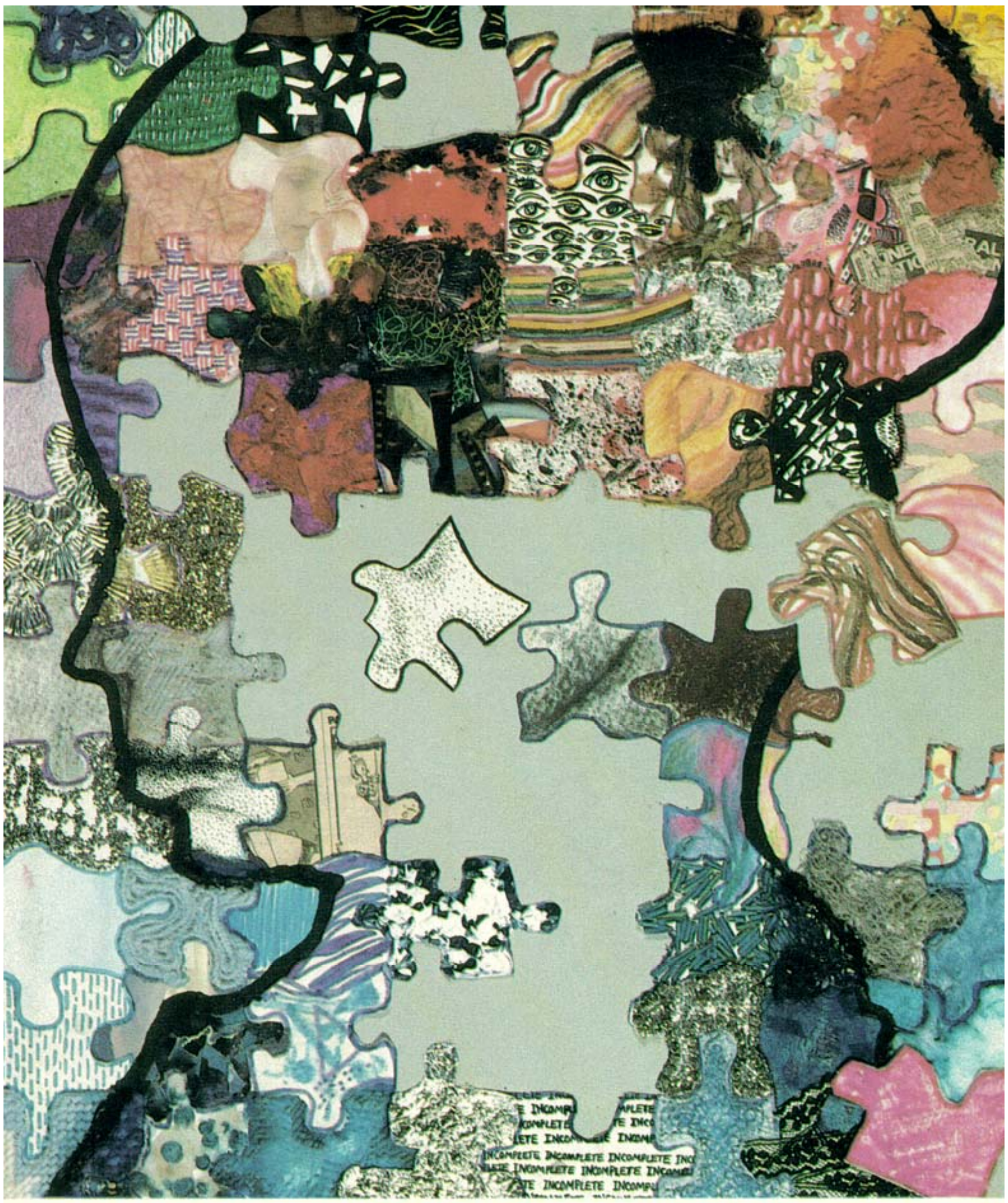
NATIONAL SCIENCE FOUNDATION 2003 ENGINEERING SENIOR DESIGN PROJECTS TO AID PERSONS WITH DISABILITIES



