NATIONAL SCIENCE FOUNDATION
2003
ENGINEERING SENIOR DESIGN
PROJECTS TO AID PERSONS WITH
DISABILITIES

Edited By
John D. Enderle and Brooke Hallowell
HEIGHT ADJUSTABLE STANDING TABLE

Designers: Chris Burneka and Maria Kahle
Client Coordinator: Jane Swickard, United Rehabilitation Services, Dayton, OH
Supervising Professor: Dr. David Reynolds
Biomedical, Industrial and Human Factors Engineering Department
Wright State University
Dayton, OH 45435-0001

INTRODUCTION
The design is a device for children with a wide variety of disabilities that aids in the process of standing. The children’s ages range from six to 10, and the design accommodates a classroom of approximately eight to 10 students. Nearly all of the children use a wheelchair but still have minimal motor function in the lower portion of their bodies. The apparatus constructed provides necessary supports to the knee joint, hip joint, and ankle. All three supports are adjustable in order to accommodate the dimensions of each individual child. The supports are designed according to the type of body joint and are constructed out of safe, durable, and low maintenance material. The table attached to the apparatus allows the child to participate in regular classroom activity. It is also adjustable for the child’s individual height. In addition, the apparatus contains a foot platform that restricts the movement of the feet and provides a comfortable standing position. Since multiple students use the apparatus, it was designed to be lightweight allowing for easy transportation between classrooms. By creating a height adjustable table, the device helps prevent muscle atrophy, increases muscle stability and provides a stable classroom environment.

SUMMARY OF IMPACT
All the required design specifications were satisfied. The client was satisfied with the results.

TECHNICAL DESCRIPTION
The project consists of five parts. The first part is the base structure of the apparatus. It is comprised completely out of 70/75 extruded aluminum and sheet aluminum. The two by two extruded aluminum with 1/8 inch walls is structured in a 30 by 48 inch L-frame containing two more cross bars with a length of 26 inches each. Off the front brace bar of the L-frame another two by two aluminum tube 30 inches long is extended upward. A second piece of 70/75 extruded aluminum but with dimensions of 1 ¾ by 1 ¾ inches with a 1/8 inch wall and 20 inches long is telescoped into the 30 inch long extended piece. After shaving 1/32 inch off the sides of the 20 inch telescoping portion, it slides with ease and little play similar to a telescope. Nine corresponding 17/32 inch holes are drilled 2 ½ inches apart through both pieces. This creates the holes for the adjustment of the table and the support systems. At the top of the telescoping portion, a 20 by 10 sheet of aluminum is welded perpendicular allowing for the attachment of the table. Another
A piece of sheet aluminum 30 by 28 inches is attached to the \([\prod]\)-frame across the cross bars. It is positioned flush with the first 26 inch extruded aluminum cross bars. This makes it possible to attach the foot platform and make angle adjustments using a wedge. Also, it adds stability and safety to the design by increasing the amount of surface area. All the aluminum pieces are welded together with TIG welds. In addition to the strength of the welding, gussets are added to the two by two extruded aluminum telescoping piece and to the sheet aluminum for the table. Each contains three gussets. The gussets eliminate most of the stress and strain of the telescoping portion. Two stationary and two swivel locking casters are attached with bolts to allow for the transportation of the apparatus. Due to the design and materials used for the base structure, it gives a strong, safe, and transportable foundation to build upon.

The second part is the foot platform. The foot platform is constructed out of poplar wood with dimensions of 12 by 18 inches at one inch thickness. On top of the platform, square wood rails are fixed at the toe and heel. These two rails keep the child’s feet from slipping off the platform. The foot platform also contains two side square wood rails that are adjustable. Pegs are attached to the rails and three sets of holes are drilled into the platform. This adjustability enables a snug fit around the foot. It also keeps the child’s foot straight. In addition to the rails, a pad is fixed in the center of the platform. The pad’s main purpose is to sustain the child in a proper stature. When the feet are shoulder width apart, it allows the reaction forces on the ankle joints to be reduced. The pad is constructed out of four by nine inch plywood with a four inch thick polyprothene foam piece attached to it. The pad is upholstered with a vinyl fabric. The assembled platform is attached to the aluminum sheet metal of the base by a piano hinge on the front section. This type of arrangement allows a wedge (18 by one inch
at one inch thickness) to be inserted under the platform. The purpose of the designed wedge is to accommodate children with tension stress ankles. The foot platform is designed to adjust for different foot widths, maintain proper stature, and relieve stress on the ankle. All three purposes will help the child increase muscular strength around the ankle region.

