Chapter 17
UTAH STATE UNIVERSITY

College of Education
Center for Persons with Disabilities
Logan, Utah

Principal Investigators:

Frank Redd, Ph.D. (801) 797-1981
redd@cc.usu.edu
Marvin G. Fifield, Ph.D. (801) 797-1981

TRANSFER LIFT

Designers: Maury Flake, Rich Geddes, Blaine Thurgood
Client Coordinator: Richard Escobaq USU AT Development and Fabrication Laboratory, Center for Persons with Disabilities
Supervising Professor: DK Thomas H. Frank
Mechanical &Aerospace Engineering Department
Utah State University
Logan, Utah 84322

INTRODUCTION

A system was designed to lift a client off a wheelchair seat, thereby freeing caregivers from heavy lifting. After the client is lifted, a transfer board may be placed underneath him, providing a stable support, and bridging across to the desired location. In many settings such a lifting device would provide a quick and easy means of transferring people without back injury.

SUMMARY OF IMPACT

The objective of this project was to design and develop a cost-effective method of transporting a client from a wheelchair to another location with minimal human effort.

There were several design requirements, including that the product be: user friendly, aesthetically pleasing, stable while a person is being lifted, safe, simple to add to an existing wheelchair, designed with 250 pounds lifting capacity, cost-effective, and portable.

TECHNICAL DESCRIPTION

The project can be broken down into three components: the lifting mechanism, the seat assembly, and the wheelchair/lift interface.

The development of the lifting mechanism included several design iterations that affected size, shape, and appearance, yet yielded the same function.

Square tubing was chosen to surround the mechanical jack because interfacing to a square, flat surface is considerably easier than interfacing to a curved surface. Square tubing is strong and stable, and prevents the lift from rotating axially.

A mechanical screw jack was chosen over a hydraulic jack or electric actuator to reduce cost, control weight, and prevent leakage.

The seat assembly is located behind the client, out of the way. With a forklift design, the seat has a cradle effect, unlike overhead sling devices, which make some users feel as though they are hanging and out of control.

The telescopic side support bars act as armrests and make the client feel secure. Attached to the end of the support bar is a crossbar, which provides support for the client and enhances the integrity of the framework.

The entire lift system can be used with a standard manual wheelchair after removing the wheelchair handgrips and drilling two 1/8" holes for upper pin placement. The only other attachment area is at the lower wheelchair frame where four 1/4" u-bolts are used to hold the aluminum base plate that supports the mechanical screw jack and the seat.

Project costs are under $400.

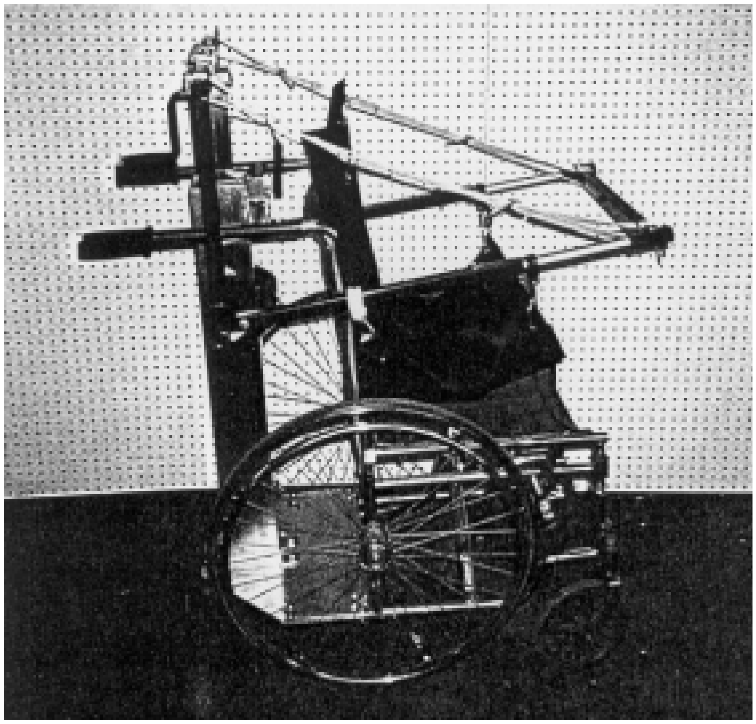


Figure 17.1. Transfer Lift.

ASSISTIVE SHOPPING DEVICE

Designers: Jerilyn Downs, Chris Potteq Devan Slade, Eric Staker
Client Coordinator: Richard Escobaq USU AT Development and Fabrication Laboratory, Center for Persons with Disabilities
Supervising Professor: Dr J. Clair Batty
Mechanical &Aerospace Engineering Department
Utah State University
Logan, Utah 84322

INTRODUCTION

A folding assistive shopping device was designed to help persons who use manual wheelchairs shop at any store. Many stores have powered scooters for shopping, but these are often difficult for users of wheelchairs to transfer into, and do not aid users in transporting purchased goods home.

