Chapter 18
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MODIFICATION TO THE EVAC CHAIR

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INTRODUCTION

An EVAC Chair (Emergency Descent Model 300H) (Figure 18.1) is an emergency evacuation device designed to escort handicapped individuals down stairwells of multi-level buildings during crisis situations, such as fires. The main problem with that device is the amount of effort/strength needed by the caregiver to maneuver an individual in the chair on level ground (Figure 18.2). This could result in early caregiver fatigue during operation, or lower back injury.

Problems with previous modifications include: instability, lack of rigidity, and a non-ergonomic release mechanism. Although the design intent was valid, the adaptation did not work, and could not maintain the weight of an occupant.

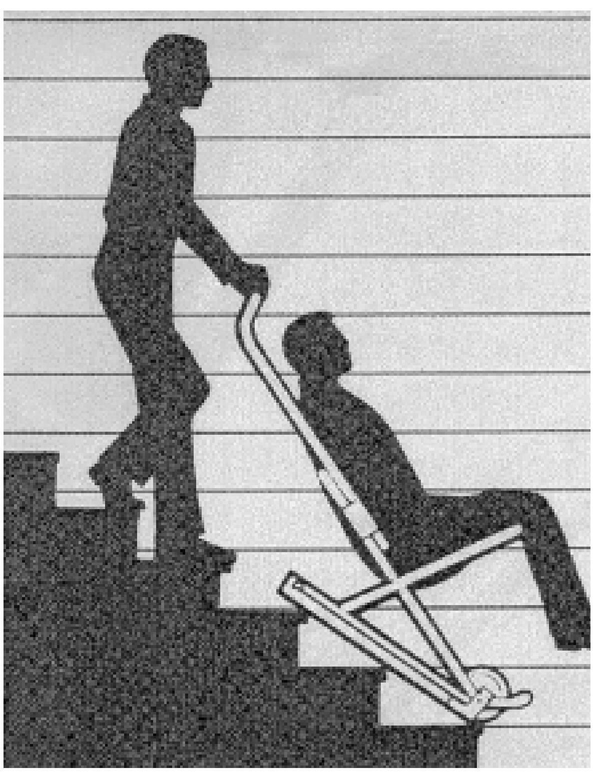

Figure 18.1. EVAC Chair used for down stairwell evacuation.

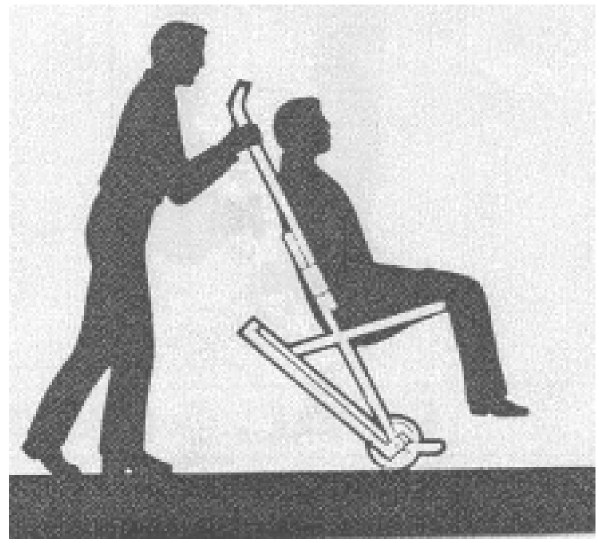

Figure 18. 2. EVAC Chair used to transport an individual on level ground.

SUMMARY OF IMPACT

The main objective of this project was to design and build an enhancement to the EVAC Model 300H evacuation chair in order to enable easy transportation of occupants on level ground. The redesign makes it possible to transport and maneuver an individual in the chair on level ground with minimum effort/strength. It off-loads the weight from the caregiver, and protects the lower back region.

TECHNICAL DESCRIPTION

The objective of the design was to increase functionality by considering ergonomics of level ground mobility, rigidity of any additions, simple means of use, low operator effort, and reduced muscle fatigue. Figure 18.3 shows the forces that were analyzed to begin the design, and the optimum height of additional structure, ‘H’.

In order to determine the height, patient comfort (proper seating position) and operator maneuverability and comfort were considered, along with dimensional restrictions, and the handle configuration.

The value of 'H' (handle configuration) was determined to be 10", based on numerous laboratory tests. The lower the height, the more stable the chair. On the contrary, the higher the height, the better the position (knee to chest) of the passenger, and the better the maneuverability for the operator.

