CHAPTER 12
TULANE UNIVERSITY

School of Science and Engineering
Department of Biomedical Engineering
Lindy Boggs Center Suite 500
New Orleans, LA 70118

Principal Investigators:

David A. Rice (504) 865-5898

rice@tulane.edu

Ronald C. Anderson (504) 865-5897

rcanders@tulane.edu

VOICE MONITORING DEVICE FOR CHILDREN WITH AUTISM

Designers: Jonathan Byrd, Paul George, Will Glindmeyer, and Ziev Moses
Client Coordinator: Carrie Cassimere, MSW, The Chartwell Center, New Orleans, LA
Supervising Professor: David A. Rice
Department of Biomedical Engineering
Tulane University
New Orleans, LA 70118

INTRODUCTION

Some children with autism have difficulty maintaining their voice at an appropriate level, often speaking too loudly or too softly. This causes difficulties in the classroom, particularly when reading aloud. The goal of this project was to create a device to enable students to monitor their voice levels while they are reading to the class. The device consists of a book light intended to provide real-time visual feedback by illuminating the book the student is reading in accordance with voice level. If the student reads too loudly, the page is illuminated in red. If the student reads at an appropriate level, the page is illuminated in blue. If the student reads too softly, the page is barely illuminated. Additionally, a column of red, blue, and white LEDs was included in the design to allow the teacher to see what the student sees without looking over the student's shoulder. A microphone acts as the voice level sensor. A custom stand integrates these items together into a standalone system.

SUMMARY OF IMPACT

This device impacts the entire classroom atmosphere. Since the students get immediate feedback regarding their voice levels, they are continually aware of their volume. This system of feedback is much less intrusive and distractive than the traditional correction method of the teacher asking students to adjust their voice level. As the students learn to control their voice levels, the classroom becomes quieter and more conducive to learning. The students enjoy this method of feedback and are observed to read for longer periods of time than before.

The teacher was excited about the project from the beginning. She believes that it might take a while for the children to become used to the device, specifically the color arrangement, but that it will help the children learn where their voice levels should be.

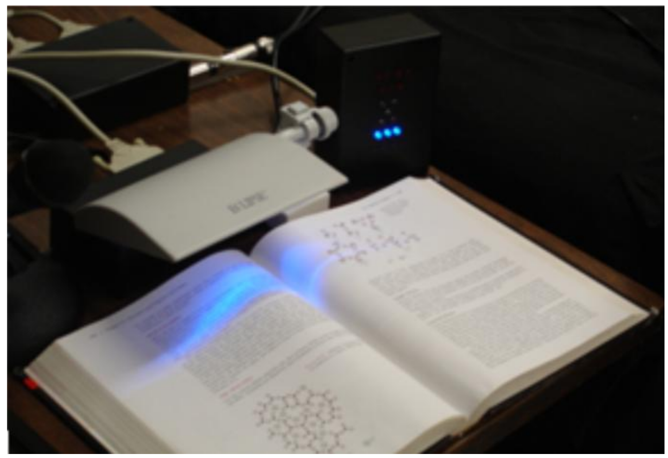

Fig. 12.1. Speech Therapy Device.

TECHNICAL DESCRIPTION

The device consists of: 1) an input; 2) a circuit; and 3) two outputs. The input is the microphone into which the students speak. The sound, in the form of a voltage, enters into the circuit. The circuit consists of: 1) a voltage follower with gain to amplify the sound signal; 2) an AC to DC rectifier; 3) an inverting op-amp with gain; and 4) an LED driver. The LED driver lights different LEDs based on the amplitude of he input signal. A potentiometer permits the teacher to control the threshold levels. This circuitry fits onto a single circuit board and is encased in a strong plastic box. Fig. 12.2 shows a diagram of the circuit.

The two visual feedback mechanisms are a book light and a column. The book light is a small plastic black box with two rows of directional LEDs coming out of the top, a row of blue LEDs, and a row of red LEDs. The LEDs shine directly upwards onto a mirror. The parabolic mirror then diffuses and redirects the light onto the page the student is reading. The column is also made of a plastic box. It consists of: 1) seven rows of LEDs; 2) two blue rows on the bottom; 3) three white rows in the middle; and 4) two red rows on the top.

The main circuitry box is connected to the two outputs through printer cables. These printer cables allowed the outputs to be disconnected and reconnected to the box easily and without any wire exposure. Also, the 10' wires are long enough to allow the teacher to move the main circuitry box or column away from the book light and student if desired. The entire apparatus can be attached via Velcro to a stand, allowing the teacher to easily move the device.

The cost of the device was about $212.

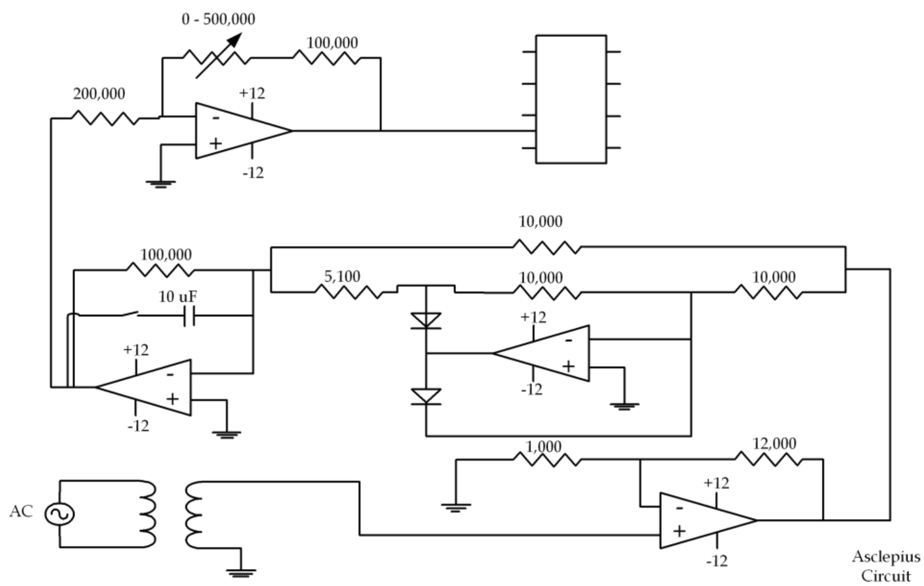

Fig. 12.2. Circuit Schematic.

