CHAPTER 8
MICHIGAN TECHNOLOGICAL UNIVERSITY

College of Engineering
Department of Biomedical Engineering
1400 Townsend Drive
312 Chemical Sciences & Engineering
Houghton, Michigan 49931-1295

Principal Investigators:

Debra D. Wright (906) 487-1989

wright@mtu.edu

John E. Beard, (906) 487-3110

David A. Nelson (906) 487-2772

ADJUSTABLE MOUNTING DEVICE FOR READING

Designers: Cris Braganza, Stephanie Deziel, Nathan Leatherman, and Megan Schaller
Client Coordinators: Kathy Penegore and Joan Pavlowich, Copper Country Intermediate School District
Supervising Professor: David A. Nelson, PhD.
Michigan Technological University
Department of Biomedical Engineering
1400 Townsend Drive
Houghton, MI 49931

INTRODUCTION

A child with a progressive motor disease and severe visual impairment, who uses a wheelchair, requires a device to allow him to read on his own. The student must be able to adjust the device so that he can read easily with proper posture. The reading surface has three degrees of freedom so that the student will have proper posture when reading. The device (Figure 8.1) is freestanding and portable so that the weight of the device is transmitted to the ground instead of the wheelchair.

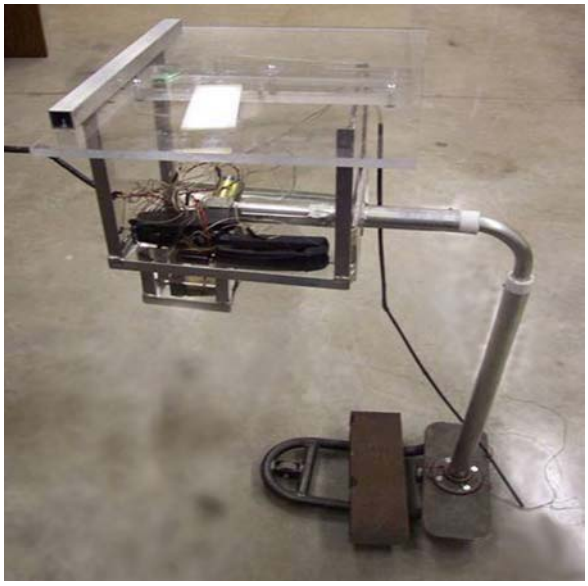


Figure 8.1. Adjustable Mounting Device for Reading

SUMMARY OF IMPACT

Prior to using the device, the student had hunched posture while reading books. The device will help the client immensely by helping him maintain an erect posture, as shown in Fig. 8.2. The strain in his neck will be greatly reduced due to better posture, and the lighting source on the device will allow him to read at night. The adjustability of the device will allow for the reading of books of different shapes and sizes, and will also allow the device to adjust to the client as he grows.

Figure 8.2. Client Operating Device.

TECHNICAL DESCRIPTION

Fig. 8.3 shows a three-dimensional schematic of the adjustable mounting device along with side and front view drawings. The device can be separated into three sub-assemble parts: 1)the base; 2)the telescoping poles; and 3) the box, which contains the control system and reading surface.