With the determined height of 10 inches, and the maximum allowable weight of 300 lbs., moment analysis determined that 182 lbs was the maximum weight to be sustained. Thus, at the given height, any modifications to the system must be able to withstand 182 lbs. of force, eliminating the need for operator 'lift.'

Two additional wheels add stability to the system and allow for better maneuverability, without the worry of tipping the chair.

Aluminum was the chosen because it is lightweight and has high strength in various grades. 6061 material was used because it has the highest strength for this design.

Any components to be added had to be small enough to retract beneath the seat while the system was being

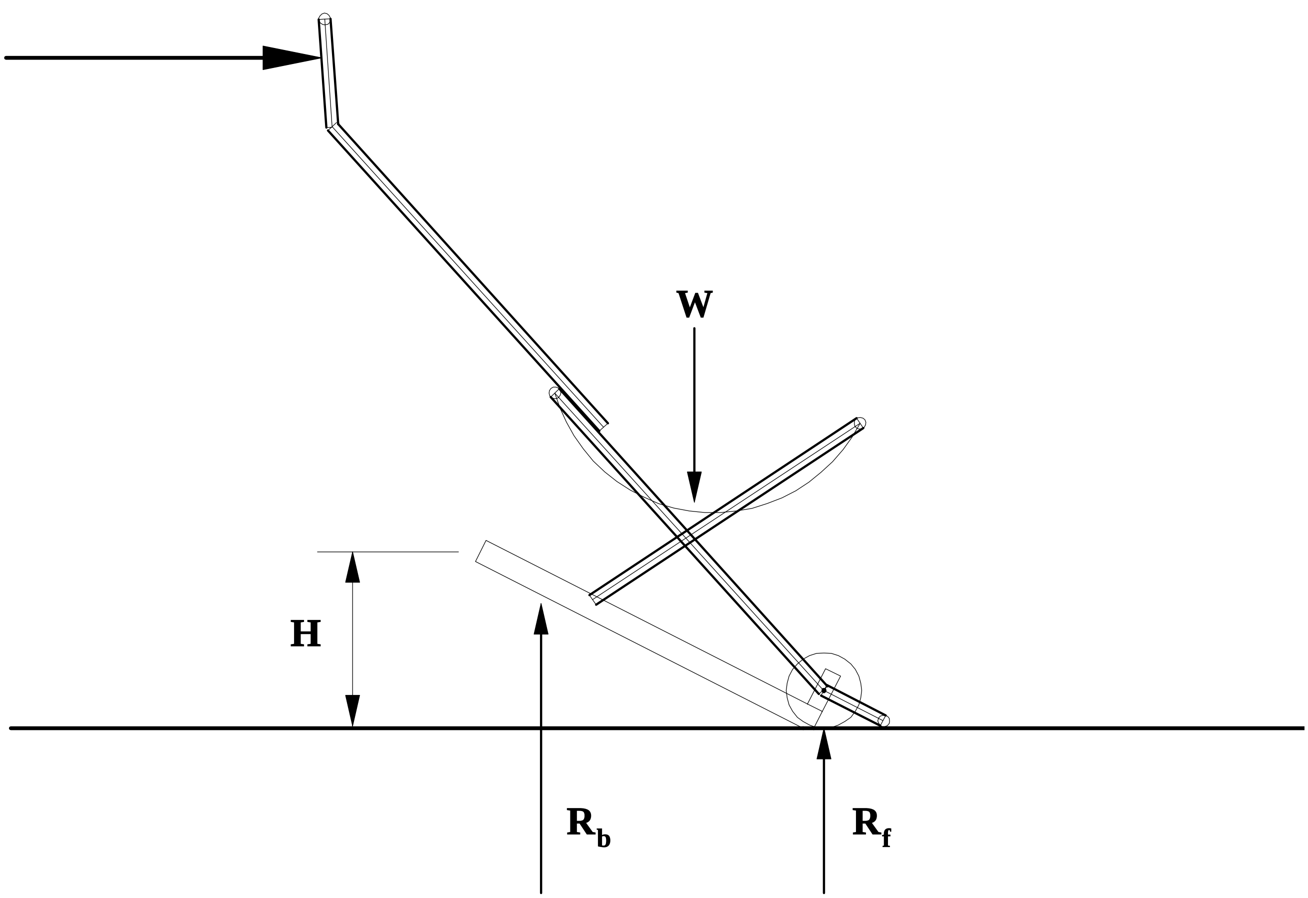

Figure 18. 3. Force Balance Schematic.

used in a stairwell (Figure 18.4)

The two castor wheels were chosen for their ability to withstand high forces, and to swivel for a reverse direction. The bar already in the chair was used as an axle. To allow for a swivel motion, this axle was fitted with brass bushings.

