand hardware. The hardware consisted of two 60 inch A frame leg singles, two 48 inch support tiers, one 48 inch stabilizing tier, 6 support bars, and all hinges and fittings to attach the horizontal tiers. Wing screws, hex screws and knobs for adjustments were also supplied with the stand hardware. The wooden formica trays were designed and fabricated at a cabinet shop. Plastic trays were available with the keyboard stand but these were expensive and would have required modification. The bottom tier holds two independent trays of 21 x 14 x 3/4 inches. The top tier holds a single 36 x 14 x 3/4 inch tray. The trays are mounted on the support bars by using screws.

The stock casters for the stand were also expensive. Two-inch locking casters were purchased and a mounting assembly was designed and machined. Aluminum bar stock was machined to fit inside each A-frame leg. Aluminum plate was machined to the required angle and welded to the bar stock. A caster was then bolted to each plate.

The total cost for both workstations, excluding shipping cost, was approximately four hundred and forty dollars ($440.00).

Portable Wheelchair Access Ramps

Designers: Dan Unger, Sing Ung
Rehabilitation Professional: Robert Perry
Vocational Rehabilitation Services
Supervising Professors: Dr. C. Ramage, Dr. E. Tsang
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INTRODUCTION

Persons confined to a wheelchair often encounter obstacles that are difficult for their wheelchairs to overcome. These people are denied access to many places because of these obstacles. The person may find it necessary to set up some sort of temporary ramp at a place he or she frequently visits, such as the home or office of a client or relative. If a prolonged stay is necessary or desired, a portable ramp of some sort would allow the person to overcome these obstacles without the assistance of anyone else.

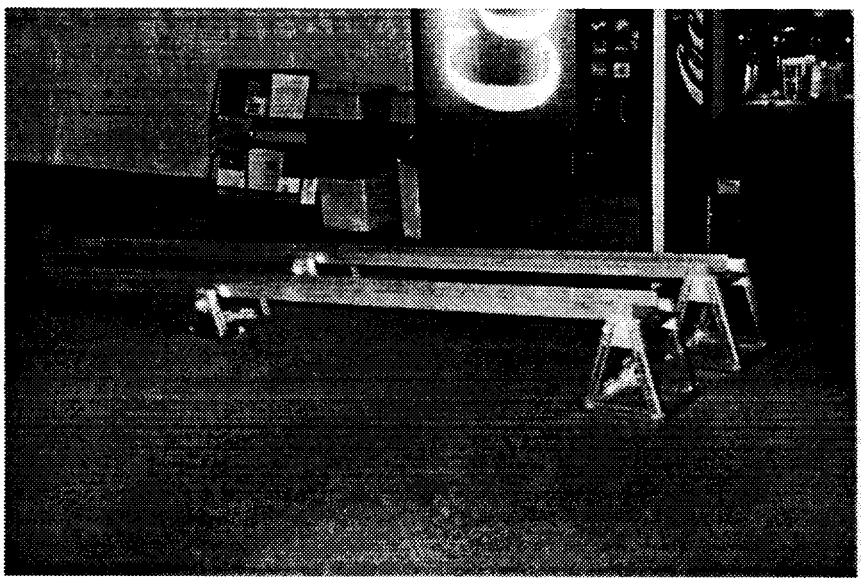
SUMMARY OF IMPACT

The person these portable wheelchair ramps were designed for was very pleased with the ramps. He now can visit friends and relatives that have houses not equipped with access ramps. With these portable ramps installed, he will find it much less difficult and demanding to maneuver in and out of their residence, creating a feeling of much more independence. An additional benefit of designing the access ramps is that more than one person confined to a wheelchair can use the ramps. It isn't necessarily designed for a particular wheelchair. The ramp designed can be used by the majority of wheelchair makes and models on the market.

