DB Engineers

Team 2004
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https://youtu.be/3oS-6ctThCM

Abstract

This year, a group of Diamond Bar High School students were inspired to design assistive devices to solve a multitude of real world problems. The models were created with the goal of making common jobs more accessible for workers with disabilities. Through virtual collaboration, DB engineers brainstormed several solutions, designing four final products. Each solution can be cost-effectively replicated for use across the country.

I. Statement of Problem

In order to assist workers with disabilities in completing their jobs, DB Engineers created designs and systems to help with 4 common tasks. The first of these tasks was to find a way to center labels on packaging since people may have trouble identifying the correct location for the label. The next was to create a device that can easily open, hold, and close plastic bags. Then, we designed a jig that allows workers to easily and safely cut loose threads on garments. The final solution involved creating an assistive system for workers with disabilities to clock in and out enabling employers to track the data of multiple workers. The DB engineers created multiple devices to provide potential solutions to these problems while taking into account limited dexterity, motor skills, and other limitations workers with disabilities may face while working.

II. Background

The SourceAmerica Design Challenge encourages student participants to create devices or inventions that assist workers with disabilities that maximize efficiency and comfort. Students have addressed key bottlenecks within the tasks outlined by the provided prompts and developing solutions specifically tailored to these issues. In doing so, the team is able to consider more holistic approaches to increase efficiency, leading to increased ease of access to workers and a reduction of unemployment in the community.

III. Rationale

After considering each of the four given prompts, students split into pairs to create preliminary concepts for each solution. The group saw potential in each idea, so DB Engineers decided to develop all four solutions. Throughout the development process, the team collaborated and gave suggestions on how to improve each design. In the end, the students developed low-cost solutions for each of the four proposed prompts, building prototypes of assistive devices for hypothetical workers with reduced fine motor skills, limited dexterity, or cognitive function.

IV. Development

a. Bag Opener

Ziploc bags (and other resealable items), though convenient, can often pose an obstacle in the daily lives of people with disabilities. Lowered dexterity can make the ‘lock’ nearly impossible to open. The bag opener is a fairly simple solution designed on the principle that Ziploc bags can be opened by using friction and forces moving in opposite directions along the two joining components located at the top of the bag as opposed to simply forcing the bag open. The development process included an initial sketch, CAD, and final prototype (see below).

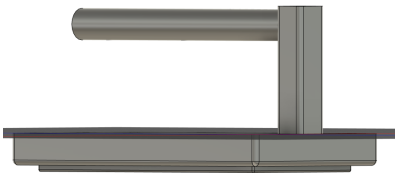


Figure 1 - Bag Opener CAD

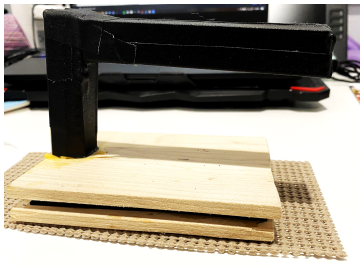


Figure 2 - Bag Opener

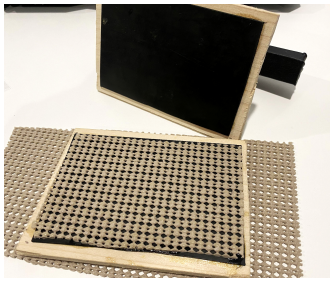


Figure 3 - Bag Opener

b. Bag Holder

The bag holder serves as a tool to easily hold a bag after being opened using the bag opener. After observing the functions of a hanger clip and binder clip, they were combined using the snapping motion of the binder clip to close the hanger clip (*see Figure 3*). Similarly, the pressure put against the bag stand by the binder clip handles (*see Figure 4*) pushed the binder clip upwards, causing the hanger clip to snap back open, releasing the bag. The design was fashioned using a 3D printed stand, 50 mm binder clip, and 27 mm hanger clip which was screwed into the 3D printed stand. At first, the binder clip was pulled upwards to release the bag, but after more attempts, pushing the handles of the clip to propel it upward proved to be an easier, consistent, and more comfortable movement. The binder clip serves to reduce the need to do any squeezing motions to open the hanger clip.