The KT Hinge Bracket was incorporated with the dual wheel support structure to provide a rigid design. The hinge is stable, rigid, self-locking, and easy to use, and allows operation in the reverse direction.

The KT Hinge Bracket is constructed out of rigid 1/8-inch steel. It is pieced together in such a way that the bracket angles slightly down at the main connection. This allows the hinge to lock down with the assistance of gravity, giving it rigidity in both tension and compression. The chair can be maneuvered in the forward and reverse direction without collapse. A foot pedal is also integrated in the design, allowing for easy retractability. Positioned with a three-inch lever

Figure 18. 4. Adaptation for Level Ground Transportation, Folded for Stairwell Use.

arm, when stepped on, the pedal unlocks the hinge, overcoming gravity by using the operator's weight. When unlocked, the wheel system can be easily rotated upward and secured away. A locking mechanism is used to hold the retractable wheel system while transporting an individual down a stairwell. This system utilizes a nylon extension block and a spring setscrew. This setscrew was drilled to allow a bike cable to be fed into it. The bike cable was attached to a shifter that allows the setscrew to travel in and out of the block for releasing or locking.

The overall design of the chair is shown below. It shows the chair in the retracted position. The enhancement to the chair, the KT Hinge Bracket, is not interfering with the original intent of the chair. The next desired position is the locked position of the KT Hinge Bracket. This allows for ease of travel on a level surface, as shown below. The adapted system is shown in Figure 18.5.

The total cost of this project was $189.03.

Figure 18. 5. Adaptation for Level Ground Transportation in Use.

WHEELCHAIR INGRESS/EGRESS BRUISE PREVENTION

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INTRODUCTION

The design objective was to develop an add-on device to prevent a wheelchair occupant from bruising and cutting himself during ingress and egress. The add-on was to be adjustable to protect the occupant when the leg support is in an extended position.

The client does not have the use of his legs. When sitting he keep his knees bent and his legs folded close to his torso. He uses his upper body strength to hop in and out of his wheelchair. This process causes abrasions of exposed body surfaces when contact is made with the edges of the leg support (illustrated in Figure 18.6).

SUMMARY OF IMPACT

This device will prevent bruising and laceration when hard contact occurs between the wheelchair occupant and the part of the wheelchair illustrated above. The device is functional with the leg support extended, and easily mounted and removed without special tools.

TECHNICAL DESCRIPTION

Two layers of foam fulfill the pertinent requirements (namely, bruise prevention & durability through due care design measures). To displace higher loads, a Super Lux foam was selected for the core pad layer. To displace lower loads, Neoprene foam was chosen as the outer pad layer. Since the protruding wheelchair hardware is tubular, the foam was purchased in tube form. Because the protrusions are pronounced, a thick layer of foam was required to provide a cushion beyond the end point of the protrusions. Multiple layers and additional specially shaped pieces were used. The design geometry of the foam padding was determined by analyzing a model of the underlying wheelchair member, taking into account the compression ratios of each foam type and the requirements of universality. Geometry was finalized after confirming commercially available stock shapes and sizes. To provide for bending and angular adjustment relief, darts were cut into the padding at critical points. To provide for ease of angular adjustment, the two layers of padding were allowed to move freely relative to each other. To enhance fitting, the underlying wedge-shaped pieces of padding were attached with Velcro.