TECHNICAL DESCRIPTION

The ramp design chosen is a lightweight portable ramp that could be set up to allow the person access over the curb. The American National Standards Institute (ANSI) recommends that wheelchair ramps have a slope of 1 to 12. For each inch of height there must be 12 inches of horizontal projection. ANSI also recommends that the ramp be 36 to 48 inches in width and have side rails at least 2 inches in height to prevent the chair from rolling off the sides of the ramp.

The ramp designed in this report consists of two separate narrow ramps, one for each side of the wheelchair. The two ramps will be positioned at a width that would allow both sides of the chair to roll up the ramp. Each side of the ramp consists of three different sections that attach to each other. To overcome a height of 18 inches, it is necessary to attach three sections per side. The width of each section is 5.5 inches. The side rails are 2.11 inches high. The material to be used in the ramp design is a lightweight, yet strong aluminum channel. Because of the constraint regarding the storage space available for the ramp, it is necessary to have the ramp separated into three six-foot sections. A bracket is used to provide support at the joints. The approximate cost was $435 for materials.



Carousel Bookshelf Design For Individuals Restricted To A Wheelchair

Designers: Shane Jones, Walter Lastinger, Wendy Thorp
Rehabilitation Professional: Robert Perry
Vocational Rehabilitation Services
Supervising Professor: Dr. Cengiz Topakoglu
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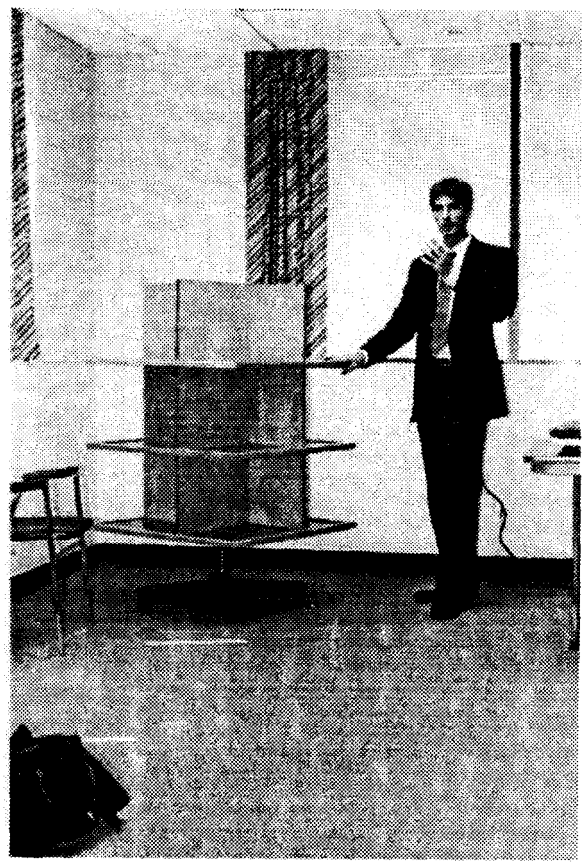
INTRODUCTION

The objective of this project was to design a bookshelf that would give an individual confined to a wheelchair or a seated position access the approximate number of books that a standard bookshelf would contain. The operator must be able to retrieve any one book from the shelf. This task must be able to be accomplished by someone with limited use of their hands and a minimal requirement of physical strength. The preliminary design of the bookshelf was begun by researching what equipment was available on the market.



This consisted of a literature search through manufacturer's equipment catalogs for the disabled from which the project group was unable to obtain any useful information.

SUMMARY OF IMPACT

The individual receiving the bookshelf has placed it in his office and found it to make many books and catalogs within reaching distance, thereby upgrading his ability to perform his job.

TECHNICAL DESCRIPTION

The bookshelf will be similar to a carousel. Its physical dimensions are a carousel shelf of thirty-two inches square, and a total height from the floor including the support pedestal of approximately forty-eight inches. The bookshelf will contain three shelves that will be equally spaced from the base of the carousel. The support pedestal for the carousel will be rigidly attached to a base that will rest on the floor. The pedestal will extend upward through a circular hub that has been cut in the center of each of the three shelves. A tapered roller bearing with a bearing housing will be attached to the circular hub of each carousel shelf. The support pedestal will then thread through each roller bearing to support shelves. The bookshelf can be rotated by applying a force to the outer edge of the carousel.

