CHAPTER 22
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AUDIO VISUAL TACTILE TIMER

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INTRODUCTION

The Audio Visual Tactile Timer is a redesign of an existing timer called the Time Timer. This project addresses teaching of concepts for time and time management. The previous product, while appropriate for simple, unchanging environments, did not have the flexibility or options to function effectively in a diverse classroom setting. The clients include a broad spectrum of students with autism, ADHD, ADD, language delay, and hearing and visual impairments. Based on the shortcomings of the Time Timer and lack of a good replacement, it was appropriate to redesign the product.

SUMMARY OF IMPACT

The utilization of the timer instills a greater comprehension level of elapsed time, which leads to more independence and effective use of time by students. The timer is appropriate for activities such as timed activities, time out, quiet time and time remaining for an activity.

TECHNICAL DESCRPTION

The engineering principles used during the design of this project include electrical analysis, mechanical/structural design, and ergonomic analysis. The circuit design (Figure 22.3) is driven by the Basic Stamp II microprocessor and a 6V, 0.85A precision stepper motor. To determine how the position of the clocks would be monitored, an RC circuit is implemented in conjunction with the Basic Stamp II, which provides both high resolution and the linearity necessary to accurately determine the position of the disks.

The peripherals such as lights, sounds, ticking, and vibrations are controlled through the use of transistors. All units incorporate LEDs to indicate power and operation of the timers. Due to the size constraints on the Tactile Timer, a circuit card was manufactured to ensure proper fit. Because of the similarity between the Main and Tactile circuitry, a duplicate card was also used in the Main Timer.

The Main Timer also provides a once per second ticking sound to indicate that time is passing. Reference bumps and the vibrating face of the Tactile Timer give feedback with regard to time passage and end of task to students with visual impairments. The Main and Tactile Timer face layout maintains the original design of a standard clock face to aid in teaching recognition of time. The Secondary Timer has a linear layout because of its

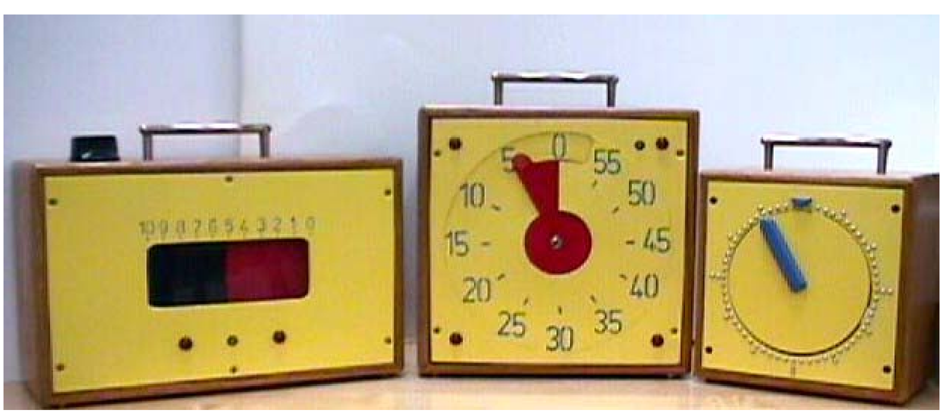

Figure 22.1. Secondary Unit, Main Unit and Tactile Unit – Front Views.

short time frame so as not to be confused with the layout of the other timers. (Figure 22.2)

The Main Timer (Figure 22.5) is used to time tasks for up to 55 minutes. It has multiple options to aid the teacher or other user in timing tasks.

This unit is constructed of ¾" red oak with a 6mm thick inset Celtec 700 PVC plastic face and back. The wood frame has been treated with a cherry stain and multiple polyurethane coats for durability. The PVC face and back were also painted with multiple paint and clear coat layers. The guide plastic and red disk in the timer face consists of 1/32 plastic sheet treated in the same fashion as the PVC faces. The face of the Main Timer has four end-of-task lights and a power light.

The Tactile Timer (Figure 22.6 and 22.7) can only be used in combination with the Main Timer. At the end of the task, a small motor causes the face of the timer to vibrate.

The case and faces match the Main Timer in both material selection and preparation process with the exception of the 1/32 plastic. This unit incorporates stainless steel balls as reference indicators for time. Stainless steel was chosen because of its resistance to oil and sweat from the hand, preventing corrosive effects.

The Secondary Timer (Figure 22.8 and 22.9) is intended to time shorter tasks. It has an upper limit

Figure 22.2. Two Students Using the Secondary Timer.

of 10 minutes. The Secondary Timer has a linear face so the students would not confuse the shorter time duration with the circular face of the Main Timer. The timer could be used for one or more students in a specific activity while the rest of the class uses the Main Timer for a different task.

The Secondary Timer case was manufactured in a similar fashion to the Main and Tactile Timers. There is an inset Plexiglas window on the front of the timer to prevent the students from touching the timer belt. The face of the timer has two end-of-task lights and one power light.

The total cost was $946.

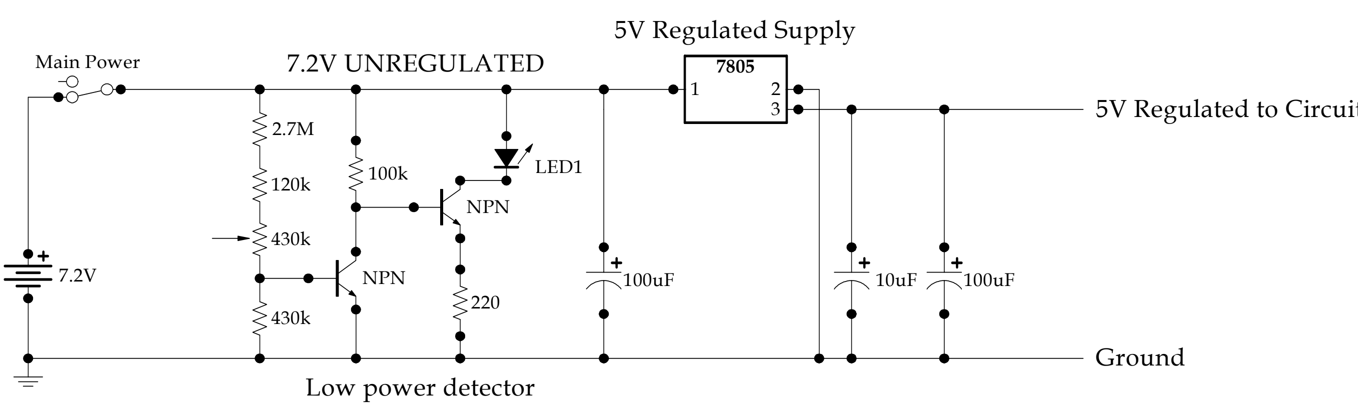

Figure 22.3. Power Supply Circuit.