The third part of the apparatus is the knee support. The main structure of the knee support is an aluminum bi-bended sheet with dimensions of 26 by four inches with 1/8 inch thickness. Two bends are made four inches from both ends. This creates a rigid U shape structure. The longer portion of the U-shape aluminum sheet serves as an attachment point for the front knee pad. The knee pad is assembled by a piece of plywood 26 by four inches and a four inch thick foam pad. The piece was then upholstered with a vinyl fabric. The shorter ends of the U-shape aluminum sheet serve as the attachment area of side support pads. The side support pads are constructed in the same manner as the knees support but contained the smaller dimensions of 8 by 4 inches. The side supports also allow for adjustment by the insertion of spacers. The spacers are light weight polystyrene blocks of both two and three inch thicknesses with the dimensions of six by four inches. The spacers are covered with black industrial tape. The side support pads and spacers both contain industrial strength Velcro for easy attachment to the aluminum. The whole knee support is attached to a six inch piece of two by two inch extruded aluminum which in turn is attached to two aluminum sliding rails. The two aluminum sliding rails fit snug around the telescoping portion of the base structure. With a corresponding hole drilled through the sliders, the knee support is easily adjusted using a pin. The knee support offers the children a chance to strengthen their leg muscles with the additive safety support at the joint. It also offers safety by restricting the outward movement of knees.

The next part of the apparatus is similar to the knee support. The hip support contains the same bi-bended aluminum sheet, the same dimensional front hip pad as the knee pad, and the same adjustment system. The difference is found in the side supports which are 16 by four inches. Since the hip support must contain a back pad support which is 28 by four inches, a notch system was needed for adjustment. The side supports are constructed out to polypropylene plastic sides that contained three notches. The polypropylene sides also contain Velcro for the attachment of spacers and side pads. The back support pad made out of plywood contains one set notches that fit secure with in the side support notches. The back support also contains foam padding upholstered in vinyl fabric. The hip support permits the operator to adjust the position of the child and arrange the appropriate padding. It also helps the lower back muscles to strengthen. The notch system enhances the safety factor by lowering the torque present on the support.

The final part is the table. The table is constructed out of poplar wood with dimensions of 24 by 18 inches. It is designed to resemble a high chair with elbow rest. The elbow rest provides an area for the child to rest a portion of their upper body weight. The table is stained and coated with polyurethane to create a hard smooth surface. The table also contains three ridges on the front and one on each side to set writing utensils and/or stop toys from rolling off. The table also comes with a chalk board insert that sits on top of the table. The table is bolted on to the top of the aluminum sheet attached to the telescoping portion of the base structure. This supplies the table with a secure attachment providing a safe and weight bearing feature. The table also encourages the child to use their back muscles to support themselves. Overall the design of the apparatus offers safety while developing the child’s muscle strength.

Certain safety considerations were taken while designing the apparatus. Maximum support is applied to the main body joints: ankle, knee, and hip. Another safety factor considered was the tipping of the apparatus. The design balances the weight of the apparatus by making the child in the center of the apparatus the weight focus. Other safety considerations were taken with the construction of the pads making sure the child had enough padding to reduce pressure sores. The edges of the apparatus are coated with plastic to ensure the safety of children around the apparatus. Along with safety, reliability of the apparatus was considered. The material was chosen to withstand the wear and tear that the child may cause. The apparatus is designed to last several years without replacement of any parts.

The total cost of parts and labor was $660.
Figure 22.3. Triple Knee Support.

