CHAPTER 18
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ADAPTIVE CONTROL OF CHILD'S SEAT HEIGHT

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INTRODUCTION

A height adjustable seat has been modified to enable a child with upper and lower limb deficiencies to safely control the raising and lowering functions of the seat for use in a classroom. Due to bilateral deficiencies, the client constantly needs the teacher or an aid to help him raise or lower his chair. The chair is equipped with a conventional control mechanism for height adjustment, and this causes constant distraction in the class. When he tries to operate the control mechanism himself, he assumes an awkward posture that puts stress along the spine, and most times he is unsuccessful with repeated trials. The request from his teacher, the school's occupational and physical therapists and the child was an assistive technology solution to enable the child to operate independently his height adjustable chair. The preferred implementation outcomes by the teacher include: (1) providing technology solution that does not make noise in class or draw attention to the client, (2) increasing differential adjustable height from two inches to four inches to enable the child reach his books below and the top of the classroom desk, and (3) implementing a control mechanism that is easily and safely accessible using the elbow. The solution involved the adaptation of a quiet actuator and switch control to modify a regular height adjustable office seat.

SUMMARY OF IMPACT

Adapting a quiet actuator made it possible to raise and lower the chair in class without being noticed by nearby classmates. Incorporating adaptive switching with mechanical advantage gave the child the ability to operate the chair independently. Increasing the vertical height adjustment from two inches to four enabled the child to reach the books below and above his desktop. The modified chair eliminated the need for the client's teacher to help him raise and lower his chair during class.

TECHNICAL DESCRIPTION

H is the maximum height of the seat from the ground, T the seat support that also provides telescoping capability for height adjustment, S the sitting area, R the rollers, B the back support and AS the seat assembly support with attached rollers. The technical solution of interest include substitute for T, coupling to AS, adaptive switch control, and the bracket.

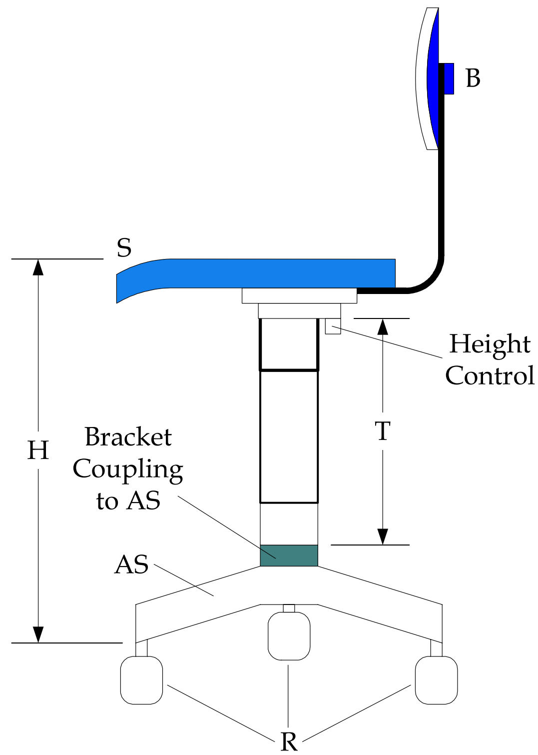

Figure 18.1: Functional Aspects of a Height-Adjustable Office Chair.

Substitute for T: A DC actuator (ECOMAG 20) by Magnetic Corporation shown in Fig. 18.2 was selected to provide the support the seat and provide telescoping functions to achieve required four-inch seat height adjustment. The actuator noise is very low, satisfying the noise condition to be used in a classroom.

Coupling to AS: A hollow interface is designed with inside diameter to match the end of the DC actuator pillar. The outside diameter is designed to fit inside an oval space at the center of the wheel base structure AS. The hollow structure is firmly attached to the end of the pillar with a tight press-fit nut. Modification is made to the seat metal bracket to provide an interface between the other end of the actuator and the seat base. This was accomplished through made-to-fit metal gaskets and tight fitting fastener. With the wheel assembly firmly coupled to one end of the actuator pillar, and the other end of the actuator firmly coupled with the seat base using the modified bracket, mechanical adaptation was completed.

