CHAPTER 14
UNIVERSITY OF ALABAMA AT BIRMINGHAM

School of Engineering
Department of Biomedical Engineering
Hoehn 368, 1075 13th St. S.
Birmingham, Alabama 35294

Principal Investigator:

Alan W. Eberhardt, PhD

(205) 934-8464

aeberhar@uab.edu

WHEELCHAIR LIFT FOR ADULTS WITH CEREBRAL PALSY

Designers: Luis Font, Brad Jones
Client Coordinator: Deborah Gustin, OTR/L; LINCPoint, UCP of Greater Birmingham
Supervising Professors: Dr. Alan Eberhardt1, Dr. Tina Oliver2
1 Department of Biomedical Engineering, 2 Department of Mechanical Engineering
University of Alabama at Birmingham
Birmingham, Alabama 35294

INTRODUCTION

LINCPoint provides employment opportunities through a program called Gone for Good, which employs disabled adults to sort paper on a conveyor belt for shredding. The majority of their employees are restricted by a wheelchair, thus they are unable to reach the conveyor line. The client requests a wheelchair lift that permits a wheelchair user to reach the work area, thus allowing them to do their daily duties. A prototype was completed last year with NSF RAPD support; however, the device had some limitations, including mobility, range of motion and an inconvenient collection of wires that were deemed hazardous by the staff at LINCPoint. The goal of this project is to modify the existing wheelchair lift, to reduce weight and footprint, improve mobility, and improve functionality in the working environment. This will allow the user ample height to reach the conveyor line as well as allow staff members at LINCPoint to move the lift when not in use. The device will support the weight of the heaviest wheelchair and user, which is approximated to be 400 lbs. Each user is allowed to work a maximum of 2.5 hours each day, thus the device must maintain constant elevation throughout their shift.

SUMMARY OF IMPACT

This device will allow the users ample height to reach the conveyor line, as well as allow staff members at LINCPoint to move the lift when not in use. The device has not yet been delivered; however, we anticipate a very positive impact on the LINCPoint facility, allowing new users to participate in the Gone for Good program activities. We hope the system proves to be durable and provides years of safe use for the staff and workers at LINCPoint.

TECHNICAL DESCRIPTION

After meeting with the staff at LINCPoint, a battery-powered mechanism was determined to be the best solution to accommodate their request to eliminate the wires. The design allows the employees to use the wheelchair lift in any place in the facility without depending on the length of the power cord and the electricity outlets in the facility. Two electric twelve-volt jacks that run from a 12 volt battery provide the lifting mechanism. Each jack has a lift capacity of 2200 pounds and the maximum load used for the design was 1100 pounds, resulting in a safety factor well above 3. The footprint of the design is not changed since the employees at LINCPoint are satisfied with the size of the previous design. The final design consists of a base that supports a platform and the lift mechanism. The base is constructed of tube steel and is able to withstand the weight that the actuators push against it and has a "pull handle" for easy transportation. A platform with dimensions of 30x40 inches is constructed with a steel mesh base overlaid by bamboo flooring material to accommodate the user in the wheelchair. A battery charger is attached to provide easy re-charging of the battery. Spring loaded casters are kept from the first design, which allow the device to roll when unloaded.

The completed design is shown in Fig. 14.1, and the total cost for the completed device is $1081.

