Chapter 13
UNIVERSITY OF DELAWARE

College of Engineering
Department of Mechanical Engineering
Newark, Delaware 19716

Principal Investigator:

Dick Wilkins (302) 831-2006
wilkins@me.udel.edu

A BEACH WHEELCHAIR TRANSPORTER FOR HANDICAPPED CHILDREN

Designers: Robert Banks, Chris Lawler, Cleveland Dargan, and Kevin Stolfo
Client Coordinator: Carol Barlow
Harbor Health Care and Rehabilitation Center
Supervising Professors: Drs. M. Keefe, D. Wilkins, A. Parvizi-Majidi
Department of Mechanical Engineering
University of Delaware
Newark, DE 19716

INTRODUCTION

A wheelchair transporter (Figure 13.1) was designed to carry a child in a wheelchair across the beach. It is an aluminum wheel-driven, platform device accessible via a collapsible ramp. It accommodates varied loads and different wheelchairs. Aluminum surfaces were treated to inhibit corrosion. Smooth edges ensure safety.

SUMMARY OF IMPACT

A beach wheelchair transporter was designed to accommodate any wheelchair; eliminate the need to transfer children from a custom chair to a beach chair; provide space for supplemental equipment, such as a respirator; be resistant to corrosion; be durable; and be aesthetically appealing. In the future, a permanent ramp may be added, and the upper frame may be welded to eliminate the need for pipe fittings.

TECHNICAL DESCRIPTION

The wheelchair transporter was designed to facilitate taking children in wheelchairs to the beach. The design was based on that of landscaping trailer decks, wood decks with simple metal framing underneath for support. The principle design requirements were that it be: lightweight; able to be pushed across the sand; able to hold a minimum load of 173 pounds (to accommodate the client's heaviest combination of chair and child); easy and quick to set up; corrosion-resistant; and safe to use.

The pinewood deck will support any wheelchair wheelbase. The upper frame, a railing assembly, is constructed of lightweight seamless aluminum tubing, painted for corrosion resistance. The varied tube lengths are joined by aluminum structural pipe fittings. The back of the railing has a quick-release assembly to enable loading from the rear. The lower frame, or truss, is made of lightweight, stiff, hollow, aluminum square tubing, also painted for corrosion resistance. The square beams were butt-welded for high strength.

Wheels were selected over a sled, treads, or a hover concept for ease of movement across sand. A disc was welded to a machined collar to create the aluminum wheel hubs. A steel axle was slip-fitted and pinned into the hubs. The pillow blocks are sealed and shielded. Lithium grease in the bearings was purged and replaced with boat trailer grease, which is better suited to salty, wet environments. Splined studs were press-fitted into the hubs to accommodate the bolt pattern on the wheels.

For added corrosion resistance, all aluminum surfaces were abraded with a steel brush, then primed and painted using coatings designed for aluminum. The wood deck was coated several times with polyurethane for weather resistance.

The wheelchair is held on the transporter via ratcheting tie-down straps, which are inexpensive and quick and easy to use.

The client provided a portable access ramp, which could easily be attached permanently via a hole pattern that could mate with three studs on the rear of the transporter.

Tests of the transporter were conducted by loading it with an adult in a wheelchair and pushing him around the beach. The metrics set forth in our design criteria were met and no major adjustments were needed.

The final cost of the wheelchair transporter is approximately $800.

Figure 13.1. Beach Wheelchair Transporter.

EASY ACCESS

Designers: Tim Clark, Keith Metzger, Eric Ramos, Steven Rosenberg
Client Coordinators: Vince Evans, Pat Moore
Supervising Professors: Drs. Dick Wilkins, Michael Keefe, Suresh Advani
Department of Mechanical Engineering
University of Delaware
Newark, DE

INTRODUCTION:

A personal storage system to be attached to a powered wheelchair was designed for a student with a progressive muscular disease. Because of his limited upper body motion and strength, the student needed a device that would carry the storage bag from its original resting position to a position where the student could access his personal belongings.

The system is mounted on top of the student's lap tray (Figure 13.2). A four-bar linkage with a DC motor drives a rigid storage bag. It is controlled via a push-button toggle switch. Top and bottom brackets are designed to allow easy mounting and disassembly from either side or from the front of the lap tray.

SUMMARY OF IMPACT

A student with a progressive muscular disease, involving limited upper body motion and strength, requested a means of accessing his belongings from a bag that is usually stored on the back of his wheelchair. The Easy Access device was designed to meet this need, and to promote the student's self-reliance and independence.

TECHNICAL DESCRIPTION

Listed in order of importance, the design criteria were that the Easy Access device: 1) provide storage for personal items and school supplies, 2) accommodate a particular range of upper body motion, 3) be accessible to a student with low grip strength and limited ability to move objects, 4) be aesthetically pleasing, 5) allow for the student's entry to and exit from the wheelchair, 6) cost less than $1,000, 7) be lightweight, 7) not interfere with the operation and functionality of the wheelchair or its accessories (including the motor, battery, electrical controls, lap tray, joystick, neck support assembly, etc.), and 8) meet the dimensions for a wheelchair and its accessories specified by the universal guidelines for wheelchair accessibility in the Americans with Disabilities Act (ADA). Compliance with the ADA ensures that the chair will fit through standard doorways and onto public transportation.

