CHAPTER 12
ROSE-HULMAN INSTITUTE OF TECHNOLOGY

Department of Applied Biology and Biomedical Engineering

Department of Electrical and Computer Engineering

5500 Wabash Avenue

Terre Haute, Indiana 47803

Principal Investigators:

Renee D. Rogge

(812) 877-8505

rogge@rose-hulman.edu

Glen A. Livesay

(812) 877-8504

livesay@rose-hulman.edu

Fred C. Berry

(812) 877-8105

berry@rose-hulman.edu

THREAD TRIMMER: PUSH MOWER

Designers: Nick Donatucci, Janine Pulley, Aren Thompson
Client Coordinator: Bob Harbison, Knox County ARC
Supervising Professors: Dr. Renee Rogge and Dr. Glen Livesay
Applied Biology and Biomedical Engineering
Rose-Hulman Institute of Technology
Terre Haute, IN 47803

INTRODUCTION

This project focuses on the creation of a device that allows employees with disabilities, specifically visual impairments and tremors, to safely, accurately, and quickly trim the loose threads of a U.S. Military Gen III shirt to within their contractual requirement of 1/8". Prior to this device, only employees with milder disabilities were able to trim the threads manually, using sharp scissors, due to the inherent safety risk involved with the process. Previous attempts to solve this problem failed due to accumulation of cut threads in the device, difficulty or complexity of the device which increased the amount of time needed to cut the threads of a shirt, inaccurate thread cutting, and excessive device noise which required hearing protection.

In the design process, the team developed several alternate designs and ultimately decided to pursue the "Push Mower", shown in Figure 12.1. The Push Mower works on the same principle as a hand-powered reel lawn mower. As the operator pushes the device, a reel consisting of several bars rolls across the fabric pulling up the threads. The reel rotates on the inside of the drive wheels along a gearing system, which pulls up the thread. The reel then draws the thread across the blade, which is attached to the chassis behind the rotating assembly, and cuts the thread. The length of the cut thread is controlled by the angle of the device, which is constrained by the geometry of the chassis and body. The long body is the handle that the user will grip to use the device. The advantage of this design is that it is small and can be operated with one hand. Since the reel and cutting surface are approximately 2.625 inches wide, the client does not need to be meticulously accurate in finding threads. As currently designed, this device is powered purely by the user, which reduces both the size and the output of noise of the product. The loose thread falls back onto the garment to be picked up by a lint roller

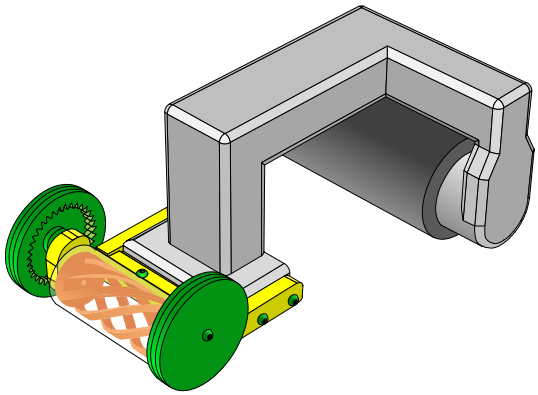

Fig.12.1. "Push Mower" design for thread trimming.

attached to the back of the handle which assists in managing the accumulation of the cut threads.

SUMMARY OF IMPACT

This small, compact device can be used by employees with tremors and visual impairments to quickly and accurately trim the threads to the contract specifications on the garments produced by the facility. The blade is contained within the device and does not pose a safety threat to employees or to the garment.

TECHNICAL DESCRIPTION

Design requirements include the ability to safely, quickly, and quietly trim the threads to military contract specifications and to increase access to this job opportunity for employees with a variety of disabilities. To meet these design requirements, the Push Mower design is divided into four subsystems: reel, blade, chassis, and body.

