CHAPTER 15
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INTRODUCTION
A prototype control device to assist people with impaired ankle function to operate an automobile accelerator has been designed and built. The device is used on a driving simulator by patients in rehabilitation at the Medical College of Ohio (MCO). The device consists of a fixed base that is rigidly attached to the floor of the car and a sliding portion that includes a foot rest and an extension arm ending with a contact roller that contacts the gas pedal (Figures 15.1 and 15.2). The forward motion of the foot is accomplished by knee joint motion causing the sliding portion to move forward; the contact roller then depresses the accelerator pedal. When the driver slides his foot backward, a return spring connecting the moving and fixed parts ensures safe disengagement of the contact roller from the gas pedal. The device is portable and is adjustable to accommodate various makes and models.

SUMMARY OF IMPACT
This project was motivated by several patients at MCO who are required to wear an ankle brace for stability. This brace prohibits dorsi/plantar flexion of the ankle, which makes automobile accelerator operation quite difficult. The device enables this task by means of knee joint rather than ankle joint movement. When tested by one of the group members on an automobile simulator located at MCO while wearing an ankle brace, it was found that accelerator operation using knee motion was very comfortable. Tests of the prototype showed it safe for normal automobile operation. It is simple and reliable with very few moving parts. The device is adjustable to compensate for different dimensions, making it adaptable to various models.
automobiles and trucks. Further testing of the device will take place at MCO under the supervision of Dr. Nemunaitis to determine the effect that the device has on the reaction time of individual patients. Dr. Nemunaitis will then determine if the device will be implemented into their rehabilitation program for patients with ankle immobility.

TECHNICAL DESCRIPTION
The entire frame of the device is machined from 3/8 in. 6061 weldable aluminum plate. As designed, the foot rests on the sliding portion of the device that includes a footrest, track rollers and an extension arm. Forward motion of the foot causes the sliding portion to roll forward on the fixed part of the device. The moving part of the device is designed as a drawer-type mechanism, track rollers are fixed to the stationary part of the device and the sliding portion acts as the drawer. The track rollers are steel cam followers; these act as bearings that support the slider; this system produces smooth translational motion during operation. A return spring acts between the moving drawer and the stationary part. The extension arm is connected to the slider near the footrest using a socket head - wing nut combination as shown in Figure 15.2. Jam nuts are also installed on the middle portion of the extension arm. A contact roller is attached to the end of the extension arm. This roller is made from two cylindrical pieces of aluminum on a steel shaft; the shaft rotates within a hole at the end of the extension arm. The roller can be extended and rotated to accommodate different pedal heights and positions. Since the roller is in contact with the gas pedal, forward motion of the former depresses the gas pedal.

This apparatus allows the foot to remain close to the gas pedal. Furthermore, the relatively elevated foot position reduces the possibility of it being hung up on the device as it moves to the brake pedal. Installation consists of placing the device on the driver’s side floor with the roller centered on the accelerator. The base can be adjusted using adjustment slots to obtain a stable position on the floor. The angle of the extension arm is adjusted by loosening its connection to the slider and rotating it until the height of the contact roller is approximately 0.5 in. above the bottom of the accelerator at its released position, then tightening the connection securely. The contact is between 0.5 and 1.5 inches from the pedal. To adjust this distance, the arm is extended or retracted by rotating it after loosening the jam nuts located on its center.

The prototype was further tested by a member of the design group in three different vehicles. A total of approximately ten miles were driven with the prototype in use. These test trials included stop and go traffic. Preliminary results of this testing were that once the driver adjusted to the slightly different motion involved in the operation of the accelerator, it was found to be comfortable and easy to use.

The final cost of the materials and components used in the accelerator control device was approximately $350.
Reduced Friction Walker

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Client Coordinator: May K. Breymaier, Physical Therapist, Rehabilitative Medicine, Medical College of Ohio
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INTRODUCTION
Experience with the use of walkers on the brick, tile, concrete and carpet surfaces in place in the areas used by rehabilitation patients at the Medical College of Ohio has shown that patients experience difficulty sliding their walker and that the rubber tips employed on the two sliding legs wear rapidly. A project was undertaken to develop a walker that would eliminate or reduce the occurrence of these difficulties.

After considering a number of options, a solution was effected by reconfiguring the sliding walker tips and substituting ultra high molecular weight (UHMW) polyethylene as the contact material. These changes are intended to reduce sliding friction to an appropriate level and to reduce the frequency of required replacement due to wear.

SUMMARY OF IMPACT
A prototype-reconfigured walker was placed in the Rehabilitative Services of the Medical College of Ohio in mid June 1994. Experience to this date indicates that the goal of greater efficacy due to reduced friction has been accomplished. It is too soon to determine to what degree footpad life has been extended. As noted below, design tests suggest that footpad wear is significantly reduced. When these effects have been verified, replacement of the rubber with UHMW polyethylene wear pads on the large number of walkers utilized by Rehabilitative Medicine will be undertaken.