Edited By

John D. Enderle and Brooke Hallowell

CHAPTER 19
UNIVERSITY OF WISCONSIN-MILWAUKEE

College of Health Sciences
Department of Occupational Therapy
212 Hartford Avenue
Milwaukee, Wisconsin 53211

College of Engineering and Applied Sciences
3200 North Cramer
Milwaukee, Wisconsin 53211

Principal Investigator:

Bertram, N. Ezenwa (414) 229-3184

bezenwa@uwm.edu

WEIGHT-ASSIST WALKER RE-DESIGN TO FACILITATE FOLDING

Designers: Fern Tuchowski, David Schneider, Department of Mechanical Engineering
Supervising Professor: Dr. Bertram N. Ezenwa
University of Wisconsin-Milwaukee, Milwaukee Wisconsin, 53211

INTRODUCTION

The goal of this project is to determine the best way to fold a modified posture control walker for a child with limb deficiencies in both arms and legs. The child is an eight-year-old boy who is missing both arms from the elbows down and both legs from the knees down. He does not have properly developed hip sockets, so the femur is connected to the pelvis primarily by soft tissues. The child wears prosthetic legs, and needs additional support from a support belt held by adults when not using a walker. However, he needs adult supervision even when using a walker. His parents and teachers would like him to be able to ambulate independently and play with other children without the need for adult supervision. An out door ability of interest to him is to be able to play kick ball with his friends. To provide the independence for him, a reverse walker (KAYE Posture Control Walker Model W3BRS) is modified to be used, hand-free. A weight belt for him to wear to provide additional upper-body support is incorporated to the walker along with a back comfortable interface. The front opening of the walker is increased to provide more open area for leg movement when playing kickball and using a urinal. Ratchets are added to the rear wheels to keep the walker stationary and provide stable support when kicking a ball or doing other activities such as drinking water from a water fountain. The size of the rear wheels is increased to add stability on uneven surfaces such as grass. The modified walker meets all of the project requirements to provide greater independence for the child. However, in widening the front of the walker by five degrees on both sides, and permanently connecting the front and back support walker for rigidity, the walker is not able to fold.

SUMMARY OF IMPACT

The optimal folded dimensions for the walker were determined to be approximately 12.00 inches thick by 31.00 inches wide by 36.00 inches tall. With these dimensions, the folded walker easily fits into the trunk of most cars, making it easy to transport and compact to store. The walker design retains all the added support in the original modification, continuing to provide the greater independence requested by teachers and the parents.

Figure 19.1. Modified Gait-Assist Walker for Fold Design.

TECHNICAL DESCRIPTION

The modified reverse walker was modeled in Pro-Engineer to determine the dimensions for developing a foldable version. The optimal folded dimensions for the walker were determined to be approximately 12.00 inches thick by 31.00 inches wide by 36.00 in. tall.

A finite element analysis was conducted to determine the points of stress in the current design, and the impact of eliminating some of the cross members in order for the walker to fold. The finite element analysis results suggested that the modifications would not affect force transmission by moving the point of angle of bend towards the back to allow straight telescoping tube on the outside of both left and right supports as movable side brace and pivoting the side supports about the pivoting frames. Using one-piece back frame will transfer most of the force straight to the ground. The main structure will consist of a one-piece back frame with two looped tubes used to provide efficient load transfer to the back frame. The others include two side frames that pivot in brackets to a folded position. The existing wheel assemblies will be used and are attached to the structure using retractable buttons. Three additional improvements were added to the list of design parameters after the boy made his initial trial of the walker. These included a method in which the child can engage and disengage the ratchets on the back wheels himself, ideally from a control on the armrests. Adjustable arm rests/guides will be added to improve the control of the walker. With the belt as the sole means of guidance, the walker tended to "drift" especially on textured or uneven surfaces and it was difficult to "steer". A more robust belt closure was implemented to enable the boy to secure the belt tightly by himself.

