
CHAPTER 23

WORCESTER POLYTECHNIC INSTITUTE

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A Wheelchair Lift

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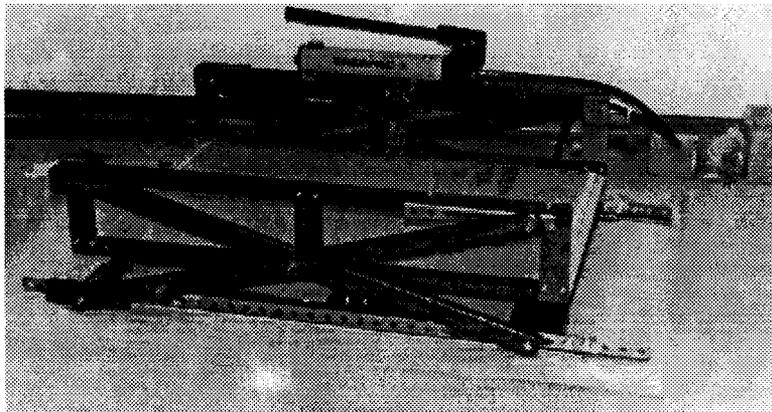
INTRODUCTION

The Massachusetts Hospital School is a residential educational and health-care facility for physically disabled children and young adults up to age 22. A primary goal of the school is to assist the students in reaching their fullest potential for optimal independence. A wheelchair lift was designed to allow a particular student to transfer from his wheelchair to his bed without assistance. Since this particular student is a paraplegic and has almost full upper body strength and mobility, the lift is manually operated. This gives the student a greater sense of participation and independence, as well as reducing the cost of the device. To use the device, the handicapped individual rolls up onto the platform and then pumps a hand pump until the platform reaches the desired height. The platform raises straight up and remains level with the ground at all times. A safety mechanism is installed to prevent the wheelchair from rolling off the platform. The device is reasonably portable, so that it also may be used to allow other students access to standard machines and work surfaces such as photocopiers, cabinets, shelves, shop machinery, etc. The lift is designed to accommodate wheelchairs up to 28" wide and 45" long, with a total lifting capacity of 275 lbs. The maximum height is 18".

SUMMARY OF IMPACT

The main objectives in designing a wheelchair lift were to facilitate bed transfers and access to heights normally unattainable from a seated level. The inspiration for this design was a 9 year old boy with Myelodysplasia. This student, who uses a manual pediatric frame (Kid's Quickie II by Motions Designs), has had an especially difficult time reaching most shelf and counter heights.

While these objectives were carried out, additional benefits of this design were noted. He can independently operate the lift by securing himself to the platform and using the hand pump to raise or lower himself to various levels. After demonstrating these abilities, it became apparent that this lift can be used with much versatility. While the design is appropriate for many students at the Massachusetts Hospital School, other uses will have vocational application. For example, it was determined that the lift can be used as an adjustable-height table for supporting any variety of vocational projects, so the platform lift can be used not only to raise the student to the object, but also the object to the student.



TECHNICAL DESCRIPTION

The wheelchair lift is composed of three functional components: the lifting mechanism, the powering device and the platform. The device is supported by a base frame made of 1-1/2" square, three-sided Kendorf channel steel.

The lifting mechanism provides the vertical lift necessary to raise the platform to the desired maximum height of 18". It consists of two parallel scissor linkages constructed of rectangular 2" x 1" x 1/8" steel tubing. A cross member is welded between the outer links to provide lateral stability. The scissors links are 42" long and move through an angular orientation from 12° to 35.7" w.r.t. the horizontal ground plane. The lower ends of the scissors links are attached the base frame; the upper ends are attached to the platform. The pin joints are made using half-inch diameter hardened steel rod and plain, oil-impregnated bronze bushings, press-fit into each link. Thrust bearings are placed between the links to give 1/16" clearance between the links in each pair. Grooves are cut into the end of each pin to hold retaining rings. Roller ball bearings are used for the moving ends of each scissor link. The upper and lower rollers travel within the Kendorf channel of the base frame and platform hangers, respectively.

The powering mechanism is a 5-ton, single-acting, spring return hydraulic ram with a separate hand pump. The ram has a retracted length of 10-3/4', outer diameter of 1-1/2" and a 7" stroke. The ram is placed between two I-beams. One I-beam is welded to the Kendorf channel as an integral portion of the base frame. The second I-beam is connected to the

sliding end of the scissors linkages with a strip of flat bar steel. Roller ball bearings are mounted on the ends of the moving I-beam which run inside the Kendorf channel of the base frame. The hydraulic pump is mounted on the top of the platform frame.