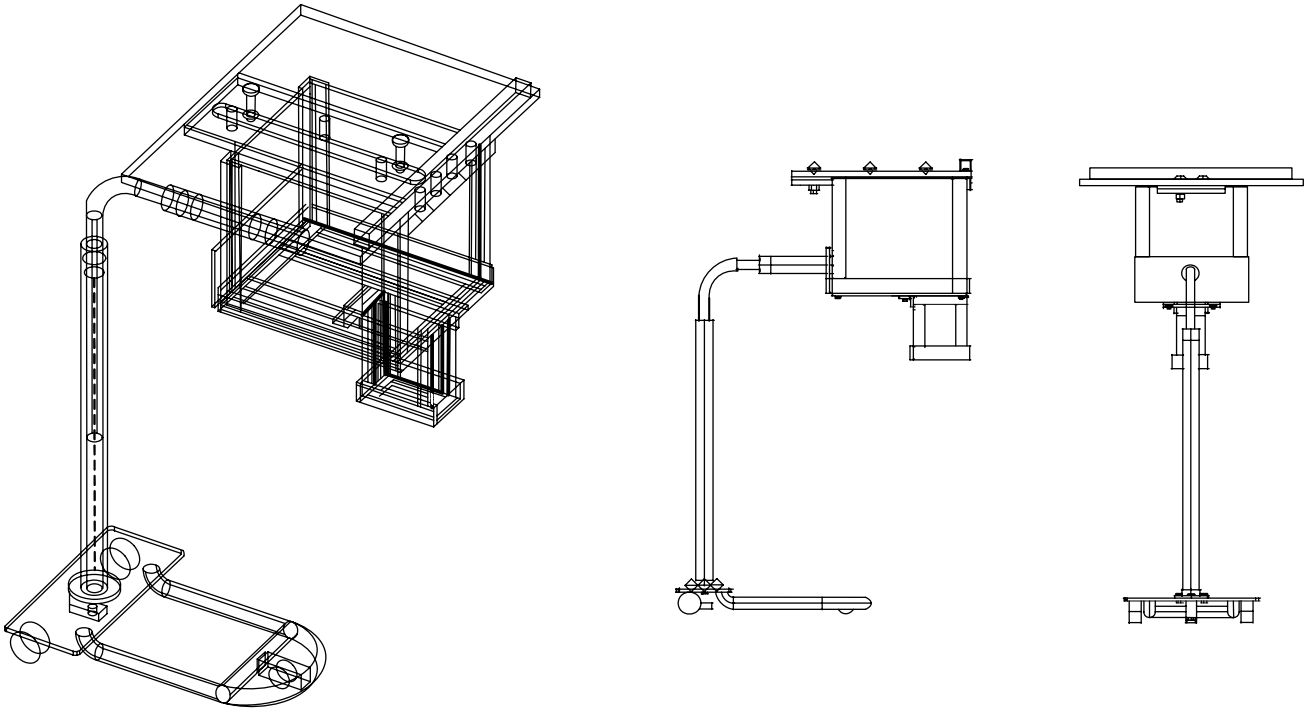
The base of the device was constructed from steel tubing and fits underneath the client's wheelchair. Swiveling wheels were attached to the base to allow easy movement. A counterweight was added to the base to prevent tipping during storage. During use, the device is attached the wheelchair.

Two telescoping poles equipped with linear actuators were used to provide motion in the horizontal and vertical planes. The poles are made out of an aluminum rod and aluminum tube, which

move with respect to each other. Teflon bushings were added to decrease the friction and to prevent the aluminum from binding. The linear actuators (Motion systems) have a stroke of eight inches for the vertical plane and a stroke of four inches for the horizontal plane.

The telescoping poles were welded to the aluminum frame of the box and reading surface. The reading surface is 20 inches wide and 16 inches tall so that the client is able to read material of various sizes. The box has an aluminum frame and panes of Plexiglas®. Plexiglas® was used because it is clear and will not obstruct the student's line of sight. A linear actuator with a stroke of 12 inches was placed inside a channel attached to the reading surface to enable angular motion of the reading surface. The reading surface can achieve a maximum angle of approximately 80 degrees.

The total cost of parts is approximately $1250.



Isometric View Side View Rear View

Figure 8.3. Drawings of Final Design.

CAUSE AND EFFECT LEARNING ENCLOSURE

Designers: Bethany Hemphill, Rhyan Hongisto, and Amanda Läde
Client Coordinators: Lisa Sporbert, Copper Country Intermediate School District (CCISD)
Supervising Professor: David A. Nelson, Ph.D
Michigan Technological University
Department of Biomedical Engineering
1400 Townsend Drive
Houghton, MI 49931

INTRODUCTION

Cause and effect learning is fostered in a client classroom for children with multiple physical and cognitive disabilities. This classroom currently uses cordless switches, receivers, and a control box for cause and effect learning. When a button is pressed, the signal is transmitted to the receiver to activate a device that is receiving power from the control box. The students learn that when the button is pressed (cause), the item of interest is activated (effect). The school requested that the system be improved to decrease set-up time, reduce the number of battery changes and prevent the students from tampering with the controls. The device also must be accessible to students who use wheelchairs.

SUMMARY OF IMPACT

This device will aid the classroom instructors by reducing the time they spend setting up and maintaining the individual control systems. With the new device, set-up time is five minutes, compared to 20 minutes with the individual components. It is expected to help engage the students' interests, since multiple devices can now be selected. All students in the classroom are now able to use the device, and the instructor will be creating a learning station so that the device can be used at any time by any student.

