CHAPTER 6
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INTRODUCTION
A Tri-Modal Caster System has been designed for Kris, a disabled student at Mississippi State University. Despite his paralysis, Kris is actively involved in wheelchair tennis and holds a national ranking of number 5 in the National Quad C Division. The objective of the Tri-Modal Caster System was to design an improved caster system for the front wheels of a wheelchair to make the wheelchair more responsive in sport settings. Because the shaft of the wheel is off-axis of the vertical rotation axis of the wheel bracket, one must rotate the front wheels before changing directions. The design of the caster system was to eliminate the time and motion associated with changing directions. The design included replacing Kris’s original “grocery cart” type wheels with three roller ball type casters mounted on an aluminum caster platform. This design is specifically for hard court surface sports such as tennis.

SUMMARY OF IMPACT
The results of the design are positive. Two tests are used to determine the success of the new design. The first test measured quickness in a straight line; while the second test measured mobility of the new system. Results of the first test showed the new casters to be somewhat faster in the straight-on sprint test. The mobility test proved that the new casters can “shave” some time off the turn-around action duration. These few fractions of time may be the difference of Kris touching a ball at all or letting one get by. Overall the results of the design are good; however, a few problems arose. First, noise was a big problem. A piece of equipment that is distracting to an opponent cannot be tolerated in a sanctioned event. An alternate “quite” design would need to be implemented for marketing. Second, the original casters are not constructed to withstand the amount of force exerted by the chair/court interaction over an extended period of time. Casters could be obtained with more durability.

Figure 6.1, Tri-Modal Caster System in Use.
TECHNICAL DESCRIPTION
The Tri-Modal Caster was designed for a particular student-client in mind, but could be beneficial to other clients with similar interests. In order to provide mechanical stability and to distribute the vertical force, three casters are employed in the design to replace each front wheel of the wheelchair. The three casters are mounted at the corners of an equilateral triangle with 4" sides (see Figure 6.2). The triangular plate is constructed out of 1/4" thick aluminum. In the center, a vertical support is mounted so that the caster system could be attached at the location where the original wheel is attached. The caster system is shown on a wheelchair in Figure 6.1.

Several engineering calculations are performed on the Tri-Modal Caster. The factor of safety is 4.8765. The minimum thickness of the aluminum platform to withstand a stress of 2 kips is .213 in. To keep the front-end of the wheelchair light, the system had to be of a small curbed weight. This weight is 1.25 lbs.

The final cost of the Tri-Modal Caster is approximately $270.

Figure 6.2. Schematic of Tri-Modal Caster System.
Canopy for Wheelchair

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INTRODUCTION
A wheelchair canopy top has been designed for the parents of a mentally and physically impaired child. The canopy top consists of mounting brackets, a top frame, a main frame, aluminum plates and a canvas top. The canopy top is lightweight that allows it to be portable. The top frame, due to pm attachments, is easily folded behind the wheelchair when not in use (Figure 6.3).

SUMMARY OF IMPACT
A child who is mentally and physically impaired is sometimes oblivious to the dangers of the environment, such as extreme radiation from the sun. Concerned parents often need a way to protect their child from such dangers when transporting the child to and from different locations. A lightweight canopy top was designed specifically to protect the child from the elements. The canopy top was designed to attach to an existing wheelchair frame.

Figure 6.3. Canopy for Wheelchair.
TECHNICAL DESCRIPTION

The wheelchair canopy top was designed with a particular student-client in mind, but could be beneficial to a client with similar disabilities. The main design requirements of the canopy top are: 1) it has to be portable so that it can be moved to a van when the family traveled; 2) it has to be detachable so that it can be removed for cleaning; 3) it has to be adequately sized due to limited space in the family van; 4) it has to be lightweight so one person can easily remove the canopy top; 5) it has to be durable to withstand the environment and have many years of service; 6) it has to be inexpensive due to a set budget. Finally, it is important for warranty considerations that the attachment of the canopy did not physically alter the wheelchair in any way.

The canopy top has five main components: the mounting brackets, the main frame, the aluminum plates, the top frame and the canvas top (Figure 6.4). The mounting brackets are made from 0.75” square steel tubing and are clamped on each side of wheelchair to the base of the wheelchair handles. The main frame is made from 0.75” square aluminum tubing and can be slid into the mounting brackets on both sides of the wheelchair. The height of the canopy top is then adjusted by raising or lowering the main frame within the mounting brackets. Welded to the top of the main frame are 0.75” aluminum plates that not only connect the top frame to the main frame via pin attachments, but also allow the top frame to be folded behind the wheelchair when not in use. The top frame is made from 0.50” aluminum tubing that is bent into a U-shape that allows for better shading of the child from the sun and rain. The canvas covering is then stretched over the top frame. The covering is attached with Velcro and is easily detachable to allow for cleaning. The final cost of the canopy top is approximately $65.