TECHNICAL DESCRIPTION
At the outset of the project, several design alternatives were considered. Among these was replacement of the two sliding feet with spring loaded rollers or wheels. The concept was that, under moderate vertical load, the rollers would facilitate moving the walker to a new location; then, under the increased vertical load associated with the patients supported steps, the spring loaded rollers being depressed and inoperable the walker would be fixed in position by friction with the contact surfaces. Review of this concept with the client advisor revealed the fact that this was not how walkers are used in practice. Rather the patient slides the walker continuously as he/she steps along behind it; there is little change in vertical load from one step to the next. Therefore, the spring-loaded roller concept was not considered further.

The design concept adopted consisted of replacement of the stock external rubber sleeve feet with internal sleeve feet utilizing a material to be selected based on the criteria of low coefficient of sliding friction and resistance to abrasive wear. To implement this concept, candidate materials were considered. After preliminary studies, five materials were selected for detailed consideration: nylon, delrin, Teflon, polyethylene, and UHMW polyethylene. To select among them, coefficients of sliding friction were measured by two different methods and a procedure was developed to compare their respective abrasion resistances. Rubber was also tested for comparison. Delrin, Teflon and UHMW polyethylene, in that order, had comparable and low coefficients of sliding friction. All had coefficients less than half that of rubber.

Abrasion was tested by measuring the volume of material removed from equal size samples when abraded by a belt sander for forty seconds under equal pressure. The results showed that rubber abraded at nearly five times the rate of all samples except UHMW polyethylene, which showed a wear rate fifty times less than rubber and almost one order of magnitude less than that of the other four candidates. Therefore, UHMW polyethylene was selected as the substitute material.

In addition to the above noted substitution of UHMW polyethylene for rubber, the geometry of the tip was
redesigned. The original tip slid over the ends of the two aluminum tubes that form the rear walker legs. The new tips were machined from solid cylinders that slipped within the tube up to a larger diameter foot section. The foot was tapered to a smaller diameter at the point of contact to reduce the contact area and, hence, the sliding friction.

Total expenses for materials and supplies are $94.
Customized Walker for Child with Cerebral Palsy

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Client Coordinator: Amy Boos, Senior Clinician – Physical Therapy
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INTRODUCTION
A walker has been designed and built for a four-year-old child with cerebral palsy for the Department of Rehabilitative Medicine at the Medical College of Ohio (MCO). Aluminum tubing and industrial aluminum fittings were used to build the frame, and 1/4" commercial plastic was used for the chest and forearm supports (Figures 15.3 and 15.4). The walker was designed to provide torso support for the child and to accommodate future growth.

SUMMARY OF IMPACT
Cerebral palsy affects every patient differently. Therefore, symptoms associated with a particular patient govern the requirements for whatever devices required to improve the quality of his/her life. The client that this walker was designed and built for is a four-year-old girl. Her weight of 25 LB is relatively light compared to other children her age. Since cerebral palsy is not a progressive disease, her present condition is expected to continue. Accordingly, provisions were not incorporated in the design of the walker to account for worsening conditions. The constraints imposed by her current physical condition on the design of the walker included: 1) limited support of her head, 2) a need for support of her upper torso, 3) impaired use of arms and legs. The walker was designed, built and it has been delivered to the patient’s family. The walker has allowed the child to walk in-
dependent of assistance from another person for the first time.

TECHNICAL DESCRIPTION

The basic procedure used to design the walker was to visit and interview various medical supply stores regarding available equipment. Shugarman Surgical Supply Company and Medicare Equipment Supply Company provided the most information to the group members. At these stores, different walker designs were observed and evaluated. Purchase of an available walker with the intent of making the modifications necessary to accommodate the needs of this patient was prohibited due to the high cost of the commercially available models.

Child measurements were obtained and included width of chest, waist and hips, distances from shoulder to bottom of foot, from shoulder to crotch, from crotch to floor, from underarm to crotch, from underarm to crease of elbow and from crease of elbow to palm of hand. In addition, the distance between the two feet and the distance from the heel of one step to the heel of the next step were recorded. Aluminum was chosen as the material to be used for constructing the walker because it was found that all the currently available walker models were made of aluminum due to its low weight and high strength. The aluminum tubing that was selected was 1” x 0.125” 6061T6 aluminum; 36 feet were required to build the walker. To allow for an easy adjustment and modification of the walker frame size as the child grows, it was decided that the frame should be connected using universal industrial aluminum tube fittings. The fittings used to build the walker include tees, joining tees, elbows, side outlet elbows and crosses. Chest and forearm supports were formed from 1/4” special plastic that was donated by Shugarman Surgical Supply.