Figure 22.4. Quadruple Hip Support.
INTRODUCTION
A client agency was in need of a device to aid its clientele in a simple sorting task. The sorting task was being performed manually in a piece-by-piece approach. The drawbacks of the manual method were loss of wages and lack of time efficiency, due to fact that the clients possess fine motor disabilities. The device was required to function such that a decision was required by the user when performing the sorting task.

To aid in the effectiveness of these clients, an electro-mechanical sorting machine has been designed. The system is comprised of a hopper and a conveyor belt. The hopper is a gumball machine that has been altered to dispense objects onto the conveyor belt. The user activates a mushroom button switch, causing the gumball machine to dispense one object. The conveyor belt is driven by an adjustable speed motor operated by a potentiometer. There are three sorting bins placed alongside the conveyor belt. Each sorting bin has its own lever-arm, operated by a reversible motor. The lever-arms are activated by a matrix of mushroom buttons. The user presses an appropriate button and the lever-arm rotates into place, causing the object to be redirected into the bin. It is important to note that the design requires decision-making of the client.

SUMMARY OF IMPACT
The design team was successful in meeting all of the requirements for the sorting machine. The product increases the efficiency and also requires decision-making by the user. The feedback received from the client coordinator and users of the machine indicated that all were satisfied with the function and usability of the device.

TECHNICAL DESCRIPTION
The conveyor belt system is driven by a 50 RPM, twelve volt DC Dayton geared motor, inline with one spindle. It is approximately four feet-six and a half inches long and six inches wide. The spindles are five and a half inches in diameter. One spindle is driven and one is slave. The belt is supported by two aluminum plates and P4000 series Unistrut. Along one side of the conveyor belt is a six-inch by six-inch by 48 inch cable trough that runs the length of the belt. This trough provided a location to securely mount all of the motors and house the circuitry. The material used for the belt is canvas. Canvas provides the amount of friction between the oak spindles and also provides durability. The power for the conveyor belt is supplied by a regulated twelve volt DC power supply. It is used for the entire system.

The arm mechanisms are driven by an 8.75 RPM, twelve volt DC motors. The arms are ten inches by one-inch by a half-inch. Double pole double throw (DPDT) latching relays are incorporated to power and reverse the motors. This process is very similar to the method by which a garage door opener works. Upon a button being pressed the motor continues to run until a limit switch is hit. This limit switch cuts the negative side of the motor and drops power. Once the reset button is pressed, the motor reverses until it comes into contact with the rear
limit switch which drops power to the motor in a similar fashion as before.

The arm motors are reversed by the control of only two buttons, the arm button and the D/R Button. The actual circuit includes three-arm motors and a dispensing motor all controlled in similar fashions. Any intersection of two wires without a node dot is simply two wires crossing one another. By energizing the A coil, the contacts move to the A side. This creates a potential difference between the two common leads. The motor receives power until the forward limit switch is pressed and the negative side is broken, cutting power. Once the B coil is energized, the contacts are moved to the B side, reversing the polarity on the common terminals of the relay and reversing the direction of the motor until the reverse limit switch is activated. The buttons are heavy-duty sixty mm/2.25-inch momentary mushroom buttons.

The buttons themselves are not attached permanently to the device. They are mounted in four; four-by-four junction boxes, which are screwed together. This creates a control panel that is attached to the device by a removable lanyard. The lanyard is created by the use of snake skin. In doing this, the user may operate the machine from the safety of their wheel chair, while well removed from the danger of any moving parts. The buttons are color coded for easier use of the machine. The dispensing button is black, and contrasting the black button is a white sticker on top. The other three buttons are red, yellow, and green. These coordinate with the three lever-arms.

The hopper for the design is an adapted gumball machine. The hand crank that typically operates the machine is replaced with a fifty RPM, twelve volt DC Dayton geared motor. The circuitry involved in providing one full rotation of the nine pin gearwheel is a simple 555 timer IC along with a debouncing circuit. The circuit provides a 760 ms time pulse, which allows for the rotation to produce one gumball out of the hopper upon each depression of the dispensing/reset button. The bottom of the machine was removed, where the gumballs typically rest after being dispensed. This allows the objects to fall directly onto the conveyor belt with no added kinetic energy. The machine sits on a wooden shelf, constructed for elevating the hopper over the conveyor belt. The gumball machines are made for distributing any type of candy and the removable sifting plate will allow a user to change the size of the object they distribute.