The approximate cost of materials for the bookshelf was approximately $285.

A Flatware - Napkin Rolling Device An Aid For a Cerebral Palsy Worker

Designers: Virginia Byrd, James Cunard, Ray Kesterson
Lynda Lebel and Geoff Painter
Disabled Coordinator: Todd Perkins, Employment Specialist
United Cerebral Palsy
Supervising Professor: Dr. Cecil H. Ramage
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INTRODUCTION

The flatware-napkin rolling device was designed to allow an adult cerebral palsy client perform the task of rolling flatware into a napkin. The design incorporates a three-roller mechanism mounted on a track with a continuous beltloop. The device's support frame is constructed of wood and a pair of drawer guides. The power source to supply the rolling action is a low-speed AC motor. The user places the napkin and flatware onto the belt and initiates the rolling action by a lever-switch mechanism. The final product is a tight and neat flatware-napkin roll.

SUMMARY OF IMPACT

The user of the flatware-napkin rolling device is an adult male who has cerebral palsy. He had been employed by a restaurant to roll flatware place settings into napkins. He was unable to perform the task satisfactorily and was dismissed. Since this person desires similar employment, a special aid to allow him to properly perform his job is needed.

The napkin rolling device has not been tested with a cerebral palsy client at this time. However, it has been tested several times using students performing the operation with their non-dominant hand.

TECHNICAL DESCRIPTION

The flatware-napkin rolling device provides the rolling action that allows flatware to be rolled into a napkin. The main components of the design are the motor, the belt drive system, and the support structure.

The Motor

The motor is a 72 RPM Bodine capacitor motor with a rating of 1/70 H.P.. The gearhead ratio is 23:1 with 10 in/lbs of torque. A flexible rubber hose coupling is used to attach the motor axle to the axle of roller 1.

The Belt Drive System

The belt drive system consists of three Ultra High Molecular Weight (UHMW) plastic rollers with dimensions of 2.375 inch diameter by 14 inches long. A typewriter roller is used as an idler to hold the belt against the drive roller. A spring beneath each end of the idler roller axle maintains contact with roller 1 and prevents the belt from slipping. The belt is made of rip-stop nylon fabric.

Support Structure

The motor and belt drive system are mounted on a base of 35 x 19 x 3/4 inch birch plywood. Drawer guides (ball bearing type) are mounted between the base and the roller table. The axles of rollers 1, 2 and 3 are 0.25 inch diameter brass rod its rolling axis. The ends of each axle are inserted into holes drilled into UHMW plastic pillow blocks. The properties of the UHMW plastic are such that bearings are not needed. The supports for Rollers 2 and 3 attach to the roller table. The supports for Roller 1 and the idler roller attach to the base.

Brief operating instructions are as follows:

I. Place the napkin on the belt.
II. Place the flatware on the napkin between rollers 1 and 2.
III. Fold the napkin over the flatware as needed.
IV. Use the handle to move rollers 2 and 3 as a unit toward roller 1.
V. As the handle is moved toward the left, the weight of the flatware causes the belt to form a pocket between rollers 1 and 2.
VI. The full left position activates the motor and the rolling action begins.
VII. As the roll is completed, the operator returns the handle to its original position, which deactivates the motor.

The final cost of the project was approximately one hundred dollars ($100) for the motor and the belt. The low cost of this project was made possible by donation of much of the building materials.

Platform Design To Aid In Balance Rehabilitation

Designers: Shane Jones, Walter Lastinger, Wendy Thorp
Rehabilitation Professional: Dr. James Wall
Physical Therapy Department
Supervising Professor: Dr. C. Topakoglu
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INTRODUCTION

The purpose of this project was to design and build the mechanics of a platform to aid in balance rehabilitation. The project was initiated by Dr. James Wall of the Physical Therapy Department at the University of South Alabama and was funded through the National Science Foundation.

