



Hall of Fame Redesign

Engineering 215 Introduction to Design - Spring Semester 2019
Humboldt State University
Client: Zane Middle School

Design by: The Framed Four

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1 Problem Formulation

1.1 Introduction

In this section, The Framed Four created a background of the client and project, the objective of the project, and a black box diagram of our plans.

1.2 Background

Catherine L. Zane Middle School is a diverse institution that specializes in STEAM (Science, Technology, Engineering, Art, and Math) based curriculum. The Framed Four's client representative is Trevor Hammons, a Zane Middle School Counselor. The current design of the Hall of Fame is located in the front office of Zane Middle School and is asymmetrical in nature. The Hall of Fame Redesign is a project that is geared towards completely restructuring the clients current design to improve upon the aesthetics of the school and showcase the level of professionalism they convey.

1.3 Objective Statement

The objective of this project is to redesign the wall of staff pictures at Zane Middle School which currently has mismatched picture frames. Some of the requirements for this is it must be safe, sturdy, updatable every year, and include the awards and principal's picture. The Black Box Model, represented in Figure (1-1), models a simplified version of the design implementation will accomplish



Figure 1-1: The black box model gives a simplified overview of what the design implementation will accomplish.

2 Problem Analysis and Literature Review

2.1 Introduction

Section 2 of the document will describe the specifications, considerations, criteria usage, production volume, and literature review for the Hall of Fame project.

2.2 Problem Analysis

2.2.1 Specifications

The specifications for the Hall of Fame are factors that must be implemented in the design process. The following three specifications will be accounted for in the design process: the size of the design must be able to fit on a wall with dimensions 176 inch by 68 inch, the product must contain no sharp edges, and must be earthquake proof.

2.2.2 Considerations

Considerations are factors that will be considered when designing the Hall of Fame project. It is important to build the project around these considerations as they are vital for the project's success.

The first consideration for the project is the children and parents, who will be passing through the office and seeing the project often. Children also need to be considered for multiple safety reasons.

Another consideration is faculty. It is important to consider the faculty's ideas and visions when brainstorming the project because they are the people who will be around the project the most.

Considerations should be made for incorporating school symbols and colors when designing the project to add school spirit to the project. The design should also fit seamlessly into the environment it will be placed in. It should stand out just enough to catch people’s eyes, but not too much to distract the office staff or the people passing through.

The last consideration for this project is the fire alarm on the wall. This will need to be taken into account because it is in the middle of the wall and cannot be covered.

2.2.3 Criteria

The criteria for the project are the standards or classifications that should be present in the final product and found acceptable by the client. Table (2-1) below shows the list of criteria and considerations built by our team with input from Trevor Hammons and related office staff members.

Table 2-1 Criteria listed that will be considered during the building of the project.

Criteria	Constraints
Safety	Must comply with safety constraints set out by the client.
Aesthetics	Must exhibit a professional manner with creative aspects.
Accessibility	Must be easily updated by staff.
Durability	The project should be very stable and safely attached to the wall, so as not to fall. It also should be built to last 7-10 years.
Cost	The total cost must be within the \$400 limit.

2.2.4 Usage

The Hall of fame will be used by faculty to display their photos to the school, for the purpose of educating students on who their teachers and staff of Zane Middle School are. Over the years, faculty will be able to easily update the display as staff continues to grow.

2.2.5 Production Volume

Only one hall of fame redesign is needed for the office space.

2.3 Literature Review

2.3.1 School

The mission of Zane Middle School is to make sure that its students build upon their knowledge, their skills, and their ability to enhance their personal responsibilities within a nurturing community that can provide them with various learning opportunities structured towards the interests of middle-level learners. Zane’s main goal strives to serve the educational needs of all students with a focus on Science, Technology, Engineering, Art, and Math. Zane is a Magnet School focused on STEAM and is partnered with the community, including Humboldt State University, in an effort to enhance the students’ education. In an education based around STEM principles, HSU students are tasked with identifying meaningful solutions around Zane’s campus to enhance the educational experience for Zane Middle students and staff (Eureka, 2018).

2.3.1.1 Child Development

When children grow older, they develop in many different ways which can include physical, intellectual, social, and emotional changes. Children grow and mature at various different rates leading to big

differences in height, weight, and build among kids. Some children begin puberty earlier than other kids when they get close to becoming teenagers. (MedlinePlus, 2019).

In middle school, kids reach milestones in developmental at different times. It can be visibly observed in a middle school that there is variation in physical maturity. However, there can be certain cognitive or social skills that middle-schoolers are working towards developing by the time they reach high school. Middle school is a time of major social and emotional growth. (Morin, 2014).

Strong relationships are very important throughout life. A middle-schooler's social ties with family members, friends, teachers and their community can impact their mental, emotional, and even physical welfare. When growing up, kids learn the social skills they need to form as well as keep relationships with others. Although it is true that at any age people can learn ways to improve relationships. (Wein, 2018).

Middle school is needed to provide students in their early adolescence stage with a safe environment that can be used to help them figure out the impact of puberty on their intellectual, social, and emotional lives. (ASCD, 2019).

2.3.2 Building Materials

This section contains the following building materials: transparent covering, wood, paint, railings, and a pulley. This section will outline the main components of the project.

2.3.2.1 *Transparent Covering*

This subsection provides different options that are used in place of glass.

2.3.2.1.1 Plexiglass

Plexiglass, or poly(methyl methacrylate), is a transparent acrylic plastic commonly used as an alternative to glass (Smith, 2005). Since glass is twice as dense as plexiglass, acrylic is much easier to use, move, and handle (Seubert, 2018). Plexiglass is also a considerably safer choice as it has 17 times the impact strength of glass (acplasticsinc 2018).

2.3.2.1.2 Polycarbonate Plastics

Polycarbonate plastics are a lightweight, transparent thermoplastic that can be utilized in various ways such as impact resistant “glass-like” surfaces (Rogers 2015). Thermoplastics are polymers that soften upon heating, which allows for contorting, and then hardens once cooled (National Research Council 1994). Polycarbonate plastics are commonly used in place of glass because of their impact and shatter resistance.

2.3.2.1.3 Anti-Glare Coating

Antireflection coatings, which are put on a substrate, are typically comprised of multiple inorganic layers, like a metal or metal oxide layer and a silica layer (Hawa, 2002). With the use of anti-reflection coatings, first surface reflection losses can be reduced, improving the contrast and boosting the transmission through the glass (Evaporated Coatings Inc.). Antireflection coating films, which reduce the amount of light reflected from the glass surface, can therefore reduce reflections or “ghost” images formed (Hawa, 2002). Glass surfaces can reflect indoor room light or other light coming through a window. Additionally, various equipment may reflect the fluorescent/incandescent lights. This glare prevents the viewing of information and images, can cause squinting and potential headaches, and is efficiency reducing. (Liu, 1986). Anti-reflective coatings consist of thin transparent film structures and have layers of alternating contrast refractive indexes. The thickness of layers are chosen or changed so that they generate destructive interference, as well as constructive interference, within beams reflected from interfaces or corresponding transmitted beams. (Diamond Coatings, 2019). In Figure (2-1), there are two examples of before and after anti-glare coating after being applied to a window.