The reel subsystem pulls the threads up from the fabric and directs them past the blade. The reel is made largely of laser-cut acrylic that is glued together, but also includes aluminum spacers to allow the reel to pass through the chassis. The

strength of this subsystem is that it operates on the simple and easily modeled principle of gears. The blade subsystem cuts the threads that are pulled into the device. The blade is held tightly in place by the chassis for accurate and precise cutting, as well as easy maintenance and replacement. The Push Mower uses a stock blade that can be purchased in bulk and at a low cost to minimize the difficulty of replacement, although two holes must be drilled through each blade to attach to the chassis. The cut threads fall from the blade back onto the garment where they are picked up by the body and thread storage subsystem. The body and thread storage are one piece, and they are connected to the chassis by two bolts. A standard lint roller is attached to the body to collect the cut threads. All of the subsystems are attached to the chassis via bolts. The chassis subsystem also includes a rapid prototyped cover that covers the reel to prevent harm to the user and the product.

The cost of parts and materials for the final design is approximately $250.

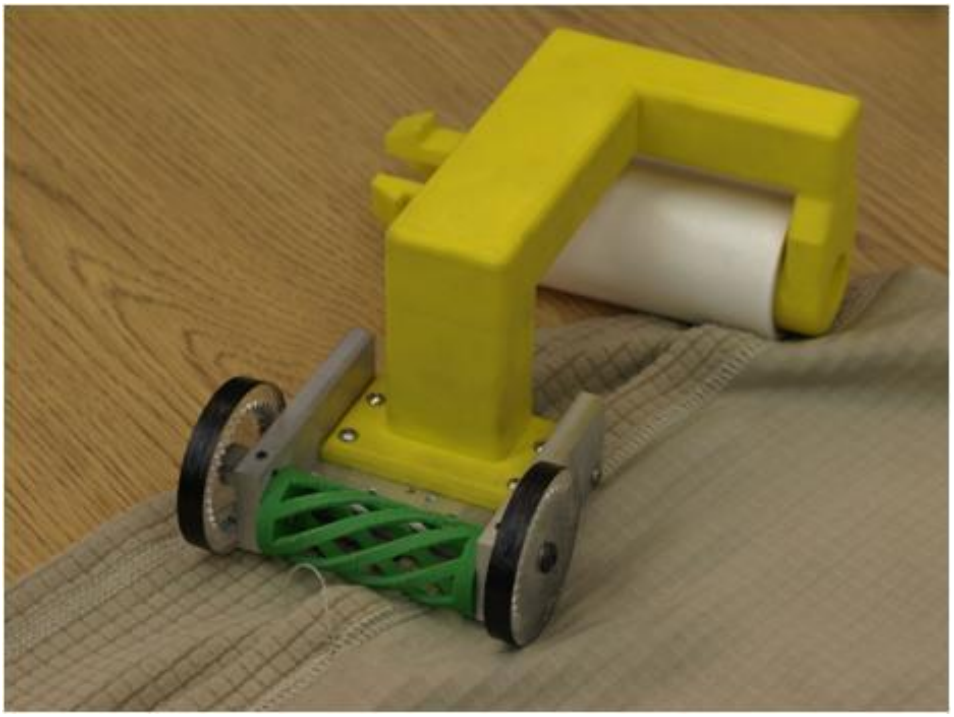

Fig.12.2. Final Prototype of the "Push Mower" design for thread trimming.

ACCESSIBLE PAPER SHREDDING SYSTEM

Designers: Sophia Percival, Praveena Theertham, Nicole Tillery
Client Coordinator: Darren Probst, Vigo County ARC
Supervising Professors: Dr. Renee Rogge and Dr. Glen Livesay
Applied Biology and Biomedical Engineering
Rose-Hulman Institute of Technology
Terre Haute, IN 47803

INTRODUCTION

The system created in this project is designed to assist our client, an individual with cerebral palsy, in performing paper shredding tasks at a local Recycling Center. Our client has little mobility in both of his arms and hands and is unable to firmly grasp objects with his hands. Due to limited range of motion, he requires assistance from a job coach to complete his work at the Recycling Center. The job coach arranges the paper for him on a table that is placed in front of a shredder. Paper is placed on rubber bands attached to the left side of the table. The rubber bands help him grasp and move the paper off the platform into the shredder using custom-made headgear.