Some of the safety considerations involved are the use of a conveyor belt and the electrical components. The design of a lanyard was produced to prevent fingers from becoming pinched if they had interaction too close to the machine. The lanyard itself is four feet in length. The user is never closer than four feet from the system. The electronic components are incased in an electric trough and the voltage used is twelve volt DC. This voltage is quite safe for humans.

The total cost of parts and labor was $810.

![Figure 22.6. DPDT Latching Relays for Controlling Arm Mechanisms.](image)
COMMUNICATION LEARNING PROGRAM

Designers: Kimberly Fowler, Faridal Mutalib, and Erin Tewksbury
Client Coordinator: Marilyn LaRocco, Gorman Elementary School, Dayton, OH
Supervising Professor: Dr. Thomas Hangartner
Biomedical, Industrial and Human Factors Engineering Department
Wright State University
Dayton, OH 45435-0001

INTRODUCTION

Communication plays a key role in allowing individuals with disabilities to achieve the greatest degree of independence. All of the children in the client’s classroom have some degree of language impairment, and three students are nonverbal. In the classroom, cards featuring Mayer Johnson Inc.’s Picture Communication Symbols (PCS) are used to help develop communication skills. With thousands of pictures available in numerous languages, the PCS symbols provide a universal communication system.

The COMLED AV and Communication Learning Program constitutes an integrated package of both hardware and software elements that form a computer-based communication learning device designed to help 10- to 12-year-old children with disabilities practice valuable communication skills, such as picture identification and telephone usage. Because many of these children are nonverbal, the software features a library of Picture Communication Symbols (PCS) developed by Mayer-Johnson, Inc. The program allows a teacher to choose four or 16 PCS symbols to display on the computer screen. She may then input a target answer using the computer keyboard. After the teacher poses a question, students may select an answer from the displayed symbols using either one or two button switches, depending upon their physical abilities. The computer then provides both audio and visual feedback based upon the student’s answer. Additionally, the device features an actual telephone for practicing telephone usage; however the button switches are also functional in this mode. As with the picture identification mode, the teacher inputs the correct telephone number via the computer keyboard, and the computer then provides feedback based on the student’s input.

SUMMARY OF IMPACT

The client requested a device that would give her class a fun way to distinguish pictures used in communication. The COMLED AV and the Communication Learning Program fulfilled all of the required needs. After a two-week evaluation period, the client stated, “The students designed a program that will be an effective tool in my classroom. They assessed the special needs of my students and creatively used switches they were familiar with. Thanks for a terrific project.”

TECHNICAL DESCRIPTION

The COMLED AV black box allows the input devices, the jellybean button switches and the telephone to interface with the computer. The button switches are connected to the COMLED AV box via monoplug cables, while the telephone is connected using a standard telephone cord. This design provides additional protection for the circuitry; if a cable is accidentally pulled, it will simply detach from the black box without harming the internal circuitry. The box houses a touch-tone
decoder circuit and a BASIC Stamp 2, together which perform the tasks necessary to integrate the input devices with the Communication Learning Program software.

In order for the telephone to produce actual touch-tones and still be used as an input device, a touch-tone decoder circuit is necessary. For this purpose, the Ramsey Electronics TT-7 has been chosen. This circuit demodulates and identifies the tones produced by the telephone. The circuit has twelve individual output pins, one for each touch-tone, that are held high at 5V; when its corresponding button is pressed on the telephone, a particular pin drops to 0V. Additionally, the circuit features a trigger pin that increases from 0V to 5V when any tone is generated by the telephone.