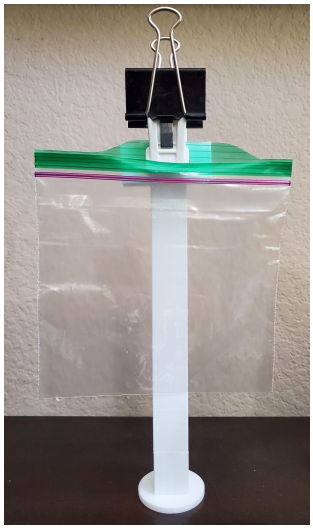


Figure 4 - Bag Holder

Figure 5 - Hanger Clip Opening

c. Label Aligner

The label aligner was designed to center shipping labels on different sized packages. Many people with disabilities have difficulty perfectly aligning and placing a shipping label on a surface, and the label can often be off center as well as crooked. Originally our team wanted to create a stationary device that would allow labels to be placed on packages by shifting the shipping package. After consideration, we decided that shifting boxes would be more difficult for a worker, and instead, we designed a movable frame as the aligner. The label aligner railing system allows centered orientation and a direct frame to place the labels on. (Figure 7) The label aligner functions on different sized boxes as well as rectangular shipping packages. This device was made out

of wood, 3D printed parts, and wood glue. This device consists of a frame to place the packing sticker in and two diagonal arms that extend from the frame in order to adjust for different sized packages. (Figure 6) This adjustability allows multi-functionality within a single device.

Figure 6 - Label Aligner Bracket

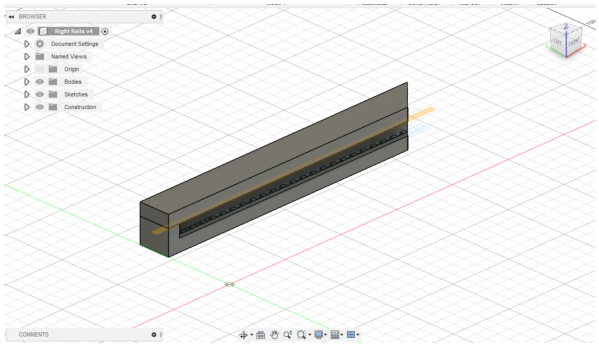


Figure 7 - Rail System

d. Trimming Station

The trimming station was created to prevent the need for scissors which require skills, such as finger dexterity and grip strength, that people with disabilities may not have. After completing the sewn object, there are usually leftover threads attached to the fabric. The team originally planned to adapt a mail cutter for this purpose, but quickly realized that this method was both unsafe, and unwieldy. The next idea involved an exacto blade since they are easily replaceable in case they become dull and are very cheap. Because exacto blades are rather dangerous to handle, we designed a jig that prevents the users from accidentally cutting themselves. After many iterations to fix the tolerances, ergonomics, and simplicity of the jig, we created our final prototype (See Figure 8 and 12). This device allows workers to easily cut the loose threads with a downward motion. To further increase the accessibility of this device for different workers, we created holders to hold the jig in different orientations and surfaces. The suction cup holder and vise enables workers to use the trimming station in every workplace (See Figure 13 and 14).

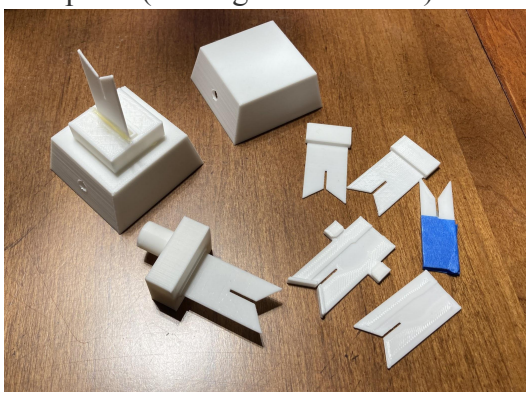


Figure 8 - Trimming Station Prototypes

e. Clock In/Out

The clock system aims to help the visually imapred to easily clock into their specified job. After brainstorming various user-interface layouts, we designed a minimal schematic that allows workers to spend less time navigating through the program and more time on the job at hand. Our initial design evolved from an excel-like dashboard