The custom-made headgear our client currently uses has a single point of contact and the paper often rotates when it is fed into the shredder. The client also experiences difficulty pressing the on/off button. As this is a necessary activity for each piece of paper that is shredded, this aspect greatly hinders our client's independence in using the device. Also, the job coach is only able to put a small stack of papers on the table at a time, thus requiring more frequent assistance.

SUMMARY OF IMPACT

The modifications to the client's headgear and shredding system provide our client with more independence in performing his job. Assistance from the job coach is currently only required at the beginning and end of his shift (or in special circumstances). The client is also able to turn the paper shredder on and off, which provides him more control over his working environment.

TECHNICAL DESCRIPTION

The client's headgear is modified with a two-pronged design to provide a more stable way to push paper into the shredder (Fig. 12.3). The two pronged modification prevents the papers from spinning which provides more control. The rubber material is threaded to fit Adam's current headgear rod so that the tip can easily be removed if necessary. This also allows for a strong connection between the headgear rod and the tip.

Fig.12.3. Modified headgear with two prongs for easy paper manipulation.

The on/off switch is modified (Fig. 12.4) with a removable addition (no permanent changes to the shredder are allowed due to machine warranties). A large, contoured switch plate covers the original switch. The new switch provides a larger surface area for contact with the client's headgear. The client uses his headgear to easily push the switch into an on, off, or reverse position.

A spring box is designed to hold paper for shredding. The spring platform pushes the paper up to the side opening and allows for the job coach to fill the box full of paper at the beginning of a shift. The box is slightly larger than an 8.5" by 11" piece of paper so that the paper fits into the box only in one direction to ensure proper paper orientation.

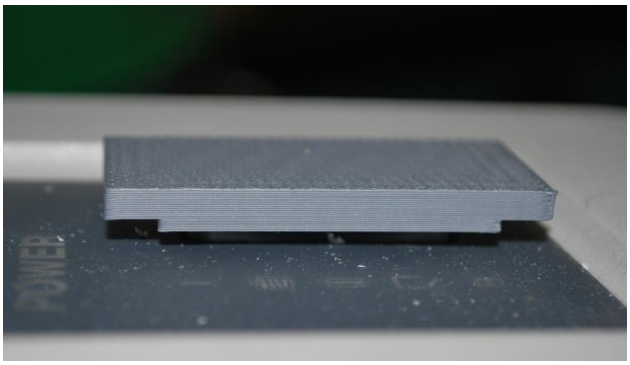

Fig.12.4. Modified on/off switch with increased contact area.

A set of four springs is positioned at the bottom of the box and platform to move the paper up toward the shredding surface as necessary. Rollers are positioned at the top of the spring box to dispense paper from the box so it will not get stuck in the side opening. Because of the rollers, the client no longer has to pull paper out of the opening using his headgear. Instead, the paper is easy to reach as it glides out of the box opening. The rollers are driven by a motor that is controlled by a light sensor combined with a programmed microchip. To activate the rollers (and provide paper for shredding), the client moves his headgear in front of the light sensor.

Once paper is moved from the spring box to the rollers, it moves onto a guide way. The purpose of the guide way is to direct paper from the spring box into the shredder. The final spring box and guide way systems are shown in Fig. 12.5. The cost of parts/material for the final design is approximately $500.

Fig.12.5. Spring box and guide way for improved access to the paper shredder.