Electrical Power and Switch Control: To supply electrical power to the actuator, an 18-volt rechargeable battery was mounted beneath the seat with the necessary electrical circuitry and a switch. The switch has the following characteristics: momentary double throw, double pole, and center neutral. To engage the switch as purchased requires strong effort and dexterity that client does not have. Also, the switch lever arm has limited length

Figure 18.2: Low Noise DC Actuator and Coupling to AS.

and surface area. Special adaptation was made to provide a mechanical advantage to overcome the limited lever arm length. This was accomplished by extending the switch lever arm by a foot, and the switch with modified lever arm was mounted from a standoff from the base of the seat. The surface area of the lever arm was then increased by a factor of 10 times from 0.2-inch diameter to two-inch diameter with surround flexible rubber. The final product is as shown in Fig. 18.3.

The total project cost is $277 for the pillar and parts.

Figure 18.3: Adapted Height-Adjustable Chair.

WEIGHT-ASSIST WALKER FOR A CHILD WITH BILATERAL UPPER AND LOWER LIMB DEFICIENCY

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INTRODUCTION

A child with both upper and lower extremity limb deficiencies needs assistive technology to safely use bilateral prostheses for ambulation and play, including playing with kick balls. When the child uses his prosthetic device for ambulation, his ability to engage in normal heel strike, flat foot, and toe off are limited and abnormal because his femoral heads were separated from his hip sockets at birth. The immediate design task was to minimize weight transfer through the soft tissue, allowing just enough weight through his prosthetic device to be able to push off with improved gait during ambulation. Other design tasks include: to provide hand-free walker support so that his upper residual limbs can be used for other activities, to meet his desire to attend the urinal unassisted, and participate in kick ball.

SUMMARY OF IMPACT

The modified walker is lighter than a reverse walker and does not require pushing. Offloading the client's weight through the walker dramatically improved his gait, making the device an invaluable companion for activities of daily living. The psychological gain of participating in kick ball and to using the urinal independently will be beneficial. Further studies could apply the design for those with functional upper extremity and weak lower extremity limbs to ambulate independently for prolonged periods of time or stand to retrieve and place items above their reach from wheelchair without fear of falling

TECHNICAL DESCRIPTION

Overall Walker Weight and Height Adjustment: To limit the weight, round aluminum seamless extruded tube with a one-inch outer diameter was used. Aluminum was chosen because of good heat-treatment, weldability and formability characteristics, and good strength properties. Also,

Figure 18.4: Weight Transfer Mechanism

aluminum alloys have high resistance to corrosion. The aluminum stock used for the design is from Kaye Posture Control Walker. The design is lighter than Kaye posture control walker because the total length of tubing in the design is less than the total length used in that walker. To provide for height adjustment, as in Kaye products, the wheels are attached to a smaller diameter straight tubing that telescope inside wider diameter straight tubing. The tube incorporates spring-loaded pin that fits into holes drilled into the walker legs for height adjustments.

Assist in Weight Bearing During Ambulation: To facilitate load-bearing assistance, the mid section of the walker was chosen for weight transfer from the user to the walker support wheels. Load transfer assist is accomplished through a combination of a wide belt with a Velcro end strip strategically attached to the middle of the rear side of the walker frame and a soft cushion covering the user side, as show in Fig. 18.4.

The belt used to secure the user to the walker is a modified weight lifter back support. The belt incorporates suspender straps, which positions the belt in an area that is easily accessible to the user, and Velcro hooking that allows the user to attach, tighten and remove the Velcro using the elbow.

Independence to Play (Kick Ball) and Use Urinal: Controlling backward movement is required when the user kicks a ball to prevent from falling backward as his weight is transferred in the natural kicking motion, and it also provides balance to use the urinal. The rear wheels are of a fixed design and do not swivel. They are equipped with ratchet mechanisms to prevent the walker from rolling backward during use, (Fig. 18.5). Each front wheel of the unit swivels 360 degrees about the point of attachment. This allows the walker to be steered by the user in any direction without lifting and repositioning the walker.

The front of the walker is made wider than the rear by implementing a five-degree curvature from the back support to the front. A U-tube is implemented at the back to provide continuous force transfer from the points of user support at the back to the wheels. Opening up the front area uniquely positioning the user with minimum hardware in front makes it possible to take part in kicking a ball or using a urinal for. Fig. 18.6 illustrates the design of the walker enclosing three sides of the user with the user facing the open side during use.

The total project cost is $566 for the reverse walker and parts.

Figure 18.5: Ratchet Mechanism.

Figure 18.6: Weight-Assist Walker