SUMMARY OF IMPACT

The shopping device eliminates the difficulty of maneuvering both a wheelchair and a cart simultaneously, and enables the user to return home with the items purchased. The requirements and restraints included: user safety, stability, simplicity, fabrication cost under $200; weight of approximately 20 lbs; load capacity of 100 lbs, collapsibility, portability, maneuverability, adaptability to different wheelchairs, durability, style, and minimal social stigma.

TECHNICAL DESCRIPTION

The Assistive Shopping Mechanism was constructed out of chromed tubular steel so it would withstand corrosion and also be pleasing to others, so as not to draw unwanted attention. The mechanism folds on hinges. Support tubes add stability. The weight constraint, combined with the weight of probable users, required a lightweight durable fabric for a bag instead of using tubular steel for the basket. The material selected was Corduroy, a lightweight, durable fabric that can withstand substantial wear and force. The bag is attached by strong Velcro straps, positioned optimally for support.

The bag rests upon the lower frame on a l/4" sheet of ABS plastic, so that the top frame does not have to support the entire load.

Three caster wheels, like those normally found on manual wheelchairs, were used to enhance maneuverability and decrease attention to the cart.

Connecting arms that link the frame of the cart to the arm supports of a wheelchair are constructed with swivel collars, allowing for rotation such that the arms are adaptable to fit different widths of wheelchair frames.

Quick release grips are welded to hinges that rotate vertically to allow for different heights in wheelchair attachment sites. The arms can be attached to either the front or back of a wheelchair with no modifications. By attaching the shorter connecting arm, the cart can be easily side mounted to a wheelchair.

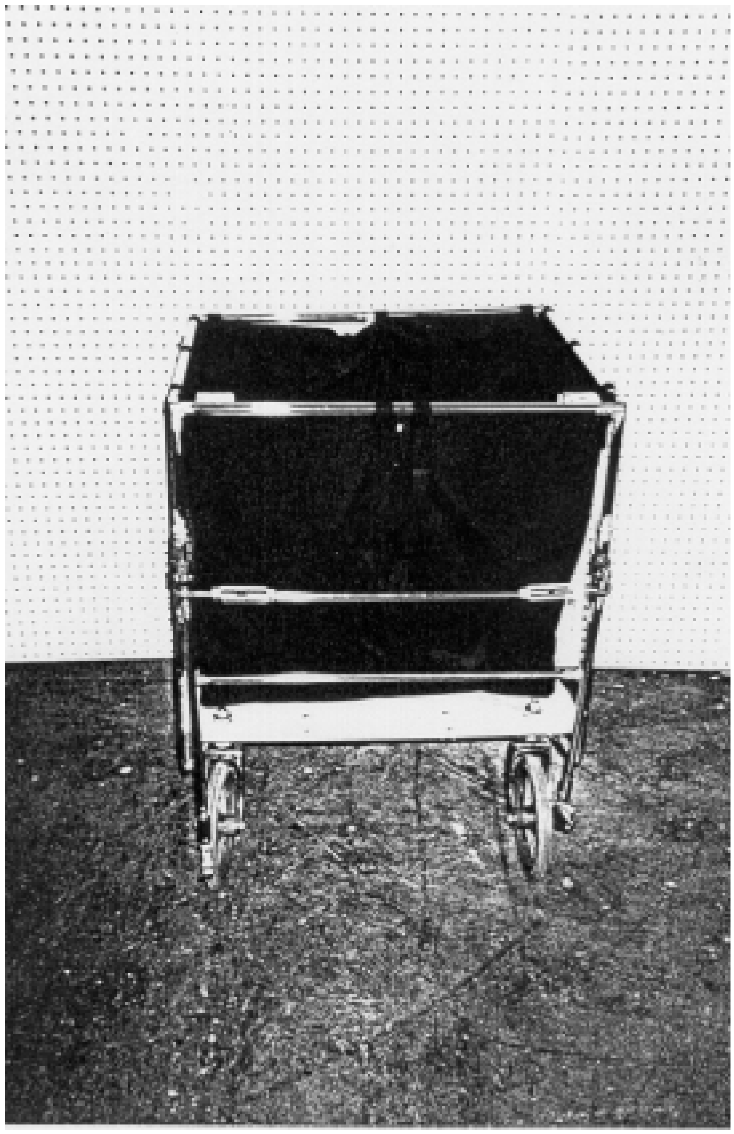


Figure 17.2. The Assistive Shopping Mechanism.

HAND-POWERED TRICYCLE

Designer: Jim Kinsley
Client Coordinator: Richard Escobaq USU AT Development and Fabrication Laboratory, Center for Persons with Disabilities
Supervising Professors: Dr. Beth Foley, Department of Communicative Disorders, Ms. Amy Henningsen, Occupational Therapist, Center for Persons with Disabilities
Utah State University
Logan, Utah 84322

INTRODUCTION

For a young child with limited or no use of his or her lower extremities, operating a commercially available tricycle is not an option. Several different types of hand-powered tricycles have been developed and marketed. Unfortunately, most are prohibitively expensive. Given the significant benefits of independent mobility for young children with physical disabilities, there is a need to develop a safe, inexpensive hand-powered tricycle that can be easily modified to accommodate specific consumer characteristics.