CUTTING AND SEWING ASSISTANCE

Designers: Elizabeth Bucey, Rachael Nestor, Jill Watson
Supervising Professors: Dr. Renee Rogge and Dr. Glen Livesay
Applied Biology and Biomedical Engineering
Rose-Hulman Institute of Technology
Terre Haute, IN 47803

INTRODUCTION

Our client employs persons with disabilities to assist in the manufacturing of products under government contracts. One of the current products is a weapon carrier made of a waterproof material with two outer zippered pockets on the front. For this carrier, there are two manufacturing tasks that are difficult for persons with disabilities to complete. The first task is the cutting process for creating the correct shape for the pockets. Each pocket has four square corner cut-outs and a long darted cut down the center of the pocket (for insertion of the zipper). Currently, the pockets are marked and then cut using four different tools. In addition to being inefficient, the tools used also have very sharp exposed blades that only the supervisor can operate due to safety concerns. The second task is the sewing of the zipper into the pocket after it is cut. The tight government specifications placed on the stitching location and orientation limit the availability of employees who are able to perform this task. Our client desires to improve the accessibility of these tasks and make the job opportunities available to a wider population of employees.

SUMMARY OF IMPACT

The modifications made to the cutting station provide some additional opportunities for workers at the facility. However, the design requires further revision due to the high force requirements for cutting the material.

TECHNICAL DESCRIPTION

The cutting design (Fig. 12.6.) provides users with a variety of disabilities to safely and efficiently cut out the corners and the long slit in the middle of the pocket with a few easy steps. The design functions similarly to a metal stamp or punch with a user-applied force on the lever serving as the actuation mechanism. The custom-made blade (Fig. 12.7.) is contained in a polyethylene casing to protect the user. All the cuts are made with a single applied force (Fig. 12.8.).

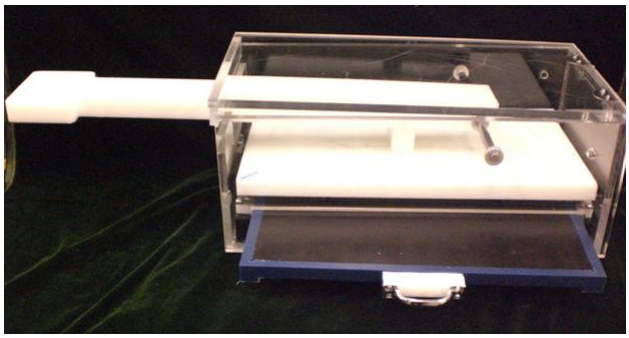

Fig.12.6. Cutting design to prepare the pockets for sewing.

Fig.12.7. Customized blade plate.

The sewing design (Fig. 12.9) consists of two tracks, an upper and a lower track manufactured from polyethylene. The user folds the pocket material by hand and then places the folded pocket on top of the zipper in between the top and bottom tracks. By placing the pocket in-between the two layers, the pocket is held in position in relation to the zipper via a clamping force from aligned magnets in the top and bottom tracks. Additionally, prior to loading the pocket material, the user places small plastic clips around the edges of the folded zipper pocket edges. These clips hold the folded edge in place so that as the pocket is sewn, the user removes the clips as they progress around the edge of the pocket.

The total cost for the parts and materials associated with both the cutting and sewing designs is approximately $2000.

