CHAPTER 11
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INTRODUCTION
The Chaircycle is the fusion of a wheelchair and a bicycle for individuals who normally use a wheelchair. The purpose was to create a practical way to travel short to intermediate distances on a daily basis. The Designers are shown creating the device in Fig. 11.1. It provides an alternative motion for propelling the wheelchair using cycling components. Users will be able to travel longer distances without having to switch their mode of transportation.

SUMMARY OF IMPACT
The Chaircycle will impact users by giving them a new degree of freedom and mobility. It will eliminate the hassle of getting into an automobile to travel moderate distances. The user can utilize the Chaircycle as an everyday wheelchair but can also use it to travel distances ranging from one to five miles on paved roads. This will impact users in their added motivation to travel and enjoy the outdoors. It will also give them another medium of exercise to improve cardiovascular health.

TECHNICAL DESCRIPTION
The Chaircycle provides an alternative input motion for propelling the wheelchair. Instead of directly spinning the wheels, the Chaircycle provides a more ergonomic motion in driving the wheels indirectly. This motion is made possible by a crank-slider mechanism. The rotational motion generated by this mechanism is transferred to an input gear, which is then transmitted to an output gear via a chain link. This output gear is attached to the 20-inch bicycle wheels. There are two identical systems, one for each side, which are not connected. They are completely independent to allow a method of maneuvering the Chaircycle. If the velocity of the right wheel is slower than that of the left, the Chaircycle will veer to the right and vice versa. The handbrakes, which are attached to each wheel and handlebar, can also provide maneuvering.
capabilities. These two methods work in conjunction with one another to provide sensitive and meticulous maneuverability.

The frame of the Chaircycle is constructed of stainless steel tubing of 1-inch diameter and 0.054-inch thickness (Fig. 11.2). There are a total of 14 individual pieces adding up to over 23 feet in total length. There are 20 weld points connecting the pieces to create the frame with eight 90-degree bends. The cycling components, which consist of the slider, input and output gears, chain link, connection hub, and main drive wheels, are all fitted into the frame, as shown in Fig. 11.3. The components work together (see Fig. 11.4) to provide the drive motion necessary to propel the Chaircycle to a speed over 10 miles per hour.

The total cost was $554.
ASSISTIVE TREADMILL
Designers: Roger Lee, Teuh Cheng, Justin Margolis
Client Coordinator: Thomas Rosati, Premm Learning Center, Oakdale, NY
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INTRODUCTION
The goal of this project was to design an adjustable weight support system to use with a treadmill. It was developed to alleviate stress for rehabilitation patients with neurological disorders of the lower limbs who want to revitalize or increase lower body locomotive functions. Such patients often have a hard time exercising and stimulating the lower body and often require assistance in their exercises. This support system eliminates the need for help from an assistant, allowing the patient to exercise independently.

SUMMARY OF IMPACT
The primary function of this machine is to hold and slightly lift the patient. This way the patient’s legs will not be required to support his or her total body weight. With less weight on the legs, the user is able to simulate walking motion more easily.

TECHNICAL DESCRIPTION
The device consists of a metal frame with a stack of weights held on the bottom. The weights are connected to a cable that runs through a hole in the middle bar of the structure. The cable then loops through two pulleys, one at the top plus an angled cantilever pulley. At the end of the second pulley a harness is attached. The harness, weights and pulley system are shown in Fig. 11.5.

To operate this device, a weight selector pin is inserted to counterbalance a selected amount of weight. The weights and pin are shown in Fig. 11.6. The harness is placed high enough to keep the patient’s feet from making full contact with the treadmill. In order to strap into the harness, the individual must step onto something slightly higher than the treadmill. The patient then steps down into the harness and can begin exercising, carrying just a fraction of his or her body weight. The frame is designed to fit electric treadmills of all sizes.

The frame is made of extruded aluminum tubing and is structurally safe for the purpose of alleviating a maximum of 100 pounds. Most stress is concentrated on the angled cantilever. With this in mind, welding was used to increase the strength of this component. A CAD drawing of the system is shown in Fig. 11.7.

The total cost was approximately $1013.
Fig. 11.6. Lower Half of Treadmill.

Fig. 11.7. CAD Drawing of Device (Isometric View).
INTRODUCTION
The objective of this project was to create an add-on device that can assist users with limited mobility in moving up and down stairs. To use the device, the user must be able to maintain a seated position in the chair as it ascends the stairs, and must be able to grip the device manually. In addition, the chair and device must be pushed and supported by a caretaker.