The primary objective was to build a low cost platform that would determine the position of the center of gravity of a standing person. The static board would attach to a home computer through its game port. Acting similar to a joystick, the board would detect movement of the center of gravity that would result in movement of the on-screen cursor. Making therapeutic exercises more enjoyable and challenging for the patient, the platform would serve as a motivational tool having the versatility of being used with different types of video games. The platform also would benefit the physical therapists by providing more quantitative data and records than the traditional exercises.

The mechanical engineering senior project group was restricted to designing the mechanics of the platform and determining the method for finding the center of gravity. An electrical engineering project group was given the task of developing and optimizing the circuitry to the computer.

SUMMARY OF IMPACT

Hemiplegia is a condition that affects stroke patients making it difficult for them to balance and walk normally. Similar problems exist with clinical conditions such as cerebral palsy, Parkinson's disease, and lower limb amputations. The therapeutic exercises used in treating these balance disorders are tedious and repetitive, and the patients lack the motivation to continue the exercises. With this type of exercise tool, the patients will enjoy the exercises, and the result will be a more complete recovery for the patients.

TECHNICAL DESCRIPTION

The resulting platform dimensions are three feet long by two feet wide by six inches high. These dimensions keep the board compact but allow for comfortable standing. The extra length of the board also gives the space needed for the person to take a single forward step.

The frame is made of one inch square aluminum tubing, because aluminum is durable yet lightweight. Stain gaged aluminum beams are welded on each of the four sides of the frame. The cantilever beams on the longer sides point outward to avoid overloading the connection point. The platform cover is made of three-quarter inch plywood bolted to the beams.

There are two Omega general purpose strain gages on top and two on the bottom of each beam to increase the reliability of the readings and compensate for temperature effects. The signal leaving the stain gages passes through wheatstone bridges, filters, amplifiers, and an analog to digital converter as designed by the electrical engineering project group.

The approximate cost of the mechanics of the platform is $230.

Modifying An Apartment Entrance Way For A Quadriplegic Resident

Designers: W. Jeff Newman and Edgar Wong
Contact: Gloria Bragg
Rehabilitation Professional: Robert Perry
Vocational Rehabilitation Services
Supervising Professor: Dr. Edmund Tsang
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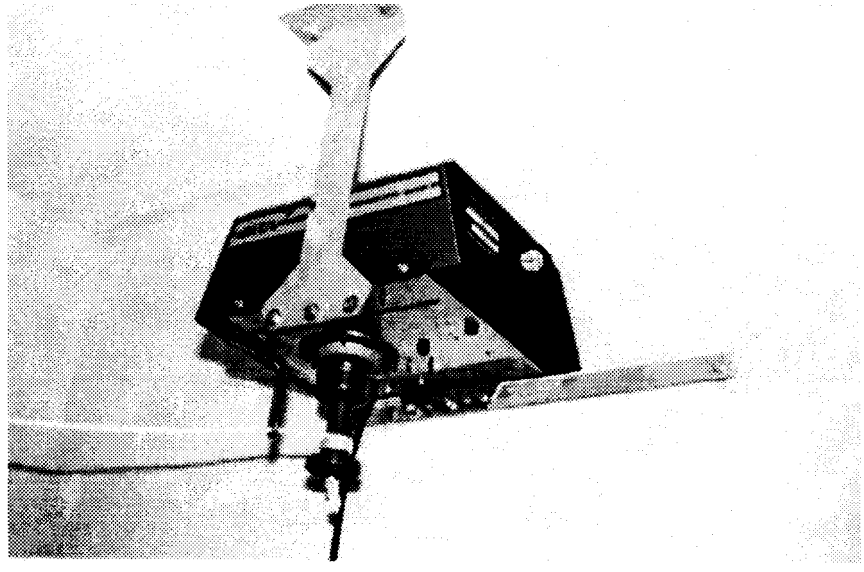
INTRODUCTION