COMMUNICATION DEVICE FOR A PERSON WITH ANOXIC BRAIN INJURY

Designers: Matt Riser, Sam DeStefano, Robbie Whitman, and Jeremy McShane
Client Coordinators: Holly Cohen, MPT, and Jill Jones, LOTR
Supervising Professor: David A. Rice
Department of Biomedical Engineering
Tulane University,
New Orleans, LA 70118

INTRODUCTION

A 26-year-old female with anoxic encephalopathy is unable to speak and receives most of her nutrition through a feeding tube. Her mobility and fine motor skills are being treated in physical therapy. She would benefit from a more efficient means of verbal communication. Previously, the client would communicate by pointing to letters on a board to spell words. This process takes a long time and can be hard to follow. In response to this need, a computer-based communication system was designed. The system allows for more effective communication through the use of basic phrases and words on a portable simplified keyboard. The keyboard was configured to be identical to the communication board that she used previously. The device uses text-to-speech software to allow the client to "type" what she would like to say. The software then "speaks" the text. The keyboard has been reconfigured with larger keys and quick keys tagged with symbols to represent commonly used phrases, greatly facilitating its use.

SUMMARY OF IMPACT

The communication system allows for expanded communication, clearly benefitting the client and inspiring her to initiate conversation with others because a "voice" can be associated with her thoughts. With the system, the client can give complete responses, as opposed to short responses associated with her previous means of communication. The ability to engage in more meaningful communication may carry therapeutic benefit as well.

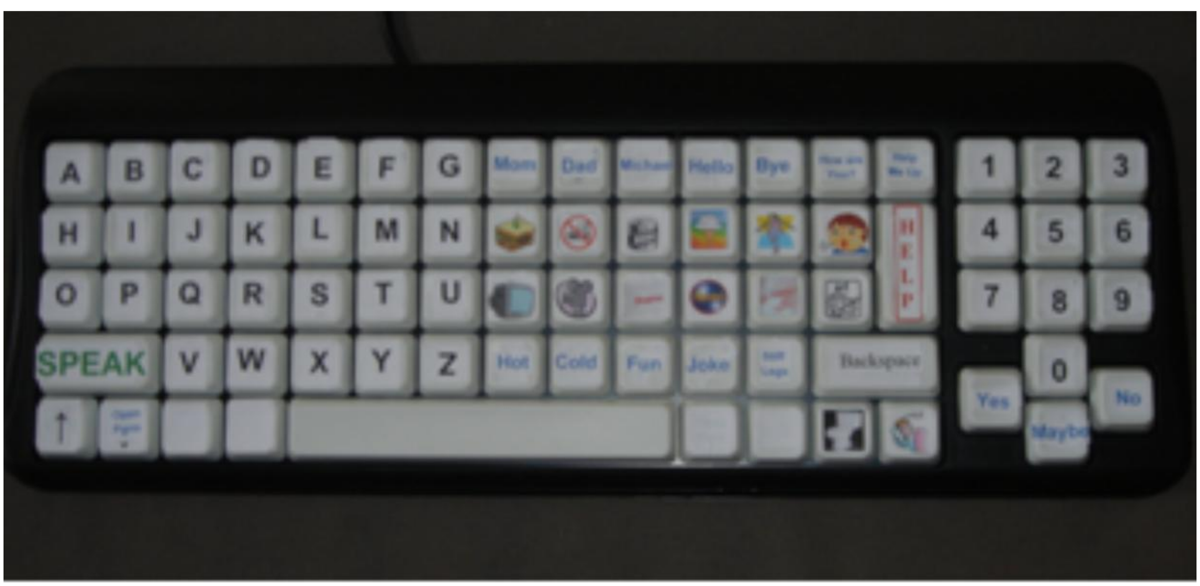

Fig. 12.3. Remapped Keyboard.

TECHNICAL DESCRIPTION

The system (see Fig. 12.4) includes a number of prefabricated devices: 1) a Compaq Presario Laptop; 2) an EZ keys Googol board keyboard; 3) Verbose Text-To-Speech software; 4) a Laptop carrying case; and 5) an infrared joystick mouse. The keyboard was remapped with specific phrases that were suggested by the client. It also contains a full alphabet on the left side with a numeric keypad on the right side. Each key was re-programmed to give a different and more cogent output (see Fig. 12.3). All keys are capable of being used to: 1) execute a function; 2) produce a phrase; 3) produce a letter; or 4) remain nonfunctional. Each key is laminated to extend the service life and to protect the associated icons located on top of each key.

The joystick mouse has a stiff joystick style without the rotational directions. The left and right clicks are located at the top of the stick while the bottom has an infrared scanner that moves the icon on the screen. Both the keyboard and the joystick are connected to the laptop through high speed USB ports. The text-to-speech software allows the client to type anything on the screen, after which the program will "say" it. The software incorporates a hot key that will open the program with a single keystroke. Text is highlighted upon being "spoken," which allows the user to continue writing without having to delete the previous text. One key executes the play of a word or phrase. The application can be exited to enable use of the laptop in regular mode.

The laptop works as the main framework for the device. It connects all aspects of the device and enables mobility. The laptop weighs about six pounds and the entire system weighs about 10 pounds. Power usage specifications can be modified on the laptop to save power and extend battery life.

The final part of the system is the case to carry all the parts. It is an efficient, durable portable case with thick rubber surrounding the entire laptop. The laptop is locked in with Velcro on the top and bottom and is also fastened in with four adjustable plastic corner holders. All cords can be run into the back of the case so that they need not be disconnected. The case also has a compartment to hold accessories. The case comes with a carrying strap.

The device is portable and lightweight. The operating system has been reconfigured for a quick system boot and a direct connection to the program so that the client may use the system spontaneously.

The approximate cost of this project was $800.

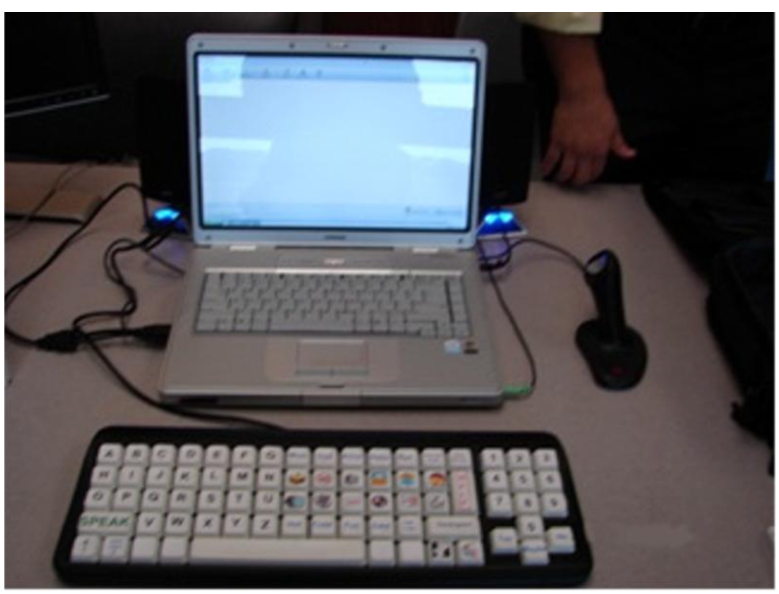

Fig. 12.4. Front View of Entire System.