The purpose of this project was to develop a hand-powered tricycle for a six-year-old consumer with spina bifida, having no use of lower extremities.

The hand-powered tricycle was designed following an analysis of the specific needs and abilities of this consumer. Its primary purpose was to facilitate the development of upper body strength and endurance, while giving the consumer an opportunity to engage in age-appropriate outdoor recreational activities. Another important consideration was that the proposed design be cost-effective. For this reason, the tricycle was assembled using recycled bicycle and wheelchair parts at a cost of less than $200.

SUMMARY OF IMPACT

Although this project was initiated with a specific child in mind, the design is flexible, to meet the needs of a range of children and young adults with similar impairments. There are no welded parts, and the construction is such that it can be easily adjusted to fit varying size and weight requirements. Anyone wishing to replicate the design can easily obtain existing parts from used bicycles, making this an extremely cost effective recreational mobility option.

The primary benefit of this project is that it can enable an individual with limited lower extremity use to increase upper body strength and endurance. This can translate into increased independence in other activities of daily living.

The hand-powered tricycle also gives the consumer access to a popular out-door recreational activity. It can provide increased opportunities for social interaction with family members, peers and the larger community and, in doing so, heighten emotional and physical well being.

TECHNICAL DESCRTPTION

The purpose of this project was to make a hand powered tricycle that was inexpensive to make and could be duplicated without welding or machining. Using different size bicycle frames and wheels enables one to make a tricycle of the desired height and length. By using the wheelchair frame as a pivoting connection to the bicycle frame, the tricycle is made adjustable; the lower pivoting bar on the frame is easily relocated.

The wheelchair frame was disassembled, and the collapsible center cross frame was repositioned in the lower section of the framework. This made the chair wider for stability, as well as adjustable. The seat frame was created by reversing the hooks and placing a 1" angled piece of 3/l6" flat steel, using the existing hole and a longer screw to hold the seat in place.

Two bicycle frames were used. One frame is the main structure supporting the entire framework, while the other is only needed for an additional crank for the hand pedals. The main frame was cut, leaving the front fork, mainframe, and rear wheel support. The other frame was also cut, leaving the parts from the seat to the crank for the hand crank apparatus. The main frame is connected to the front lower cross arm of the wheelchair. The arm was cut in half and placed in a tube inside the lower crank arm, making a snug fit. 3/l6" machine screws with nylock nuts make the tricycle adjustable. Adjustable cables in the front and back of the seat frame attach the bicycle frame to the wheelchair frame, providing stability and adjustability.

A front wheel with a three-speed coaster hub was used for optional speeds and also for braking capabilities. A chain running between the upper crank arm and the front wheel hub required two idler sprockets to keep the chains clear of the framework. These sprockets were taken from the bicycle's derailer. It is important that these sprockets are made of steel, as many inexpensive bikes have plastic sprockets that do not hold up to the pressure exerted on them

Costs are less than $100.

Figure 17.3. The Hand-Powered Tricycle.

TEEN JOYSTICK-CONTROLLED GO-CART

Designer: Rich Kauer
Client Coordinator: Richard Escobaq USU AT Development and Fabrication Laboratory, Center for Persons with Disabilities
Supervising Professors: Dr. Beth Foley, Department of Communicative Disorders, Ms. Amy Henningsen, Occupational Therapist, Center for Persons with Disabilities
Utah State University
Logan, Utah 84322

INTRODUCTION

Concern for the appropriateness of powered mobility for children has lessened as children as young as 24 months have demonstrated that they can safely operate powered vehicles such as toy jeeps and cars. Powered vehicles allow children with disabilities to experience movement, and control and can facilitate their social, cognitive, perceptual and functional development.

Although an increasing number of joystick-controlled products are now available for young children with disabilities, few are appropriate for young adults with disabilities who exceed the size and weight limitations of "kiddie-type" vehicles. In addition, available devices are expensive, and require special adaptations for individuals who do not have sufficient cognitive and/or motor ability to use them independently.

The purpose of this project was to design an inexpensive joystick-controlled go-cart for a 15-year-old boy with spastic cerebral palsy. Although this consumer had access to a powered wheelchair in school, his home was not wheelchair accessible and opportunities for using the chair were limited. For this reason, he had a continuing need for powered mobility training to ensure development of the skills he needs to control a powered wheelchair safely. In addition, he expressed an interest in having some form of independent mobility other than a wheelchair to use for recreational purposes. He eagerly participated in the development of his “hot rod,” which was assembled and customized using parts from old wheelchairs.

SUMMARY OF IMPACT

This go-cart design incorporates a number of important safety features, including a five-point harness and a roll bar. It utilizes a wheelchair base, batteries, and a seating system. This design can be replicated using recycled wheelchair parts for well under $200.