Figure 2-1: An example of the application of an anti-glare coating (Screen Solutions International, 2006).

2.3.2.2 Wood

Wood, in terms of construction, is a frequently used building material because of its durability and versatility (Heritage Builders Ltd 2017). Within this design, wood would be used in two separate ways: display casing and shelving. Depending on the stability of the structure desired, softwood or hardwood can be used. Softwoods are commonly used because they are cheaper and easier to work with. Hardwoods are utilized mainly because of their endurance and easy maintenance (Conners 2015).

2.3.2.3 Paint

Paint is any pigmented liquid that is used to provide color to an object. To get the desired appearance for the project, matte, satin, and gloss paint can be used. Matte paint provides a smooth coating and can cover any faults the surface may have. Satin paint reflects more light and is more susceptible to wear. Gloss paint is durable and has a higher capacity for moisture (Fivestarpainting 2018). Figure (2-2) gives an example of the different types of paint side by side (Lamaisson Gourmet 2019).

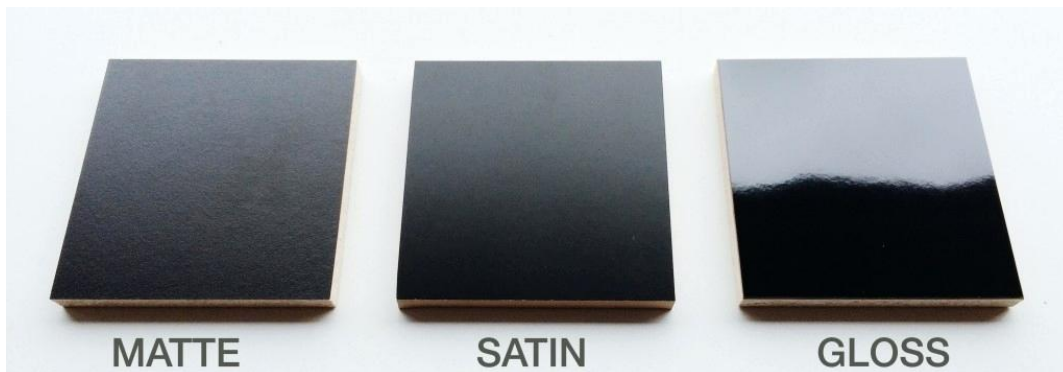


Figure 2-2: An example of the different types of paint side by side (Lamaisson Gourmet).

2.3.2.4 *Railing*

Manufacturers of higher-quality units have made installation simple and straightforward. A roller assembly is adjusted to be clicked in and out of a channel in the sliding frame closure, like door or window closures. The roller assembly is comprised of an outer static frame with a pair of equally positioned slots to allow frictional and mechanical movement of the roller inside the channel, so the frame does not fall out and stays in the track as seen in Figure (2-3). The removal and replacement of the roller assembly can be accomplished with minimal skill and equipment, in a timely fashion. A roller assembly of simple, yet also durable design can be easily mounted and dismounted from the frame of the sliding closure (Dallaire 1981).

Plastic tracks can be installed so that the doors stay vertical and aligned in their upright position as seen in Figure (2-4). Sliding doors usually are built with one movable section and one fixed section of the door. However, sliding windows are basically smaller versions of this. Since they are lighter in weight than sliding doors, sliding windows don't necessarily need to have rollers—their frames simply glide along the tracks. Adjustable rollers can be used so that doors slide easier across the tracks (HomeTips LLC 2019).



Figure 2-3 Rollers that can be imbedded in sliding doors (FamilyHandyman)

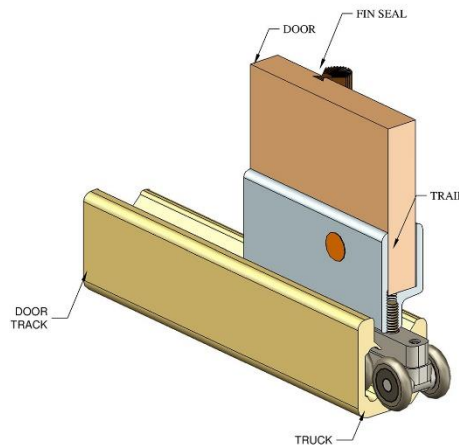


Figure 2-4 An example of rollers attached to a door in its set track (BoatOutfitters)

2.3.2.5 *Pulley System*

A pulley is a simple machine that includes collection of wheels over which a rope is looped to multiply forces making lifting heavy objects easier (Woodford 2018). One wheel in a pulley reverse the direction of force so that lifting an object up requires downward force on the rope but do not reduce the force required to lift the object. Using more wheels reduces the force needed to lift an object which is called mechanical advantage. Mechanical advantage is a measurement of how much a simple machine can multiply force. (Woodford 2018). The Mechanical advantage of a pulley system is equal to the number of ropes supporting the load. (Fritts 2017).

2.3.3 Drywall

Drywall is a compound made up of talc, calcite, gypsum, silica, limestone, dolomite, mica, perlite and water (Beach 2019). Drywall is thin and not strong enough to hold many heavy objects. Drywall is typically attached to wooden 2x4 or 2x6 beams called studs (Stansley). Studs are typically spaced about 16 - 24 inches apart measuring from the center of each stud and on either side of windows (Stansley 2014). When attaching lightweight objects (20 pounds or less) to drywall, standard picture hangers or wire hangers can be hung safely. For medium weight items (20-40 pounds) a spreading type ribbed plastic anchors or threaded anchors would be necessary. Anchors will be discussed in a future section. For heavy objects (over 40 pounds) a fastener that distributes the weight behind the wall is required (Lipford 2009).

2.3.3.1 Wall Mounts

One possible way to hang heavy objects using wood is to use three horizontal wood pieces. One piece of wood should be installed at the top, another in the middle and the final one on the bottom of the cabinet or large case that is being hung and screw it to the wall directly into the studs (Almward 2019).