WORKSTATION FOR A PROFESSIONAL WITH A LIMITED MOBILITY

Designers: Jenae Guinn, Adam Herder and Brett Weiner
Client Coordinators: Morteza M. Mehrebadi, PhD, Donald P. Gaver, PhD
Supervising Professor: David A. Rice
Department of Biomedical Engineering
Tulane University
New Orleans, LA 70118

INTRODUCTION

The client is uses a wheelchair and has limited mobility. He works from home, but has a difficult time accessing and utilizing standard desks. The client requested an L-shaped workstation that would facilitate working from home. The unit had to: 1) fit into a specific room of his house; 2) not obstruct access to nearby windows and doors; and 3) have a suitable working height so that the desktop would clear the client's wheelchair. The device had to be custom-built because existing L-shaped desks were too large and thus blocked the window, door, or both. The workstation consists of a desk and a moveable CPU stand with an adjustable shelf.

SUMMARY OF IMPACT

The workstation provides the client with the means to conveniently and comfortably work from home. He can use the desk to hold his printer, computer peripherals, and other necessary office supplies. The separate CPU stand frees up valuable workspace on the desktop and is mobile for convenient positioning. The adjustable shelf allows the stand to be used to hold other devices in the event that the client purchases a different model

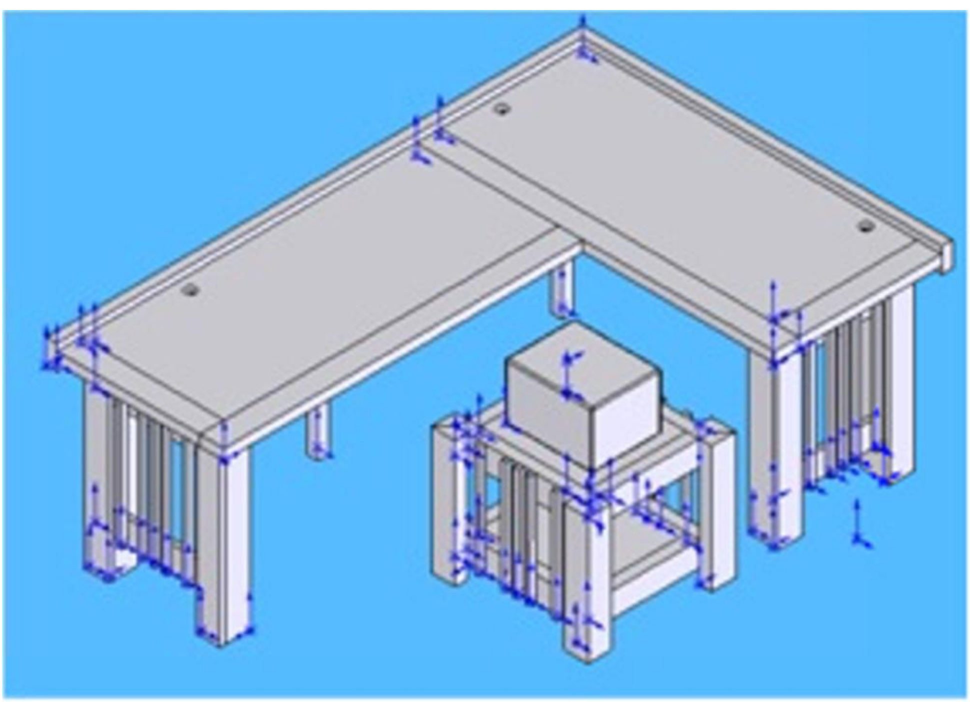

Fig. 12.5. Schematic of Desk and CPU Stand.

computer.

When the client used the workstation for the first time after installation in his home, he was pleased with the outcome. The physical dimensions of the desk were ideal for him and his office space. The aesthetic desires were met and, as a result, he has a piece of furniture that blends harmoniously with his interior design. He is no longer reliant on small, temporary folding tables as a work surface to hold his papers; this creates more space in his home and allows for better access.

TECHNICAL DESCRIPTION

At the client's request, the workstation was made from wood and designed in the manner of prairie or mission style architecture. To maintain the aesthetic of natural material, birch plywood was used for the large surfaces and oak for the legs and decorative edging. A natural polyurethane satin finish was applied to preserve the wood and produce an aesthetic finish.

The workstation was designed using SolidWorks design software. Analyses were performed with the COSMOSWorks add-in. Material properties of oak were found in the Forest Products Laboratory wood handbook ("Wood as an engineering material." Gen. Tech. Rep. FPL-GTR-113. Madison, WI: U.S. Department of Agriculture, Forest Service, Forest Products Laboratory, 463 p.). Material properties for birch plywood were unavailable, so a loading experiment was performed to determine Young's modulus. A section of birch plywood was simply supported and a known force was applied. Maximum deflection was measured, and the elastic modulus was determined from the equation dmax = -PL3/48EI. Due to the alternating laminate layers, the material properties of birch plywood were approximated as isotropic.

With this information, an L-shaped desk was designed that is structurally sound without support from a leg at the inside corner, facilitating client maneuverability underneath the desk. The desk measures 28″ from the floor to the bottom surface of the desktop, 75.5″ long, and 52.25″ wide. The CPU stand measures 14.25″ x 17″, and is 20″ tall, including casters.

The cost of the project was approximately $390.

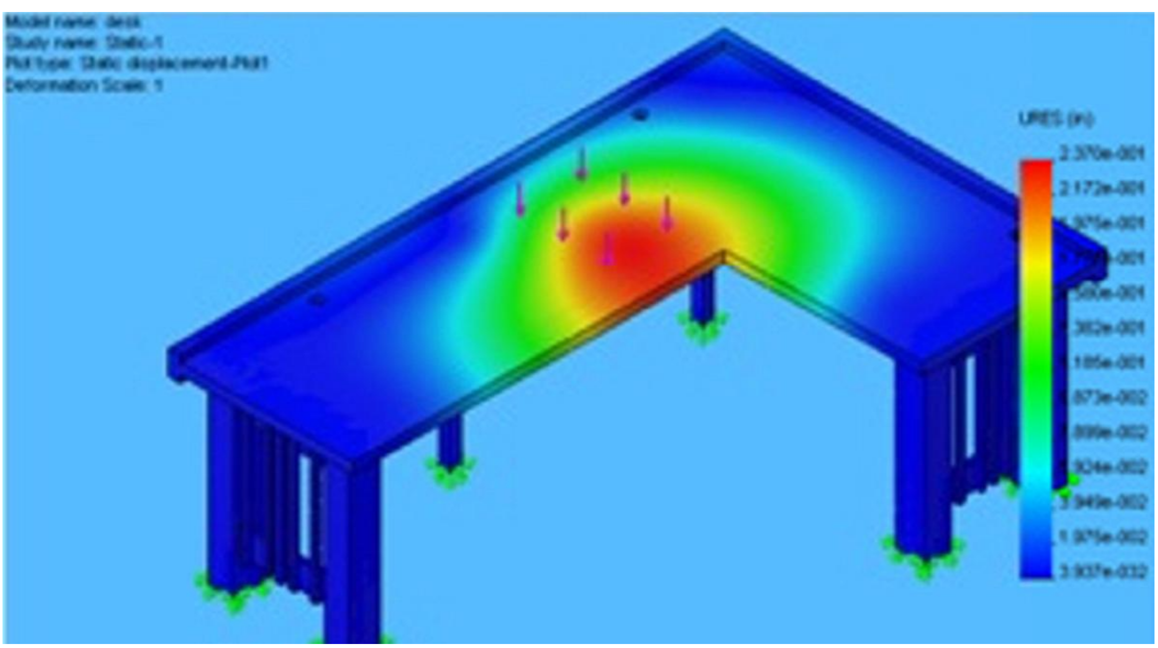

Fig. 12.6. Mechanical Analysis of Custom Workstation.