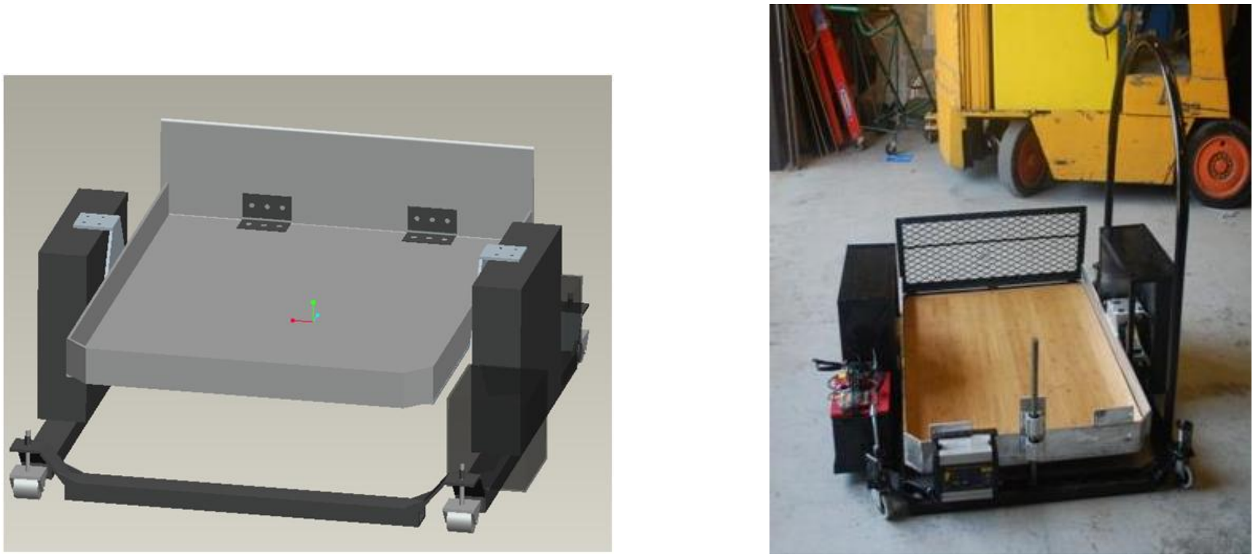

Fig. 14.1. CAD drawing (left) and completed prototype wheelchair lift (right) for LINCPoint. The design features battery powered car jacks for lift, reduced weight as compared to an earlier design, and spring loaded casters for mobility when not in use.

AN ADULT SENSORY STIMULATION STATION

Designers: Tim Fee, Eric Franks, Josheua Samuelson, Matthew Sapp
Client Coordinator: Deborah Gustin, OTR/L; LINCPoint, UCP of Greater Birmingham
Supervising Professor: Alan Eberhardt, PhD
Department of Biomedical Engineering
University of Alabama at Birmingham
Birmingham, Alabama 35294

INTRODUCTION

LINCPoint is a non-profit organization that provides a variety of opportunities to patients ranging from physical therapy to a paid work experience. Patients with more severe developmental disorders, those most likely to take advantage of aural-visual stimulatory devices, are cared for by attending personnel and are provided everything from physical therapy and skill training to craft projects and other stimulatory tasks designed to improve quality of life. LINCPoint is seeking to expand their capabilities by adding an aural-visual stimulatory device to their therapy inventory. The student design team has the task of developing an interactive adult sensory stimulatory station for use, at any one time, by four to six developmentally challenged individuals while at the LINCPoint facility. In addition to the interactive features, it was requested that the staff have some interaction and control.

SUMMARY OF IMPACT

Patients with cerebral palsy can display sensation, perception, concept formation, and symbol formulation deficiencies, which can greatly inhibit learning, reasoning, and general cognitive function. Sensory stimulation is one of the older treatment methods used in the care of CP patients. Love (1969) evaluated the effects of aural stimulation, visual stimulation, and combined aural-visual stimulation on CP patient wellness and found that combined aural-visual treatment resulted in improved motor control for articulation. These results illustrate the benefits of combined aural-visual stimulation as a non-evasive treatment method for CP that clearly produces marked improvements in CP patient motor function.

The completed design was delivered to LINCPoint and early reports are overwhelmingly positive, indicating that the users enjoy the device and that the staff find it extremely useful in their interactions with the users.

TECHNICAL DESCRIPTION

The device is constructed of wood, with an octagonal base to provide stability, riding on six casters for mobility. A pull handle is attached to the device along with a label indicating that movement of the device should be performed by pulling the device using the handle. A stability analysis was performed that ensured the device would not tip during transport from room to room. The device contains an interactive bubble tube, removable tactile boards, rope lighting, a laptop connected to a projector and speakers, as well as an aroma therapy element. Large button, hand-held switches allow the user to control the colored lights in the bubble tube (red, yellow or blue), while the LINCPoint staff access the laptop to control the audio/video.

The laptop is a donation, bringing the final costs for the design to $1,256.