SUMMARY OF IMPACT
To suit the needs of the broad range of users, the add-on device attaches onto an already existing wheelchair. It enables the user in a wheelchair to scale stairs.

TECHNICAL DESCRIPTION
A schematic of the design is shown in Fig. 11.9. Track [A] is attached to Track Leg [B] via a rectangular piece, Track Adaptor [K]. Track Adaptor [K] acts as a joint connector with a bolt inserted through the bottom hole. Since this adaptor must be able to rotate, a shoulder bolt secures the two together.

Track Leg [B] is inserted directly into the Track Adaptor [K]. Here it is pegged on the side, in the upper hole, to keep it in place.

The Secondary Wheel [J] is made to be in plane with Track [A] in front of it, so that contact can be initiated. Fig. 11.8 shows the device at rest position. The Track’s lower edge is higher in this position.

Fig. 11.8. Isometric View of the Device.
than the Secondary Wheel [J].

Track Leg [B] is made of two segments, allowing it to extend and retract; the segments are made of two hollow tubes. The larger diameter tube is attached to the Track Adaptor [K]. The smaller diameter tube is located within the larger tube at one end, and the other end is attached to the Rod Ends [C]. Use of a spring latch allows the two bars to catch within each other, preventing further extension.

The Secondary Wheel Leg [I] is attached at one end to the Secondary Wheel. The other end is attached to the axis where the Rod Ends [C] turn.

There are a total of three other adaptors, not including the Track Adaptor [K]. The Front Track Adaptor [D] and Back Track Adaptor [G] both attach the Slider Tube [F] to the perpendicular joints of the wheelchair. Four-fingered or three-fingered grips are designed to be able to wrap around the wheelchair tubing. Nuts and bolts are then used to clamp the ends down.

The Sliding Tube Adaptor [E] is the most complicated of the four. This is because it is multifunctioning as a corner rotating joint. The Sliding Tube is inserted into one end of it and pegged down. On the other end is a square opening for insertion of the Rod Ends. In addition, there is a tube that enters the side of this opening to act as axis on which the Rod End rotates. The Rod End [C] is used as a rotating joint for the track leg.

To elaborate on the Sliding Tube [F], both ends are inserted into adaptors that are then pegged in. A slider attachment is attached to the tube. The Connecting Bar [H] connects the slider attachment with the outer tube of the Track leg assembly to cause the rotating and extension property.

The cost of the device is roughly $1000.

Fig. 11.9. Component Breakdown of Design.
INTRODUCTION
The Multifunctional Quadricycle was designed for working parents of a family of four living in a suburban neighborhood. They wished to have more time for their children while also exercising and accomplishing chores around the home.

SUMMARY OF IMPACT
This machine will allow the clients to spend time with the whole family while exercising and mowing the lawn. A CAD drawing of the prototype is shown in Fig. 11.10.

TECHNICAL DESCRIPTION
The Multifunctional Quadricycle has two seats for adult passengers located at the rear. It also accommodates two small child passengers in the front two seats. The children can be seated with their feet resting on a bar, and they have a long handle bar to hold. The adult passengers power the vehicle.
by pedaling. The steering is controlled by one adult. The frame is roughly 3’ by 5’. It is tapered in front to allow for steering by turning the front wheels. The steering system is aided by a double U joint which is connected to several eye joints that help to direct the wheels. Brackets are extended for easier turning abilities.

The brakes are caliper brakes, similar to those of a bicycle. Braking may be controlled by either of the adult passengers. Reel mowers can be pulled along behind the quadricycle or easily detached. The mowing part of the project was not completed due to lack of time and funds. A finished prototype is shown in Fig. 11.11.

The total cost of the prototype is approximately $1500.

Fig. 11.11. Quadricycle Prototype.
ACCESSIBLE MEDICATION DISPENSING DEVICE

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INTRODUCTION
Many people have to take several medications with specific dosages on a daily basis. Difficulties can arise when trying to remember to take a specific dose of a particular medication, especially for patients with disabilities.

SUMMARY OF IMPACT
The goal of this project was to develop a device to keep track of a patient’s complicated medication schedule. The dispenser automatically alerts and dispenses the proper dosages necessary. To accommodate patients of different abilities, the dispenser has a variety of notification methods. The system can also keep track of what medications have been taken and what is currently in the inventory. The final product is shown in Fig. 11.12.