TECHNICAL DESCRIPTION

A powered wheelchair was widened by detaching the cross braces and using them to make the lower support frame. The font end of the wheelchair, where the front wheels are attached, was cut off. The frame was lengthened by 16 inches using 3/8" aluminum pipe inside of the chrome pieces, cut from the frame of a manual wheelchair. These inner pieces run the entire length of the frame making it more rigid. A front wheel frame was reattached by welding it to the frame. The frame is reinforced with additional cross members, welded to give added support. During testing, the cart withstood weights of over 240 pounds.

A fiberglass seat replaced the sling seat that is standard with most of these types of powered chairs. This seat was placed in front of the battery compartment between the rear wheels. A metal floor and foot rail were welded to the tubular frame. The battery compartment was covered with a plastic shell.

All components of the go-cart are from recycled materials, except for the two 12-volt batteries that power the two 24-volt motors that operate the cart. The turning radius is very small, as the rear wheels are run independently with separate motors.

Total cost was under $100, including the two 12-volt batteries.

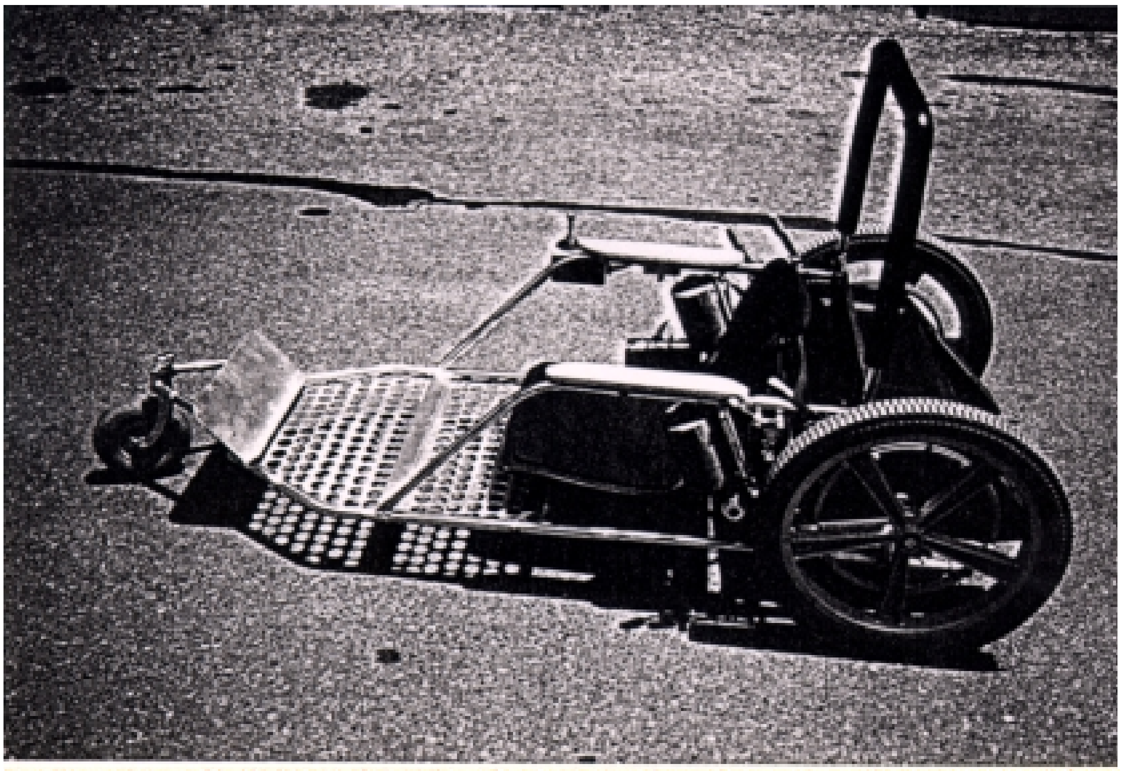


Figure 17.4. Teen Joystick-Controlled Go-Cart.

TOY JEEP ADAPTATION

Designers: Troy Kunzler, Cameron Evans, Shawn Hawk, Eric Worthen
Client Coordinator: Dr Richard Baer; Center for Persons with Disabilities
Supervising Professors: Dr. Beth Foley, Department of Communicative Disorders, Ms. Linda Chisholm, Center for Persons with Disabilities, Ms. Amy Henningsen, Occupational Therapist, Center for Persons with Disabilities
Utah State University
Logan, Utah 84322

INTRODUCTION

Some young children with mobility impairments have a need for an alternative mode of transportation that is affordable and fits their environment. Powered wheelchairs are not always affordable or feasible for a young child. Also, wheelchairs are conspicuous and may not always accommodate the social needs of the young child.

An affordable adaptation kit with joystick control was designed for the readily available Power Wheels Jeep, a small battery-powered toy car made for children between the ages of four and 10. The kit makes the Jeep accessible for children who do not have adequate muscle control in the legs or arms to operate the standard Jeep.