An apartment entrance has been modified so that a quadriplegic resident can enter and exit the apartment as well as lock and unlock the door. The door opening mechanism is based on a standard 1/3 horsepower Sears garage door opener. The unit has been modified to mount securely to the wall opposite the door, and the sprocket on the output shaft has been replaced by a spool. One end of a rope is attached to the spool and the other end is attached to the door. When the motor is activated the rope winds up to the door. When the motor is activated the rope winds up on the spool and the door opens. The rope unwinds and a door closer pulls the door closed when the motor is reactivated. The handle on the existing dead-bolt lock has also been modified so that it can be operated without using any gripping force. With this modification, our client can lock and unlock her door manually.

SUMMARY OF IMPACT

The client had no way of opening and closing her door or locking and unlocking her door on her own. That was not an acceptable situation because she had no way to exit her apartment in an emergency or to lock her door if she felt threatened. The components that were developed provide a solution to both problems. Just as important, they give the client an added amount of independence. Although she can not drive herself, she can now leave her apartment to visit neighbors or just to enjoy a pretty day. She can now let visitors into her apartment at will and lock her door after they leave. In short, these solutions have increased her ability to function as an independent individual.



TECHNICAL DESCRIPTION

An apartment entrance has been modified so that a quadriplegic resident can enter and exit the apartment as well as lock and unlock the door. The modifications performed were targeted toward a specific individual and are meant for her personal use. The criteria for this project were as follows:

1) The door opening mechanism must not detract from the existing architecture.
2) No solution can seriously alter the construction of the doorway.
3) The solutions must not make the apartment less accessible, even in the event of component failure.
4) The solutions must be safe to operate.
5) The door opener must be operated by remote control.
6) The total cost of the solutions must be under $500.

The door opening mechanism is based on a Sears 1/3 HP garage door opener. This garage door opener was chosen because of its low price, remote control operation, adaptability, and safety features. Metal mounting braces were attached to the existing mounting locations on the opener to provide a means to attach the opener to the available studs and rafter. The door opener was mounted upside down (with the output shaft vertically downward) against the wall adjacent to the door. The sprocket that was originally mounted to the output shaft was replaced in favor of a spool. A rope was then wound around this spool and the free end was attached to the door. When the motor is activated, the rope is wound on the spool and the door is opened. Upon activating the motor again, the motor drives the spool in the opposite direction and the rope unwinds. A door closer then pulls the door closed. The number of turns of the spool is adjustable by limit switches. Also, if something is in the way of the door or the operator attempts to open the door while the door is latched closed, the opener will stop and reverse to remove the tension in the rope and relieve stresses in the door and mounting hardware.

It was decided that the deadbolt lock originally on her door would be modified so that the client could operate it manually. The door originally has three locks; a door knob on bottom, a privacy dead bolt about 5 inches over the door knob, and a keyed dead bolt about 5 inches over the first dead bolt. To move the keyed deadbolt into the client's reach, the position of the knob and the keyed (top) deadbolt was interchanged. To allow the client to operate the lock now that it is within her reach, the thumb turn originally on the keyed deadbolt was replaced by a loop made of 1/8 inch diameter steel rod. The client merely puts her hand into this loop and rotates it 90 degrees to lock and unlock the deadbolt. The knob was also prevented from latching so that it would not have to be turned before the door opener was activated. Since the door is not latched when it is closed, the door closer was adjusted to provide sufficient force to keep the door closed in a fairly strong wind. If, in very strong wind or other unforeseen circumstances, the door closer did not provide enough force to keep the door closed, the deadbolt lock could be used to stabilize the door.

The final cost of the project was less than $250. The least expensive commercial door opener that was available cost between $800 and $950 depending on the features ordered. These devices did not include a method of locking and unlocking the door.