TECHNICAL DESCRIPTION
Figure 11.14 shows an assembly drawing of the prototype. The device stores medication in carousel systems, as discussed below. The mechanical structure has a flat square base. Two crossbar uprights are erected on the opposite sides of the base with three beams. These beams support the dispensing structure. Four right-angle brackets are erected from the four corners of the base to support the enclosure. Clear polycarbonate lexan is used to make the cover for the enclosure and is attached to the uprights. For the front, a lexan door (Fig. 11.13) is attached via a hinge to the enclosure. A magnetic latch is used to hold the door closed. The thickness is 0.25”for the uprights and beams to provide rigidity while keeping them light in weight. One stepper motor is placed at the middle of each beam. A large hole at the center of the beam allows for an adaptor shaft, which transmits power and motion from the motor to the carousel and dispensing system.

Dispensing System:
The dispensing system begins at the storage area. The medication pills, tablets, or capsules are contained in the dispensing carousel, which has 31 usable compartments. The carousel tray has a cover that fits tightly with an o-ring seal between the cover and the tray wall. The carousel tray is located on the beam of the machine via two ¼” pins. This prevents any motion along the beam surface, which might otherwise cause the carousel to move upward or fall off the motor shaft. A ball detent locks it into the divider disc. The dispensing system releases the medication by incrementing a stepper motor 11.25 degrees. Each rotation moves a filled compartment over an identically shaped hole in the carousel tray. The medication then falls into the dispensing chute.

Electrical System:
The design of the medication carousel depends on a specific rotation each time. The design requires 11.25 degrees of rotation. This is accomplished by half-stepping the stepper motor. The motor has a 7.5
degree step; pulsing the motor to increment 3 half-steps provides 11.25 degrees. The motor and LCD screen are controlled through a parallax electronic board powered by a 12V power supply. The microcontroller is programmed with BASIC Stamp.

**Operation:**
The first step in using the accessible medication dispenser is for the user to enter his or her medication schedule. Each carousel is simply loaded by placing the medication into a compartment. If the user is not capable of loading his or her own medication carousels, loading may be done offsite by a caretaker.

When it is time to take the medication, an alarm sounds and a light flashes to alert the user. Upon hearing the alarm, the user pushes a button that causes the system to dispense the proper medication into a tray. The LCD screen displays a message that dispensing is complete and shows how much medication is left in the carousel. If the button is not pressed after two minutes the alarm and the buzzer stops and it records the event.
INTRODUCTION
At a school for children with physical disabilities, students often must transfer from a wheelchair to a floor mat, where they sit during lessons, and then back to a wheelchair. This requires the caretakers to move each student in and out of a wheelchair numerous times a day. This can be strenuous for caretakers. The goal of this project was to reduce the burden on caretakers through assistance in transfers from a wheelchair to bed or floor mat.

SUMMARY IMPACT
The users are children with a maximum height of five feet and weight of 150 pounds. The energy spent in lifting and lowering a child manually is lessened by a mechanical crank winch. The mobility of the device allows it to be used in various situations and locations.

TECHNICAL DESCRIPTION
The device has two main components: the frame and the car. Each component was treated as two smaller projects although the design and manufacturing of the frame relies heavily on the design of the car.

The frame acts as a support for the lifting mechanism. It is designed to support a load of 600 pounds, which includes a factor of safety for four children, at any point along the track. Buckling and balance issues were checked through analysis. Steel was selected as the best material for the frame. The track is attached to the top of the frame at a height of 60 inches to provide an elevation range of 0-30 inches. Casters are attached to the bottom of the frame to allow mobility (see Fig. 11.16).

The car (Fig. 11.17) provides a simple translation motion in both horizontal and vertical directions. Aluminum was used to construct the car because it weighs less than steel. A winch with a high load capacity is used to lift and lower the user. The V-groove wheels of the car enable the user to be moved along the tracks of the steel frame to the desired location of a bed or floor mat. A brake system (Fig. 11.18) is installed on the rear two wheels of the car for safety. The wheels on the car and on the frame can be locked during loading and unloading to prevent injury. A three-dimensional view of the device is shown in Fig. 11.15.
Fig. 11.16. Prototype.

Fig. 11.17. 3D View of Car.

Fig. 11.18. 3D View of Brake System.
ARTICULATING THERAPEUTIC WHEELCHAIR

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INTRODUCTION
The goal of this project was to design a wheelchair that allows the children with physical disabilities to move from a sitting position to a standing or lying position. For lying down, the seat of the wheelchair remains stationary while the back reclines and the leg support is raised. For standing up, the seat and back of the wheelchair are moved together to a vertical position as the leg support lowers to the ground for stability. The ability to move from a lying down position to a standing position promotes physical health by increasing circulation, preventing muscle atrophy, and preventing respiratory problems. It also enhances the user’s independence.