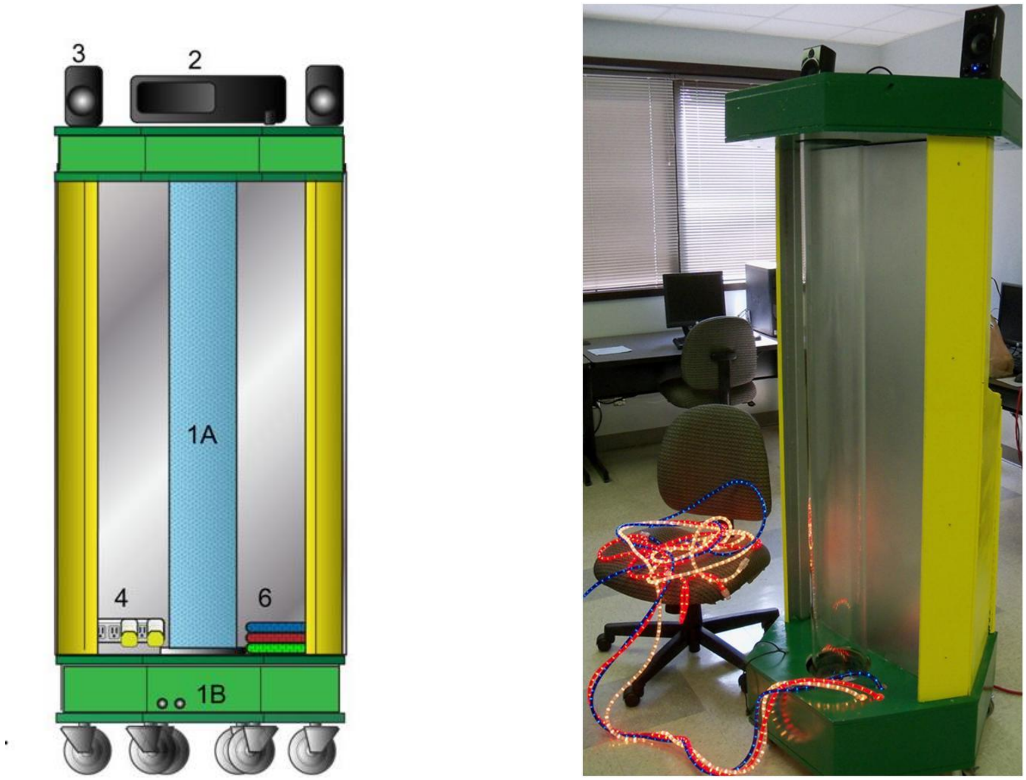

Fig. 14.2. (Left) Schematic and (Right) completed sensory stimulation device including: bubble tube (1A), interactive controls of the bubble tube (1B), projector (2), speakers (3), aroma therapy (4), tactile boards (5), and rope lights (6).

UNIVERSAL HEADREST ASSESSMENT DEVICE

Designers: Allison Wade, Justin Lesley, Melissa Schaefer, and Komi Vovor Dassu
Client Coordinator: Michael Smith, PT; Hand in Hand, UCP of Greater Birmingham
Supervising Professor: Alan Eberhardt, PhD
Department of Biomedical Engineering
University of Alabama at Birmingham
Birmingham, Alabama 35294

INTRODUCTION

Many individuals who are confined to wheelchairs are unable to hold their heads up due to a lack of control of their neck muscles. In these situations, headrests are attached to the wheelchair in order to help the individual hold their head upright and to be able to see straight in front of them. However, currently available headrests can be very expensive and difficult to adjust. Michael Smith, physical therapist at Hand in Hand, expressed the need for a wheelchair headrest assessment device that could be transferred to a number of different wheelchairs, and able to accommodate children between the ages of 2 and 5 years old. He requested a headrest assessment device that can accommodate a variety of headrest pads and arrangements such that it can be used to test the best headrest type for each specific child. It also needs to be easily adjusted to work with a variety of wheelchair and patient sizes.

SUMMARY OF IMPACT

The completed device was delivered to Hand in Hand and early reports indicate that the design was successful in meeting the project goals. It easily adapts to the variety of wheelchairs used at the daycare and also provides for an assortment of headrest pads to be easily interchanged to determine the optimum configuration.

TECHNICAL DESCRIPTION

After analyzing all options, the Otto Bock Headrest Adapter Kit was selected for mounting this headrest assessment device to the wheelchair frame. S.T.S clamps are used to attach the adapter kit to the chair and three sizes of S.T.S clamps (3/4", 7/8", and 1") were purchased to ensure that this device can be used with a variety of wheelchair sizes. For the headrest mount subsystem, three 6061 aluminum rods (1/2"x 24") are mounted to the back of Otto Bock Headrest Adapter Kit. One rod was placed in the center of the chair to accommodate the neck rest pad and the generic centered headrest pads. The other aluminum rods are placed on either side of the center rod to accommodate a range of widths for the cheek and temple pads. These outer rods will have the ability to slide horizontally across the Otto Bock Headrest Adapter Kit and be locked in place in any desired position. Each vertical rod incorporates a machined clamp which also holds the headrest bar. A custom cube clamping system attaches the headrest bars to the vertical neck pieces.