There are many different types of wall anchors that can be used to hang items of different size and weight. Metal picture hangers are angled nails that fit in a hook to increase their holding power. Metal picture hangers are typically inexpensive and available in a wide range of sizes and they support between 40-60 pounds in drywall (Lipford 2009). Another type of anchor is plastic anchors; however, these plastic anchors do not provide as much holding power in softer surfaces like drywall (Lipford 2009). These anchors work by being hammered into the wall and then flaring out behind the wall once a screw is inserted to hold the item in place. The next type of anchor is threaded anchors which are mainly used for drywall, with their threads providing increased holding power to support up to 80 pounds (Lipford 2009). Molly Bolts are inserted in a hole drilled in the wall or can be hammered directly into drywall without drilling and increase holding power by tightening up the bolt, which causes the casing to expand behind the wall. Molly bolts achieve their holding power by supporting over 100 pounds, however, often spin in drywall when being tightened and are impossible to remove once installed. (Lipford 2009). Threaded toggles are easy to install but hard to remove and safely supported over 200 pounds in drywall. However, they often leave a big hole in the wall, and are expensive. (Lipford 2009). Toggle bolts support over 300 pounds in drywall and require an oversized hole in order to insert the spring-loaded fastener. (Lipford 2009).

2.3.4 Electrical

Electricity is defined as the flow of electrons through a wire. In electrical conductors, a current result from the movement of electrons from one atom to the next. Electrons are either positively or negatively charged and negative electrons are attracted to positive electrons. (Thiele 2018). Current is defined as two types: alternating current (AC) and direct current (DC). Alternating current is the form of electricity that operates lights, appliances, and outlets. Direct current is the form of power provided by batteries. (Thiele 2018).

2.3.4.1 Wiring

There are many different types of wiring that can be used when working with electricity. One type of wiring that is often used for interior circuits such as outlets, switches, light fixtures, and appliances is non-metallic sheathed cable (Romex) (Thiele 2019). These cables are typically made of three or more wires wrapped in a flexible plastic jacket. White-sheathed non-metallic cable is used for 15-amp circuits, while yellow non-metallic cable is rated for 20-amp circuits (Thiele 2019). Another type of cable used is direct burial cable. This cable is typically used for outdoor work and is then installed underground. These cables are made of conducting wires embedded in solid vinyl to fully protect from moisture (Thiele 2019). When connecting electricity, it is important to match the colors of wires and to install the copper ground wire to the green grounding screw.

2.3.4.2 Display Case Lighting

Accent lighting offers an extra spotlighting which can be used for highlighting something special. Accenting light allows for the opportunity to focus attention on a specific area or object in the room while

not acting as a main piece of lighting for the room itself as seen in Figure (2-5). Many modern accent lights today can fit under a cabinet, high up on ceiling molding, and into tight spaces. Being LED accent lights as well means it won't be necessary to change lights that are hard to reach often. (Lumens, 2019).

A phenomenon called voltage drop occurs when the beginning of a length of Flexible LED strip appears brighter than at the end of the strip. After a distance of about 25 feet, there is a noticeable voltage drop. One way to minimize this drop is to split the strip into lengths that are less than 25 feet. In ideal circumstances, LEDs are rated for 50,000 hours (about six years) of continuous use. LED lights do not contain mercury in them and can be recycled. They are safer than fluorescent bulbs, which do contain mercury in them and are hazardous when broken. (LED Distributors, 2019).

Light strips can be curved or cut, and then connected to fit any length, like longer distanced sections of wall that could be expensive to properly light up. Built thin, with a low profile and adhesive backing, these lighting strips can stay completely hidden but still provide lighting directed at the target object. More importantly, these lighting strips can be taken down, reassembled or reconfigured as a business grows or when needed (Flexfire, 2018).



Figure 2-5 An example of accent lighting (Indiamart).

2.3.4.3 Sound Board

Speakers are measured in units that describe the resistance presented by a speaker and is interpreted by the amplifier. With many different types of speaker systems, there are both 8-ohm load and 4-ohm load. Drawing more power than the amplifier was designed for will often damage the amplifier. It is necessary to bridge amplifiers together when connecting multiple speakers to play the same type of sound. When bridging an amplifier, the + terminal from one channel and the - terminal from the other are used to connect the amplifiers together, causing the output to be 4 times the power of a single channel on the amplifier. When wiring speakers together, it is important to use speaker wire instead of cheaper electrical wire (LaLena 2019).

2.3.5 Picture Frames

2.3.5.1 Recycled Wood Frames

The directions included in this subsection for building a single recycled picture frame are designed to house an 18x24 canvas but can be easily altered to fit the necessary dimensions. The materials necessary to construct the picture frames include two ten-inch long recycled 2x4s, frame mounting hardware, a saw, a drill, two and a half cm screws, four cm screws, wood glue, and wood filler (Georgia 2012). After getting these materials, the next step is to cut the 2x4s so there are two 31cm pieces for the top and bottom, two 18 cm cut pieces for the sides, two 31cm pieces for the top and bottom trim, and two 28 cm pieces for the side trim. After these are cut, the next step is framing. Start by connecting the two 18cm side pieces with

the two 31cm top and bottom pieces. Use the four cm screws, and glue, to drill through the top of the top board and the bottom of the bottom board and into the sides. The next step will involve adding the trim. Drill through the trim and into the frame with two-and-a-half cm screws and glue. The trim should be flush with the right and left sides of the frame as well as across the back. Make sure the side trim is flush with the edges of the top and bottom trim, and attach the side trim the same way as the top and bottom trim. The next and final step includes adding finishing touches. Sand all the wood down so it is smooth. There are multiple options for finishing the frame. It is possible to coat the frame with any color of paint. It is also possible to cover the frame with art. This picture frame does not include glass in it, so the picture would be nestled inside the frame (Georgia 2012).

2.3.5.2 *Upcycled Wood Frames*

These steps will describe how to make a picture frame out of new materials. The materials needed are picture frame molds, which can be bought on Amazon or in a local craft store. Another material includes a meter box with a hand saw. A meter box is a wood working tool that is used to guide a hand saw in order to make precise miter cuts in a board. Miter boxes are typically 3-sided boxes with an open top and ends. The box is made wide enough to accommodate the width of the boards to be cut. Miter boxes can be bought on Amazon or eBay or in a local hardware store. Their prices for miter boxes start as low as \$3.00, and can get as expensive as \$70.00 (Midland Hardware). More materials needed for this project include clamps, wood glue, a heavy-duty stapler, a light-duty stapler or small nails, sawtooth picture hangers, a hammer, a piece of cardboard, and 150-grit sandpaper. Before cutting, it is important to tightly clamp the miter box to a sturdy tabletop, to ensure a durable cutting environment. There are two ways to cut the wood the miter box. These ways include cutting the wood at a 90-degree angle and cutting it at a 45-degree angle. This project will include cutting the piece of wood at a 45-degree angle in the miter box. The next step is to measure how long the piece of wood should be. Depending on what goes inside it, the size will vary. To do this, simply use what will go inside the picture frame to figure out how long it should be. Draw a line on the wood on the thinner side of it. Once the line is drawn, it is time to cut the other side of the piece of wood. Cut the wood where the line was drawn when it was measured. Begin where the line is drawn at the thinner side of the wood. This will be cut at a 45-degree angle, so the thinner side of the wood has a smaller length than the thicker side. It is important to cut the wood at the right 45-degree angle; an incorrect cut will prevent the wood from being useful in this project. These measuring and cutting steps will be repeated for all four sides of the picture frame. Once this is completed, it is time to glue the pieces together. Use the wood glue to attach all four pieces of wood together and use the clamps to hold them shut when they dry. Once the frame is dry, use a heavy-duty stapler on each back corner to attach the frame pieces for extra protection. The next step is to attach picture hangers. Use sawtooth picture hangers and attach them to the top center of the back of the picture frame. These can be placed on the top and on the side, for use in both orientations. This depends on what picture goes into the frame. The next step is to sand the frame, where there may be visible dried glue or where the corners are sharp. Next, cut out a piece of cardboard that is the same size as what will go into the picture frame. The next step involves using a light-duty stapler to attach the cardboard and the picture to the back of the frame (Appiah, 2018).