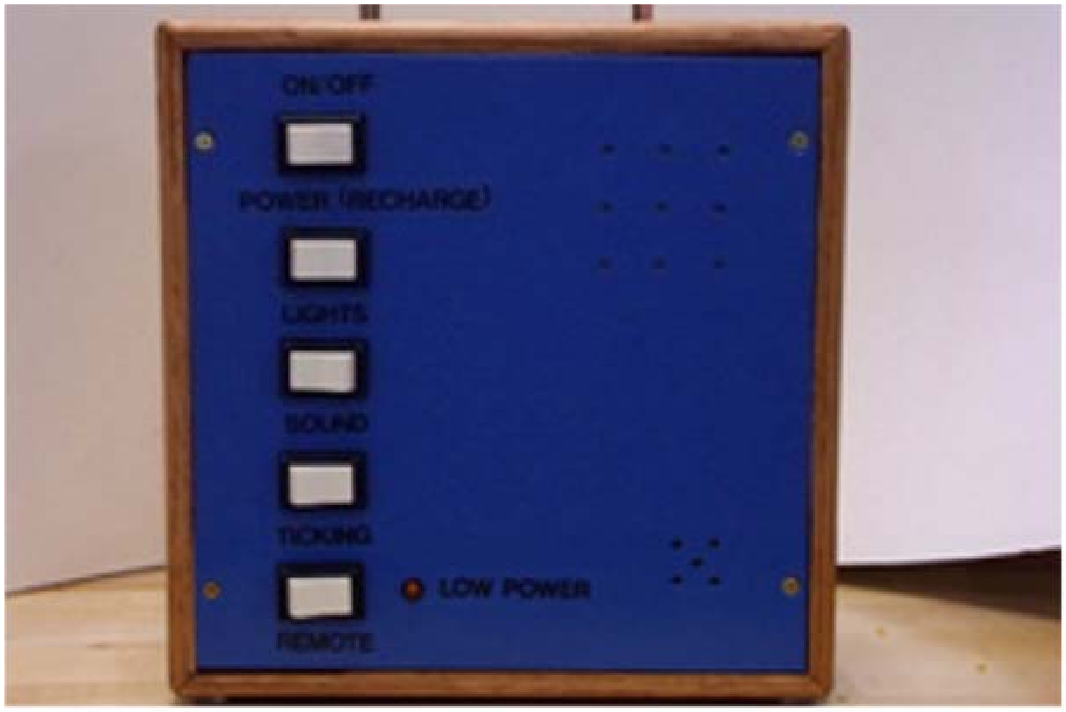

Figure 22.4. Face and Control Panel of the Main Timer.

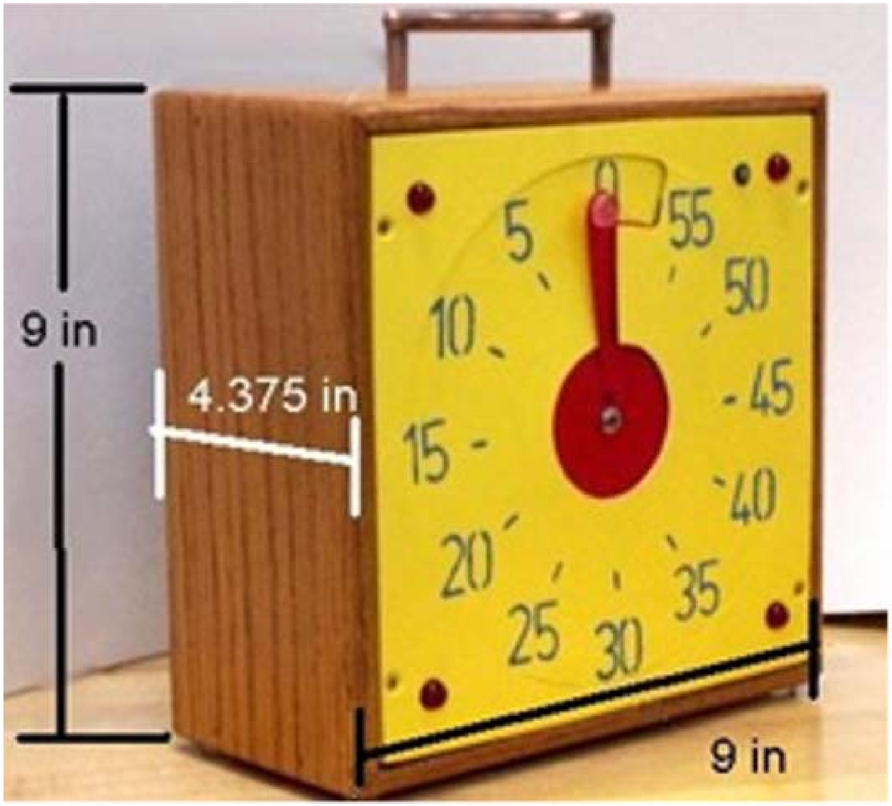

Figure 22.5. Dimensions of the Main Timer.