PAINTING EASELY

Designers: Emily Florine, Caroline Haas, Cole Johnson, Sara Thorson
Client Coordinator: Ronald C. Anderson, PhD, Annette Oertling, PhD
Supervising Professor: David A. Rice
Department of Biomedical Engineering
Tulane University,
New Orleans, LA 70118

INTRODUCTION

A portable and easy-to-use easel was designed and constructed for a client with osteogenesis imperfecta, a disease characterized in part by brittle bones. She has limited mobility, small stature, and paints while lying down. She is an avid artist and requested that an easel be built to move the canvas for her. The device allows the client to paint large canvases independently. The design consists of a motorized base on which is mounted a vertical frame. The vertical frame contains the canvas mount and the motor systems to move the canvas horizontally and vertically. The canvas mount also allows the tilting of the canvas. The vertical frame collapses on top of the base and rolls on the rear wheels for portability.

SUMMARY OF IMPACT

The client has short stature and limited ability to reach all areas of large canvases. Before receiving the easel, the client needed an assistant to move the canvas for her. The easel moves the canvas horizontally and vertically. The easel also allows the canvas to be tilted toward and away from the artist. This easel allows the client to paint independently in any location to which the easel can be transported.

TECHNICAL DESCRIPTION

The goal of this project was to create a remote controlled motorized easel that: 1) allows for movement of the canvas in four degrees of motion: tilt, x, y, and z directions; 2) is portable; 3) is safe; 4) is easy to use; and 5) can support canvas sizes between 10" x 10" and 36" x 36".

The motion of the canvas in the x, y, and z directions is accomplished by the activation of three motors, one controlling each direction of motion. The motors are reversible to allow motion in the positive and negative directions along each axis. The motors are activated by remote control. There are six buttons to control the three motors, with one button

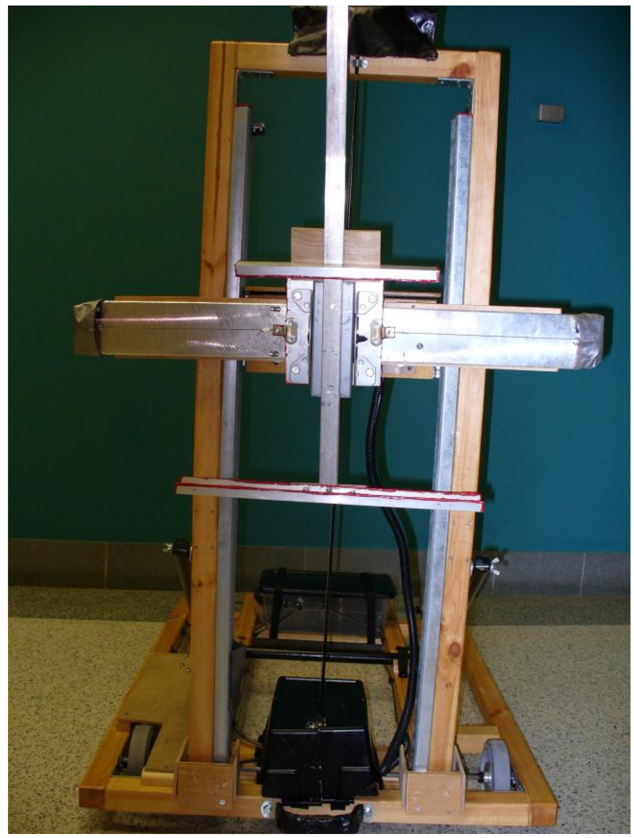

Fig. 12.7. Easel Front View, No Canvas.

for each direction. The motors are all run from one 12-V DC battery. The motors cause motion via pulley and cable constructs. For the x and y directions, the pulleys wind and unwind aircraft cable to pull the canvas in the appropriate direction. The canvas slides along rails that attach to the wooden frame to guide the movement. For the z direction, the pulley turns a timing belt to rotate the axle attached to the base of the easel. Tilt is controlled by manual adjustment.

The easel collapses so that the vertical portion of the frame, which holds the easel, folds down onto the base. The easel collapses onto itself to a transport and storage height of approximately 10 inches. The easel can be pulled to the desired location by rolling it on its rear wheels (see Fig. 12.8).

A charger is provided with the battery. The charger is a trickle charger so the battery cannot be overcharged. If used unplugged, the battery will last for 16 hours. It requires 16 hours to completely charge a drained battery.

Safety features incorporated into the design include: 1) limit switches to prevent the canvas from moving off of the slides in the vertical or horizontal directions; 2) a limit switch to prevent activation of any motor when the easel is not set in its upright and locked position; 3) strain relief on all electrical wires; and 4) covering of all electrical wires, pulleys, motors, and pinch points.

The total cost of the easel was $885.

Fig. 12.8. Easel Collapsed Side View.

POLE TRANSFER AID

Designers: William Heim, Cindy Lumby, Kara Tellio and Dena Wiltz
Client Coordinators: Holly Cohen, MPT and Sharon Crane, LOTR
Supervising Professor: David A. Rice
Department of Biomedical Engineering
Tulane University
New Orleans, LA 70118

INTRODUCTION

The client is a 12-year-old girl with cerebral palsy. She has a marked lack in trunk strength but her arm and upper body strength are sufficient to enable her to pull herself along a rail. She also has some leg strength. A pole transfer aid was developed to allow more independence for moving between the client's bed and wheelchair (see Fig 12.9).

The pole stretches from the floor to the ceiling for maximum stability. It is anchored to the floor by a flange and to the ceiling by an adjustable telescope-like flange. The telescope-like flange corrects for any height variations between the floor and ceiling. The flanges are attached using screws. There are two circular rings on the pole. The rings allow the client to pull herself as she swings her body. The lower ring is placed at a position where she can grasp it from a sitting position in her wheelchair. The higher ring is placed at a comfortable position for grasping while standing. Each ring is connected to a center rectangular pole using horizontal connecting spokes. The rings are connected together using vertical poles that serve to support the client as she rotates herself. The connecting poles are attached to the center pole using collars attached with Allen screws. The collars allow the rings to be height adjustable. Sport tape covers the area of the pole that she grips.