2.3.5.3 *Plastic*

Plastic is any material containing a vast array of synthetic or semi-synthetic organic compounds that are malleable and can be sculpted into solid objects (Teegarden 2004). There are a couple different types of plastic picture frames, including imitation wood frames and clear acrylic frames.

Imitation wood frames are made of polystyrene, a dense, substantial plastic that is easy to cut and screw into. Imitation wood frames are usually half the price of comparable wood frames yet are indistinguishable from regular wood frames when hung on a wall (Framing4Yourself). Stores that sell imitation wood picture frames include, the Dollar Tree, Target, Home Depot. Online stores include Amazon, Etsy, and eBay.

Acrylic or plexiglass is made of synthetic plastic chemicals, including polymethyl methacrylate (PMMA). It is used in picture frames because it is more durable than glass and it is less expensive to ship

(Kanerva 1997), (YourPictureFrames). Stores that sell acrylic picture frames include Crate and Barrel, Target, Michaels, and online stores include Amazon and eBay.

3 Search for Alternative Solutions

3.1 Introduction

Alternative solutions for the Hall of Fame Redesign have been generated through creative brainstorming sessions with all the members of the Framed Four. The solutions were made to meet the specifications and criteria of the Hall of Fame Redesign and its clients. There are eight total alternative solutions created.

3.2 Brainstorming

The Framed Four met for a one-hour meeting to collaborate on different design ideas for the project. The session was conducted by one facilitator who wrote down each member's specific model. After each idea was specifically listed, the group then condensed the options down to eight alternative solutions. By doing this, the group was able to analyze whether each idea hit the criterion for the project. These eight alternatives will then be condensed further for a final design.

3.3 Alternative Solutions

The following alternative solutions have been collectively created through a group brainstorming process. These solutions have been thought out and compared to the criteria the client representative listed. Each alternative solution was then critiqued by the client representative and other staff that are directly related to this project. The planning was done through a model office and each alternative solution was then placed inside the model and compared to the surroundings to confirm it matches the room aesthetically and dimensionally.

3.3.1 Large Display Case

The large display case functions as a container to hold the picture frames. The goal of the large display case is to make the picture frames and the wall have a professional appearance while still maintaining the order and functionality of the current picture frames. The large display case would be made up of multiple 2x4 wood planks to create the frame and plywood to create the back wall. This meets the safety criteria by providing multiple secure places to mount the case to the studs in the wall for maximum durability and making it resist earthquake disasters. The front of the display case would be made of plexiglass mounted on rails so that it can be opened easily by sliding the glass along the rails. The glass would then open each section separately which further fulfills the accessibility criteria. The sliding glass could also contain a lock at the opening point to make sure the case stays closed and is only accessed by faculty but is not necessary. The pictures inside the display case would be enclosed in individual picture frames that are the same size. An example of the type of display case that would be used to contain the picture frames can be found in Figure (3-1).



Figure 3-1 Environmental Resource Engineering Large Display Case in Science D

3.3.2 Small Display Case

The small display case includes two to three individual display cases to be placed on the wall. There will be a small display case, which will hold the pictures of the administrative staff, as well as a larger display case to go below the small one, that will hold the teachers and additional faculty. The principal's display case will go on the top of the wall, with the second display case of administrative staff below, and the third display case of teachers and secondary staff on the bottom. The simple design for each display case includes a plywood backing to be drilled to the wall, a plexiglass front to display the pictures, and wood siding to connect the front and back. Every picture will live in identical frame sizes and every frame will be nailed to the plywood. To increase the aesthetics, there is an option of finding frames or painting frames to match the school colors.

Each variation pointedly adheres to the safety and accessibility criteria set out for the product. The glass of the principal's display case will have hinges on the left side, to open and close the glass like a door, with a lock on the bottom right. The glass of the display case of administrative staff will have hinges on its bottom and will open like an oven. There will be a lock on the top right to keep the picture in place. The largest display case, with the teachers and secondary staff, will accommodate the most pictures and therefore requires the most plexiglass to display those pictures. There will be two glass sheets on the front to display the picture frames. They will have wheels on their bottom so they can easily roll to open. The glass sheet on the left side will sit in front of the glass sheet on the right, so they do not interfere when each one slides open. This meets the accessibility criteria because it will make replacing the pictures every year simple and easy. This display case will have two to three rows of pictures inside it. There are 50 total teachers and secondary staff. See Figure (3-2) for a drawing of this alternative solution.