The final cost of the device is $673.82.

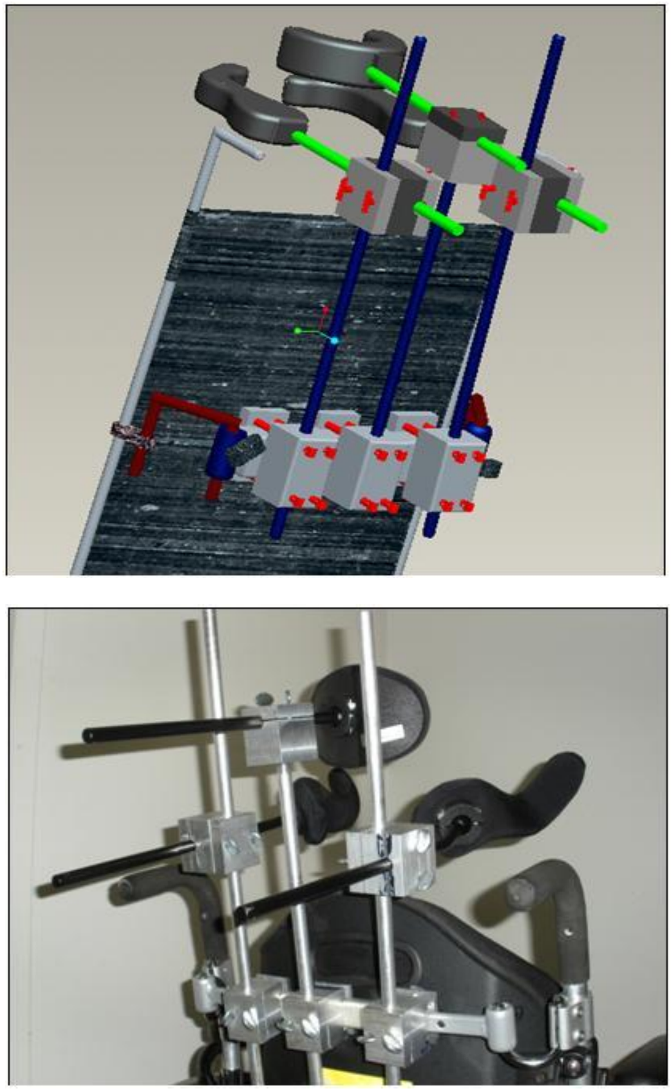

Fig. 14.3. CAD drawing (top) and photo (bottom) of completed wheelchair headrest assessment device. Tennis balls were added to each of the protruding bars to ensure safety during use.

WHEELCHAIR TRAINER

Designers: Olajide Akinsanya, Ricky N. Bowling II, Reshu Saini, and Wassamon Viriyakitja
Client Coordinator: Mr. Billy Ronilo at Children's Rehabilitation Services (CRS)
Supervising Professor: Alan Eberhardt, PhD
Department of Biomedical Engineering
University of Alabama at Birmingham
Birmingham, Alabama 35294

INTRODUCTION

Children's Rehabilitation Services (CRS) provides rehabilitation services to an estimated 175 children per year. Mr. Billy Ronilo is a physical therapist working with CRS. Many of Mr. Ronilo's clients include children ages 2-4 with cerebral palsy (CP). Children visit to learn how to operate powered wheelchairs. However, in some situations children cannot travel to CRS, so Mr. Ronilo must train them at home. At the time the project began, the client used a rear wheel drive Invacare Power Tiger (PT1) and a center wheel drive Invacare Storm TDX5 for training purposes. Mr. Ronilo employed the two wheelchair trainers because some children operate the wheelchairs more effectively with their head, while others are more comfortable operating wheelchairs with their hands or feet. The objective of the present design is use the two trainers to create a single wheelchair trainer for children ages 2-4 with CP capable of both joystick and head array control. The design needs to include a larger Invacare Power Tiger base (PT2 provided by CRS) with Orbit seating and tilting capabilities and a novel, transferable joystick mounting device capable of multiple degrees of freedom to accommodate a defined range of motion.