The platform is constructed of 3/4" plywood with a frame of 1-1/2" x 1-1/2" x 1/8" angle iron. The platform dimensions are 31" x 45". To achieve the lowest possible starting height of the platform, it must be suspended from the scissors linkages using 1/4" steel hanger straps. In its lowest position the platform is 2" above floor level, therefore ramps are attached to the lift's base frame. These ramps are each 12" long. The platform is fitted with a roll stop mechanism that must be activated before the hand pump can be operated. This safety feature prevents the lift from being operated unless the roll-stop gates are locked in the up position. The roll stop gates are 3-1/2" high and become a part of the access ramps when in the down position. The roll-stop linkage is a fourbar, non-Grashof mechanism that is designed to be locked in the toggle position when the gates are up. The mechanism is duplicated on both ends of the platform. When the gates are down, the linkage's handle is positioned such that it prevents the use of the hydraulic pump.

The completed lift weights about 200 lbs. Casters are attached to the base frame to aid in moving the lift to various locations at the hospital school, if necessary. The total cost of construction was \$487. The hydraulic ram and pump cost \$378, steel tubing \$66, bushings and bearings \$16, plywood \$10, gate hinges, nuts, bolts, etc. \$17. The Kendorf channel and ball bearings were donated, and have an approximate value of \$75.

Handicapped Athletic Standing Assist Device

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INTRODUCTION

Handicapped individuals are becoming increasingly interested in participating in a variety of sports. The goal of this project was to construct a device that will allow paraplegics to participate in sports that require swinging motions of the upper body such as golf, tennis and baseball. Existing standing assist devices are not well suited to these types of sporting activities. These devices typically support the user from the front; many are designed such that the user leans forward into the structure, some are fitted with trays or have large wheels in front of the user that would interfere with upper body mobility and freedom necessary for swinging. Special adaptations of conventional equipment such as golf carts and lightweight wheelchairs have been designed to allow paraplegics to participate in various sports from the seated position, however, they cannot develop a proper swing nor maximize their upper body strength from this position.

The athletic standing assist device is designed for a paraplegic with good upper body strength and mobility. The stand allows the user to develop more natural body motions for swinging sports by providing support from the rear instead of the front. The device consists of a base plate or "artificial ground plane", an adjustable back column or stand, a horizontal support and belt at hip level, a heel rest and a seat. The device was designed to accommodate users weighing up to 250 pounds, and is adjustable for a range of heights.

SUMMARY OF IMPACT

Sport and recreation are essential to the rehabilitation process. However, participation in such activity is often inhibited in the absence of necessary modifications or assistive devices.

The effective use of a standing device for participation in golf, tennis, basketball or baseball has been realized in a variety of ways. For example, a student had never swung a golf club before. To perform this task was most difficult from a seated

position. For the first time, this person was able to play this sport. Secondly, utilization of this device has contributed to a greater sense of accomplishment in sports. With an ability to stand, the student can shoot a basketball from a wider range as well as to experience shooting a basketball from a traditional orientation (i.e., standing). Finally, and most noticeable is the increased level of enthusiasm for participation when the appropriate equipment exists. With the right equipment, one student could readily participate in this variety of sports. Having greater sense of accomplishment, the desire for continuing with activity was persistent. Moreover, interest from other students was apparent as they observed a demonstration.

It is anticipated that this standing device will improve the participation levels of at least 4 students at the Massachusetts Hospital School who have Spina Bifida or less severe forms of Cerebral Palsy. This research project has also helped with an ongoing observation of the effective use of assistive devices for sports and recreational activity.

TECHNICAL DESCRIPTION

The base plate is constructed of two layers of 3/4" pressure treated plywood, 36" x 44". Casters are mounted to the base plate for mobility and ease of transport. The column is made of two sections of 1/4" thick square steel tubing. The lower section is welded to a flange that is in turn bolted to the plywood base, which is reinforced from below with a sheet of 1/8" aluminum plate. One-half inch holes are drilled at intervals of 2" along the length of the lower section of the column to allow for adjustment of the height of the upper support and seat. A single set of holes is drilled near the bottom of the upper section of the column and fitted with a 1/2" bolt to adjust the height of the device.

The horizontal upper support is constructed of a single bar of aluminum, 52" x 3" x 1/2", which is rolled into a semi-circular arc. A nylon webbed seat-belt is attached to provide frontal support so that the user can lean into the swing if desired, and

the bar is padded with foam for comfort and safety. The upper support is attached to the top of the column with four 1/4" bolts.

A standard bicycle seat is mounted on a horizontal steel post that is in turn welded to the upper section of the column at a distance of 15" below the upper support. A 4" x 4" x 24" long piece of pressure treated wood serves as a heel rest and prevents the user's feet from sliding backward as he leans forward or during swing.

Total cost of the project was \$245, including the aluminum upper support at \$138, steel tubing \$40, plywood and wooden heel rest \$38, seat \$5, misc. fasteners \$12, nylon belt \$12. Several pieces of scrap steel and aluminum were also used, at no cost.