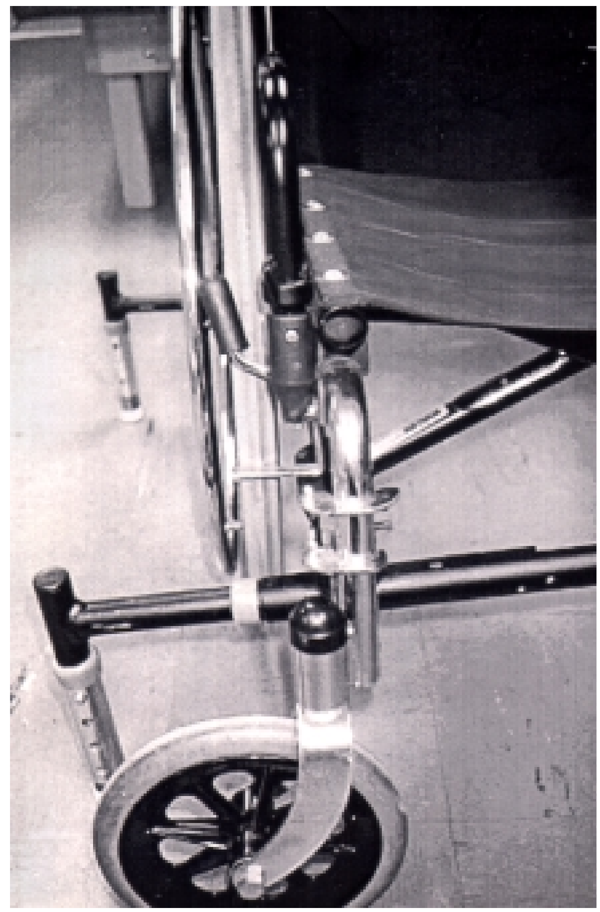

Figure 18.6. Sharp Edges with Potential for Injury During Ingress / Egress.

Figure 18.7. Geometry-Specific Design.

The two foam layers are enveloped in a vinyl boot, secured to the outer foam layer with Velcro strips and circumferentially with additional Velcro strips at each edge. Finally, straps on either end of the boot are tightened around connecting members to prevent axial rotation and shimmy of the pad assembly. An elastic Lycra panel allows the boot to conform to the adjusted angle of the wheelchair member.

The entire assembly can be mounted or removed in about 5 minutes.

Figure 18.7 shows the illustration of the geometry-specific design. The final assembled system is shown, covering the sharp edges, in Figure 18.8.

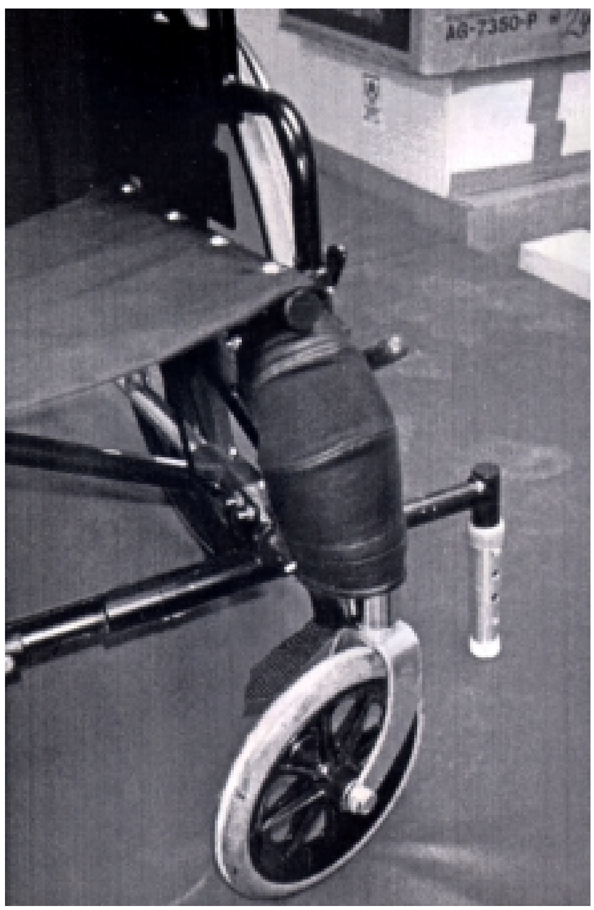

Figure 18.8. Adaptation to Eliminate Sharp Edges.

DESIGN OF FORCE FEEDBACK SYSTEM FOR STROKE PATIENTS

Designers: John Bowlby, Mark Fox, Tim Puente
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INTRODUCTION

A stroke patient showed signs of motor return when presented persistently with mechanical stimulation and positive visual reinforcement. A caregiver wanted to expand the scope of stimulation to facilitate more return via a force feedback system with the following capabilities:

- When pressed with hand, a visual force readout proportional to the effort in the direction of the applied force is obtained.
- The system accommodates paralysis of either a right or left hand.
- The device is ergonomically efficient for hand usage.
- The system is able to sense all levels of force produced by the patient.

Based on the above requirements, the purpose of this project was to design a device that produces visual feedback to motivate and reinforce the recovery of a patient with paralysis due to stroke.

SUMMARY OF IMPACT

The force feedback system could play a major role in recovery from paralysis for stroke patients.

TECHNICAL DESCRIPTION

The mechanical section of this device consists of the bedside table, and the hand pad adaptation. Spiral springs were added to the interface of the mounting pad and the hand pad to off-load the sensors when not in use. Tracks and rollers were mounted to the bottom of the bedside table to allow the device to slide side to side, to accommodate for either right or left hand usage. The top of the bedside table was used for the placement of the visual display monitor and the corresponding electrical instrumentation.