TECHNICAL DESCRIPTION

The final design incorporates two sub-systems, as shown in Fig. 8.4. The Transmitting system contains three switches (seen on the bottom of Fig. 8.4). The Power and Receiving system incorporates the control units and receivers (seen on the top of Fig. 8.4). The two sub-systems can be independently positioned so that all students in the classroom can utilize the device. A polycarbonate enclosure was constructed to house each sub-system to limit the students' access to the vital controls of each system. The enclosures have snap-on lids which can be removed by the teacher for easy access to the interior to allow for battery changes and control adjustments.

Figure 8.4. Cause and Effect Learning System.

The Transmitting system contains three Cordless Big Switches (AbleNet, Minnesota) that were rewired to one rechargeable battery source. The 9-volt battery connectors in the switch were wired in parallel to a single 9.6-volt rechargeable RC battery. This rewiring eliminated three batteries, allowing for simpler battery changes and longer periods of use between changes. The switches were placed in the polycarbonate enclosure and a lighted on/off switch was added to the outside of the enclosure to turn the switch module on and off.

The Power and Receiving system contain two PowerLink units (AbleNet, Minnesota) and the receivers for the Cordless Big Switches. The receivers were converted to AC power by cutting the wires leading to the battery housing, and reconnecting them to a 1/8" panel mount jack. Three 1/8" mono plugs were wired parallel, inserted into each receiver and wired to an AC/DC converter to complete the conversion to AC power. A single power strip provides power to the two PowerLink units and AC/DC converter. Then the

entire Power and Receiving system was placed into the polycarbonate enclosure.

The finished device is able to transmit and receive signals when the subsystems are separated by up to 20 feet. This is an improvement over the Cordless Big Switches as received from the manufacturer. Initial testing showed that signals were able to be received and transmitted up to nine feet. It is possible that increased amperage is being transmitted to the receivers, which may cause a circuit in the receiver to overheat and malfunction at some point in the future. The device is able to activate one item of interest at a time. The classroom teacher desired to have multiple items activated at once, but this is not currently possible. Despite these weaknesses, the device meets all requirements of the teacher utilizing the device, and will be used extensively in the next school year.

The total cost for parts for the device is $820. Additionally, two PowerLink units (AbleNet, Minnesota) and three cordless Big Switches and Receivers (AbleNet, Minnesota) were purchased by the client for an additional cost of $90.

ASSISTED BALL THROWING DEVICE

Designers: Megan Ballard, Miranda Fry, Brandee McMichael, Erin Sturgell
Client Coordinator: Traci Steele, Gwinn High School
Supervising Professor: Dr. David A. Nelson, PhD
Michigan Technological University
Department of Biomedical Engineering
1400 Townsend Drive
Houghton, MI 49931

INTRODUCTION

Students with multiple physical and cognitive disabilities would like to participate in ball throwing activities in gym class. While there are ball throwing devices on the market, these are designed specifically for one type of ball, such as a tennis ball or baseball. These devices are also not controlled with switches that the students are able to operate. The goal was to design a device that could throw multiple types of balls for the students at the push of a button. A picture of the final device is shown in Fig. 8.5.

SUMMARY OF IMPACT

When introduced to the device, the students showed enjoyment at being able to throw a ball. The device allows the opportunity for students with physical disabilities the ability to participate in games with their peers, and gives them opportunities for more positive feedback from their fellow students. There were, however, requests for improvements such as decreasing the weight and allowing for throwing angle adjustments. The device fulfilled the original requirements. Future work will address these new needs.

TECHNICAL DESCRIPTION

The throwing mechanism of the machine consists of two vertically aligned wheels placed one above the other, as shown in Fig. 8.6. The wheels are powered by two identical motors that are held by upper and lower motor mounts. The lower mount is stationary and the upper mount is held in place by two support rods and an acme threaded rod. This can be turned by means of a hand crank to raise and lower the upper wheel to accommodate different sized balls. The speed of the motors is adjustable through the control panel, which also contains the power switch for the motors. Power to operate the motors is provided via a 12 volt rechargeable battery connected to the control panel.

Figure 8.5. Assisted Ball Thrower.

A chute and gate, shown in Fig. 8.7, feed the ball into the throwing mechanism. The chute consists of polycarbonate sheets placed in a v shape that slants down from the ball entrance to the throwing wheels. The gate mechanism consists of an aluminum gate attached to the bottom motor mount's anchoring plate. This gate is held at an angle of approximately 15 degree angle from the horizontal by a spring and acts to stop the ball at the base of the chute. The gate is lowered by means of two solenoids: one pulls up on the end of the gate and a second pulls down on the opposite side. This gate mechanism is triggered by pushing the large yellow button that completes the circuit connecting the battery to the solenoids. The device is reset by the action of the spring once the button is released, cutting off power to the solenoids. A wiring diagram for these components is shown in Fig. 8.8. When the gate is lowered, the

ball is fed by gravity into the throwing mechanism which, when powered, launches the ball.