SUMMARY OF IMPACT

The adaptation kit makes it possible for the parent of a child with a mobility impairment to purchase the Power Wheels Jeep, and without unreasonable difficulty, adapt the Jeep to be controlled by a joystick. This enables young children to have a reasonably affordable, alternative mode of transportation that is both practical and fun.

TECHNICAL DESCRIPTION

The Jeep adaptation kit is composed of two parts. The first part is a joystick interface to the wiring of the Jeep. A small board of relays is connected to the motors that control the Jeep. The kit uses two independently powered motors for the two rear wheels. The joystick interface provides separate power and control to turn each wheel separately. This results in a one-wheel turning method (left or right rear), a two-wheel drive for straight forward, or one-wheel drive for reverse.

The second part of the adaptation kit involves modification of the front wheels to accommodate the turning method employed. This is accomplished by locking the front wheels, using a piece of wood placed in between the front tires and mounted to the frame. On this wood two smaller swivel wheels are attached. These swivel wheels are lower than the existing wheels, which results in the original wheels not being in contact with the ground. This allows the front portion of the Jeep to "free wheel" in order to accommodate the one-wheel drive turning technique.

Project costs are under $300, including the toy Jeep.

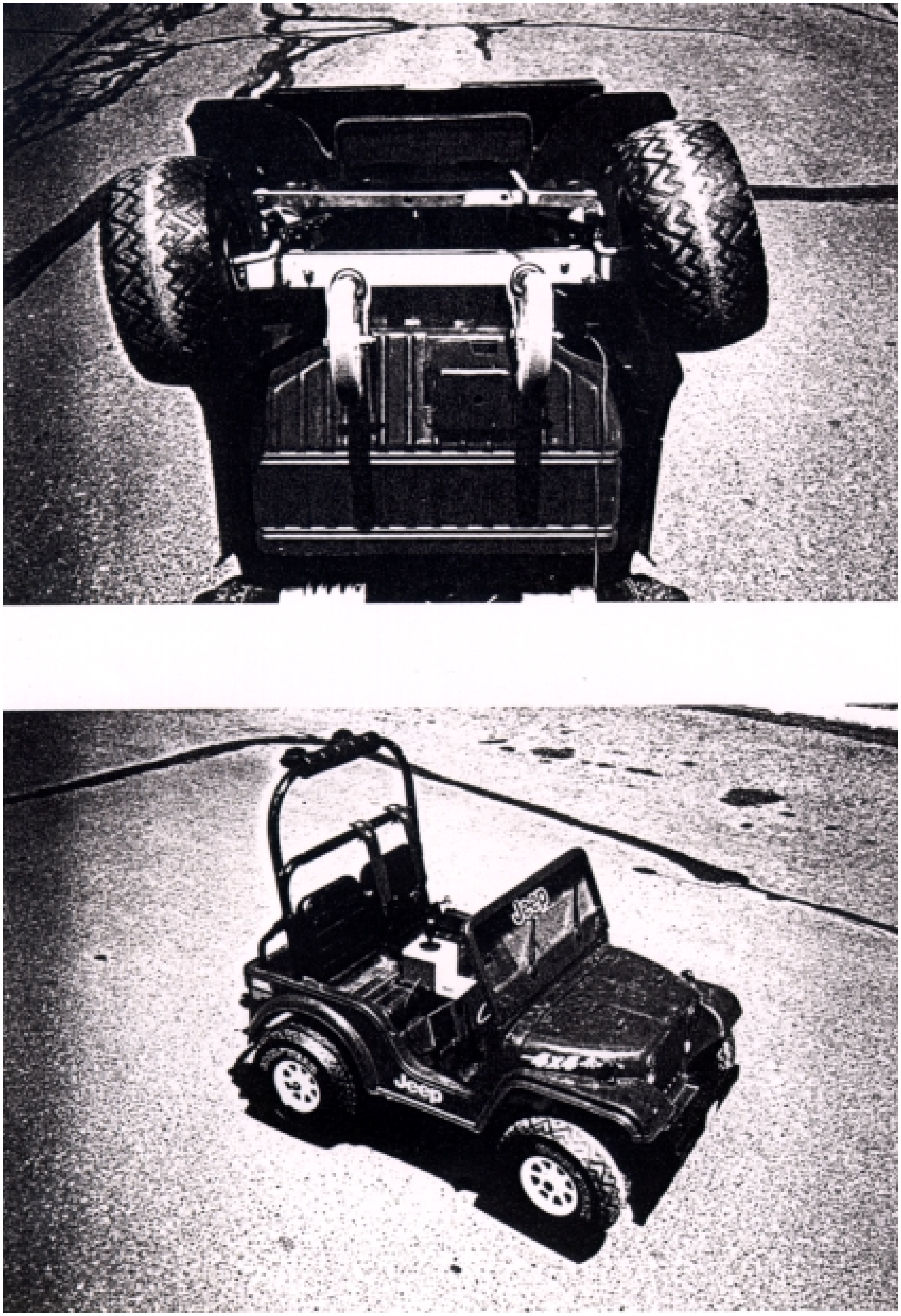


Figure 17.5. Toy Jeep Adaptation Design Project.