SUMMARY OF IMPACT

This system allows the client a sense of independence. She is able to autonomously move herself from her wheelchair to bed and vice-versa. In addition, it allows her to use the strength she has and to exercise her muscles. The device is height-adjustable and easily modifiable such that custom alterations can be made. The physical therapist indicated the device is sufficient for independent transfers and will give the client enough stability with the multiple gripping surfaces. She noted that the vertical bars in the design will allow for easier hand repositioning. She also noted that the tennis grips were a good addition because they are cleanable, replaceable, and form a secure gripping surface.

Fig. 12.9. Transfer Pole.

TECHNICAL DESCRIPTION

The pole transfer aid consists of a height-adjustable ring system, a top flange, and a center pole with an attached bottom flange. The rings and horizontal supports are steel; the collars, flanges, and center pole are galvanized steel. The device is designed to be anchored to the floor and ceiling by the flanges with 14" x 1.5" wood screws; five wood screws screw into the bottom flange and floor and four wood screws screw into the top flange and ceiling. The ring system is adjustable to the individual's height. Each ring is laterally connected to a collar by three spokes. Each collar is attached to the center pole via two Allen screws, which allow for height adjustability. Two vertical poles connect the two rings to each other. The rings and vertical poles are covered with polyurethane foam core grips. The top flange is attached to the center pole by two set screws.

The total weight of the pole transfer aid is 44 lbs with final dimensions of 18" x 18" x 9' (length x width x height). Its exterior was treated with Rustoleum to resist rusting.

Overall production is simple and can be done with limited and nonspecialized equipment and readily accessible materials. The pole transfer aid is an economical solution to the problem posed and meets all requirements of strength and durability.

The pole transfer aid cost about $500.

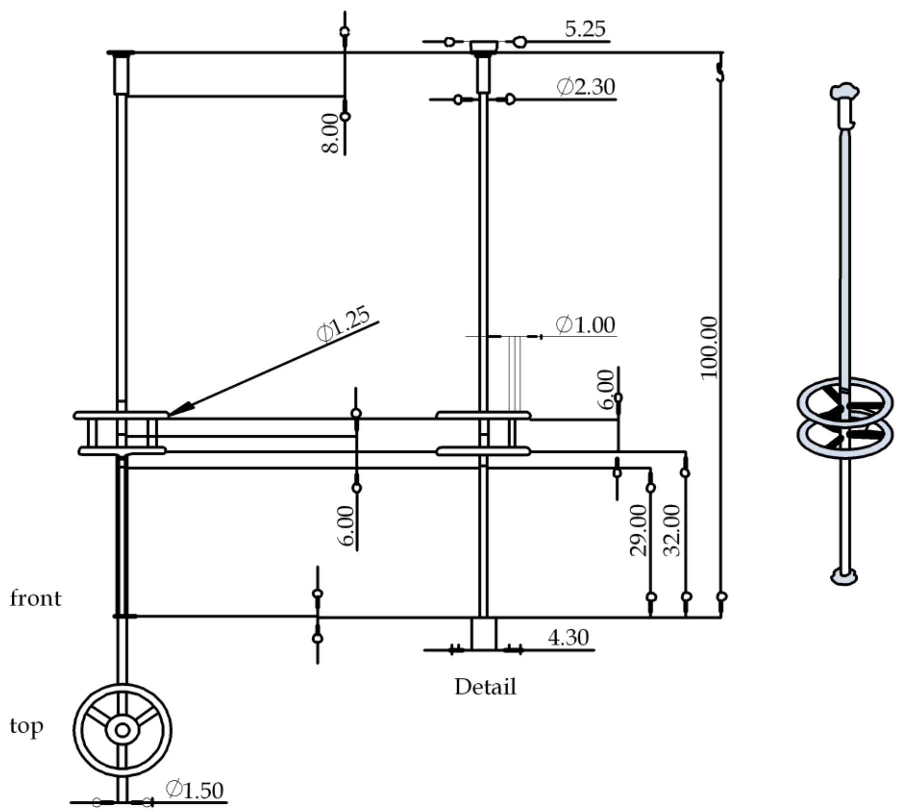

Fig. 12.10. Dimensions of Transfer Pole.

KIDS' INTERACTIVE SENSORY SYSTEM

Designers: Kimberly Bordeaux, Sarah Flanders, Elliot Hardy, and Helen Witt
Client Coordinators: Elaine Joseph, Ed.D. and Debbie Pavur, Newcomb Nursery, New Orleans, LA
Supervising Professor: David A. Rice
Department of Biomedical Engineering
Tulane University
New Orleans, LA 70118

INTRODUCTION

The Kids' Interactive Sensory System (KISS) was developed for a children's facility for which staff members requested a sensory development tool. Those who are potentially able to benefit from additional sensory experiences include children who have been diagnosed with autism, pervasive developmental delay, ADD or ADHD, and sensory integration or processing difficulties. The Kids' Interactive Sensory System provides tactile stimulation to aid children's development.

Snap Wall® pieces have a sturdy design that ensure a safe structure and allow for simple incorporation of tactile features. Plywood backing holds the tactile pieces in place but is easily removed for cleaning or replacement. A no-slip backing adds to the safety features of the design. The seven panels can be connected both vertically and horizontally to allow for comparison of the varying tactile surfaces and easy storage. Additionally, the large surface area allows for indoor motor activity with a large group of children, encouraging peer interaction.

SUMMARY OF IMPACT

Stepping between pieces with vertical differences encourages bodily awareness and careful placement without compromising safety. The facility director is pleased with the overall design, textile materials, and potential for use in the classroom. She was able to find an easily accessible storage location, which will encourage use of the device. Additionally, she mentioned that while there are many sensory development tools currently on the market, none meet the needs of an indoor motor system. KISS allows the children to play on a rainy day without resorting to bringing outdoor toys into the playroom. Finally, she looks forward to encouraging her teachers to use it for all age levels, but recognizes that it will most like benefit the one- and two-year-old groups in daycare. The one-year-old group finds exploration of the individual surfaces to be the most entertaining, while the two-year-old group enjoys stretching from surface to surface to compare the different tactile sensations.

Fig. 12.11. Kids' Interactive Sensory System in one Possible Configuration.

Fig. 12.12. Kids' Interactive Sensory System in another Possible Configuration.

TECHNICAL DESCRIPTION

Galvanized steel wall anchors (molly bolts) are inserted into each of the four corners of one side of each of the seven Snap Wall® pieces. Round edged plywood backing, 22" x 22" x 0.5", was stained with a waterproof polyurethane coating to add durability. After aligning the backing with the plastic pieces, holes were drilled and countersunk to fit flathead screws. Textile pieces attach to the plywood with a combination of staples, adhesive caulk, and epoxy to ensure sturdy adherence and allow for simple replacement or touch-up. The plywood is backed with a no-slip stair grip to minimize motion of the pieces when laid flat on the floor, the most likely configuration, as shown in Fig. 12.13.