view to a more user-friendly magnified interface. The positioning of large buttons is specifically designed so that users with impared vision can easily locate their name and clock in/out. We extended the usability of our program by using color-blind-friendly schemes, making the interface accessible for users with color vision deficiency. The clock in/out data points are automatically exported to a local excel sheet, which can be emailed to an employer for review.

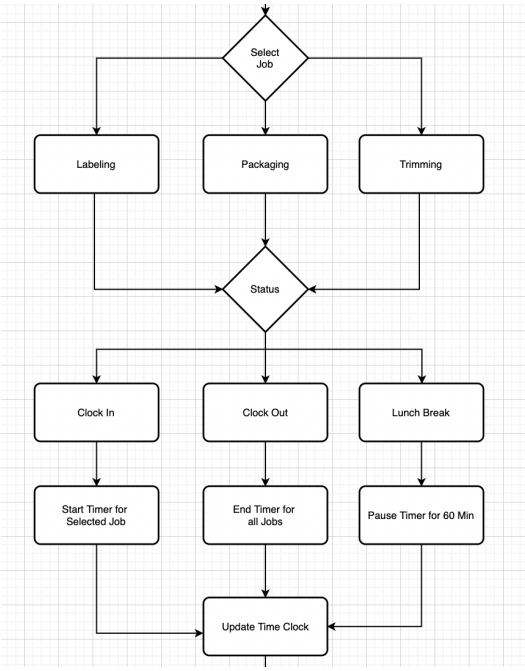
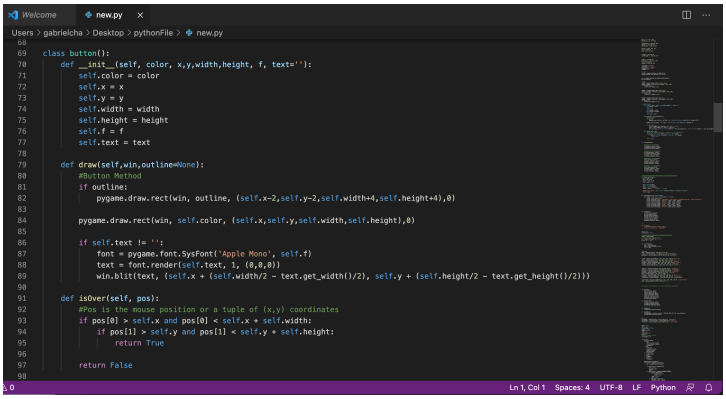


Figure 9 - Employee Selects Job (Section of Flowchart)



```
class button():
    def __init__(self, color, x,y,width,height, f, text=''):
        self.color = color
        self.x = x
        self.y = y
        self.width = width
        self.height = height
        self.f = f
        self.text = text

    def draw(self,win,outline=None):
        #Button Method
        if outline:
            pygame.draw.rect(win, outline, (self.x-2,self.y-2,self.width+4,self.height+4),0)

        pygame.draw.rect(win, self.color, (self.x,self.y,self.width,self.height),0)

        if self.text != '':
            font = pygame.font.SysFont('Apple Mono', self.f)
            text = font.render(self.text, 1, (0,0,0))
            win.blit(text, (self.x + (self.width/2 - text.get_width()/2), self.y + (self.height/2 - text.get_height()/2)))

    def isOver(self, pos):
        #Pos is the mouse position or a tuple of (x,y) coordinates
        if pos[0] > self.x and pos[0] < self.x + self.width:
            if pos[1] > self.y and pos[1] < self.y + self.height:
                return True

        return False
```

Figure 10 - Main Function for Button Creation

V. Final Design

A. Bag Opener

The device is composed of two components made of the following materials: plywood, rubber sheets, drawer liners, tape, and wood glue. Rubber and drawer lining was used to provide grip and increase friction between the device and the bag, as well as between the device and the flat surface it lay on. It is roughly 3” x 5” x 4” (See Figure 2 and 3).