ASSESSMENT AND REMEDIATION TOOL FOR PHONOLOGICAL DISORDERS

Designer: Cameron Evans
Client Coordinator: Dr. Beth Foley, Department of Communicative Disorders
Supervising Professors: Dr: Ben Abbott, Electrical and Computer Engineering, Dr Boyd Israelson, Electrical and Computer Engineering DI: Nicholas Flann, Computer Science, Dr. Beth Foley, Department of Communicative Disorders
Utah State University
Logan, Utah 84322

INTRODUCTION

Over three million children and many adults in the United States have some difficulty with articulation, the production of speech sounds, and/or phonology, the knowledge and use of speech sounds. Problems with production of intelligible speech are referred to as articulatory or phonological disorders. A national shortage of speech-language pathologists (SLPs), the professionals who treat these disorders, has resulted in inappropriately large caseloads for most SLPs. Due to time constraints, many children who need intensive speech therapy receive only minimal treatment during the most important developmental years. Since a shortage of time is one of the main factors interfering with the quality of care for children with moderate to severe speech sound disorders, there is a need for a product that can significantly contribute to the productivity of practicing SLPs faced with time constraints.

The purpose of this project was to develop a prototype for an intelligent software tool for the assessment and remediation of phonological disorders. It utilizes two computer tools. The first is a high quality speech recognition system that was needed for transcription and analysis of children's speech samples. The second is a knowledge-based tool developed by a master's degree student in computer science, with assistance from faculty in computer science and communicative disorders. This tool was developed to take in a recorded speech sample, transcribe it phonetically, compare the transcription with the correct production of each word, then identity and describe any deviations present in the sample using the terminology preferred by SLPs.

By integrating these two components in a user-friendly interface, this project was designed to provide the SLP with a detailed summary of the assessment information, thus enabling her to move more quickly to the intervention phase of treatment. In addition, the results of the assessment can be used to select appropriate computer assisted instructional activities and stimuli for children with simpler disorders, so they can work on their speech independently, or with supervision, while receiving active response-contingent feedback on their progress.

SUMMARY OF IMPACT

This prototypical intelligent software tool integrates state-of-the-art speech recognition technology and a phonological disorder knowledge based tool into a program that can complete a phonological disorder assessment. It provides the SLP a description of a child's use of normal and/or deviant phonological processes, and based on that description, designs appropriate remediation exercises, using a highly interactive, and engaging multimedia format. Further development of the tool is needed to increase both the quality of the speech sample recording and the accuracy of the phonetic transcription of the recordings. Once the accuracy of the system reaches a level comparable to a trained listener and extensive field-testing has been completed, the product can be recorded on a CD and used with confidence by the SLPs.

TECHNICAL DESCRIPTION

The Phonological Disorder Assessment and Remediation Software Tool was developed using an IBM-compatible personal computer equipped with multimedia hardware (CD ROM, sound card, speakers, microphone, and modem).

The prototype consists of two parts, the user interfaces, and programming among the different components. A brief technical description of each follows.

USER INTERFACES

The project required the design and implementation of an interactive, multimedia, user-friendly Client

User Interface (WI). Each client using the system is prompted to produce 44 target words, which comprise the input for the assessment. Once the target words have been spoken and recorded, the CUI sends the speech recordings to the Speech Recognition Engine, using simple DOS commands and files.

A SLP User Interface (WI) was also needed so that data obtained from the GUI could be displayed appropriately and played back if desired. An important design consideration was that SLPs using the system must be able to make changes easily in both assessment reports and proposed intervention activities and stimuli, if necessary.

Project costs are under $460.

DYNAMIC SEAT CUSHION

Designers: Brian Anderson, Gary Malmgren, and Trent Gunnell
Client Coordinator: Dr. Richard Baer, Department of Communicative Disorders
Supervising Professors: Dr. Beth Foley, Department of Communicative Disorders, Ms. Linda Chisholm, Center for Persons with Disabilities, Ms. Amy Henningsen, Occupational Therapist, Center for Persons with Disabilities
Utah State University
Logan, Utah 84322

INTRODUCTION

A dynamic seat cushion was designed to prevent pressure sores. By alternating the air pressure, the seat assists the natural shift of an individual, thus reducing pressure on the individual's seating area, as well as facilitating blood flow through a wave or pulsing action of high versus low pressure. This theoretically could alleviate the problems of constant pressure with individuals in wheelchairs.

SUMMARY OF IMPACT

Humans have a physiological need to shift body weight to decrease pressure and stimulate circulation throughout the seating area. A dynamic cushion simulates, as closely as possible, the natural sitting behaviors of the body.