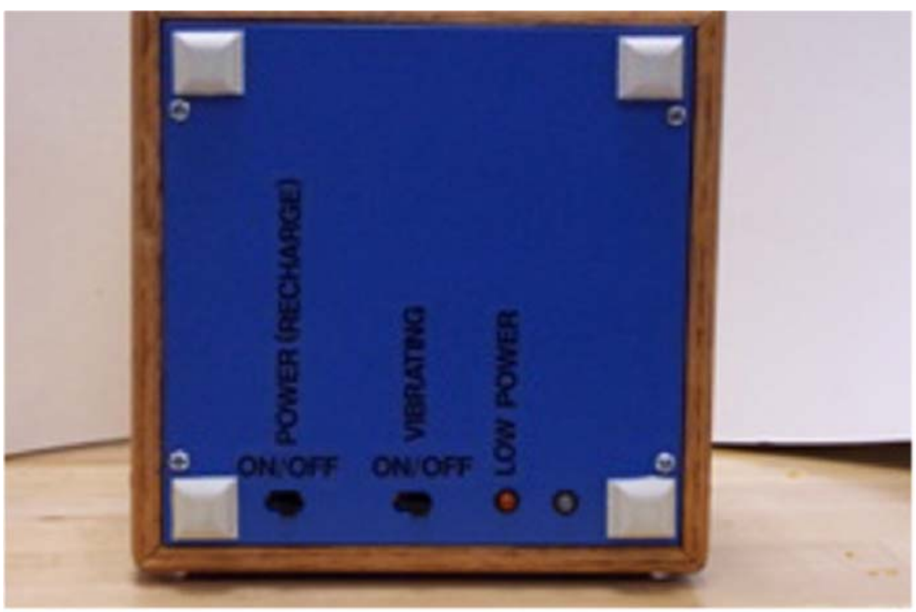

Figure 22.6. Face and Control Panel of the Tactile Timer.

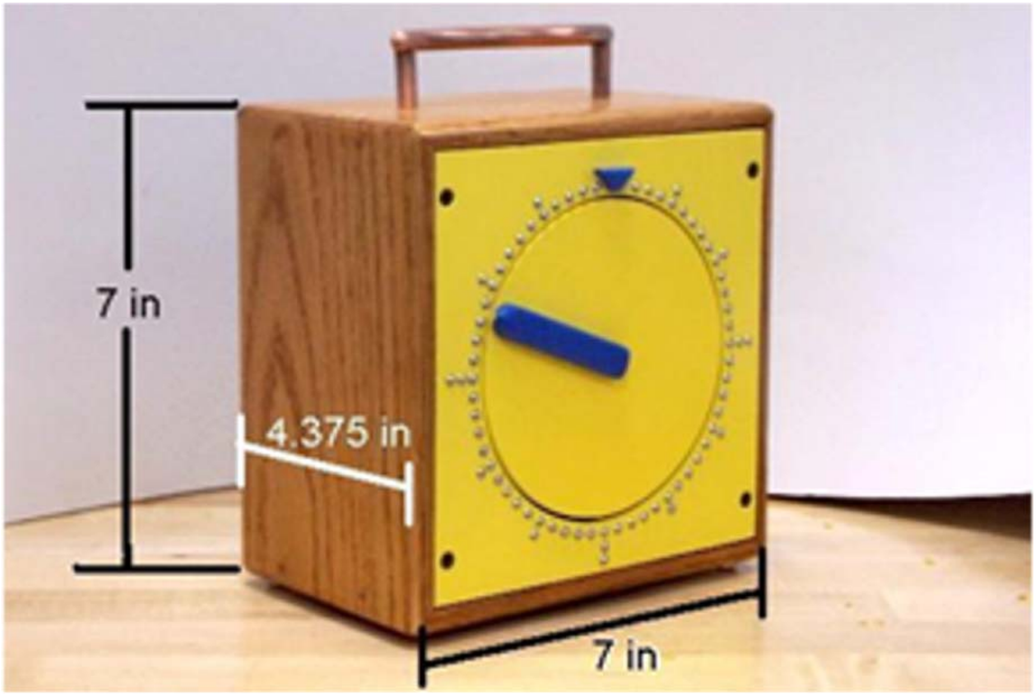

Figure 22.7. Dimensions of the Tactile Timer.

Figure 22.8. Face and Control Panel of the Secondary Timer.