Figure 19.2. Re-designed Weight Assist Walker.

ADAPTIVE TOY CAR

Designers: Adam Fink, John Teah, Department of Mechanical Engineering
Supervising Professor: Dr. Bertram N. Ezenwa
University of Wisconsin-Milwaukee, Milwaukee Wisconsin, 53211

INTRODUCTION

The aim of this project was to modify a Power Wheels Firerock™ Jeep® Wrangler by Fisher-Price to enable a child with upper and lower limb deficiencies to drive the electric toy car. The jeep operates from a single pedal using the retardation provided by its two electric motors to stop. The motors power the two rear wheels and a switch controls their direction. It has a maximum speed of 3.5mph, and is designed to carry one child up to 65 pounds, (29.5kg). The steering is controlled by manually turning a wheel attached to a bar connected to the front axle. The child is missing both arms from the elbows down and both legs from the knees down. His femur is connected to the pelvis primarily by soft tissues. The child has difficulty getting in and out of the Jeep, reaching and controlling the steering wheel when inside. The main aim of the project is to modify the steering control, accelerator and drive direction controls to enable him to control the vehicle.

SUMMARY OF IMPACT

Accomplishing the objectives while maintaining the integrity of the vehicle, and not disrupting the style or entertainment value of the vehicle, enabled the child to drive the electric car and interact with his friends.

TECHNICAL DESCRIPTION

A test-drive by the boy revealed that the steering control required power assistance and easier access to enable him to reach and use it comfortably. The direction control button needed to be automated as he kept forgetting to press it and hence the vehicle would travel in the opposite direction to which he was expecting. The accelerator, located on the inside floor of the vehicle was out of comfortable reach for him and since it was a simple on/off switch would jerk the child as it started. The identified problems were eliminated as illustrated in Fig. 19.3.

Steering: The locations and orientations of the wheels with their linkages were reversed with the left wheel on the right hand side and the right wheel on the left hand side. This resulted in the steering link being moved forwards providing the needed room to insert a servomotor. The Futaba S5302 servomotor used was rigidly mounted in this space beneath the battery and between the front wheels. Rubber grommets provided with the servomotor was used to reduce the shock of impact load as the servomotor turns. This was expected to reduce the