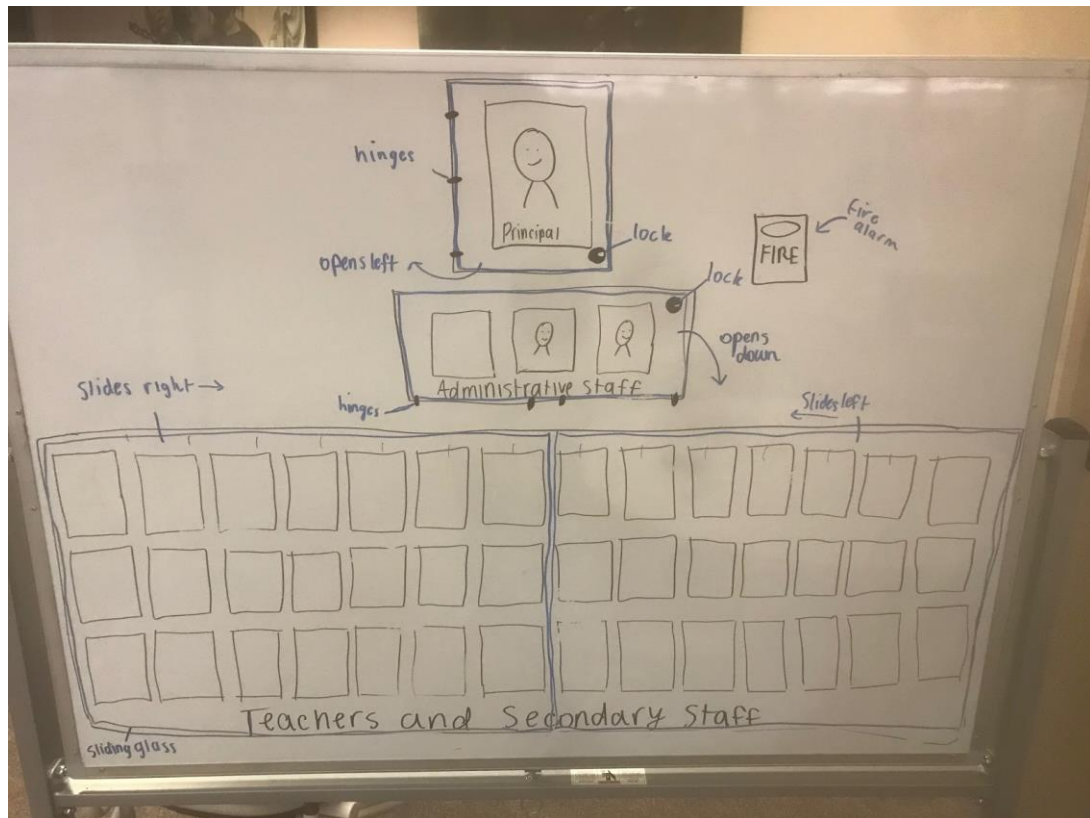


Figure 3-2 Shows a drawing of the possible layout for the multiple display cases.

3.3.3 Collage Wall

The collage wall would be created utilizing different sizes of picture frames to assemble a unique formation against the wall. Figure (3-2) shows a possible layout, of many, that the pictures could form into. For this design, picture frames would be obtained from several outlets, not necessarily similar in color or shape. In addition, this design would incorporate a coding system with the pictures, so the staff would be able to easily access the pictures and replace them. The coding system, in this case, would incorporate attaching a number to the wall and the same number to the back of the frame. This model will be able to last them multiple years and does not pose any dangerous situations for children meeting the durability/safety criterion of the project.

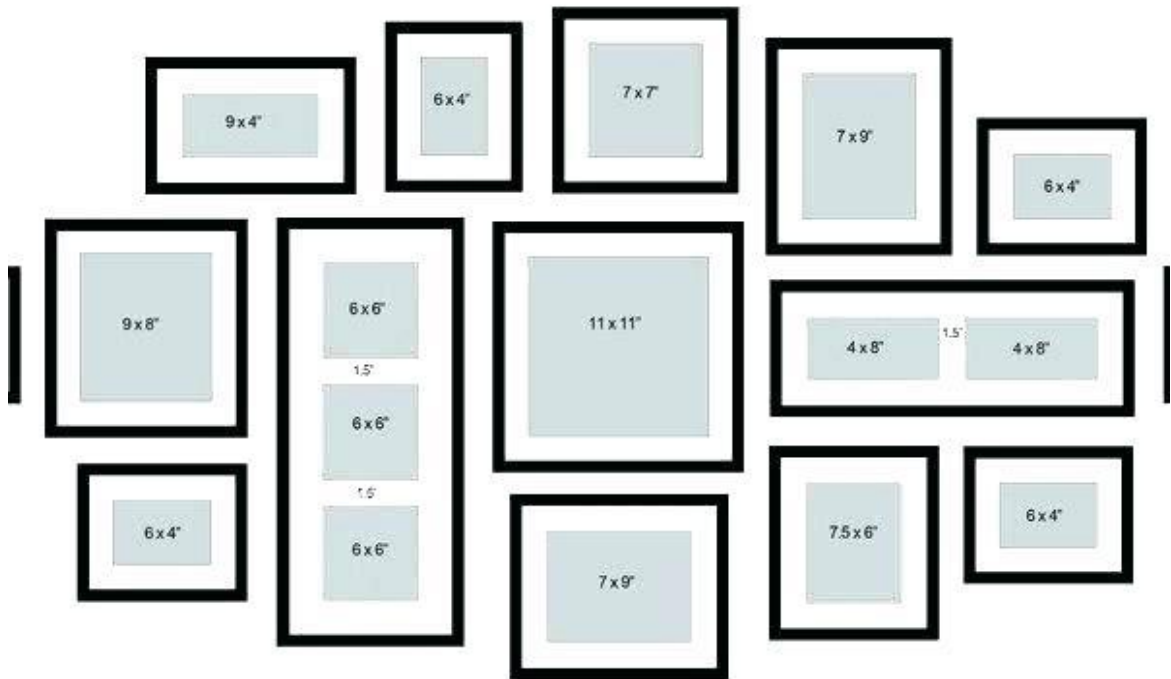


Figure 3-3 A layout for a possible collage wall that would include the staff's photos (Iniciativapenalpopular 2018)

3.3.4 Z Design

The Z design would include three evenly arranged rows of staff photos with the principal and admin stacked on top. The symmetry of this model would specifically meet the aesthetics criterion of the project. For this design, most of the picture frames would be painted yellow or black with picture frames in the middle of the rows painted red to form a “Z”. The “Z”, in the case, would represent Zane Middle School. This model would last them multiple years meeting the durability criterion of the project. In addition, there would be two falcons on top of the rows on either side of the principal and admin to personify the school’s mascot.

3.3.5 Hanging Pictures

The hanging pictures alternative solution is designed to hold the pictures in place while allowing for pictures to be changed or moved easily. The design of the hanging pictures incorporates multiple levels of string stretched across the wall with some slack in the string. The string would be tied around a screw that would be sticking out slightly from the wall. The pictures would then be hung on the string using clamps or clothespins as seen in Figure (3-3). This design does not require complex mounting systems and a simple screw or anchor would be able to support the pictures which means this solution automatically meets safety requirement of resisting earthquakes. The screws would not be a safety hazard and still meet the safety criteria because they would only stick out of the wall enough for the string to be tied to and no more than is necessary. Each picture would not be in a frame to reduce weight and allow for more convenient mounting. This design follows the accessibility criteria by allowing easy switching and moving of pictures once they are hung. The pictures could be hung in alphabetic order or any order that is desired.



Figure 3-4 A creative picture hanging design (Kboury 2019).