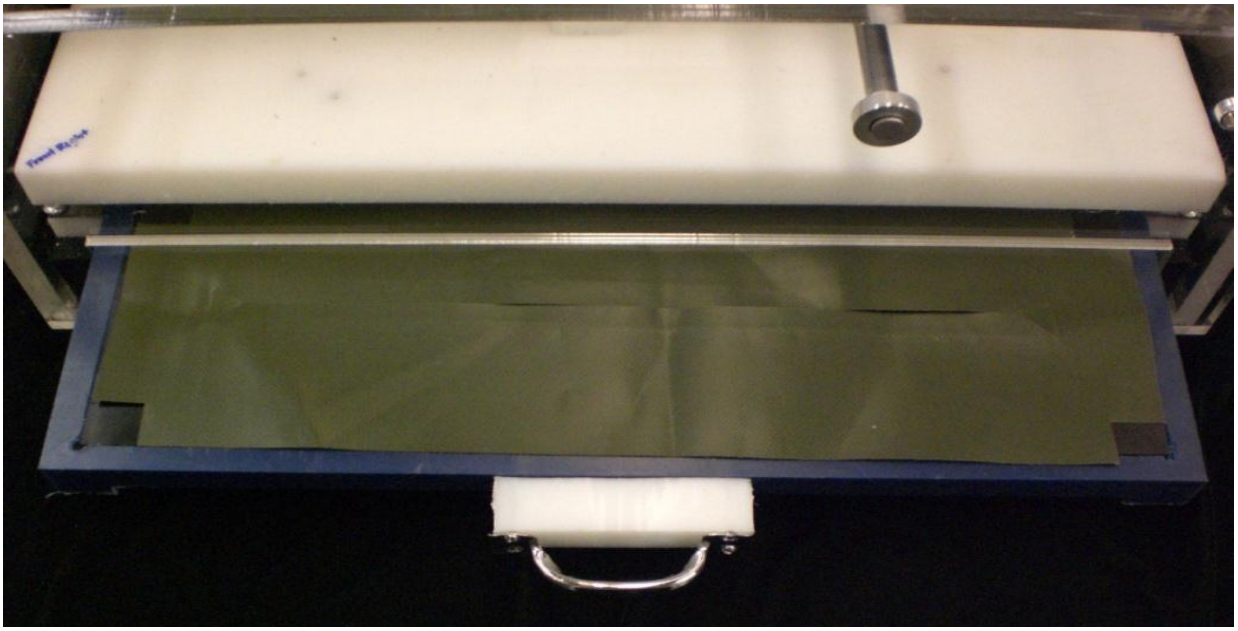

Fig. 12.8. Finished cut-outs for the pockets using the cutting design.

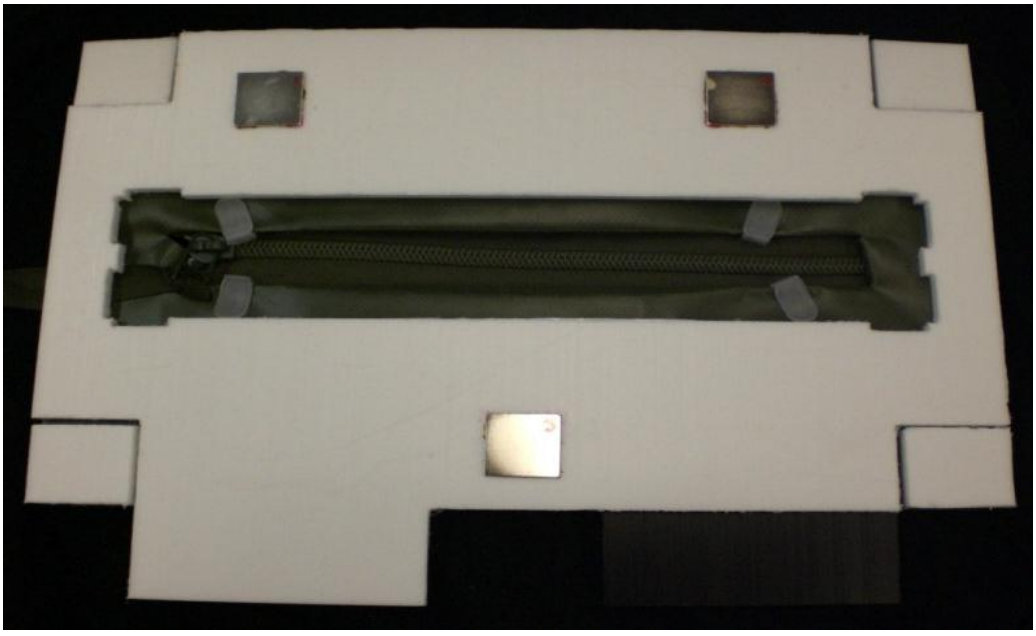

Fig. 12.9. Sewing design to minimize complexity of sewing the zippered pockets.