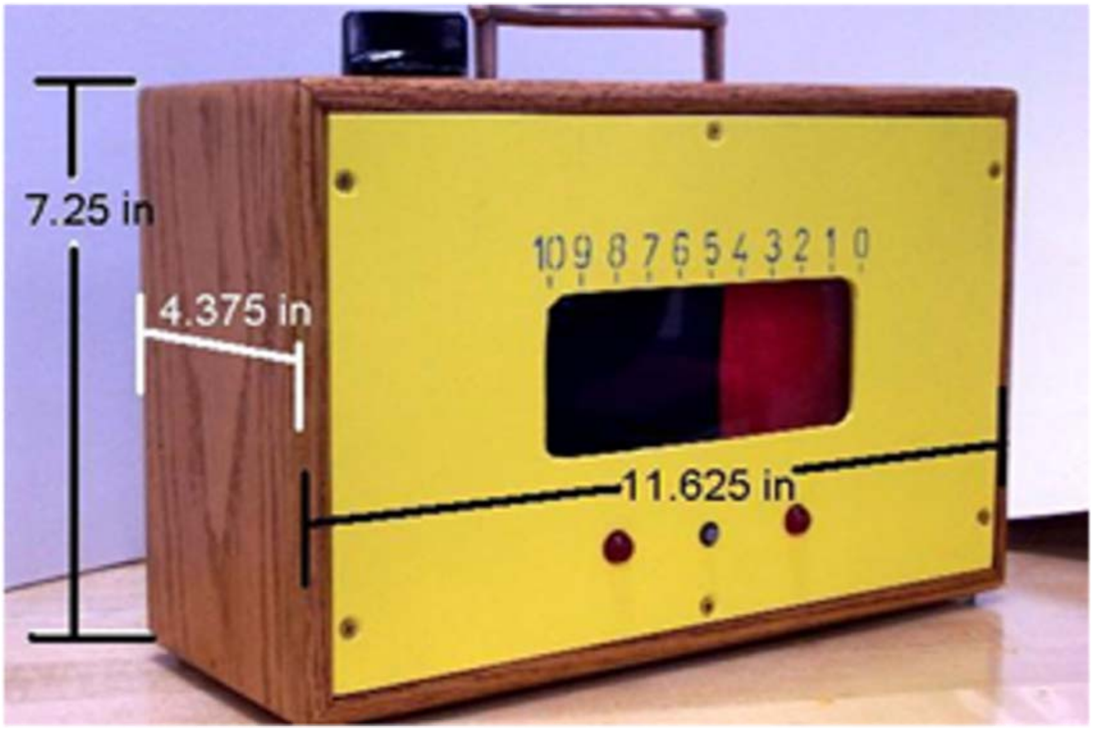

Figure 22.9. Dimensions of the Secondary Timer.

PEDESTRIAN CHILD HEADFORM

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VRTC Advisors: Roger Saul, Jason Stammen
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INTRODUCTION

The goal of this project was to design a child headform that will meet the revised specifications set by the International Harmonization Research Committee (IHRC). Presently, there is only general adult and child headform in existence. As a result of testing, the existing child headform has been determined to be inappropriate for a six-year-old child. This problem stems from an inaccurate moment of inertia. The goal was to design the headform with a realistic moment of inertia and a natural frequency that does not interfere with that of the accelerometer.

SUMMARY OF IMPACT

The significance of a pedestrian headform is to reduce the number and impact of injuries.

TECHNICAL DESCRIPTION

The order of importance for the design is mass, center of gravity, accelerometer placement at the center of mass, vibration characteristics, and moment of inertia (Figure 22.12).

The headform is being built by First Technologies Safety Systems (FTSS). The structural analysis is considered in the design of the headform because the aluminum shell can not fail or deform during repeated use of the headform. The aluminum shell is the main load bearing structure of the design. The structural integrity of this component was also analyzed using DesignSpace®. On average, the headform experiences about 330g at impact. To provide for extra integrity, the force applied to the impact end of the shell was over-estimated at 350g. This is equivalent to 12,000 N of force. The maximum amount of stress undergone was at the impact end of the shell and was approximately 19 MPa. In the design, the shell underneath the headskin is entirely aluminum and the cap, or base-plate, is steel. The accelerometer is mounted at the center of gravity and will see natural frequencies no higher than about 5000 Hz. This accelerometer is a tri-axial damped automotive accelerometer made by Entran®. (Figure 22.10)

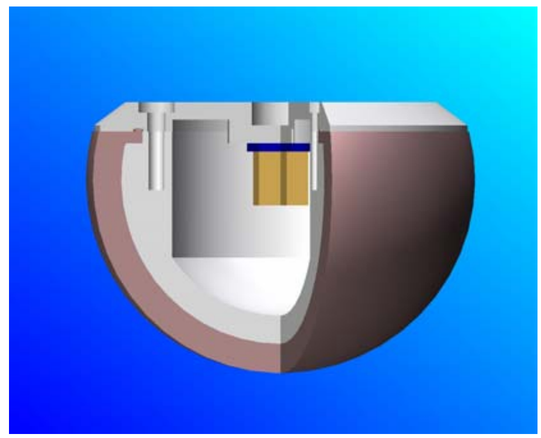

Figure 22.10. Headform Design Cutaway.

When evaluating pedestrian safety issues in car or pedestrian collisions (Figure 22.11), accident reconstructions can be done to evaluate damage done to the head. If the desired data is a result of only the head impact, accident reconstruction tests can be done, by setting up a headform and propelling it onto specific point locations of the

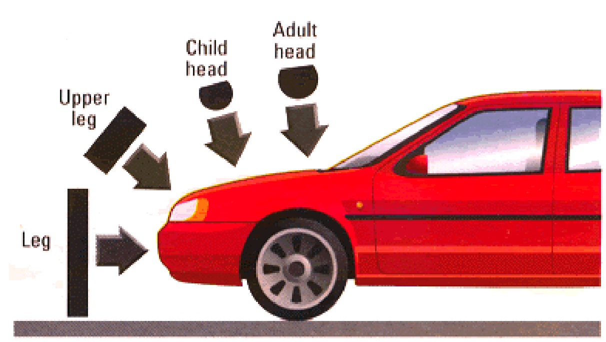

Figure 22.11. Pedestrian Collision Impact Areas.

vehicle.

These points, along with impact velocities and angles, are determined through computer simulations based on actual collision data. The headform is used to collect data that is then linked to actual pedestrian impact and injury data to create an index of impact severity to injury sustained, called Head Injury Criteria (HIC).

Specifically, the accelerations of the headform are recorded and the HIC are calculated using the following formula:

$$HIC = \int a(t)^{2.5}\, dt$$

The aim is then to use the HIC values to estimate relative injury that could be suffered from particular vehicle designs and provide guidelines for the surfaces of new cars to make them less injurious to pedestrians.