3.3.6 Adapted Artwork

This adapted a is solely based on making the office space more fun and livening up the framed photos of staff. It is geared towards kids and parents and to catch the eye of anyone entering the office. The idea for the design is to have multiple large frames placed on the office wall, where the frames of staff are currently. The pictures within the frames would be very recognizable and famous art pieces, as seen in Figures (3-5, 3-6, 3-7). However, the faces of each art piece would be replaced with the faces of the faculty. Below each piece, a plaque that lists which teachers are in the art piece and information about the art or artist would be included. The famous artwork would be scaled up or scaled down to specifically fit the proportions of the photos, since all the staff photos are 5x7. The frames have the potential to be upcycled frames, bought from thrift stores, or hand crafted out of recycled or new materials, all of which fall well within the \$400 price range constraint. For the purpose of safety, as well as durability, the frames would be wood and sturdy enough to last many years. Aesthetically, these paintings would be very distinct and noticeable from anywhere in the room, and humorous in design, as well as adding a pop of color to the office walls. It also will allow for kids to view the plaques under the art and be engaged with not only their staff members, but also learning about the art they reside in, adding educational value to the Hall of Fame Redesign.



Figure 3-5 *American Gothic* by Grant Wood, where the pictured couple could have faces replaced with staff members.



Figure 3-6 *Mona Lisa* by Leonardo da Vinci, an example of a larger photo that could have Zane Middle's principal put on it.



Figure 3-7 *Dogs Playing Poker* by Cassius Marcellus Coolidge has multiple places where dogs faces can humorously be replaced with faculty faces.

3.3.7 Bobblehead People

The alternative design of using bobbleheads in place of picture frames, where the faculty's faces would be cut from their photos and placed on the faces of bobblehead people figures. The teachers and staff could pick their own individual bobblehead character that their face would go on. This leaves variability in what bobbleheads are chosen and give the teachers more freedom in portraying their own likes and interests in a strange and expressive way. The bobbleheads can range from famous athletes, scientists, and artist to cartoons, superheroes, and even book characters like in Figure (3-8). Depending on where the bobbleheads are bought from, this design can potentially be within the \$400 price range, but in general this design would

exceed the price range. These bobbleheads are easily replaced or updated when new staff members are added or removed in future years as the staff photos are just placed on top and their names can be displayed under the bobbleheads. Aesthetically, these bobbleheads would draw in the attention of anyone entering the office with their quirky appearance and style. They become conversation starters and can engage students to learn more about the interests of their teachers, bringing a social aspect to this design.



Figure 3-8 A superhero bobblehead character that a teacher could place their staff photo on.

3.3.8 Giant Picture Frame

The giant picture frame will act the same way it sounds. There will be a giant border, with a plexiglass sheet under it, and with backing to attach the pictures. The staff pictures will go under the Plexiglass sheet and form a collage looking format. The pictures will go in alphabetical order. See Figure (3-9) for an example drawing of this alternative solution.



Figure 3-9 Depicts a drawing of the desired layout for the giant picture frame solution.

4 Decision Phase

4.1 Introduction

This section of the document will use the Delphi method and the criteria listed in section II to make a final decision. The choices for this decision come from the alternative solutions described in section III.

4.2 Criteria Definition

The following criteria (Table 4-1) were defined in section 2.2.3 based on the client's specifications. These criteria were used when choosing the final design.

Table 4-1 Specification of Client Criteria

Criteria	Constraints
Cost	Must have a total cost within a \$400 limit.
Safety	Must comply with safety constraints set out by client. Must not have sharp edges and must be earthquake proof.
Aesthetics	The way the project looks is must appeal to the faculty, parents, children, and client and should have some aspects of organization.
Accessibility	The project must have pictures that can be easily replaced and updated.
Durability	The project should be very stable and safely attached to the wall, so as not to fall. It also should be built to last 7-10 years.

4.3 Decision Process

As seen in Table (4-2), the criteria and the weight of importance are listed to help with the Delphi method. The decision process for this project heavily incorporated the Delphi method. The Delphi Model used for this project, as shown in Table (4-3) operates by weighing each of the criterion on a scale of 1-10, with 10 being the highest, to describe how important each criterion is to the final design. Then, on a scale of 1-50, with 50 being the highest, is assigned to each alternative solution to identify how thoroughly each solution contributed to the criterion provided. The weight score is then multiplied by each respective alternative solution score. From there, all the numbers for each solution are added together to form an overall total, which showcased each solutions capability to satisfy all of the listed criterion. Utilizing the results of this model, the solutions with the highest scores were then analyzed for the final design.

Table 4-2 Criteria and Weight

Criteria	Weight (0-10)
Cost Efficiency	8
Safety	10
Aesthetics	9
Accessibility	8
Durability	6

Table 4-3 The Delphi matrix used for the Decision Process

Criteria	Cost Efficiency	Safety	Aesthetics	Accessibility	Durability	Total	
Weight (0-10 high)	8	10	9	8	6		
Alternative Solutions (0-50 high)	Large Display Case	40	45	30	40	40	1600
	Multiple Display Cases	35	40	35	40	35	1525
	Bobble Heads	10	5	30	20	30	740
	Collage Wall	40	15	40	25	35	1240
	Z Design	40	15	50	25	35	1330
	Adapted Artwork	40	15	20	20	33	1008
	Giant Picture Frame	35	40	15	23	40	1239
	Hanging Pictures	50	40	10	45	20	1370

4.4 Final Decision Justification

The design model that was chosen as the Hall of Fame Redesign project’s final design is an amalgamation of the top scoring alternatives. The designs that earned the highest scores using the Delphi Matrix method to assess the project's ability to meet each part of the criteria were the large and multiple display cases, and the art aspects of the Z design were favored as well. The twin flying falcon feature mixed with the durability of the display cases option make it both appealing to the client and meets functionality for the project, compared to the options that scored very close. Therefore, the team chose to combine the top two high scores as the most liked art aspects will satisfy each of the weighted criteria, making it the final decision for the Hall of Fame Wall.

5 Specification of Solution

5.1 Introduction

Section 5 is an analysis of the final design, including a consideration of four of the main components in the design. This section includes a detail on total costs in terms of money and work time, of the project itself and its implementation, as well as a report of the results of the project’s performance.

5.2 Solution Description

The solution description will review and describe different elements of the final design and provide illustrations of the said elements.

5.2.1 Wall

The dimensions of the wall that the frame is mounted on are 176 inches across and 68.5 inches tall. There are two objects on the wall that needed to be considered when designing; the fire alarm and the motion sensor. The fire alarm is 5 inches by 4 inches, while also being 27 inches from the top and 104 inches from the left. In addition, the wall connects to shelving that the client will be using frequently even after the design is mounted. A rough sketch of the wall can be seen in Figure (5-1).