THE BUBBLE WALL

Designers: Chris Bowen, Tim Parsons, Corey Nigh
Supervising Professors: Dr. Renee Rogge and Dr. Glen Livesay
Applied Biology and Biomedical Engineering
Rose-Hulman Institute of Technology
Terre Haute, IN 47803

INTRODUCTION

The Bubble Wall is a device used to aid persons with a visual disability in swimming laps in an Olympic sized pool. Persons with visual impairments have difficulty when attempting to swim in a lap pool due to an inability to sense lane dividers and the end walls. One existing solution to this problem is a floatation device that rests on the surface of the water. Parallel bars run the length of the pool and have cylinders positioned along the length of the bars that alert a swimmer of deviation from a straight path via a contact method. As the user reaches the end of the pool, an end bar alerts the swimmer that the solid wall is approaching. Swimmers reported that the contact method of notification was not optimal and interrupted normal swim patterns.

The device designed in this project uses an air pump to pump air into the water in a controlled manner. The air is pushed through tubes which are in a rectangular formation on the bottom of the pool. The rectangular formation is three feet narrower than a standard Olympic sized pool lane and 30 feet shorter than a standard Olympic sized pool lane. Holes in the rectangular formation allow bubbles to rise to the surface of the pool. The bubbles form a boundary within the pool lane within which the swimmer can stay by feeling when he or she is nearing the bubbles. When the swimmer crosses the bubbles at the end of the rectangular formation, they know that the end of the lane is only 15 feet away. The Bubble Wall is available for use by anyone who is visually impaired and wants to swim laps in an Olympic sized pool. The Bubble Wall allows visually impaired swimmers to maintain a course within a pool lane without impacting the lane lines or edges of the pool.

SUMMARY OF IMPACT

During testing, the Bubble Wall successfully indicated lane boundaries and provided swimmers with the necessary guidance to stay on course and be aware of the end of the lane. Swimmers noted that the air bubbles were subtle enough to indicate location without disturbing swim patterns.

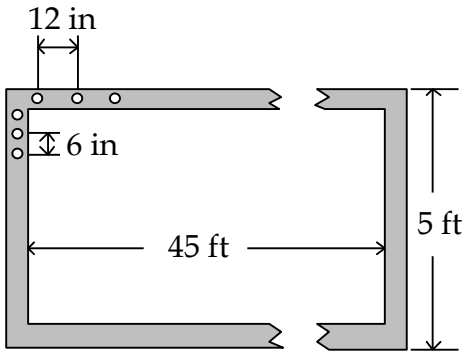

Fig. 12.10. Spacing of the holes along the Bubble Wall.

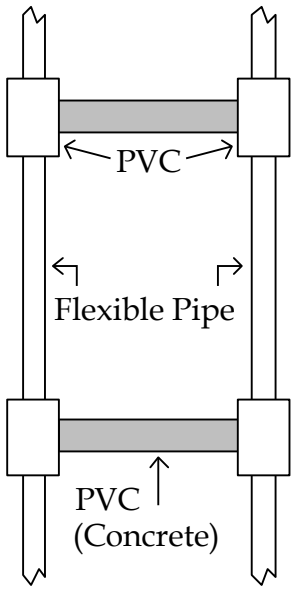

Fig.12.11. PVC Stabilizers for the Bubble Wall.