It would have been desirable to reduce the size of the tubing to reduce cost and weight since its strength was excessive for the child’s lightweight. However, this was not possible since one-inch aluminum fittings were the smallest commercially available. The final cost of the walker was about $350.
Restorator for in Bed Use

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INTRODUCTION

Recovery of patients confined to bed in the supine position is hampered by difficulty in engaging in significant muscle and/or cardiovascular exercise. Bed ridden patients who can sit up are able to use “restorators” as a means of exercise. A restorator has some of the characteristics of a stationary bicycle, it has pedals that rotate against friction resistance, without a seat.

In normal use, the patient using the restorator sits on a chair, bench, or the edge of a bed with the restorator placed on the floor or a platform in a position to permit pedaling. The goal of this project was to develop a restorator that could be operated by a patient reclined in the supine position in a hospital bed.

Two prototypes were developed. One of these consists of a mounting bracket that fixes floor mounted restorators in a position to be utilized by a patient confined to bed in the supine position, see Figure 15.5.

The second prototype was developed to correct inadequacies in the floor-mounted restorator and its adaptation for use in bed by patients confined to the supine position. Standard, available floor mounted restorators are equipped with insensitive friction adjustment and a strapped down mounting bracket is not consistent with patient expectations for professional hospital equipment. The prototype, see Figure 15.6, incorporates a sensitive adjustable disc brake operating on an aluminum flywheel. The device clamps to a standard hospital bed trapeze by means of a standard trapeze clamp.

SUMMARY OF IMPACT

Both prototype restorators were placed in service in the hospital units of the Medical College of Ohio in mid June. To date, each has been utilized by only a few patients. Both function satisfactorily. As expected, however, the trapeze-mounted unit is preferred by the therapist for its convenience, adjustabil-
ity and appearance.

**TECHNICAL DESCRIPTION**

Adaptation of the standard floor restorator on bed mounting has been accomplished by mounting it on a 2'x2' plywood sheet with one end elevated 3 1/2" above the flat surface. The plywood served to spread the load over a large area of the mattress, thus stabilizing the device position. Elevation was required to provide heel clearance during pedaling. Nylon webbing straps have been utilized to fix the device in position on the mattress. The straps are hooked to the restorator and bed supports then tightened in position. This system provides sufficient stability under the exercise loads experience as shown in Figure 15.5.

The second unit was designed to be secured by the trapeze hardware that fits the hospital beds employed at MCO. Every bed in the hospital accommodates these units. The footboard bar with a vertical bar and clamp are sufficient to provide a mounting platform for this restorator. Height above the bed and position from one side of the bed to the other are adjustable. Distance from the foot of the bed is adjustable over a range of about 18". The pedal of the crank mechanism was developed using bicycle components with machined shaft and sleeve bearings.

Friction is provided by means of disc brake pads, adapted from stationary bicycle components, acting on an aluminum disc fixed to the crankshaft. The brake pad pressure is adjustable over a wide range yielding smooth changes in required pedaling torque from almost frictionless to very difficult for a healthy individual.

The cost of the project included $56 and $101 for the materials and components in the retrofit and trapeze mounted prototypes, respectively.
INTRODUCTION
A seven-year-old boy with Cerebral Palsy was unable to use a conventional foot driven tricycle due to the limited strength and control over the movement of his lower limbs. Since he had greater control and strength in his arms and shoulders, his therapist believed that an arm-powered tricycle could be both good therapy and fun. A hand-powered vehicle sized to fit the patient was developed to serve these purposes.

SUMMARY OF IMPACT
A four-wheel hand pedaled vehicle was delivered to Rehabilitative Medicine at the Medical College of Ohio in mid May 1994. The vehicle, as shown in Figure 15.7, was sized to fit the patient's dimensions. Initial trials indicate that he is able to pedal and steer the vehicle. Its effectiveness in its intended roles as a source of physical therapy and an outlet for youthful energy awaits continued use.

TECHNICAL DESCRIPTION
At the outset of the project a number of design alternatives were considered. A concern existed regarding the intended operator's ability to steer effectively while simultaneously cranking; specifically that unintended steering might occur while cranking. Consequently, the vehicle was designed with a fixed hand crank powering the rear wheels through a chain drive. The gear ratio was selected to require only moderate torque. Substitute sprockets were provided to permit adjustments as skill and strength improve, see Figure 15.7.

Steering is accomplished through a conventional handlebar type steering post. The steering post was given sufficient friction to hold its position without being held.

A four-wheel design was selected to achieve a high degree of stability. The frame, seat, steering mechanism and axles were purchased in the form of a "Kettcar" manufactured by Heinz Kettler Gmbh of Germany. A seat belt was added to secure the rider in position. Larger bicycle style wheels were substituted for the original rather small wheels. This greatly reduced rolling friction.

The total cost for the parts and materials necessary to construct the vehicle was $271.
Figure 15.7. Hand powered cart.