Each of the seven panels have a different textile attached to them: 1) panel 1 is a cotton pillowcase that has been quilted, and several of the sections have rice sewn into them to provide contrasting textures within the panel; 2) panel 2 is pieces of various patterned felt covering a soft foam layer; 3) panel 3 is the reverse side of a rubber bathmat with suction cups; 4) panel 4 is a clear plastic bathmat with raised circular nodules; 5) panel 5 is a faux leather material covering a soft foam layer; 6) panel 6 is the top side of a rubber bathmat with soft rubbery extensions; and 7) panel 7 is a doormat with stiff plastic extensions. The system can be assembled as: 1) a mat on the floor; 2) a cube; and 3) a vertical wall.

The total cost of parts and materials was about $720.

Fig. 12.13. Different Textiles and Bright Colors Appeal to Children.

BULL-RIDING TRUNK TRAINER

Designers: Anna Brahm, Nicole Lehrer, Amy Levelle, and Justin Lipner
Client Coordinators: Holly Cohen, MPT and Lauren Best Shapiro, LOTR
Supervising Professor: David A. Rice
Department of Biomedical Engineering
Tulane University,
New Orleans, LA 70118

INTRODUCTION

A nine-year-old boy with cerebral palsy has weak trunk tone, making it difficult for him to maintain his upper body in an upright position. The hypertonicity of the client's legs causes adduction, which leads to scissoring of his legs while walking. The device developed in response to this problem is a trunk tone trainer. The trainer simulates the movements of a mechanical bull. With the control of a supervising adult, the device moves the user around in an unpredictable way. The weight and imbalance of the user is the source of the system's movement. The "bull" swings back and forth and side to side. This forces the user to adjust his trunk position and utilize his balance to avoid falling. His legs are abducted throughout the riding session. The bull is narrow enough for the user to straddle but wide enough for him to stretch his legs apart. It has appropriate padding and a pommel in the front for him to grip. This system provides a fun and useful way for the client to get the exercise and muscle development that he needs.

SUMMARY OF IMPACT

The bull provides a fun means of social interaction among the client, friends, and family. He readily interacts with other individuals to demonstrate the bull. Straddling the bull has become easier for him over the short period of time it has been installed in the home. Most importantly, it provides a convenient way for the client to stretch and engage in exercises from the convenience of his home, as opposed to isolating his physical therapy to the therapy center, or in the presence of a physical therapist. The client's parents may increase the challenge of his riding as they deem appropriate.

TECHNICAL DESCRIPTION

The two major components of the trainer are the frame and the bull. The timber frame is 10 feet long, six feet wide, and eight feet high. The bull is a padded 12" PVC pipe suspended by four ropes. The ropes attach to the pipe at four points. These ropes run through pulleys and attach to the bottom of the frame. The frame, ropes, and bull form a four-bar mechanism that ensures a rolling motion while the bull moves. This forces the client to grip and engage his trunk muscles to remain mounted. The ropes are pulled manually to simulate the movement of the mechanical bull. The bull is narrow enough for the client to straddle but wide enough for him to stretch his legs apart. The bull is equipped with straps that hold him securely to the saddle but still allow independent trunk movement. The saddle also has handlebars for further grip points. A 6" deep pit of garden mulch lines the ground below the bull to offer padding in the case of a fall. Also, the posts are padded to eliminate hard surfaces.

Fig. 12.14. View of "Bull" and Enclosure.

The cost of the device was approximately $460.

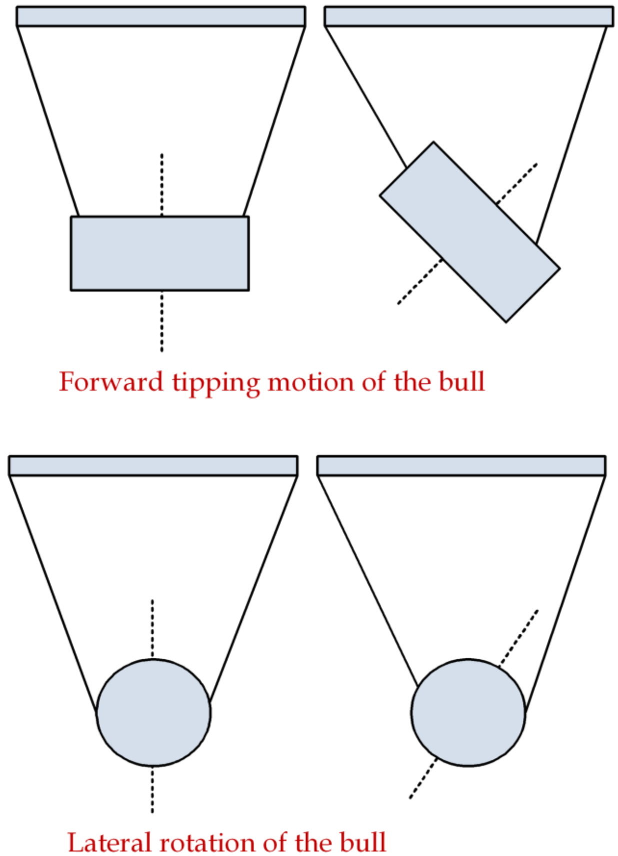

Fig. 12.15. Forward Tipping of Bull Exercises Lower Back Muscles and Lateral and Medial Abdominal Muscles; Lateral Rotation Exercises External and Internal Obliques.

SCHOOL DESK WITH MOTORIZED SLANTBOARD

Designers: Samy Abdelghani, Justin Cooper, Elizabeth Doughty, Grace Ledet
Client Coordinator: Valerie Faneca, LOTR, Jefferson Parish School District, LA
Supervising Professor: David A. Rice
Department of Biomedical Engineering
Tulane University,
New Orleans, LA 70118

INTRODUCTION

A school desk (see Fig. 12.16) was constructed for a kindergartener with arthrogryposis. The student lacks use of her arms, uses a mouthstick and wheelchair, and requires the use of adaptations and assistive technology to participate in academic and motor activities.

The main body of the desk is made of wood and features a motorized slantboard with a magnetic surface that allows the client to completely control its angle. The slantboard is controlled with two buttons that are located on the desktop. The desk also features height adjustable legs with locking caster wheels that allow it to be mobile. The slantboard is battery-powered to eliminate the necessity for any connection to an external power supply. The slantboard allows papers to be held with magnets; and has a ledge at its base that prevents any books placed on the surface from falling when the slantboard is tilted. In addition to its novel features, the desk has all the amenities of a normal school desk. It has a large, flat workspace for schoolwork and two storage units for school supplies. Rubber edging has been added around the edge of the desk and slantboard to eliminate any sharp edges that could prove unsafe in a classroom. The desk is similar in appearance to other desks used by the class.