SUMMARY OF IMPACT

According to physical therapist, Mr. Billy Ronilo, before an insurance company is willing to provide powered wheelchairs to children with CP, the children must demonstrate their ability to use the wheelchair effectively. The completed device allows Mr. Ronilo to more efficiently and effectively use his travel time to train children with disabilities on wheelchair operation.

TECHNICAL DESCRIPTION

The first task involved transferring components from the PT1 and Storm TDX5. Using a simple toolkit, including Allen wrenches, hand wrenches, and power tools, the student team was able to transfer the head array and control from the Storm TDX5 and the batteries, seat, control box, and joystick from the PT1 to PT2. The team was also able to unplug the Storm TDX5 control box with the head array attached, and plug it directly into the PT1 control box. A simple key sequence on a hand-held Invacare programmer is used to program the electronics to accept the head array and control box. To address the need for an emergency stop mechanism, a ribbon switch is plugged into the Storm TDX5 control box, which responds to bending and allows the attendant to stop the wheelchair. The Storm TDX5 control box, which contains inputs for the head array and the kill switch, plugs directly into the PT1 control box, which contains an input for the PT1 joystick. Together the control boxes provide wheelchair mobility using either the joystick in the first drive mode or head array system in the second drive mode. The joystick of the wheelchair trainer must be highly adjustable so that the client can access the optimal joystick position for each child at CRS. In order to allow for joystick adjustability, an easily transferable joystick mounting device capable of accommodating a defined range of motion (as listed in the design constraints) is included in the design. In addition to being adjustable, the mounting device is easily transferable. Our clients can use the device for children who need either hand or foot control.

The final device and fully functional wheelchair are shown in Figs 14.4 and 14.5. The total cost is $270.03.

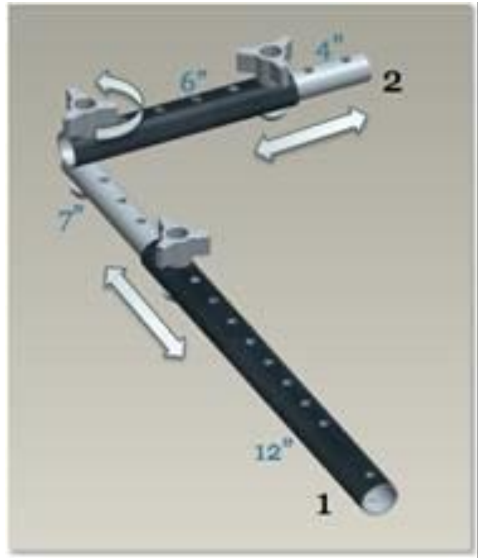

Fig. 14.4. CAD drawing of device.

Fig. 14.5. Photo (left) of the adjust-able joystick mount, which was designed to be attachable at two sites permitting hand control (right) or foot control.

CLIMBING WALL FOR CHILDREN WITH SPECIAL NEEDS

Designers: Jason Quinn, Todd M. Hyche, Adrienne Elliott, Ashley Farr, Brian Webber
Client Coordinator: Mary Beth Moses; The Bell Center of Homewood
Supervising Professor: Alan Eberhardt, PhD
Department of Biomedical Engineering
University of Alabama at Birmingham
Birmingham, Alabama 35294

INTRODUCTION

The Bell Center of Homewood requested a climbing apparatus for children ages 2 to 4 with varying levels of disabilities. The design is constrained to an area of 56 square feet and a maximum platform height of 3 feet. Ms. Mary Beth Moses, a physical therapist at the Bell Center, requested that two ramps be included in the design. To account for varying degrees of disability, one ramp was to be angled at a 45° and the other at a 30° from the ground surface. As requested by the client, toys and a slide were to be incorporated into the structure to provide rewards and to encourage children to climb the apparatus. The design is capable of being fully disassembled with most of the components being stored within the base.

SUMMARY OF IMPACT

The completed device was delivered and early reports indicate that the device has been extremely well received by the users and staff at the Bell Center. The climbing wall accommodates children of varying sizes and levels of ability and the curved slide allows one staff to handle more than one child at a time. The ease of disassembly is especially appreciated along with the ability to store the parts within the base of the system.