At the heart of the COMLED AV box lays the Parallax BASIC Stamp 2 (BS2). Powered by the 9V AC adapter that also supplies power to the telephone, this microcontroller contains an internal 5V voltage regulator, which, in turn, is used to supply power to the touch-tone decoder and Jellybean button switches. The BS2 serves to generate ASCII output based upon the telephone button or jellybean button pressed. The Communication Learning Program software uses this ASCII output. The BS2 contains sixteen input pins, fifteen of which are utilized. Twelve pins are connected to the output pins of the TT-7, one pin is connected to the TT-7 trigger pin, and two pins are connected to the jellybean button switches. Using PBASIC, the BS2 is programmed to continually monitor the TT-7 trigger and Jellybean button input pins. If the BS2 detects a signal from the TT-7 trigger pin, it then scans the remaining input pins to determine which number was pressed. The corresponding ASCII code is then transmitted to the serial port of the computer via the RS-232 cable. If the BS2 detects a signal from the jellybean button switches, the appropriate ASCII code is transmitted to the serial port of the computer. In either case, the program then resumes monitoring the three previously mentioned input pins immediately after outputting the appropriate ASCII code.

The Communication Learning Program is written in Visual Basic version 6.0. The design of the program consists of nine different forms. Of these nine forms, only seven are considered important and essential to the program. Of these seven forms, two are associated with the 4-picture mode, two with the 16-picture mode, and the remaining three with the telephone mode. The other two forms are the simplified manual and the splash screen. The program then can be divided into three different modes: the four-picture mode, the 16-picture mode, and the telephone mode.

Seven folders are included on the Communication Learning Program CD. The folder with the program in it is entitled COMLED. This folder is the only one necessary to run the program. To install the program, the teacher must simply copy the entire COMLED folder onto the C:\ directory of the computer. The teacher then can execute the program by clicking the executable file inside the COMLED folder. No pictures need to be added if the teacher is content with her choice of 626 pictures. Also included on the CD are the picture library, the Companion Metafile program, and Universe font. These folders are used in the process of adding new pictures to the program. Source code and the PBASIC editor and code have been included in case any modifications need to be made. Finally, an electronic version of the manual is provided in the CD.

The total cost of parts and labor is $565.
INTRODUCTION
The client coordinator from a school requested that a toy garage be redesigned so that students with disabilities may play with it. The students range from four to six years old and have a combination of cognitive and physical disabilities. The resulting device is a garage with push button activation of the doors which allows for easy operation by a variety of students. At the bottom of the ramps, there is a circular track for the cars so that they do not roll off the table. The entire unit is designed so that the structure and any free parts are contained within a small area. Some students exhibit aggressive behavior, so the designed toy is sturdy with durable parts. The toy garage leads to increased stimulation and fine motor learning for the children in the classroom.

SUMMARY OF IMPACT
All design goals were achieved. The client was satisfied with the resulting design and function of the toy garage. Testing of the toy garage with a four-year-old child confirmed the design was durable enough and simple enough for young children to operate. The subject thoroughly enjoyed herself while playing with the toy. The toy garage brought

Figure 22.9. Toy Garage in Use.
stimulation and enjoyment to the targeted audience of young children with disabilities.

TECHNICAL DESCRIPTION
This toy is operated from a Basic Stamp Board of Education microprocessor. When the child presses the switch the microchip is activated and the double doors open. The interior of the garage is arranged with an angled ramp so that the car rolls smoothly out of the garage. The car then rolls down the ramp and come to a stop within the pen area. Once it rolls out of the garage, the Basic Stamp is programmed so that the doors will automatically close. If the child wishes to play with the car and garage again, all they have to do is lift the car and place it in the slot carved into the garage’s top surface, and the cycle starts over again.

The Basic Stamp microprocessor is placed between the inner walls of the two garage units. Its dimensions are as follows: height: 3.25 inches, width: 4.5 inches, depth: one inch. The Basic Stamp is selected to simplify the circuit design and provide the servo with a set number of pulses required in opening and closing the doors. When the switch is activated, the Stamp sends out a set number of pulses to the servo with a value corresponding to a location preset within the servo. Once the door reaches its complete open position, the servo pauses and then sends a series of pulses in the same manner as the opening routine which closes the doors.