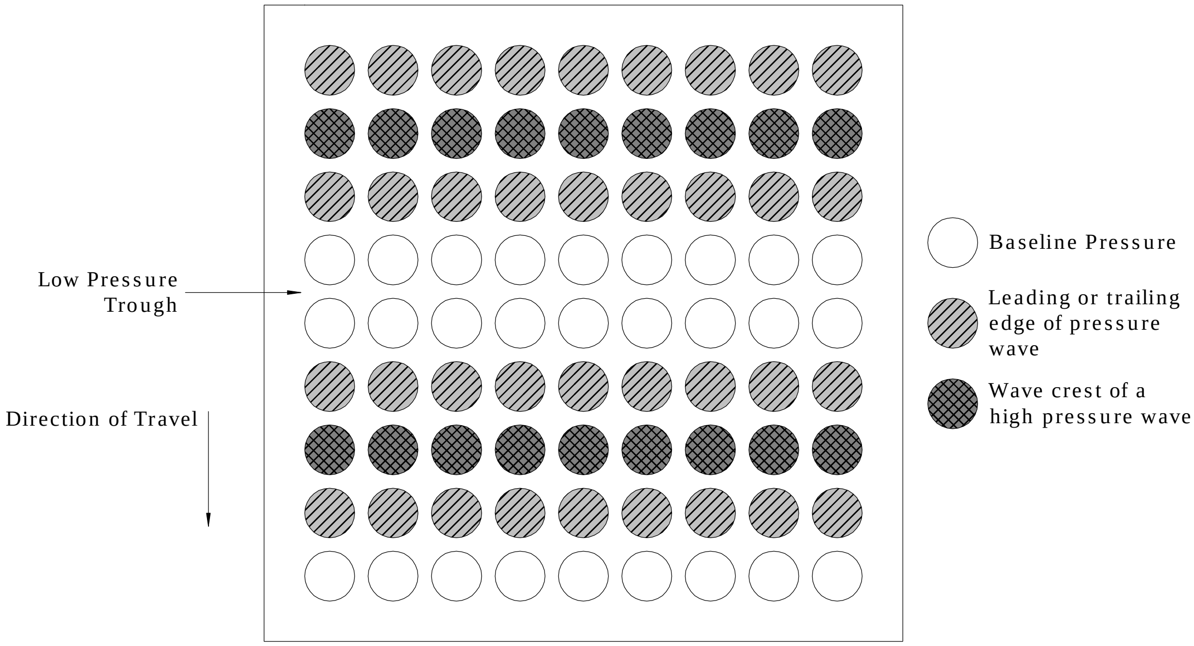
TECHNICAL DESCRIPTION

The design incorporates a modified Roho brand Hi-Profile seat cushion, chambered so that air can be moved by both rows and quadrants. By moving air row by row, a low-pressure trough, followed by a high-pressure crest, may be created (Figure 17.6). By isolating a low-pressure trough between two crests, the area of pressure is reduced, thus improving circulation. By moving this wave at the appropriate speed, pressure may be relieved and circulation improved in the seating area.

After a series of waves, the cushion returns to a predetermined baseline pressure throughout. From this position, one half (front and rear quadrants) of the cushion inflates to the high pressure point. After a set number of minutes, this side returns to baseline and the other half of the cushion inflates to the high pressure point. Again, after a set amount of time, this side returns to baseline, and the front half (left and right quadrants) inflates to the high pressure point, followed by the opposite side. The cushion then returns to baseline and remains there for a desired amount of time. At this point, the wave cycle begins again.

Various medical professionals are providing feedback to evaluate the theory of a weight shift and a wave of low pressure to relieve pressure and improve circulation. With this information, the appropriate modifications will be made and a working prototype will be developed.

Estimated costs are approximately $1000.



FRONT

Figure 17.6. Dynamic Seat Cushion (View From Above the Cushion).

JOYSTICK-CONTROLLED MOTORIZED TOY VEHICLE

Designers: Cheryl Freeman, Jeremy Freeman, and Paul Rew
Client Coordinator: Mr. Richard Escobar; USU AT Development and Fabrication Laboratory
Supervising Professor: Dr Steve Folkman, Department of Mechanical and Aerospace Engineering Utah State University
Logan, Utah 84322

INTRODUCTION

Independent mobility for disabled children is crucial to their development as self-confident, self-reliant adults. Unfortunately, many insurance companies and related professionals are reluctant to recommend or fund motorized wheelchairs for small children (age four and older) who have not yet proven their ability to operate motorized vehicles or who will grow out of the expensive chairs very quickly. A series of modifications allow the conversion of a commercially available motorized toy car for joystick control. The modifications are simple, inexpensive, and able to be completed by most parents or other caregivers of disabled children.

SUMMARY OF IMPACT

Two major goals were to make the modifications to the vehicle inexpensive and simple to perform. The parts may be purchased at stores that are accessible to most Americans (Radio Shack, a hardware store, an auto parts store, and an electrical supply store). Only basic tools are required: a hacksaw, a Phillips screwdriver, a few wrenches, and a drill.