B. Bag Holder

The bag holding device was crafted from a 3D printed stand, a 27 mm hanger clip to secure the bag, and a 50 mm binder clip to open and close the hanger clip. The hanger clip was secured onto the stand with a screw to keep it in place and prevent any parts from falling off (See Figure 4).

C. Label Aligner

The aligner consists of a frame and the opening measures four inches by six inches which is the standard size for a United States shipping label. (Figure)There are two arms that extend from the diagonals of the aligner and adjustable brackets are attached to each of the arms. These brackets slide on the diagonal arms, which allow the brackets to be repositioned on different sized packages. There are grooves on the

diagonal beams of the device which allow the brackets to slide and lock in place. This allows faster cycles if multiple boxes are the same dimensions. The label aligner is made out of a wooden frame along with 3D printed parts for the diagonal arms and the brackets.

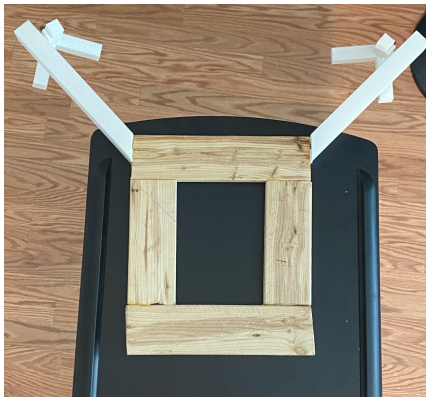


Figure 11 - Label Aligner

D. *Trimming Station*

The trimming station allows the user to grab hold of the loose thread and pull down to cut away the excess thread. The main part of the trimming station consists of a jig that holds a replaceable exacto blade. This jig is designed with an emphasis on safety and simplicity containing only two parts: blade holder and cover. The blade is placed in the blade holder that is then slid into a cover to prevent users from accidentally cutting themselves. The handles on the blade holder allow users to easily grip the device when changing blades. To accommodate for different types of situations, we made multiple holders for the jig. The suction cup allows for usage on flat surfaces such as glass while the vice clamp allows users to use it on rough surfaces or even vertical surfaces such as a door or chair. The versatility and simplicity of this device makes it appealing for all workers regardless of limitations who are interested in simplifying the thread cutting process.

Figure 12 - Blade Jig

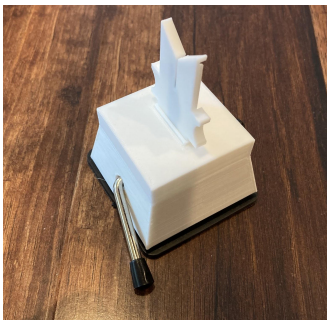


Figure 13 - Suction Cup

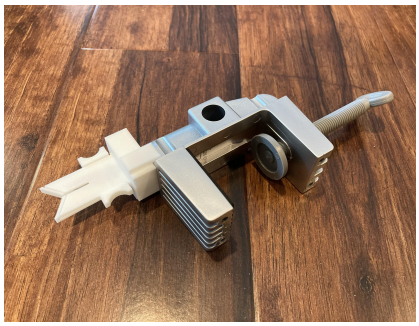


Figure 14 - Vice Clamp

E. *Clock In/Out*

The interface eliminates the need to read by implementing icons in place of words. Moreover, the program makes use of color-blind-friendly schemes, making the interface accessible for users with color vision deficiency. The minimal design allows workers to spend less time navigating through the program and more time on the job at hand. The clock in/out data points are automatically exported to an excel sheet, which can be emailed to an employer for review.