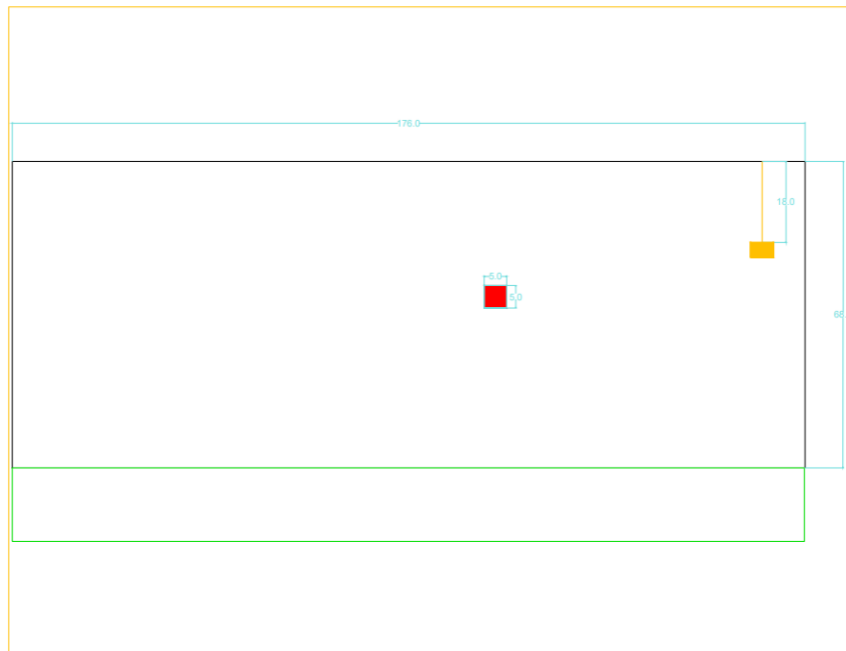


Figure 5-1 AutoCAD Drawing of the Dimensions of the Wall (Generated by Anissa Stull)

5.2.2 Frame

The frame is a large frame made of wood that is 4x14 feet and is designed to house the staff and faculty picture frames as seen in Figure (5-2). The backing of the frame is made up of two sheets of CDX plywood that are each 7x4 feet. The plywood is $\frac{3}{8}$ inch construction grade. These two sheets of plywood combine to make the back end of the frame equaling a total of 14 feet. A hole was cut where the previously mentioned fire alarm is located. The borders are made of 2x4 boards built into a rectangle and attached to the plywood sheets. The dimensions of the rectangle board are 4 feet tall on the sides and are cut at 7 feet to match the plywood sheets' dimensions. The frame is painted with a dull black paint and red, yellow, and white paint were used to create a splatter effect along the background. The frame can be mounted on the wall by drilling through the back of the plywood and into the studs behind the wall at multiple intervals along the length to make it more secure and earthquake proof.

The Framed Four

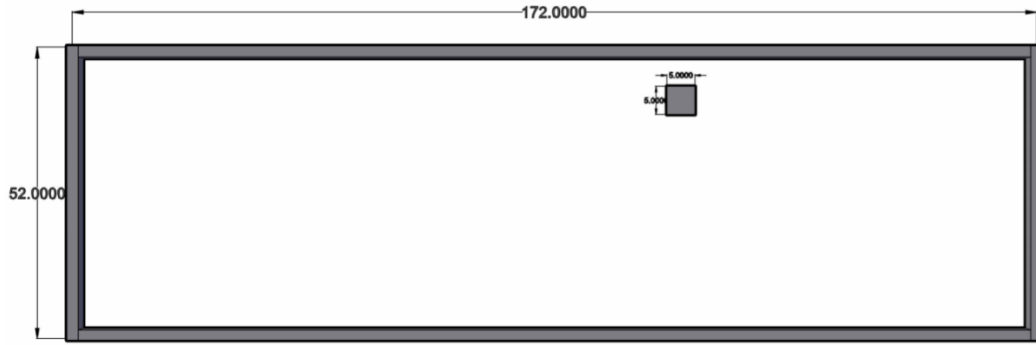


Figure 5-2 The Frame drawn in AutoCAD (Generated by Andrew Kizer)

5.2.3 Picture Frames

There is a total of 56 picture frames inside the display case, organized in four rows of fourteen. These frames are 8x10 and have a silver and black border as seen in Figure (5-3). There is a matte inside each frame which alternates from yellow to white, to add an aesthetic aspect while also incorporating the school colors. The pictures inside the frames are 5x7, and inside the display case there are 50 frames of faculty members, which are the teachers and the secondary staff. The frames are hung up on small nails that are attached to the plywood backing. Above the display case, there is a single row of four picture frames. In these frames live the three assistant directors and the principal. The principal's photo is an 8x10.

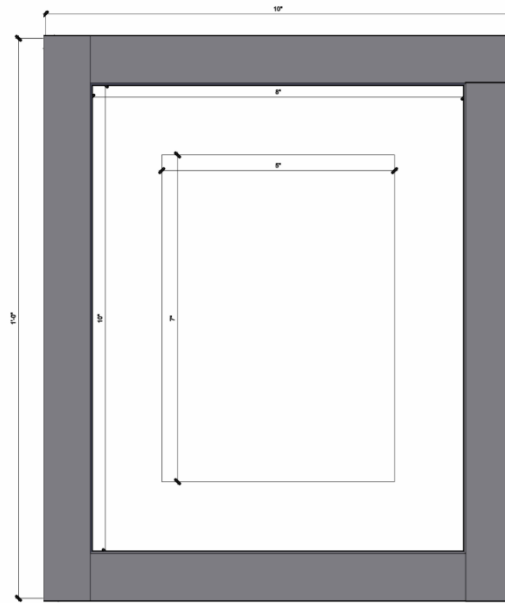


Figure 5-3 shows an AutoCAD drawing of the picture frames (Generated by Grace Johnson)

5.2.4 Wings

There are two spread falcon wings to be placed on either side that are 15x35 and are covered in painted feathers made by students at Zane Middle as seen in Figure (5-4). The feathers are 4x2 and overlap each other to give a realistic look to the wings. The feathers are in alternating colors of yellow, red, and white, as they match the school colors of Zane. They are made of cardboard and paper and are hung above the entire display case next to the principal and counselor's photos.

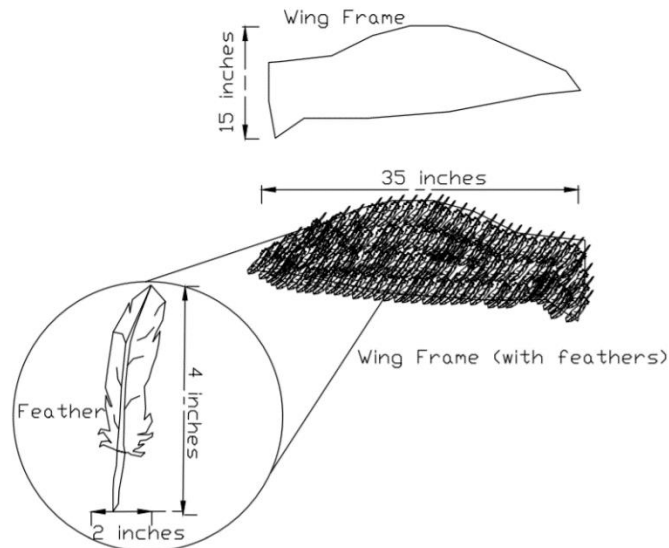


Figure 5-4 AutoCAD drawing of the paper wings and feathers (Generated by Alex Halter)

5.3 Cost Analysis

The costs for the overall design are explained within this section, which includes: design hours, implementation, and maintenance costs for the Hall of Fame Redesign.