SUMMARY OF IMPACT
Children with disabilities can have difficulty laying...
down when they are tired, or standing up to move their muscles. The children for whom this project was created had to be moved by caretakers every half hour from a stressed to an unstressed position. This takes significant time and effort for both the child and caretaker.

**TECHNICAL DESCRIPTION**

The articulating wheelchair has two linear actuator systems to control its motion. System A has a single actuator mounted to the bottom of the seat. It controls sitting to lying down or lying down to sitting. As the linear actuator pulls the bottom shaft, it raises the leg support and the vertical shaft lowers the back support. The central pivot is grounded to the main pin connecting the back support plate to the thigh support plate. The linear actuator is connected to the quaternary link at the node closest to the main pin. The two other nodes connect to links going to the back support plate and the leg support plate. The leg support plate is shown extended in the CAD drawing in Fig. 11.21.

System B moves the device from sitting to standing or standing to sitting. Two linear actuators are mounted on both sides of the device for strength and balance since these support the user’s weight while in the sitting position. The system is directly linked to the main pin support, and connects the back plate to the thigh plate. Three actuators are used, one with 10 inches of travel, and two with 16 inches of travel. They have self-locking power screws and have a maximum load rating of 250 pounds. The control system has two switches, one switch for each system. The circuit design enables the switches to reverse automatically and independently the polarity to each system. The wheelchair was manufactured using wood to reduce manufacturing and material costs. The actuators chosen were from automotive applications to cut actuator costs by two-thirds while still meeting design requirements. Fig. 11.19 and 11.20 show the prototype design.

The total cost of the prototype is approximately $742.

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![Fig. 11.21. CAD Drawing of Articulating Wheelchair.](image-url)
EASY TOILET ACCESS WHEELCHAIR

Designers: Stanley Boutin, Chang Gen Tan
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Supervising Professor: Professor Lili Zheng
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INTRODUCTION

The Easy Toilet Access Wheelchair was designed to allow individuals with disabilities easier use of the restroom. The objective was to design a wheelchair that allows individuals with disabilities to use the toilet without having to physically move from their own wheelchair. This design will also function as a normal wheelchair. Overall, the design will make the task of using the restroom more convenient and hygienic.

SUMMARY OF IMPACT

For wheelchair users to use the restroom, they must get out of the chair and sit on the toilet seat. This can be time consuming and may even require the assistance of a helper. The Easy Toilet Access Wheelchair helps the user use the restroom more conveniently. It also helps avoid the dirty surfaces common to public restroom seats. Fig. 11.22 shows how this product can easily be used in a public restroom.

TECHNICAL DESCRIPTION

Wheelchair Frame

The design contains a frame that is modified from a standard wheelchair, the Invacare Tracer Ex2 Swingaway. The tubing is chrome plated carbon steel with an outer diameter of 0.875 in. and inner diameter of 0.75 in. The Tracer Ex2 is a foldable chair with a crossbar under the seat. The crossbar imposed a problem with backing the wheelchair into the toilet seat area, and was eliminated in the new design. The toilet dimensions of 14 in. width and 17.5 in. height were used to calculate modifications needed to provide clearance of the toilet. In the new design, the height from the seat to the floor is 21 in.

The first modification done to the frame was to weld three horizontal bars along the width of the frame. The three bars measure 21 in. each. The frame is wider than most standard wheelchair frames. This design allows enough room for the wheelchair to clear the width of the toilet. The second modification made to the wheelchair was to raise the height of the wheelchair. The height of the seat of the original frame was about 17 inches.
Seat and Cutout
The seat (Fig. 11.23) is rectangular, with a width of 22 in. and depth of 16 in. There is a cutout section at the back of the seat. The seat is made of 0.5 in. hard plywood, a strong material that will be able to hold the required weight. There is a piece of aluminum sheet metal below the plywood to help keep it clean and dry when used. The aluminum surface also permits easy cleaning.

The seat cutout contains two symmetric sections made of the same material as the rest of the seat. The two sections are 11 in. long and 4 in. wide at one end and 2 in. wide at the other. This is the approximate shape of a toilet seat. Each piece is 4.25 in. diameter and 0.5 in. deep. This allows it to connect to the linkages.

Mechanism for cutout motion
The mechanism for raising and lowering the cutouts consists of a series of linkages. The system has one degree of freedom with one driving bar. It has a four-bar linkage, two on each side, to allow the load to be distributed equally four ways. As the bottom piece connected to the ground rotates, the other bars are forced to follow a set pattern. This makes the section open and close. The section is shown open in the CAD drawing in Fig. 11.24.