Figure 18.9. Force Feedback with output to a personal computer

Attached to the table is the pad for hand-press, on which the patient applies his/her force. This force is detected by load cells, strategically placed on the mounting pad. There are five possible directions of force for which the patient may get visual feedback: fore, aft, left, right and downward.

Once a force is applied, an electrical signal is sent to the instrumentation, which converts the signal into a corresponding force readout, observed on the display monitor.

The system is shown in Figure 18.9.

The design specifications are as follows:

- Load cells detect loads from 1 to 40 lbs.
- A signal conditioner handles signals corresponding to 1 to 40 lb of force input.
- The display monitor responds to a signal range of interest.

- The overall weight of the hand pad and plate assembly is minimized.
- There is an optional adaptation for a computer display.
- The system must be able to accommodate either left or right hand paralysis.

Materials and Costs are as follows:

(2) ¼” x 10” x 9” 6061T6 Aluminum plate
$18.15 each

(1) ¼” x 19” x 8” 6061T6 Aluminum plate
$22.00

NLS Series 8000 Signal Conditioner; 8000-2-09*-60*
$334.00

Triplett Model TB-52; 450-103
$180.00

(5) RT Planar Beam Force Sensor Model 802
$48.00 each

(2) Stanley Box Tracks Model 3J403
$30.85 each

(4) Stanley Hangers Model 3J368
$24.78 each

Invacare Overbed Table Model 6417
$125.00

BK Elevating Support Unit
$85.00

Total $1183.12

Tests show that the system performed as designed.

The total cost of the system was $1183.12.

ACTIVITY ENABLING ENVIRONMENT

Designers: Jacqueline Henderson, Linda LaFleur
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INTRODUCTION

A 6-year-old child has severe spastic quadriplegia. He is unable to walk and has limited use of his hands while lying on the floor. He cannot stand up nor can he hold himself up while lying down on a mat. He would like to be able to play with his favorite toy during class play periods.

The objective of this design was to develop an activity-enabling environment that will overcome the child's physical limitations to allow him to use his toys, an adapted remote control car and an activity box for matchbox cars.

SUMMARY OF IMPACT

The client is able to play along with other children in his class.

TECHNICAL DESCRIPTION

After numerous visits with the client and ergonomic considerations, a platform was designed to enable the client to play with his toys. The platform is a stable, low-lying device that allows a toy to be placed at a convenient angle and height without slipping. It has adjustable legs.

The main performance focus in the design was to develop a simple platform that allows for quick assembly. It also needed to be stored conveniently because the play area in the client's school is located in a small congested room with many tools and other toys. The platform folds out when being used, and back in so that it can be carried, like a briefcase, for easy transport.

The design was created using AutoCAD 13.

Although aluminum is light and durable, it was not used because it is not very durable in winter and not easy to weld. Also, metal platform edges may not be safe for the client. Metals such as steel and aluminum may be too cold. Wood was thus selected because it is strong enough, yet light, durable, and easy to work with.

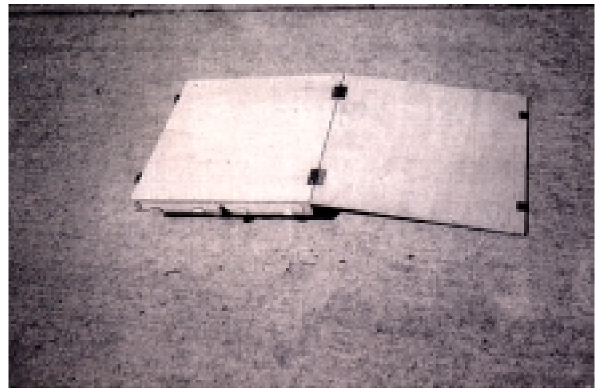

Figure 18.10. Activity Enabling Environment (unfolded).

Figure 18.11. Activity Enabling Environment in a folded position and adapted remote controlled car.

The developed activity environment consisted of an inclined platform with non-skid surface and storage compartment (Figure 18.10). Figure 18.11 shows the system in the folded state. The client can play with his toys using the inclined section. An adapted remote controlled toy car is included. To ensure that the car stays within sight of our client, the play area was secured with a nylon hose barb splicer, 2 inches in diameter and 4 feet long (Figure 18.12).

During tests, the activity enabling system performed as designed.

The total cost is $156.37.

Figure 18.12. Nylon Hose Barb Splicer to Secure the Toy Car During Use.