Figure 6.4. Schematic of How the Canopy Top is Folded Behind the Wheelchair.
A Tilting Wheelchair Desk for Paraplegic Persons

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INTRODUCTION
A tilting wheelchair drawing table has been designed at Mississippi State University for a paraplegic student in the architecture program. The design consists of a Lexan desktop, two support rods and two hinges. The Lexan desktop is rectangular, corresponding to the width of the wheelchair, and is bolted to two support rods. The support rods supply strength and stability to the desktop. Each support rod extends from a hinge that allows the table to tilt and lock at three different positions. Each hinge consists of a spring wired catch, a release mechanism and a catch joint. The hinges are designed to lock into three different positions and release past the final position. The unit fits into the wheelchair via removable plastic caps that cover hollow rods of the wheelchair arm. This design avoids alteration of the wheelchair and maintaining the requirements of the warranty.

SUMMARY OF IMPACT
Many paraplegic students feel limited by their environment. Jim Sargeant, an architecture student at Mississippi State University, spends many hours at the College of Architecture at his drawing desk. Jim, unlike other fully able students, is confined to his desk when drawing sketches and is also unable to simply prop his knees to draw on a portable desk when drawing outside the Architecture building. A portable, tilting wheelchair table/desk that simulates the stationary drawing desk satisfies his needs. The designed table/desk provides the tilt that the stationary desk provides. The table/desk also allows Jim the freedom to draw anywhere. When not tilting, the table/desk serves as a desktop for his laptop computer, which the College of Architecture is now requiring in their curriculum. Currently there is no known desk on the market that would meet Jim’s needs.

Figure 6.5. Assembled Wheelchair Desk.
TECHNICAL DESCRIPTION

The wheelchair table/desk was designed with a particular student-client in mind, and may be only applicable to his particular case. Many wheelchairs are custom built, and therefore each has different dimensions and different accessories to attach the desk. For this client's case, the main design requirements are: 1) it has to alter the wheelchair as little as possible; 2) it has to sufficiently simulate the stationary drawing desk; 3) it has to be removable and portable; 4) it has to minimize possible impairment of vision. Finally, it has to be durable and safe to use.

The wheelchair table has two main components, the desktop and the supporting frame. The frame consists of two hinges each soldered to a steel rod of 3/4" diameter x 5" length that fits into the wheelchair and to a steel rod of 3/4" diameter x 8" length, which supports the desktop. The hinges are obtained from a chaise lounge chair and are modified to reduce the number of possible lock positions and to change the position of release. The rods that are placed in the wheelchair create adequate friction to hold the desk in place because the receiving hollow tubes of the wheelchair are uniform, and therefore the desktop rods fit securely. The desk is constructed of 5/8" thick Lexan. An additional 1/4" ledge is constructed to prevent small objects from falling into the student's lap. The overall dimensions of the desktop are 21" x 14", which corresponds to the width of the wheelchair and the length to Jim's feet since Jim is accustomed to accounting for this distance as he moves. These dimensions not only protect the desk from tear, but also make the desk more convenient for Jim. The desk is constructed of Lexan not only for its durability, but also for its transparency that does not impair the student's visibility when travelling.

The estimated cost of materials is $65.

![Figure 6.6. Schematic of Wheelchair Desk.](image-url)
Stationary Exercise Device For Manual Wheelchair Users

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INTRODUCTION
An exercise device has been designed and constructed for manual wheelchair users. The machine is one piece, with the exception of a removable ramp. A two roller-pin design serves as the exercise site that is encased within a rectangular platform (Figure 6.7). The user rolls on the pins to power the chair at the exercise site. A tension adjusting mechanism is fixed adjacent to the front roller, and doubles as a brake for access on and off the rollers. The unit has been designed to be used in on-campus facilities, but easily transported to any location.

SUMMARY OF IMPACT
Disabled people who are resigned to manual wheelchairs are, for the most part, very active people. Incredible arm and shoulder strength is needed to propel the device. If a person can not use the wheelchair as extensively as desired, it may result in a loss of strength that is needed for their daily activities. The most common occurrence is that unfavorable weather prevents wheelchair use for many days. Once a user tries to move around after missing many days of normal activity, he or she can encounter extreme fatigue. Therefore, a device is needed that allows disabled people to maintain the strength required for mobility. An exercise machine that allows the user to simulate normal wheelchair activity without setting the chair in motion alleviates the problem. This device works all muscle groups involved in everyday use.