TECHNICAL DESCRIPTION

Flexible tubing comprises the piping system of the Bubble Wall. Holes are drilled every 12 inches down

the length of the pipe and every six inches across the width as shown in Fig. 12.10. Subject testing confirmed that the spacing created appropriate bubble notification to the swimmer. An air pump provides the air flow for the system due to its ability to supply a steady stream of air for a long period of time. The Bubble Wall rests in the middle of a pool lane; 15 feet from the walls at the end of the pool and two feet from the lane divider ropes. The final dimensions of the Bubble Wall are forty-five feet long and five feet wide (45′ x 5′). The PVC Stabilizers (Fig. 12.11) are composed of five foot long PVC sections filled with concrete which have T-fittings on their ends. These stabilizers slide over the flexible piping. Each of the ten PVC Stabilizers weighs approximately four kilograms, i.e. a total of 40 kg keeps the Bubble Wall secured on the bottom of the pool. The stabilizers can slide across the flexible tubing. A schematic of the Bubble Wall is provided in Fig. 12.12. The entire system is compact and portable for easy deployment in any standard pool, as shown in Fig. 12.13.

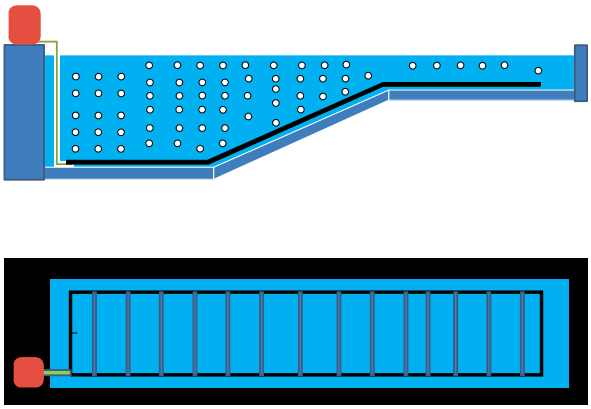

Fig. 12.12. Side (top picture) and bottom (bottom picture) schematic of the Bubble Wall.

The total cost of the Bubble Wall is approximately $1000, including development costs.