The total cost of the Pedestrian Child Headform is $700.73

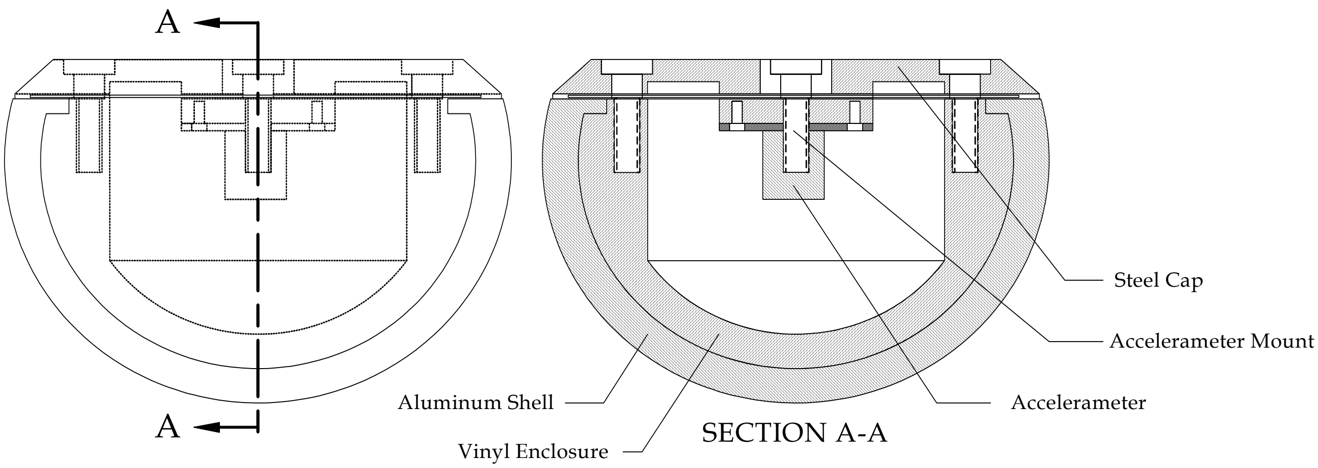

Figure 22.12. CAD drawing of Assembly.

EMERGENCY CALL BUTTON FOR A HYDROTHERAPY POOL ROOM

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INTRODUCTION

An Emergency Call Button was needed for a Hydrotherapy Pool Room. The previous call button was not easily accessible to therapists. Requirements and design constraints included the need for a lever with a pull cord attached to a loop, an audio and visual alarm, and poolside placement of the auxiliary actuator. The moist, highly chlorinated and warm environment presented design constraints related to corrosion and waterproofing.

SUMMARY OF IMPACT

In providing treatment to individuals with disabilities in the pool, therapists are in need of an effective alarm. This alarm will facilitate quality care to patients receiving therapy as therapists are now equipped to obtain water-trained personnel in an emergency. The audiovisual alarm is an alerting device that indicates to staff that an emergency is occurring in the hydrotherapy pool area. (Figure 22.13)

TECHNICAL DESCRIPTION

The testing procedures performed throughout this design project were static load testing on the human actuator interface, static load testing on the limit switch with the human actuator interface, and the measurement of voltage and current of the alarm system.

The human actuator interface is a pull cord allowing the user to actuate the auxiliary alarm system. The human actuator interface consists of a ring, break-away system, and a rope, all of which are resistive to the hydrotherapy pool environment.

The ring is a grasping device for the human actuator interface. The chosen ring for the final design is a rubber molded dog toy. The rubber molded dog toy is durable and is able to withstand applied forces in excess of 50 pounds. The ring is connected to the break-away system by looping the Velcro (Figure 22.14) around the ring. The break-away system is a safety feature designed into the human actuator interface. The break-away system is made from a hook-n-loop form of Velcro, which loops around the ring. The Velcro surfaces break away from each other at a force of twenty pounds per square inch. The break-away system is attached to the rope using repetitive stitching with mason twine and tightening the Velcro strap by wrapping the twine around the rope and Velcro combination.

Figure 22.13. User Demonstrating the Activation of the Auxiliary Alarm.

The electrical components of the system consist of a limit switch, a disconnect switch, an audiovisual alarm, and the existing system. The system is wired with twelve gauge stranded industrial wire in an appropriate configuration allowing the alarm to be seen and heard.

The limit switch (Figure 22.15) is a D Square electromechanical switch with a lever arm attached for activation purposes. The switch has one million cycles and introduces minimal impedance to a system when closed. This switch can be wired normally open or closed. For this project, the switch is wired normally open. The limit switch is wired in series with the disconnect switch.

The disconnect switch is a selector switch allowing the auxiliary alarm to be turned off or on. In the off position, the auxiliary alarm will not function if activation occurs, as an open connection exists in the loop and current cannot flow. In the on position, the loop is closed allowing current to flow and the auxiliary alarm to be activated. This switch is installed as a safety mechanism should the auxiliary alarm fail or the customer chooses not to have it functioning depending on the patient in the hydrotherapy pool. This switch is also normally wired open.

The visual portion of the alarm is a strobe light with a blue acuity lens covering. The audio portion of the alarm is a vibrating horn with a power level of 118 decibels. The audiovisual alarm is part of the existing system.

After static load testing was performed on a prototype of the human actuator interface, a pool diving ring was determined to be the weakest component of the interface. (Figure 22.16)

The final cost was $914.15.

Figure 22.14. Stitching and Looping of Velcro.

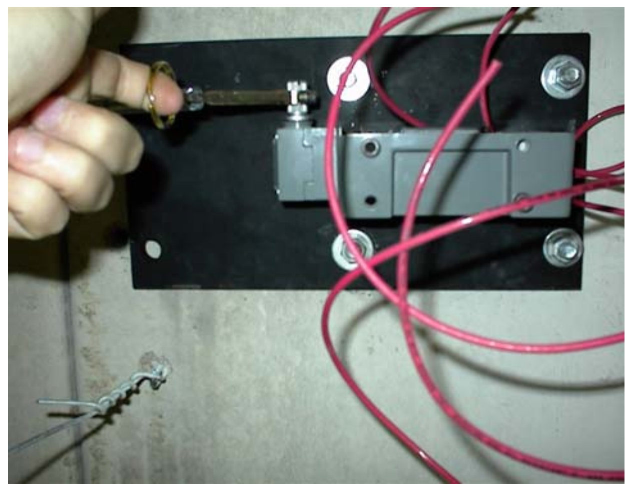

Figure 22.15. Limit Switch (Gray Box in the Center of the Black Plate).

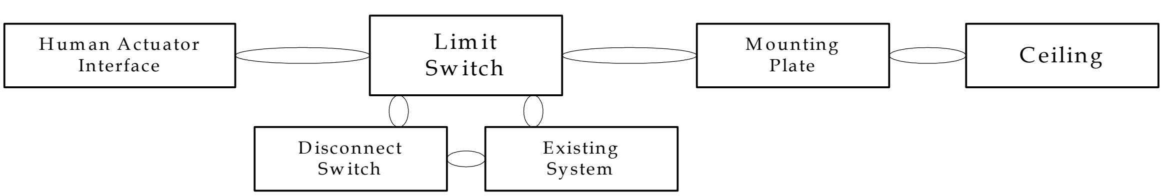

Figure 22.16. Block Diagram.