SUMMARY OF IMPACT

This desk promotes successful integration within the classroom setting, adjustability to growth, ease of movement and access in the educational environment. The design meets all of the specifications discussed in the planning process.

TECHNICAL DESCRIPTION

The desk has three major parts: 1) the frame; 2) the legs; and 3) the slantboard. The frame of the desk was made from wood constructed using biscuit joints and wood glue. The legs were made from telescoping aluminum tubes that lock in place, making the desk height adjustable, without sacrificing strength. Locking caster wheels were attached to the bottoms of the legs. The legs were then attached to the desk using metal brackets that were covered with decorative wooden housings. The slantboard was made from half-inch plywood with a steel surface. This allows for a stable writing surface that is easy to clean and magnet-friendly.

The slantboard was attached to the frame of the desk using piano hinges. It was also attached to a linear actuator that allows it to be controlled by the pushbuttons. The actuator was connected to the frame of the desk and the slantboard with two pin hinges. The linear actuator has a 6” stroke to lift the hinged slantboard. The actuator is powered with two 6-volt batteries and draws at most 4 amps. The actuator can lift with a force of 110-lbs and can hold a load of 550 lbs in static equilibrium. Two momentary SPDT switches are used in conjunction with two 4PDT relays to switch the polarity of the voltage applied to the motor. Pushing one of the switches causes the actuator to extend and raise the slantboard; the other switch lowers the slantboard.

Lockout logic is applied to cancel the action of the motor and prevent the battery from short circuiting in the event the user presses both switches simultaneously. Additionally, the slantboard has a key switch with a removable key that prevents the slantboard from being used without the key in place. This feature allows teachers and aids the ability to monitor the use of the desk and prevent other students from misusing the slantboard. The linear actuator has internal limiting switches that stop the linear actuator at its maximum and minimum heights.

The desk is lightweight, mobile and strong. It can be easily pushed by one person and can hold the weight of a grown student. All surfaces of the desk have been stained and sealed so that it matches the desks that are currently used in the classroom. The size of the desk is about the same as two average school desks side by side. This allows the desk to be arranged easily by others.

The final cost of the desk was approximately $500.

Fig. 12.16. Front and Side Views of Desk.

MOTORIZED GLIDING CHAIR

Designers: Cameron Charbonnet, Rachael Dula, Dave Siet, and Preston Smith
Client Coordinator: Carrie Cassimere, MSW, The Chartwell Center, New Orleans, LA
Supervising Professor: David A. Rice
Department of Biomedical Engineering
Tulane University
New Orleans, LA 70118

INTRODUCTION

Many children with autism have difficulty regulating their activity level and emotional state. A device was needed for calming autistic children in an elementary school classroom. The children misbehave at times and have problems settling down and maintaining focus. This in turn becomes a disruption for the entire classroom. A motorized gliding chair was requested to provide a calming device to be used without disrupting other members of the classroom (see Fig. 12.17 and Fig. 12.18). The goals for the chair were to: 1) provide even, natural motion; 2) run smoothly when propelled; 3) swing at its natural frequency; and 4) be aesthetically pleasing to the children.

SUMMARY OF IMPACT

The specialized chair tested well with the students. The repetitive movement, which can either be controlled automatically or manually, is useful in promoting an appropriate motion magnitude. The chair seems nonthreatening to the students. The instructors use the chair to help the classroom run more smoothly and without disruption and to help the students learn self-regulation.

TECHNICAL DESCRIPTION

The chair's motion is particularly important because the child needs to feel pressure at the forward and backward apex of the glide. The selected chair had joints that provided the desired motion. To drive the chair, a 1/17 horsepower gearmotor was selected after tests with a stronger 1/8 horsepower motor. The stronger motor did not produce fluid motion when forces like those a child produces were applied. The stronger motor also made more noise, which could create a distraction in the classroom setting.

An eccentric 5 lb weight with a 6" offset attaches to the motor. This provides the driving force. The approach requires that the frequency of the motor's rotation match the frequency of the chair's natural gliding motion. This is accomplished by running the motor with a variable DC controller that can slow down the speed to around 1.1-Hz. This method provides a safer mode of driving force and easier maintenance and repair than the other alternatives considered. This method also reacts well to disturbances during rocking. The housing of the chair itself provides a natural barrier so that children will not be exposed to the motor or weight. The ottoman, also fitted for gliding, needed rigid but adjustable attachment to the chair. It was decided that this was the safest strategy for movement while also providing consistent and smooth motion.

Fig. 12.17. Motorized Gliding Chair.

The teachers designated a specific isolated area for the chair to be placed. After safety testing and implementation, the chair became available to students who are over-stimulated and it did not cause a distraction to others in the classroom.

Total cost of the chair was approximately $500.

Fig. 12.18. Chair Demo and Motor Control Switch.

CUSTOM WORKSTATION

Designers: Stephanie Fiebrink, David Lipps, David Simon, and David Welch
Client Coordinators: Ronald Anderson, PhD and Darryl Overby, PhD
Supervising Professor: David A. Rice
Department of Biomedical Engineering
Tulane University,
New Orleans, LA 70118

INTRODUCTION

A custom workstation was designed for a woman who has polio. She has only limited use of her left arm and uses a wheelchair. It is difficult for her to use a regular desk because she is limited in her ability to reach and regular desks do not accommodate to the shape of her powerchair. She needed a workstation so that she can be self-sufficient. She requested: 1) support for a keyboard and mouse accessible from her chair; 2) tissue storage at a reachable location; 3) file storage accessible from the top of the desk; 4) a place for her respirator and hose; 5) storage space; and6) other accessible organization units.

SUMMARY OF IMPACT

This project improved the client's work life. She no longer has to rely on her business partner to do simple things for her, from getting her a tissue to getting her files. She now has easy access to a keyboard and mouse as well as her files. She is able to store ordinary desk items such as pens and a checkbook, accessing them as necessary.

TECHNICAL DESCRIPTION

This workstation (see Fig. 12.19) is composed of three units, arranged in an L-shape. The first unit, the main portion of the workstation, is at an appropriate height for the client to fit her wheelchair under the desk. There is a cutout in the left corner for her wheelchair joystick to maneuver under the front of the desk. The second and third pieces are located to the left of the first unit. A shelf is located under each of these pieces, one specifically for the client's respirator. There are nylon clips attached to the side of the unit to keep the hose in place. Both the second and third pieces also contain a section of the top that slides back to expose hanging file storage. On top of each sliding piece is an organizer tray with removable dividers. All three pieces are equipped with adjustable feet to customize the height of each piece according to the client's desires.

The total cost of this project was $338.

Fig. 12.19. Custom-Built Workstation.