The total cost of the prototype is approximately $469.

Fig. 11.24. CAD Drawing of Easy Toilet Access Wheelchair (Isometric View).
BEACH MOBILITY DEVICE: BANDIT

Designers: Odean Foster, Adam Kulawy, Aaron Machtay, Jonathan Vaillancourt
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INTRODUCTION
The objective for this project was to design a device that allows persons who use wheelchairs to traverse the rough, uneven, shifting beach terrain. Two designs were considered and manufactured: a manually driven separate chair (see Fig. 11.25) and an electrically powered platform. The platform is compatible with the individual’s original chair (Fig. 11.26).

SUMMARY OF IMPACT
The BANDIT was designed as a treaded cart, capable of going over rough terrain. In the ideal situation, the BANDIT will give users independence. Current designs, including the manual wheelchair design presented here, usually require a caretaker to push the user. The BANDIT eliminates the caretaker’s driving or pushing role.

TECHNICAL DESCRIPTION
Of the two designs built, the manual wheelchair design (Fig. 11.25) is much simpler. It is a basic wheelchair with oversized, under-inflated tires. These tires yield a larger surface area in contact with the sand, which prevents them from sinking and jamming. Four tires are used to increase stability compared to a three-tire option. This design requires a second person to act as the driving force. Towards the back of the assembly, an arm is attached to assist the second person with pushing or pulling the chair. This arm also acts as a lever; when lifted or lowered it allows the vehicle to pivot around a point for steering.

In contrast, the BANDIT is a much more complex design. The design resembles a treaded cart, and can be compared to the system seen on a tank. The user is transferred onto this cart and drives it onto rough terrain. Each track is driven and controlled independently. This is done by using two separate 600-watt motors and twist-grip throttle controllers. Each side also utilizes a contactor that reverses the electrical poles, which allows the motors to drive in reverse. Because each track is driven independently, the steering mechanism employed involves driving one track faster than the other. A CAD drawing of the tracks can be seen in Fig. 11.26. This method is called skid steering and turns the vehicle in one direction or the other. An Electrical Control Unit was utilized to control the voltages in the motors, and to change the rotations per minute of the output.

The frame of the vehicle is made of aluminum, which was found to be structurally sound. Using aluminum reduces weight and cost, while still providing enough structural stability to withstand a variety of load intensities. A simple suspension system is attached to this frame. For each track, a bogie system is utilized, similar to the suspension found on a snowmobile. These systems have a torsion spring to enable suspension travel. They also act to increase the tension applied on the tracks.

The total cost of the prototype is approximately $1,700.
Fig. 11.26. BANDIT.
INTRODUCTION
The Patient Transferring and Positioning Aid (PTP) was designed to make it easier for patients with disabilities to have access to medical imaging devices with less effort for the doctor or caretaker. It will help patients with limited leg movement be transferred onto a medical imaging table, such as for MRIs, CTs, and X-rays. It will also help patients remain in a static position during a medical imaging scan.

SUMMARY OF IMPACT
The PTP was designed based on the needs of six patients with disabilities such as paralysis, heart failure, diabetes, obesity, stroke, and Parkinson’s disease. The PTP will make it easier for these patients to have access to medical imaging devices. The seating frame can be transformed from a seat to bed and raised to heights of medical imaging devices. This makes it easier for patients to get onto high tables. The positioning aids are placed on a mat, and the mat is placed on the seat. The PTP can be slid onto imaging tables, and will assist in keeping a patient in static position during a scan.

TECHNICAL DESCRIPTION
The PTP is made of two parts, the transferring device and the positioning mat. The transferring device is a metal frame that can be folded down from a seat to a flat bed. It consists of three hydraulic jacks, one for raising and lowering the back, one for the legs, and one for raising and lowering the seat. A scissor bar linkage provides extra support and prevents tipping of the device. The frame is made of steel and steel tubing. A track with rollers on top of the aid allows the positioning mat to be slid on and off the device. The positioning aid contains no magnetic parts, which is crucial for use with MRI and CT machines. It is made of wood with mattress foam for cushioning. The positioning aids are similar to pillows filled with cotton fiber.

The cost of the project is approximately $785.
Fig. 11.29. Cad Drawing of Transferring Frame (Isometric View).

Fig. 11.30. Positioning Mat and Body Segment Aids.

Fig. 11.31. Positioning Mat Layout.