PEDIATRIC ADAPTABLE COMMODE CHAIR

Designers: Jeremy Chaney, Sharon Dillhoff, Julia Rose
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INTRODUCTION

Gorman Elementary School was in need of a re-design of a restroom chair for their students with disabilities. One commonality of these disabilities is poor muscle control, which inhibits the students from sitting independently, and therefore the students cannot use the restroom without assistance.

The Pediatric Adaptable Commode Chair is a product that can be wheeled over the existing toilet, and when not in use, can be stored under the changing table that is located in the restroom facility. The chair is mobile so that a person without a disability can easily move the product out of the way and use the toilet.

This product offers support in the form of a security strap, high back support, headrest, footrest, and front support (i.e. tray to lean on). The product is mobile because its base has four swivel casters with locking mechanisms. The chair's high back can be easily folded down for storage purposes. The chair is made of materials that can be easily cleaned for sanitation reasons. The final product has the ability to support the requirement of 60 pounds.

SUMMARY OF IMPACT

The adaptable commode chair design allows a child with physical disabilities to independently stay on the toilet.

TECHNICAL DESCRIPTION

The pediatric toilet is 10 inches in height and narrow enough to fit between the wall and the pipe, which is less than 19.25 inches wide. The product must also be small enough so that is can be stored under the changing table in the restroom, which is only 27.5 inches above the floor. (Figure 22.19) The design must also be made of easy-to-clean non-corrosive materials due to the fact that it will be used in a restroom environment. It must also offer security or support (straps, headrest, and footrest) to the user. The design must also be comfortable, functional and flexible in order to accommodate heights of children of 30 to 42 inches. (Figure 22.20)

Figure 22.17. Front and side view of the Pediatric Adaptable Commode Chair.

The engineering principles that were applied to the design of this product were the usage of static analysis. The engineering analysis was evaluated in Design Space. A 500 Newton load (approximately 120 pounds) was applied to the device, which was evenly distributed over the plates.

The Flamingo Seat ® by R82 (Figure 22.18) was found to be the best choice because it is made of easy-to-clean materials (ABS plastic), supports enough weight, is comfortable, and is able to be folded down for storage. After obtaining this chair, a mobile base was designed to fit the space limitations and weight requirement. Stainless steel was chosen for the mobile base because of its strength and resistance to corrosion. The design of the mobile base was entered into Solid Edge ® and analyzed using Design Space ® (stress, deformation, and safety factor). This base was made mobile by using four two-inch, swivel caster wheels. Straps, footrest plates, a tray, and a vertically adjustable headrest were added to aid in supporting the user. Finally, the product was powder coated and assembled.

The approximate cost of the product is $931.71.

Figure 22.18. Baby Crane ® Toilet in Classroom's Restroom.

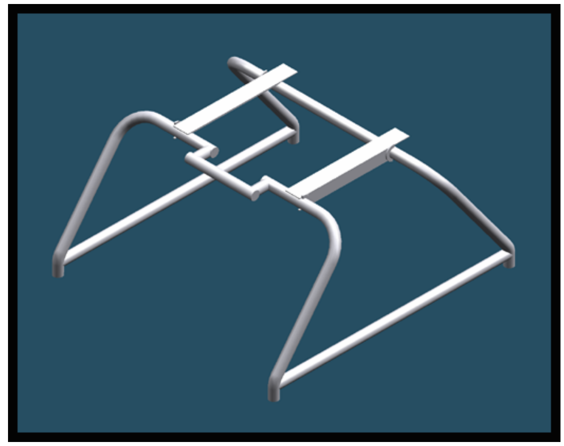

Figure 22.19. 3-D View of Mobile Base in Solid Edge ®.

Figure 22.20. Pediatric Adaptable Commode Chair Folded Down for Storage.

ADAPTIVE KEYBOARD AND INTERACTIVE SOFTWARE

Designers: Ruzbeh Shariff, Joseph Blake, Tejdeep Rattan
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INTRODUCTION

A teacher desired a stepping stone to the Intellikeys® system. The design team created a new system consisting of an adaptive keyboard device interfaced with the standard personal computer, related materials, and a software package.

SUMMARY OF IMPACT

The system is designed to offer feedback to the student on the accuracy of his or her answer. This is necessary so that each student recognizes the correctness of his or her response in comparison with the task that is prompted by the teacher. Such feedback will allow the system to be an interactive educational tool.

In the new system there is a strong emphasis to create a product that provides adequate visual and audio feedback. To create this adequate feedback, a system that is simple but at the same time clear and powerful is necessary.

TECHNICAL DESCRIPTION

The parallel port is the optimal means of interfacing the adaptive keyboard device to the standard PC. Many PC's have different design standards regarding their parallel port and as a result, all calculations in this design are based on data regarding IEEE 1284 standards. The standard parallel port is most commonly found at base address 378h and is usually labeled as LPT1 by the PC. It is composed of a data register (8 bits), status register (5 bits), control register (4 bits), and 8 ground bits. The data register is primarily used to send data from the PC to an external device. The status register is used to receive data from an external device. The control register is more versatile and allows bi-directional data transfer. The following is a pin-out of the standard 25 pin, female D-type parallel port connector and labeled bits. D denotes data register bits, S status register, and C control register bits. (Figure 22.21)