The design has five main components: a personal storage unit, a four-bar linkage system, power and transmission, electrical control, and a protective cover. The storage unit combines a rigid frame using fabric stiffeners and nylon liners. The rigid frame and large opening of the bag allow for easy accessibility of stored materials. An outside shell of canvas material is used to emulate commercial backpacks.

The linkages are designed as a rocker-rocker four-bar system. Two identical sets of standard four-bars are situated at either end of the storage unit for stability. A common rotating shaft powers the two drivers. The initial and final positions of the bag are set to obey ADA laws, and accommodate the customer's range of motion. The initial position is such that the additional width to the wheelchair is minimized, while the final height of the bag is placed 3" above the lap tray.

Weight restriction is necessary for portability. For this reason, the battery and DC motor were separated from the portable system. For simplicity, the DC motor is permanently attached to the bottom of the wheelchair seat, near the 24V battery. A flexible power drive shaft is used to connect the power from the DC motor to the gearbox that generates the proper torque. The gearbox is then connected onto the drive shaft by a spring coupler.

For easy accessibility, a large pushbutton is used to control the raising and the lowering of the linkage system. When the large pushbutton switch is activated, the motor is powered and the linkage system moves. When the linkages reach a given upper point, they trigger a limit switch that simultaneously activates the brake and cuts the power to the motor. When the switch is activated again, the brake is released and the motor is powered in the reverse direction. Again, the linkage system travels until it reaches the lower limit switches, activating the brake and cutting the power to the motor. A jog switch has also been included so the circuitry can be bypassed in case the linkages are stopped mid-path.

Finally, the portable linkage system is housed in a protective cover. This cover protects most of the moving parts and electronics from dirt and wear. In addition, the cover provides the rigid structure needed to mount the system to the lap tray. The cover also offers aesthetic value to the design.

Modifications for the device include the use of a geared DC motor mounted on the housing to drive the shaft. This will eliminate the need for a flexible shaft.

An estimate of the final cost for the storage system is approximately $700.

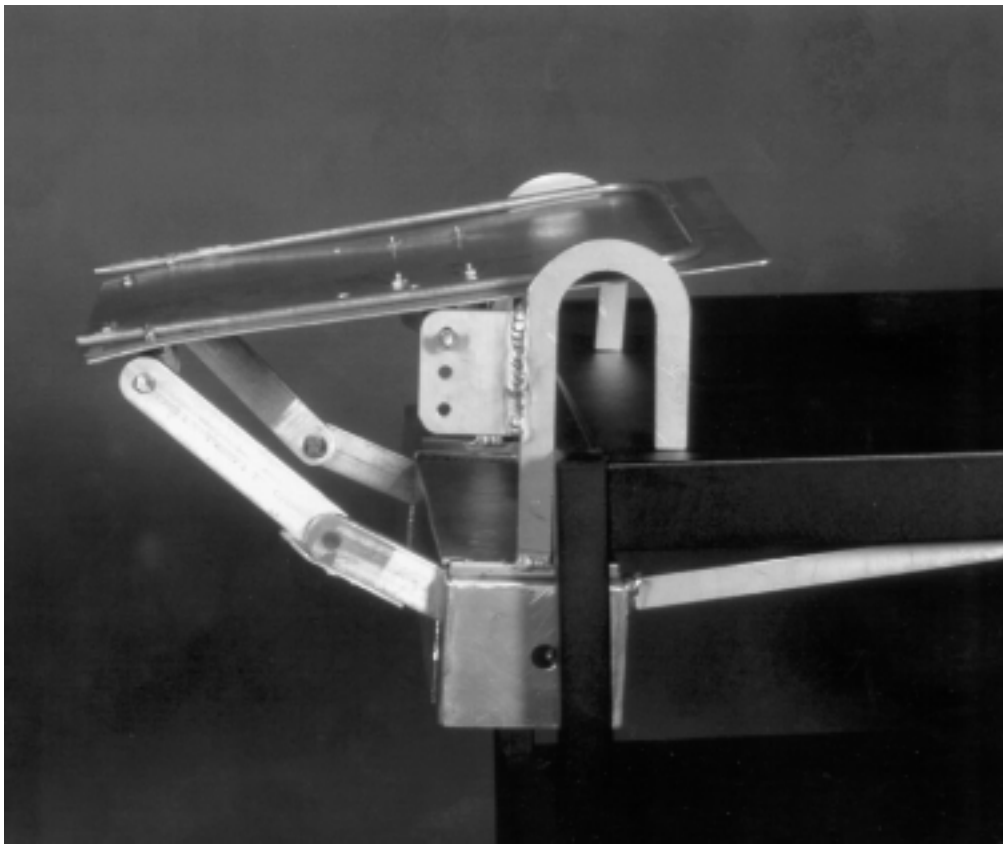

Figure 13.2. Easy Access.