The garage is constructed from MDF, oak wood, and balsa wood and the ramps are made out of plastic. The dimensions of the entire unit are as follows: height: 1’ 7 ¼ inch, width: two feet, depth: two feet.

There are three main engineering principles applied to this design. First, using the servo mechanism is a mechanical decision made after considering the angle at which the doors open. In the design, the radius of movement of the servo control arms and the connecting piece on the doors was considered. Using the foot switch interface is an electrical application. Within the input pins on the Basic Stamp, there is a 400 mV floating voltage. In order for the program to work correctly, a 1KΩ resistor is added. Finally, programming the Basic Stamp microprocessor enables further development of the design team’s computer programming skills and the opportunity to learn a new programming language.

Given that children would be operating the toy, safety is a major consideration. Even though wood is used in the construction of the product, there is no splintering due to its finish. Also, the speed at which the doors open is not fast enough to injure someone.

The reliability of the product is also a major consideration. The children operating this toy are rough and aggressive in their play habits. The toy is built to be sturdy and durable, with all the electrical components covered.

The total cost of parts and labor is $735.
INTEGRATED EMERGENCY ALARM SYSTEM

Designers: Michael Kahelin and Christian Stray
Client Coordinator: Jane Swickard, United Rehabilitation Services, Dayton, OH
Supervising Professor: Dr. Chandler Phillips
Biomedical, Industrial and Human Factors Engineering Department
Wright State University
Dayton, OH 45435-0001

INTRODUCTION
A client agency requested an improved design for their panic alarm system. This system consists of four alarm activators with corresponding alarm indicators. The problem arose from the fact that the indicators are only effective in a small vicinity. There are often only a few people in the building to respond to an emergency, and the previous alarm system did not reach enough of the building to notify help. The objective was to design alarm indicator banks that can be placed at strategic locations around the building to notify help during emergencies.

The solution consists of the four alarm activators which are wired to a hub. From the hub, the alarm activator wires are split four ways and run to each of four indicator banks. These banks have five lights on each of them and two different sounds. Four of the lights indicate alarms for each of the four corresponding areas and the fifth light is room for expansion should they install an alarm in a different location. The system is also equipped with a power alarm which sounds if the in-wall transformers are unplugged. This power alarm is based around a 555 timer. This design will help staff respond more quickly to emergencies.

SUMMARY OF IMPACT
The design has met all the requirements of the client. The coverage area of the system was almost doubled. In addition to a larger coverage area, a more strategic placement of the indicators increased the probability that a staff member would be alerted to an emergency. Upon evaluation, the client noted, “[the] system will be a real asset and greatly enhance safety”.

TECHNICAL DESCRIPTION
The four alarm indicator banks that are installed are 298 millimeter cylinders with a 40 millimeter diameter. They are mounted via three mounting bolts. These are bolted to the drop ceiling supports. The units weigh 0.34 kilograms and consume 3.9W of power. The driving circuit (transistor switches) and power failure alarm are housed in six by four by two inch PVC boxes. The activator buttons are connected to the hub with 22 AWG wire and the hub is connected to the indicators via 28 AWG telephone wire. The system’s function is very passive from the user’s perspective in that there are no changes to the user’s normal routine to achieve the desired benefits.

The system has numerous safeguards incorporated into the design. First, the displays are fused at 1A. This ensures that if there is a short to ground, the fast-acting fuse will burn before the ceiling of the building. The system is transformed down to 24V to ensure that it would not have to tie into the 120V electrical system. Another safety and reliability consideration is the continued function of the...
existing system, independent of this design in the event of a system failure. Due to the fact that the existing system provides only enough current to switch the transistors, major current leakage is not an issue. Also, the existing system runs on about 400mA. If something were to go wrong, this relatively huge current would simply burn out the transistor and stop the short. The system is also very reliable due to the power failure alarm. If power is interrupted, the staff will be alerted and can plug it back in. In addition, the driving circuit and wiring is hidden above the drop ceiling. This greatly reduces the possibility of the unit becoming damaged, which contributes to the reliability.