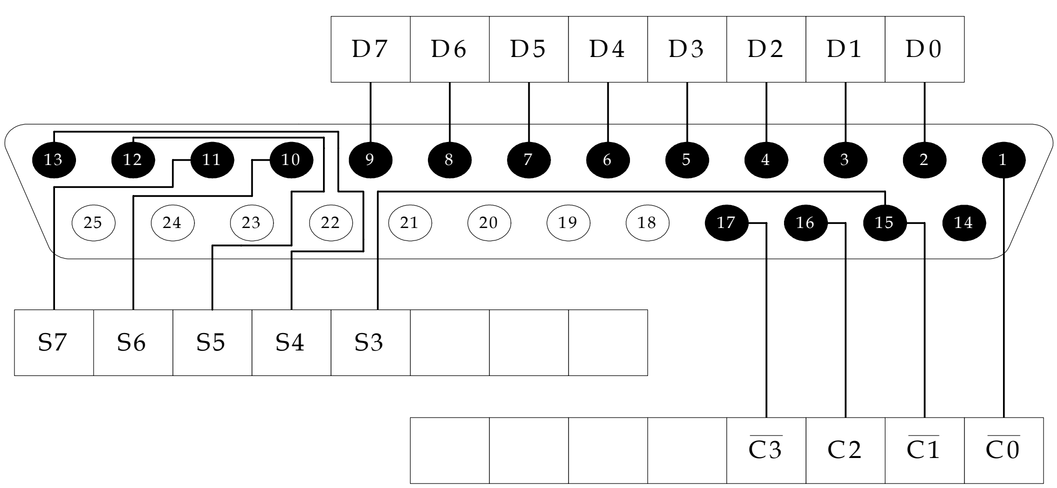

Figure 22.21. Parallel Port Pin-Out Information.

While the control register does allow both input and output, it has some advantages about it that make using the status register the most practical for the five switch inputs to the computer. Since the parallel port is composed of three registers, in order to read or write anything on these registers, it is necessary to know the address of each.

Visual Basic 6.0 was selected as the development environment to create the program that will interact with the adaptive keyboard. The device consisted of five buttons and five lights. The device was modified externally by removing a cover and attaching picture insert holders.

Internally, the device was dismantled and in place of the original circuitry the design team inserted the new circuit board, which operates the adaptive keyboard device (AKD). In consideration of the needs of the students, a stand was created for which the AKD attaches. The stand allows the AKD to be presented at various angles by a mechanism on the rear of the stand that is manually changed by the teacher.

Safety considerations were made regarding the voltages and currents used in the design of the device. Since the adaptive keyboard device does not operate with voltages greater than 5 volts and currents more than 36mA, the device housing that covers the internal components of the device is adequate to protect users from possible shock or injury. (Figure 22.23)

The system gathers external input from the sensing switches via the status register of the parallel port. The software program written in Visual Basic interprets this input information. The software program then compares the pressed switch to the switch that it prompted the student to press. Then it sends a signal to the data port to turn on the keyboard lights appropriately for negative or positive feedback (Figure 22.22).

The total cost of the Adaptive Keyboard and Interactive Software is $550.

Figure 22.22. Modified Device.

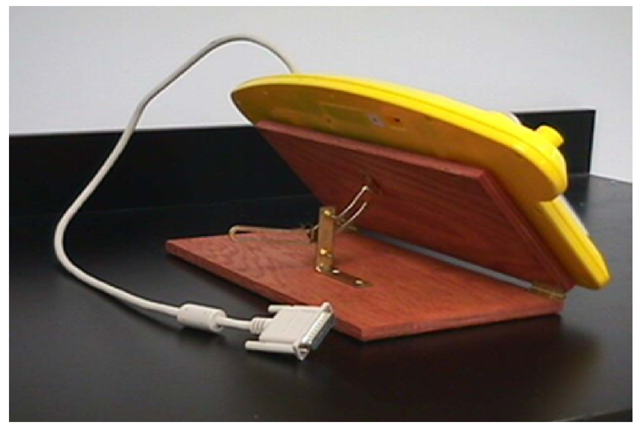

Figure 22.23. Adaptive Keyboard Device Stand.

TIME KEEPING TASK SCHEDULER

Designers: Patty Gehring, Rachel Kinsler, Ed Sims
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INTRODUCTION

A microprocessor-controlled device allows the instructor to program time intervals for up to 12 tasks as a facilitating tool in teaching students with autism. Data entry is accomplished using a digital alarm clock type interface. The tasks are pictorially displayed on one-inch square cards around a clock-like face. As the time interval for each task expires, a window closes, concealing that task. Finally, several rows of LEDs turn on and off and audio tones of varying pitches remind students as time intervals progress. Power is provided using rechargeable batteries. The wood and plastic materials used in the case design result in a durable, attractive and easy to use task-scheduling device.

SUMMARY OF IMPACT

First, the device features a microcomputer controlled, sealed design that prevents the students from accessing the task images or sliding the task cover or timer devices. Access to the mechanical elements of the device is only possible by releasing the quarter-turn quick release door fasteners located at the front and back of the unit. These fasteners are operated using a common, flat-tipped screwdriver. While the use of a tool to open the device is more cumbersome than would be the use of hand operated closing devices, it also makes opening the device by the students virtually impossible.

The audio and visual attention getting stimuli feature a five-row LED display and sound system. As the time for each task advances, the five rows of LEDs incrementally flash and extinguish row by row, while a pulsing tone sounds at 1/5 time intervals. For example, if the device is timing a 15-minute task, after three minutes have elapsed, all LEDs flash and the first row of LEDs is extinguished, while a tone of a certain frequency beeps several times. After another three minutes, the remaining LEDs flash and the second row of LEDs is extinguished, while a tone of a lower frequency beeps. This continues until all LEDs are off, at which time the window over the task will be completely closed. The timer advances to the time entered for the next task, all the LEDs re-light, and the process begins again.