PUTT-PUTT PUTTER

Designers: Brandy Alvarez, Bryan Bell, and Selma Hokenek
Client Coordinator: Erich Sollenberger, BSW, MED, Grace King High School, Metairie, LA
Supervising Professor: David A. Rice
Department of Biomedical Engineering
Tulane University,
New Orleans, LA 70118

INTRODUCTION

An instructor at a local high school coordinated the construction of a special putt-putt course designed to be used by students who have disabilities and use wheelchairs. He requested that a putter be designed and constructed to enable the students of the high school to putt a ball at the push of a button. With the device, the students can aim the ball with the aid of pushbutton controlled laser attachments, and can putt the ball with another pushbutton. Alternate jacks allow for other control mechanisms to be used, such as sip-and-puff switches. The device is designed to rewind automatically after a putt, so no adjustment or further control is needed after a swing. With this device, a wheelchair user can play a round of putt-putt golf on the course with as little assistance as possible.

SUMMARY OF IMPACT

The putter was designed to provide students with a reliable mechanism with which they could play alongside their peers. A critical design point was to have the putter system itself swing, rather than to depend on wheelchair motion to strike the ball. With this device, the students can play a round of putt-putt with minimal assistance on the specialized course.

TECHNICAL DESCRIPTION

The putter system consists of two main pieces: the backboard and the cross bar (see Fig. 12.20). All moving parts are attached to the backboard. The putter is made of fiberglass and the shaft has been bored to allow for a ¼" shoulder screw to securely attach it to the board. This connection allows the putter to freely pivot during the swing. A second hole was bored in the shaft to allow an aircraft cable to pass through. A catch on the aircraft cable moves the putter when the cable is wound up by motor. Springs keep the aircraft cable taut at all times. As the putter is moved into a ready state, a catch system locks the putter in place. The cable is then automatically unwound to its initial state to allow for the putter to freely swing. The catch system is released by activating a solenoid attached to the catch. All moving parts are housed in a wooden frame with clear acrylic cover.

Fig. 12.20. Side View of Putter.

The cross bar rests on the arms of the wheelchair secured by adjustable straps. The control system and battery are located on the cross bar and are housed in respective project boxes. The battery weight balances the putter mechanism on the wheelchair. The control system consists of a master key switch for security, on or off switch with activation LED for putter power (see Fig. 12.21). A momentary contact pushbutton activates the lasers.

Two crossed lasers are used so that the proper elevation of the putter can be readily established when it is mounted onto a wheelchair. The lasers also provide a marker for aligning the putter relative to the ball. The push of the "fire" button initiates the swing as well as an automatic rewind and clock of the putter. A dashpot snubber slows the putter at the end of its stroke. Positioning the putter so that it hits the ball during this deceleration phase enables the player to control the strength of the putt.

The laser and fire controls are equipped with attachments for other control mechanisms, such as sip-and-puff or pedal switches. The system is composed of three relays, a 12-V battery with charger, and 5A fuse for protection.

The cost of the putter system was about $300.

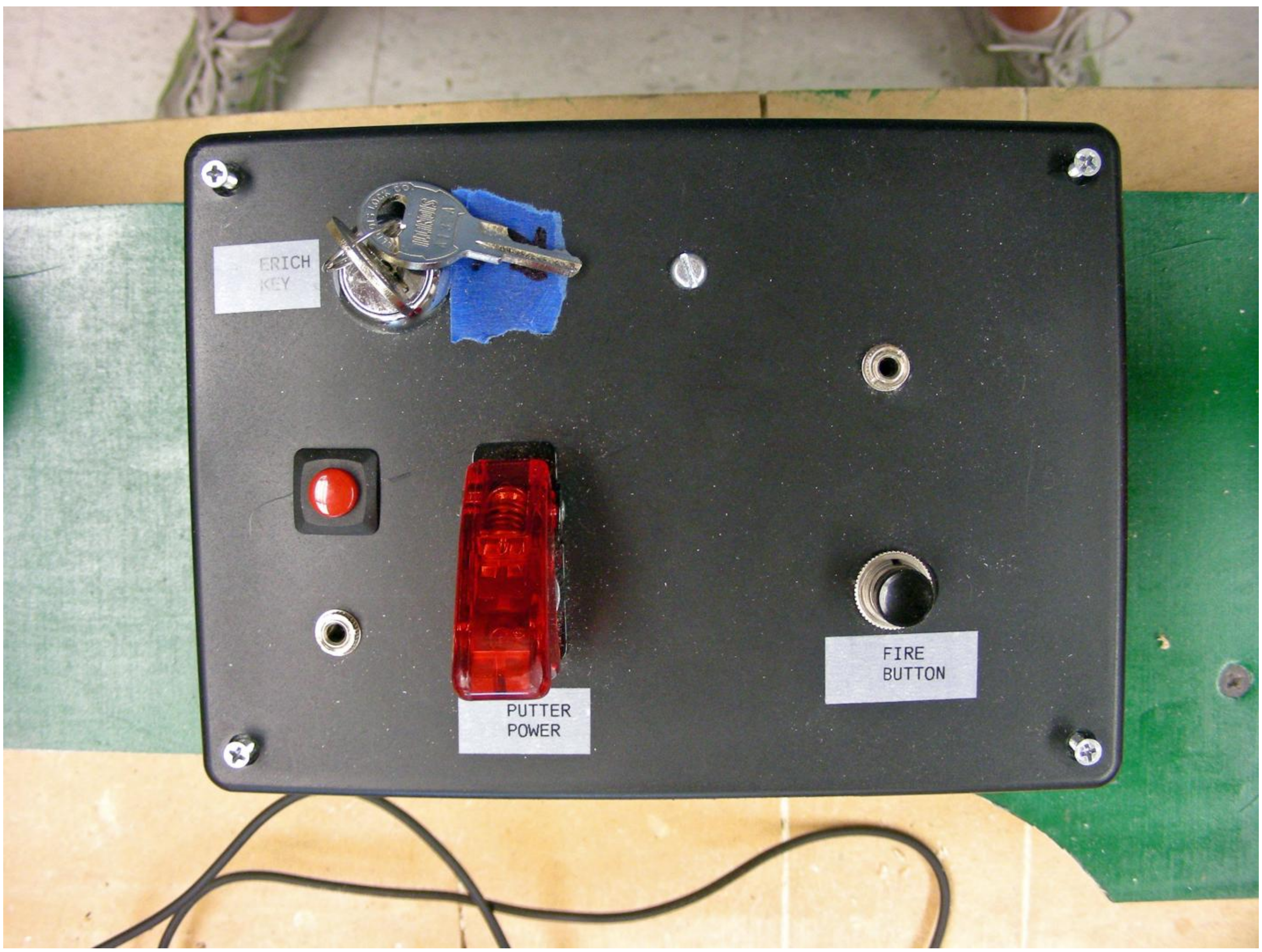

Fig. 12.21. Control Panel.