TECHNICAL DESCRIPTION

The two ramps, base walls, and platform are composed of Nida-Core/E-glass sandwich composites. The sandwich composite structure is made by vacuum processing. The process involves layering the composite. Each side of the 1.5 inch Nida-core is coated with vinyl ester resin and then the two E-glass woven rovings are placed on each side. The composite is then placed within a bagging material and a vacuum is pulled while curing. Attachment points are needed so that screws and bolts are secure in the design. Holes are drilled in each panel that requires fasteners. Resin with chopped glass fiber is used to fill the holes. C-channels are added to the edges to provide a finished edge and also provide support to prevent the composite from delaminating.

The four walls constructed form the perimeter of the base. Each wall is attached to each other using two 4”x 4” brackets, secured 8 inches from the top and bottom from every corner using 0.25 inch fasteners specified by ASTM A307. The safety walls and ramps are attached to the base by custom engineered brackets. The base has a four point bolt arrangement. The ramps are made with 1 inch diameter aluminum pipes that slide into holes on the base and are secured using 0.25 inch pins. The pins are removable so that the apparatus can be disassembled. The slide, periscope, and wheel are purchased directly from a manufacturer.

The total cost of the design is $970.

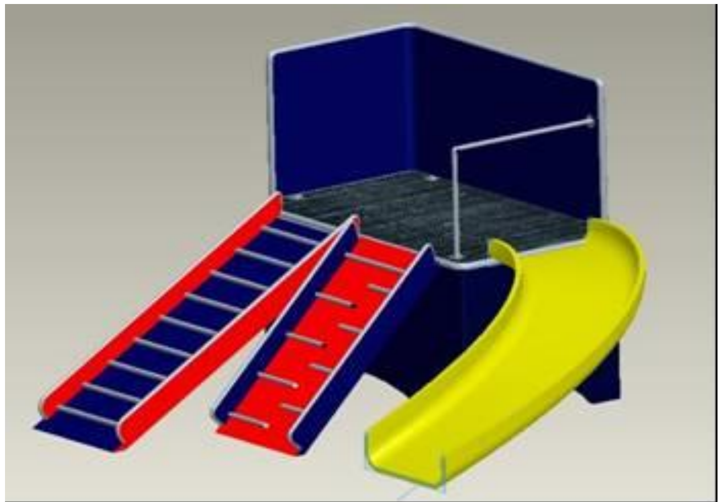

Fig. 14.6. CAD drawing of climbing wall device for children.

Fig. 14.7. Photo of completed climbing wall device for children at the Bell Center. The composite structure features two climbing surfaces for varying levels of ability, and the entire structure is easily disassembled for storage.

STANDING BOXES FOR ADULTS WITH CEREBRAL PALSY

Designers: Eight teams of four students = 32 freshman engineering students
Client Coordinator: Deborah Gustin, OTR/L; LINCPoint, UCP of Greater Birmingham
Supervising Professor: Alan Eberhardt, PhD
Department of Biomedical Engineering
University of Alabama at Birmingham
Birmingham, Alabama 35294

INTRODUCTION

LincPoint serves people with disabilities by providing them access to occupational and physical therapists as well as job training. Cerebral Palsy is a disorder caused by abnormal development or damage to one or more parts of the brain. The problems associated with this disorder are difficulty controlling and coordinating muscles, walking, sitting, standing, and many other motor skills. The staff at LINCPoint requested the design of an enclosed standing box with an adjustable height table top at an affordable cost, which is also stable, mobile, and lightweight. The design constraints of this project are cost ($250/device), time (5 weeks), mobility (device was to be moveable by female staff when not in use); and adjustability (height of working surface should adjust to accommodate different sized adults. The devices must also be safe and aesthetically pleasing.

SUMMARY OF IMPACT

Each student team completed the design task within the time allowed and under budget. The devices range from simple wooden structures with ramps and hand-driven adjusters, to complex devices that incorporate a car jack to adjust the height of the working surface. Upon completion, the staff inspected the devices and chose four to take back with them for use at LINCPoint. Examples of the standing boxes are illustrated in Figure 14.8.

Fig. 14.8. Example adjustable height standing boxes completed by the freshman engineers in EGR 100 Introduction to Engineering. Each if these devices, along with one other (not shown) were selected for use by staff at LINCPoint to serve adults with cerebral palsy.