The problem of the teacher controlling the device, and thereby being viewed as the controller of time, is eliminated by the use of the microprocessor to control all timer elements. The teacher is free to monitor other classroom tasks, and any aggressive tendencies of the student towards the timekeeper are passed from the teacher to the device. (Figure 22.24 and 22.26)

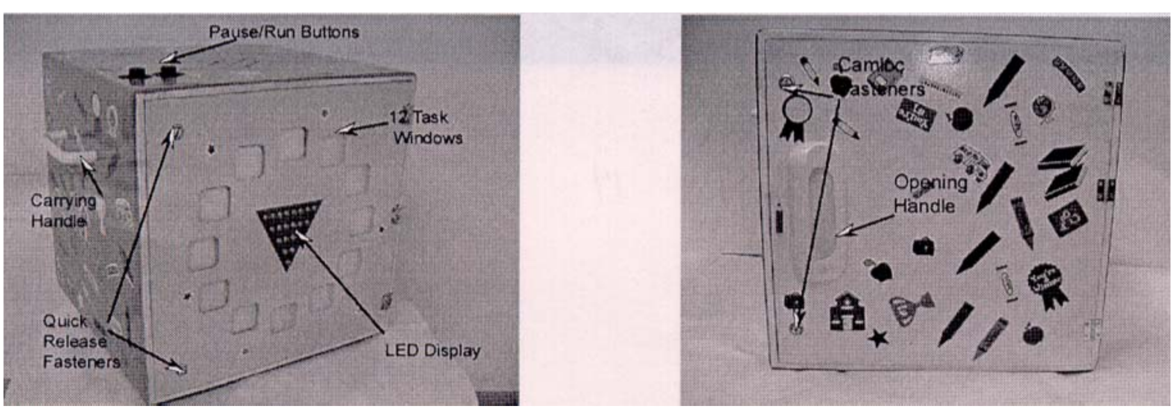

Figure 22.24. Front and Back Views of the Time Keeping Task Scheduler.

TECHNICAL DESCRIPTION

The cubical casing is constructed of half-inch thick hard maple. The front face is Optix ® clear acrylic. The casing is decorated with Krylon ® paint and clear coat, and stickers with a school theme. There are two white plastic handles on the side for ease of transportation. Four anti-skid vinyl pads are attached to the bottom to prevent slippage of the device and scarring of the paint. The front face and back panel both have two quarter-turn quick-release fasteners that open with a common flat-tip screwdriver. The back panel also has a wooden handle for opening it.

The task window plate is composed of a steel plate bonded to an aluminum plate. There are cutouts in the aluminum plate to allow placement of the task pictures. The steel plate provides a surface for the magnetic backing of the task pictures. An eight-inch diameter notched plastic disk is attached to the gearhead shaft with small aluminum mounting plates. This disk rotates from behind to in front of the task window plate, thus covering the task pictures.

Behind the disk and task window plate is the aluminum plate to which the gearhead and motor assembly is attached. The motor and gearhead assembly consists of two steel spur gearheads with ratios of 60 to 1, in series with a 12VDC stepping motor. The overall gearing ratio is 3600 to 1 from motor shaft to output shaft to which the plastic disk attaches. The purpose of using the gearheads is to improve the torque output and provide an extremely fine rotational resolution. (Figure 22.25)

The heart of the system is the BASIC Stamp IIe microprocessor located on the Stamp Module near the front of the interior of the device. The Stamp IIe is a 20 megahertz microprocessor manufactured by Parallax Inc. It features 32 bytes of RAM, 8 x 2 kilobytes of EEPROM, 16 I/O lines, and is programmed using PBASIC, a form of the BASIC computing language specially formulated by Parallax. This processor was chosen for its ease of programming, processing speed, and size of memory locations.

The total cost of the project is $944.10.

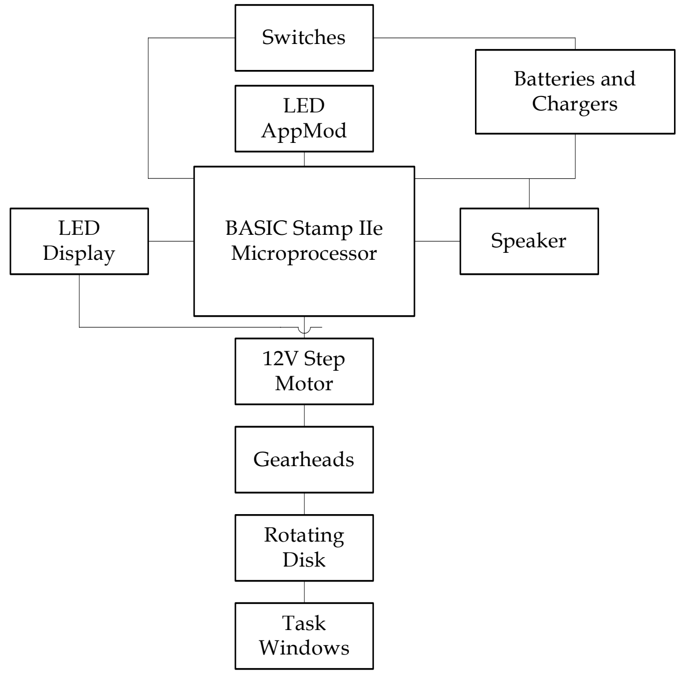

Figure 22.25. System Block Diagram.

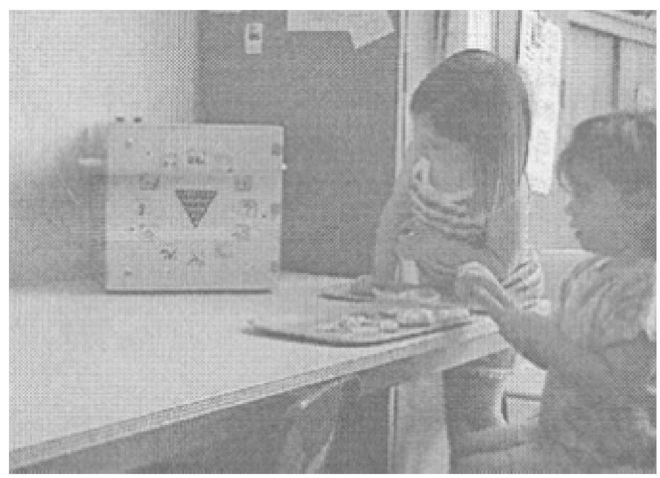

Figure 22.26. Students with Timer.