Figure 15 - SME Chooses Job and Clocks In/Out

VI. Assembly Process

Each individual component can be put together in order to create one cohesive system. The clock in/out program can be used to track worker hours in a sewing or embroidery task (supported by the trimming station). The bag opener and holder can be used to place the finished product into resealable bags and the label aligner will take care of the final packaging. Each of these devices require minimal assembly, as they were designed with the intention of simplifying parts and reducing the amount of steps necessary to put everything together.

A. Bag Opener

The bag opener itself requires no assembly. In order to operate the device, place the base on a flat surface and lay the ziploc bag on top of the base. Using the handle attached to the upper component, place it flat on the base. Proceed with a light sawing motion while keeping the two components parallel to each other and do not use too much pressure.

B. Bag Holder

The bag holder functions by placing one flap of the bag inside the open hanger clip. After it has been placed, slide the binder clip which is attached to the top of the hanger clip down to secure the bag. The handle of the binder clip that is closest to the stand should be pushed downward against the stand to reopen the hanger clip.

C. Label Aligner

In order to place a shipping label on the package, the label aligner should be placed on the face of the package. Slide the brackets until they fit snugly on the corner of the box. Place shipping label in the opening of the frame of the label aligner.

D. Trimming Station

The trimming station is made up of three main components: the blade holder, the cover, and the holder. The blade is first inserted into the blade holder. Next, place the blade holder into the cover to prevent the blade from being accessible to anything other than the threads. Since the covers are already attached to the holders, the last step is to simply attach the holder onto the work surface. This can be down by pushing down on the lever on the suction cup or screwing the vise onto a horizontal or vertical surface.

E. Clock In/Out

The clock in/out system program can be downloaded on any mac or windows device after installing python3. Pip3 pygame extension must be installed afterwards.

VII. Cost Analysis

Bag Opener and Holder		
Material	**Cost**	**Vendor**
Scrap Wood	$0.25	Home Depot
Glue	$3.50	Lowe's
Binder Clip	$0.90	Staples
Hanger Clip	$0.19	Walmart
Drawer Liner (5in x 3in)	$0.08	Amazon
3D Printed Stand	$0.65	Creality
Total	**$5.57**	

Label Aligner		
Material	**Cost**	**Vendor**
Wood Beam	$2.12	Home Depot
3D printed parts	$2.01	Creality
Wood Glue	$2.97	Home Depot
Total	**$7.10**	

Trimming Station		
Material	**Cost**	**Vendor**
Suction Cup	$1.50	Daiso
Vise	$1.50	Daiso
3D printed parts	$0.48	Creality
Exacto Blades (10 pc)	$1.99	Amazon

Total	**$5.47**	

VIII. Testing Procedure and Results

Students were able to formulate a testing procedure by conducting trials while simulating disability (such simulation typically included wearing thick gloves to simulate reduced dexterity and only using one hand). During the testing phase, we emulated the hand motions of those with impared dexterity by wearing mitten gloves, covering half of our vision view, and using one handed operations. Prototypes were based on our experimentations and iteratively designed to meet the needs of workers with disabilities.

IX. Community Impact

While the solutions that students developed are not immediately applicable to any one particular task at a particular company, these concepts can be easily adapted to create real world solutions. The promotional video shows an assembly process that integrates all the devices into a potential real world scenario that requires sewing faces masks, packing them into bags, and finally shipping them to other locations. The demonstration proves that our project has a potential to impact workers with disabilities all around the world.

X. Conclusion

Students expanded their design, engineering, and communication skills throughout the development of these assistive devices. They learned time management and organization in the documentation process. The Source America Design Challenge is a very hands-on project that requires proper communication, coordination, and organization. As a result, online collaboration proved to pose many challenges to the team. Because students weren't able to meet in person, the work flow and distribution of materials was often interrupted by time and distance. Although we were able to meet online and interact virtually, the end solutions, though ingenuitive, are less cohesive and much more of a patchwork of different ideas than they would have been in a normal year. Overall, the team succeeds in engineering assistive devices that have the potential to impact employees on an international scale due to their versatility and various applications.

XI. References and Acknowledgements

Students would like to acknowledge the following individuals for their support and guidance throughout the duration of the SourceAmerica Design Challenge:

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