TECHNICAL DESCRIPTION

As purchased from the store, the toy motorized vehicle has a forward / reverse switch, a high speed / low speed switch, and a steering wheel by which the child controls the direction of the vehicle. The vehicle is powered by two six-volt batteries controlled by a "gas pedal" on the floor of the vehicle, supplying power to two motors that turn the vehicle's back wheels. The modifications transfer all of this capability into a joystick, mounted on the vehicle, within the child's reach. The joystick controls power, direction, and speed.

Automobile relays are wired to the joystick and the car's motors to control forward / reverse motion. A steering motor is attached to the front wheels so that the child's own arm strength is not required to turn the vehicle's wheels. The design uses an automobile windshield wiper motor as a steering motor. This motor is connected to the joystick through automobile relays. The relays are housed in a circuit box that is attached securely under the body of the vehicle, protected from damage by use or inadvertent contact.

It is estimated that the modifications would take about four hours to complete. The final cost of modifications is approximately $100, in addition to the cost of a toy motorized vehicle (about $200).

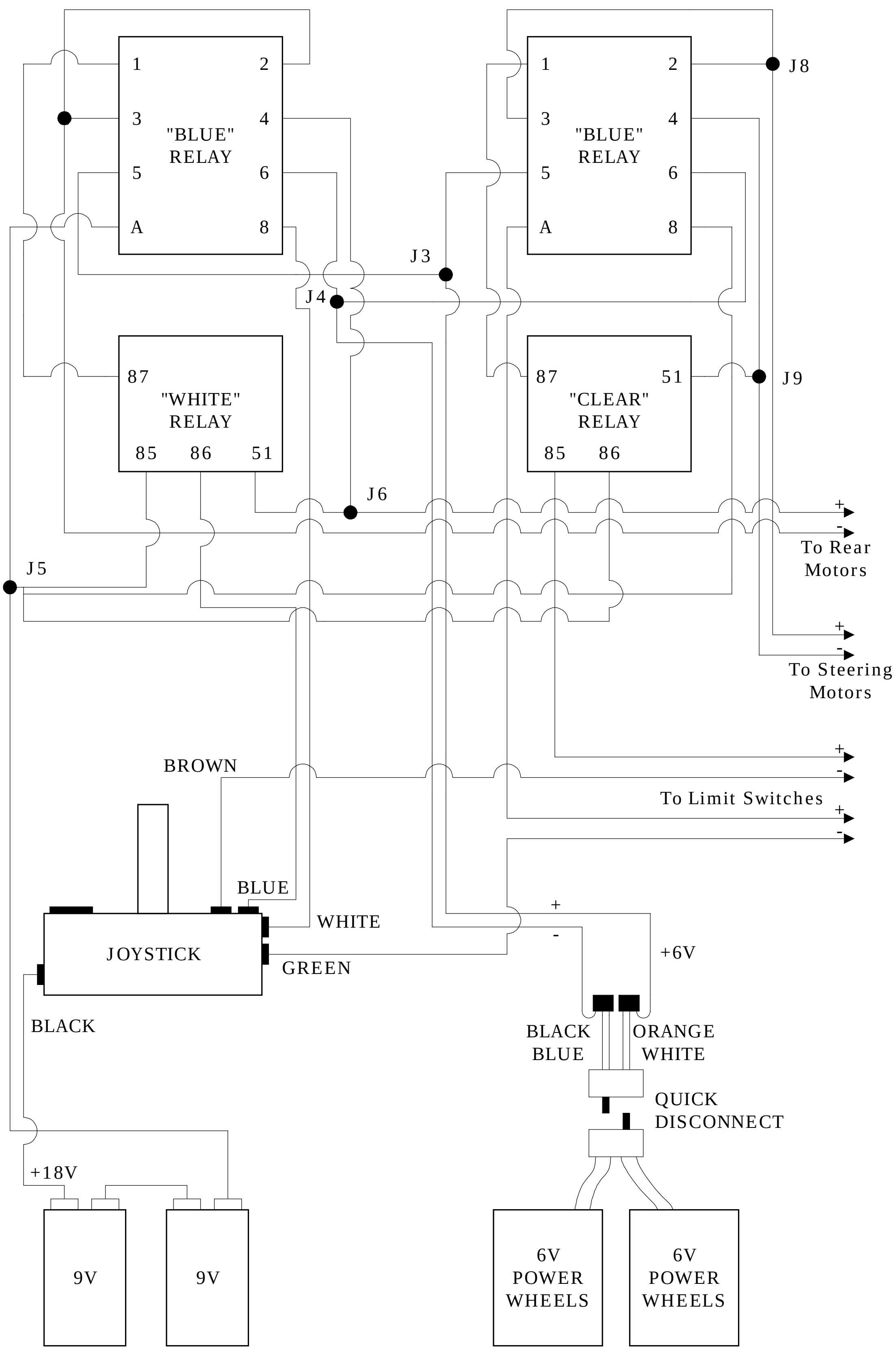


Figure 17.7. Circuit for the Joystick-Controlled Motorized Toy Vehicle.