5.3.1 Design Costs

Figure (5-5) breaks down the total design hours into a pie chart. These hours account for the overall time The Framed Four spent working on this project, which encompasses researching and building. Overall, the team spent # hours working on the Hall of Fame.

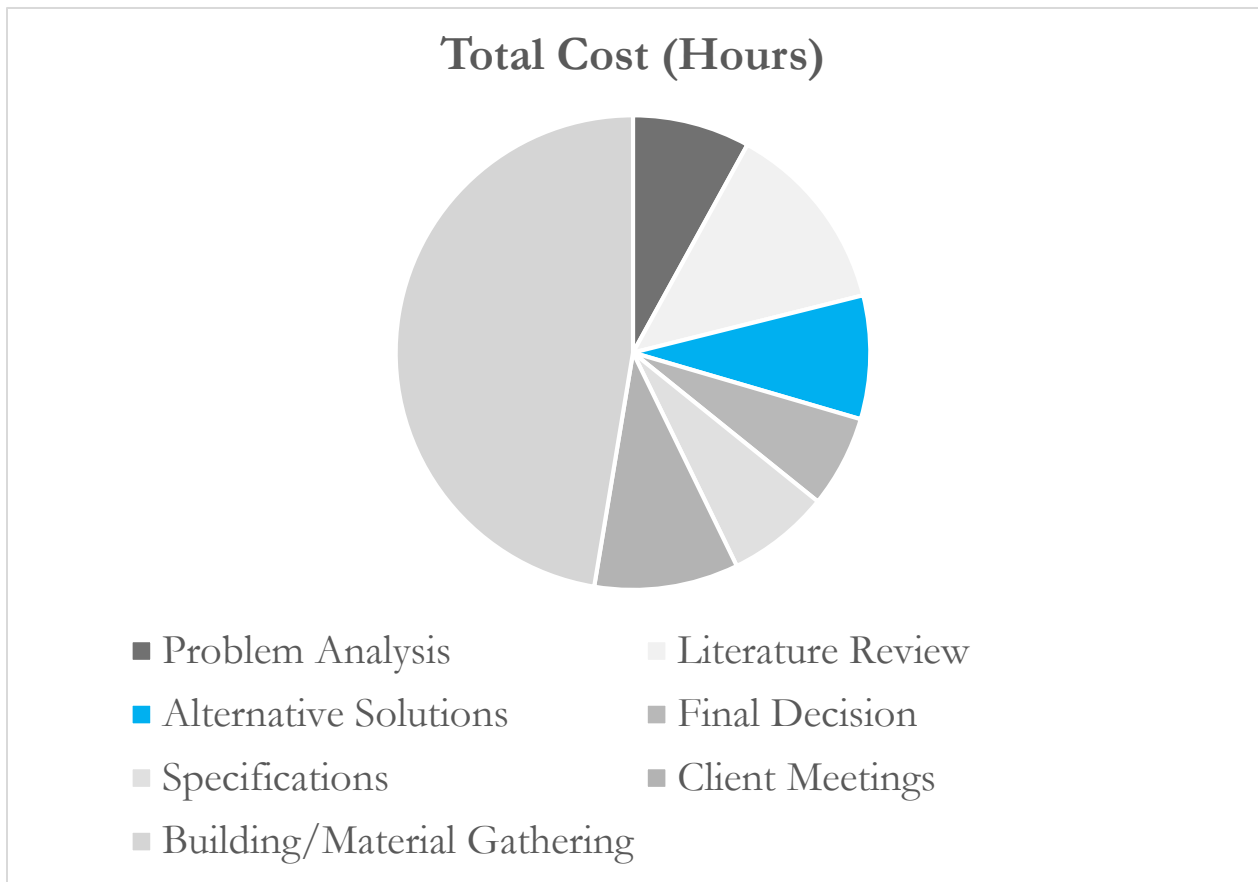


Figure 5-5 Amount of design hours spent on each area by all team members

5.3.2 Implementation Costs

The cost of construction for the Hall of Fame Redesign is summarized in Table (5-1). This cost for the team totals \$181.59.

Table 5-1 Breakdown of Implementation Costs

Item	Quantity	Cost
Picture Frames	60	\$99.02
Paint Rollers	20	\$3.50
Paint Brush	1	\$4.25
White Mistint Paint	1	\$1.99
Yellow Mistint Paint	1	\$4.99
Red Paint	1	\$13.99
Black Paint	1	\$31.99
Wood Boring Bit	1	\$4.99
Jigsaw Blade	1	\$2.59
Sandpaper	1	\$2.39
Drywall Screws	40	\$3.79
Hardware Screws	30	\$8.10
2x4 Wood Plank	8	Donated
7x4 Plywood Sheet	2	Donated
Total		\$181.59

5.3.3 Maintenance Costs

Table (5-2) analyzes the amount it would take to sustain the design throughout the years. Overall, the design requires minimal maintenance averaging a total of \$23.99.

Table 5-2 Maintenance Cost Breakdown

Task	Frequency	Quantity Needed	Cost
Paint Job	Every 7-10 Years	1 Quart	\$13.99
Replace Picture Frames	Every 7-10 Years	10 Frames	\$1.00 per frame
Replace Velcro on New Pictures	Yearly	56 Dots	Provided by Team

5.4 Maintenance and Implementation Instructions

The display case will be updated every year. In order for that to occur, the pictures inside the frames need to be replaced with those of the current school year. The picture frames will be hung up on a small nail, which will be attached to the plywood backing. That way, the pictures will be easy to access and replace with each school year. For convenience purposes, there will be numbers written on the back of each frame which will coordinate to the name of a staff member. The staff will be organized in alphabetical order, beginning with the teachers, and ending with the secondary staff. Ways to maintain this display case would be to replace picture frames, or to repaint the backing. This display case is designed to last for a long time and will not need much maintenance.

5.5 Results

An entire display case was delivered and installed at Zane Middle School as seen in Figure (5-5). This case encompasses all of the staff and faculty pictures. The pictures within the display case will be changed on a yearly basis as the staff update their pictures. Overall, the design was a success, elevating the professional environment of the front office and exceeding our client's needs.



Figure 5-6 The final design on display at Zane Middle School

6 Appendices

6.1 References

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