The entire device is anchored to an aluminum base plate and enclosed by polycarbonate at the side the ball enters and Plexiglas on the other three sides and top, as shown in Fig. 8.9. This enclosure is held in place by aluminum framework with plastic connectors. Two wheels located on the bottom of the frame, and a handle on the enclosure (not shown) permit easy movement of the device to the desired location. The battery is held in a toolbox that is bolted to the base. Holes in the toolbox permit the wiring for the control panel, motors and solenoid to pass through.

A drawing of the entire design with portions of the enclosure removed is shown in Fig. 8.9. It performs as required with the ability to throw balls ranging in size from a tennis ball to a basketball at ten different speeds. The gate functions could be improved by making it stronger and less likely to stick. The adjustable throwing mechanism works well, but the enclosure protecting the device should be adjusted to allow slightly larger balls to pass through and have increased strength to avoid cracking during use.

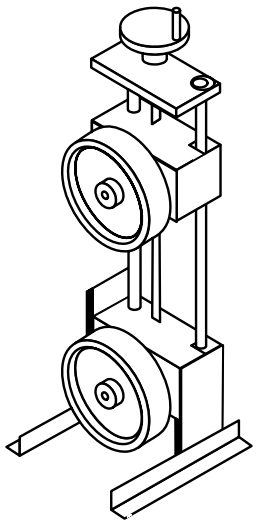


Figure 8.6. Drawing of Throwing Mechanism.

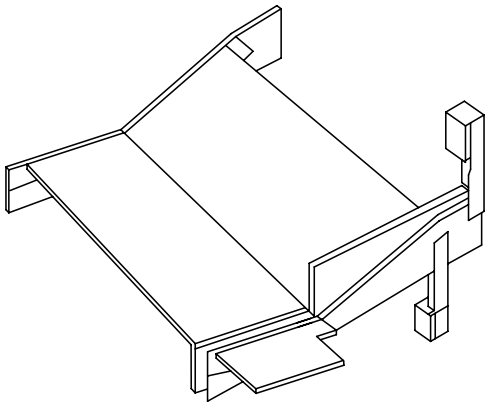


Figure 8.7 Drawing of the chute.

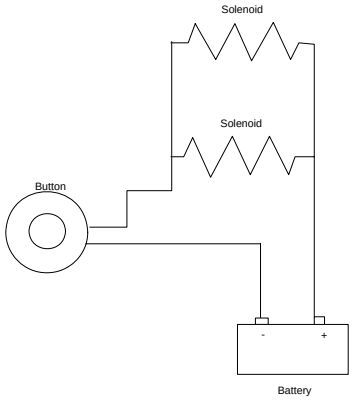


Figure 8.8. Circuit Diagram for Solenoids

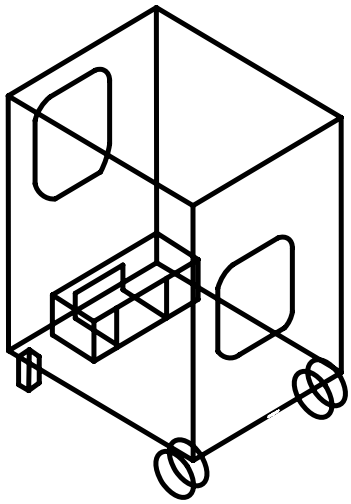


Figure 8.9. Enclosure diagram

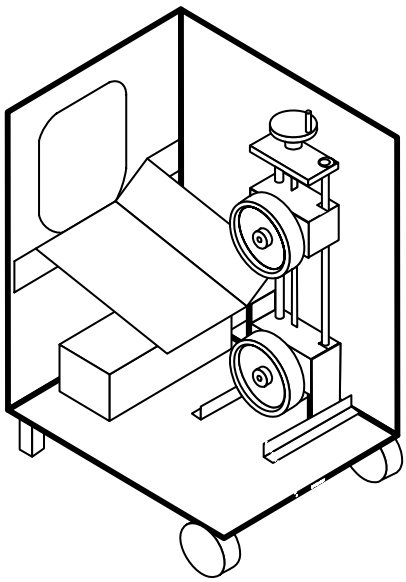


Figure 8.10 Diagram of entire device without outer housing so that detail is shown.