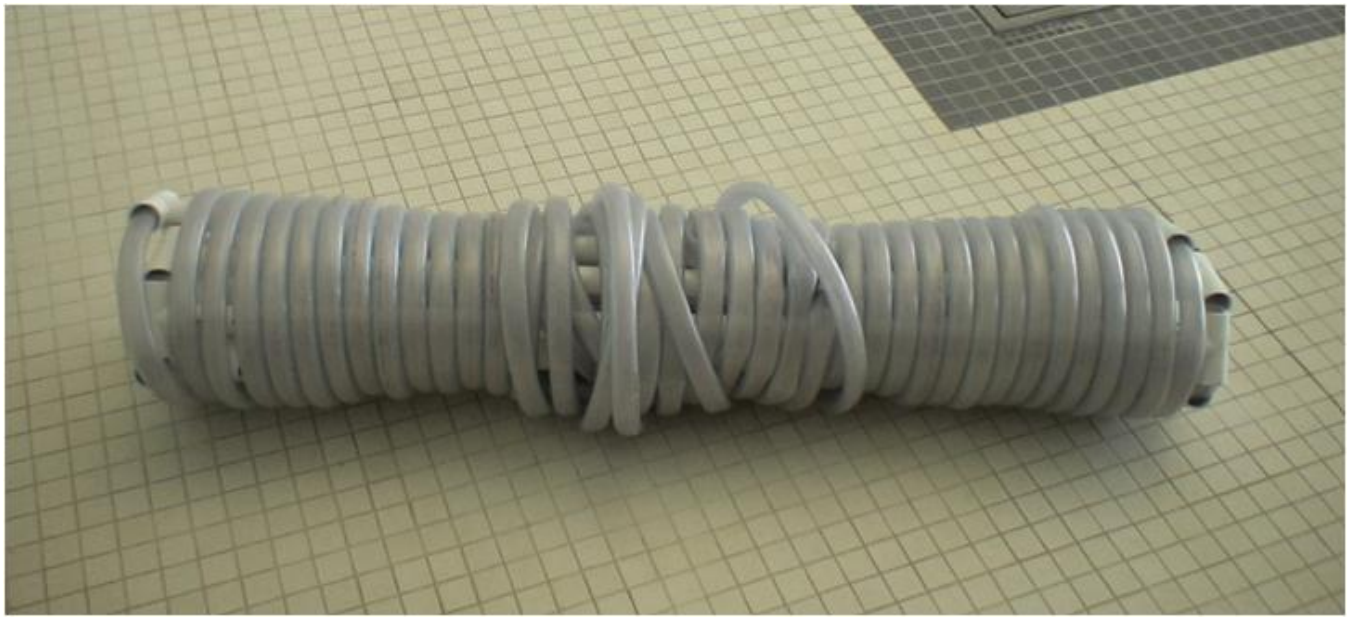

Fig.12.13. Bubble Wall prepared for storage or transport.

COLOR DETECTION TOOL

Designers: Natalie Dickman, Beau Inskeep, Katie Wolber
Client Coordinator: Dr. Peter Coppinger
Supervising Professors: Dr. Renee Rogge and Dr. Glen Livesay
Applied Biology and Biomedical Engineering
Rose-Hulman Institute of Technology
Terre Haute, IN 47803

INTRODUCTION

Our client has a disease called deuteranolmaly which results in the inability to see red and green pigments. Therefore, he also has problems distinguishing between shades of brown, gray, and pink. The ability to see these colors would be extremely beneficial in aiding him in activities such as shopping for clothes and home & gardening activities. Currently, a device to aid him in such activities does not exist on the market.

SUMMARY OF IMPACT

The prototype detects different colors but is not suitable for distinguishing between various shades of the same color. Further development and microcontroller programming is required before final delivery to the client.

TECHNICAL DESCRIPTION

The Color Detection Device makes use of a color sensor which contains an LED to shine light that is reflected off an object and back to the sensor. The sensor reads the wavelength reflected back through four color filters and sends the color data through its analog to digital converter to the microcontroller. Due to the extremely small size of the color sensor, it is soldered onto a small printed circuit board (with an area of four cm^2) so that it can be mounted onto a bread board for preliminary development. A PIC18f4520 microcontroller analyzes the data received from the color sensor and sends the resultant color information to the LCD for viewing by the user. All of the components are powered by a 9V battery. The entire device can be seen in Fig. 12.14. A pre-made casing was used instead of a rapid-prototyped custom casing. The pre-made casing is machined to allow for LCD placement and reset-button accessibility. Two voltage regulators are included to drop the voltage from the 9V battery down to 3.3V and 5V for the color sensor and the LCD, respectively. Resistors are included as pick-up resistors for the color sensor and the PIC microcontroller.

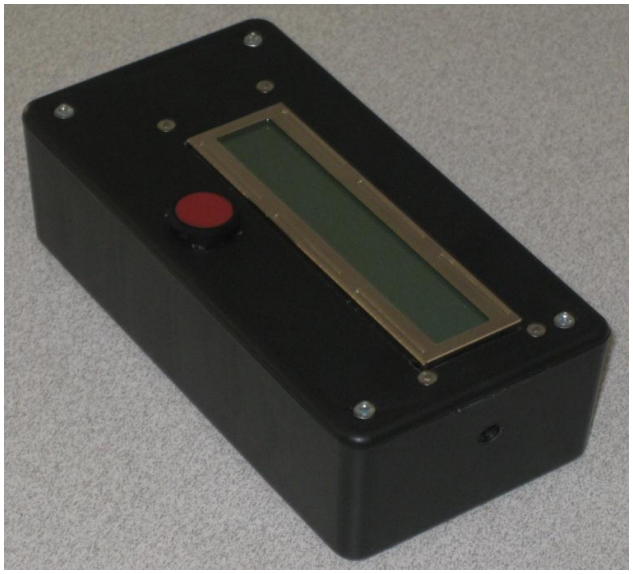

Fig.12.14. Color Detection Device.

The total cost of the Color Detection Tool is approximately $500, including research and development costs.