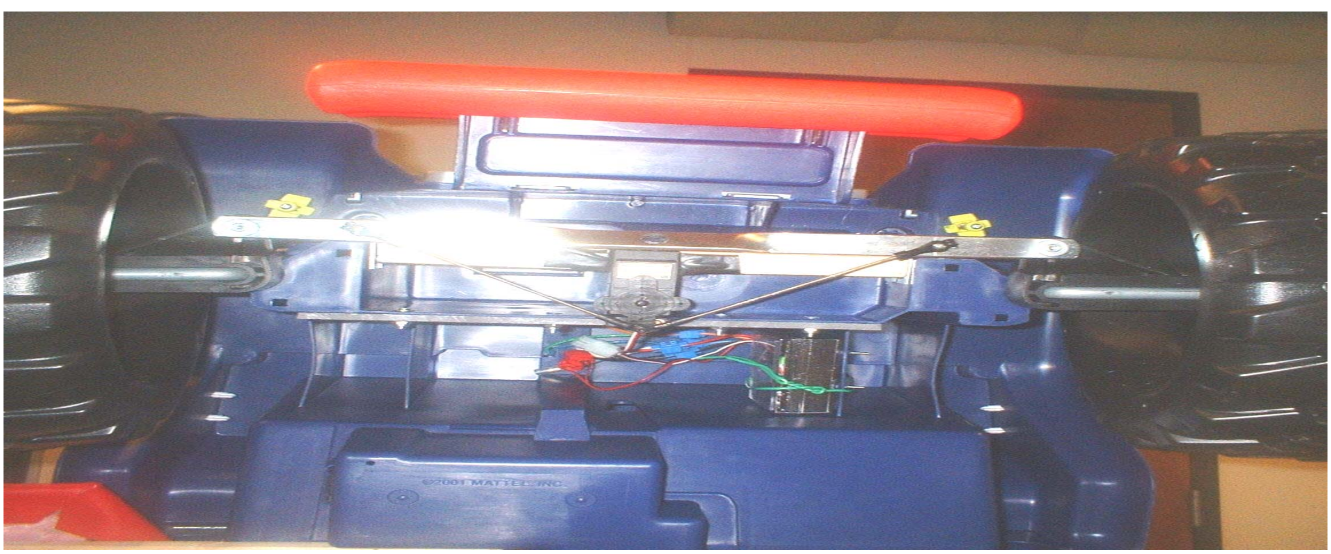


Figure 19.3. Technical Modifications.

loading stress on the servomotor, and hence enhance its lifetime. The largest of the supplied servo arm was used to provide a fixing point for the linkages to the steering link. These links consisted of ball joints at each end of a 4/40 inch thickness threaded rod. The rods were cut at 130 millimeter length and threaded into the ball joint assembly that was bolted onto the servo arm/steering link. The servomotor connected electronically into the controller. This was housed close to the servomotor due to the short length of connection cord. The servomotor control and the speed control stored in a small plastic box and the servomotor control were connected to the joystick with potentiometer via the control receiver.

Power Switch and Dashboard: The power switches for the control receiver and the speed control were connected to the main color-coded ON/OFF power switch on the dashboard. The dashboard was made from a piece of 18x5x1/4 inch plastic. On top of the dashboard mounts the power switch and joysticks flush with its surface. The dashboard was held in position with hinges when down and matching Velcro strips when lifted to the windshield as in Figure 19.4.

Speed Control and Control Receiver: A variable speed control was implemented by using a speed controller with reverse function. It was connected to a joystick with potentiometer through a control receiver. The speed of the drive motors would then vary with the amount the joystick is moved and their direction changes with the direction of the joystick. It is located with the servomotor controller due to the short length of connecting cord. The speed controller also connects to the drive motors and the main six volt battery. It has its own power switch which controls the power to the servomotor and drive motors. The control receiver was the connection between the servomotor control, speed control and the joysticks. It was a dual band R/C receiver, powered by eight AA batteries. It had a power switch and a low battery alarm, which sounded when the batteries were nearing depletion. Snap connectors were used to run wires to the joysticks, where they were soldered to the potentiometer.

Figure 19.4. Dashboard with controls.

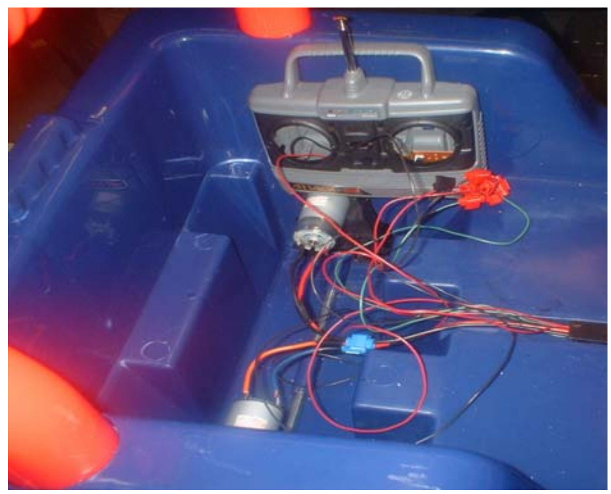


Figure 19.5. Connection for Speed and Receiver Control.

The child's ability to enter the vehicle independently needed improvements. A fold down control panel was added to the vehicle to allow the child to reach the controls without twisting and stretching his back. Finally, it was made easy for him to get in.

The total cost for the toy car and the parts for the project was $623.