Before installation of the system, the effective area of the existing system was analyzed. Effective area was defined by two criteria: direct line-of-sight to the indicators and minimum sound level of 70 dB. The reason this level was chosen was because 40 dB is considered the normal noise level for an office and for an alarm to be guaranteed to be heard, it should be 30 dB over the background noise. The total effective area of the original system was approximately 5022 square feet. After installation, the effective area was 10014 square feet. This was a 99.4% increase in effective area of the alarm system. Area was not the only consideration in assessing the effectiveness of the system. The placement of the new indicators was more effective than the old ones. One indicator was at a receptionist desk which was staffed continuously throughout the day. The other indicators were all in hallways, which were very high traffic areas, and were likely to attract attention.

The total cost of parts and labor was $980.

Figure 22.12. Circuit Schematic.
SENSORY STIMULATION STATION

Designers: Adrienne Bolds and Becky Ruskowski
Client Coordinator: Mandy Arnold, Five Points Elementary School
Supervising Professor: Dr. David Reynolds
Biomedical, Industrial and Human Factors Engineering Department
Wright State University
Dayton, OH 45435-0001

INTRODUCTION
A sensory stimulation station was built for children with disabilities to help encourage interaction, increase attention span, and provide entertainment during free time. The station needed to be constructed for easy mobility and transportation, and to be sturdy enough that the students did not cause the station to move at an inappropriate time.

The resulting device is the Sensory Stimulation Station for Students with Multiple Disabilities. The goal of the station is to stimulate as many of the five senses as possibly in a creative fashion. Tactile stimulation is incorporated by the use of various materials and switches. To integrate auditory and visual stimulation, a sequence of LEDs and music are used. Olfactory stimulation is achieved by a series of atomizers.

SUMMARY OF IMPACT
The final design is a child safe stimulation station in which a student can be entertained while stimulating his or her senses. The final product has components which stimulate four of the five senses (auditory, visual, olfactory, and tactile). The client coordinator is satisfied with the final product design. The students are able to use the station with no difficulty and are entertained while using it. The station is successful in attaining the main goal developed for the station, sensory stimulation.

Figure 22.13: Student Using the Sensory Stimulation Station.
TECHNICAL DESCRIPTION

The entire station consists of three box-like panels constructed out of plywood. The two side panels are each two by two feet and six inches thick. The middle panel is also six inches thick but is two by four feet. The back of the panels are attached to the front by a hinge on the bottom and Velcro along the top, making the inside components such as batteries for the electronic components and the scents of the atomizers easily accessible to the teacher. The legs of the station are constructed of metal and can be adjusted vertically from 17.5-25 inches. They contain a series of holes in which a button is latched to the desired height. The entire station is covered in blue felt to eliminate the chance of the student getting injured by the surface and edges of the plywood, and to increase attractiveness of the station for young students.

The right panel contains the black light and the 8-LED running light system. The black light and the running lights are operated by separate switches. The switches are similar in appearance and activate the desired component by pressing the switch. When the black light is triggered by the student, the beads begin to glow to induce a distinctive visual experience. The running lights are operated by the use of two separate buttons. When switch one (green oblong button) is pressed once it turns the LEDs on in a sequential fashion. If the switch is pressed again it causes several LEDs to light up at the same time at an increased fluctuation rate. The second switch (big blue button with a horn imprint) turns the system off. When the second button is pressed again it resets the system so that it can be repeated. The goal of this switch is to help the student learn the pattern required to produce the visual stimulation.

The middle panel contains the system of four atomizers and the tactile board. The ball for each atomizer is a relatively large ball that resembles a basketball; this is for the convenience of students with limited dexterity. By squeezing the ball the student releases a spray from the cap of the atomizer. The four different scents are rose, freesia, pear, and raspberry. It is hoped that the different scents will trigger various reactions in the student, eventually making a connection between the stimulus and response. To prevent the possibility of spray entering the student’s eyes the height of the atomizers was strategically placed above eye level. The tactile board has four different types of textures.

The total cost of parts and labor was $760.