Figure 6.7. Stationary Exercise Device for Manual Wheelchair Users
TECHNICAL DESCRIPTION
While this device was designed for a particular student, it will be placed at a location where it can be used by other wheelchair users. The major design requirements are as follows: 1) It has to simulate actual wheelchair use in order to develop the same muscle groups; 2) It has to contain a tension adjustment device for variable intensity workouts; 3) It has to uphold ADA regulations and be safe to use; 4) It has to be financially feasible; 4) It has to accommodate different types of wheelchairs; 5) It has to be easy to use; 6) It has to be an effective exercise device to maintain strength; 7) It has to be easy to transport. The machine is made of 1" X 6" pine wood supports and 3/4" Grade A-C plywood. The platform height is 6 1/4". The platform requires 4' of width and 5'6" length to accommodate the wheelchair on the platform. ADA regulations place the ramp at 6'3" in length and 4' in width. The ramp is placed to the side of the platform so that the user is able to roll up the ramp and on the platform. The user then makes a sharp turn to their right to the front of the platform, and then rolls back on to the rollers to begin their workout. The ramp is bolted to the platform so that it can be removed for storage and transportation purposes. Anthropometric considerations are also added to accommodate both the widest and most narrow wheelchair widths. Two conveyor rollers (3 1/2" diameter and 39" length) are placed 12" apart to accommodate the stability of the wheelchair when in use. The top of the rollers is at the same height as the platform (Figure 6.8). A nylon strap is used as the tension adjuster and brake. The locking device to the strap is mounted on a piece of wood 2' above the platform. The total cost of the project to approximately $175.

The overall objective to build a device that enables manual wheelchair users to maintain their strength for mobility. Not only does this device maintain essential muscle groups strength, but the stationary wheelchair is flexible enough to serve alternative needs, such as muscle building, aerobic activity, and physical therapy for both present and new users.

Figure 6.8. Schematic of Stationary Exercise Device.
An Elevated Rest Platform for Cerebral Palsy Children

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INTRODUCTION
An elevated rest platform was designed for a handicapped child with cerebral palsy at Starkville High School in Starkville, MS. At present, the student is placed on a mat on the floor when he is not in his wheelchair. However, the transfer of the student from the wheelchair to the floor is strainful and the floor becomes uncomfortably cold during the winter. To solve these problems, an elevated rest platform is designed. Several elevated platforms already existed: a wall mounted platform and a table platform. The wall-mounted platform is not considered because limited wall space existed in the classroom and because it is not portable. The table platform is not used because the platform can not be disassembled to save room space. The final design option considered is a disassembling plywood platform. (Figure 6.9). This design option can be taken apart into seven pieces (two supports, tabletop, two rails, foam mat, and vibration pad).

SUMMARY OF IMPACT
Many cerebral palsy clients have limited cognitive and motor functions, and are often confined to a wheelchair. To provide therapy, the client must be removed from his wheelchair. This can be stressful to the “lifter” and depending on the therapy space, stressful for the client. The elevated platform provides less stress to the “lifter” as well as the client. The height of the platform is close to the height of the wheelchair and allows the transfer of the client to be less stressful for the “lifter”. The platform has many added comforts such as a foam mat and a vibrating pad, which provide a less stressful environment for the client.
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TECHNICAL DESCRIPTION

The elevated rest platform is designed with a particular student/client in mind and can be beneficial to other clients. The specifications for the elevated platform are: 1) a stimulant such as a vibration or rocking motion be incorporated into the platform; 2) the platform hold a minimum weight of 300 pounds; 3) the platform be portable; 4) the platform be large enough to hold both the student and the teacher; 5) the platform be user safe.

The elevated platform consists of seven pieces: two supports, tabletop, a foam mat, a vibration pad, and two rails (Figure 6.10). The supports are two rectangular boxes that are made into shelves for extra storage space. Locking casters are attached to the supports to allow for relocation in the classroom. The casters could be locked when the platform is in use.

A 3' X 6' tabletop is constructed from seven plies of pine plywood. The tabletop is supported by the rectangular boxes. Both the tabletop and the rectangular boxes are assembled with wood glue, screws, and nails. A 4" thick foam mat covered with vinyl is placed on top of the platform and held stationary by Velcro adhesion. The mat is used to provide comfort for the client. In order to provide a stimulant to relax the client, a 24" x 82.5" electrically operated vibration pad is used. The pad is simply placed over the top of the vinyl covered mat. Steel rails are added to the side of the platform for safety purposes. Each rail is detachable as well as adjustable.

The final cost of the project is approximately $305. Special thanks to Mr. Fred Melloy of Flexsteel Industries, Inc. for his assistance in obtaining the vibration pad.

Figure 6.10. Schematic of Elevate Rest Platform.