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**Team T.A.L.K. presents...**  
**THE NOT A BENCH BENCH**



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# 1 Problem Formulation

## 1.1 Introduction

Section One shows the team's objective statement and the Black Box Model for the project. Team T.A.L.K. uses the Black Box model, as seen in Figure 1-1, to try and solve the problem of the Rectangle of Doom at Zane Middle School.

## 1.2 Background

Catherine L. Zane Middle School located in Eureka, California, caters to a large and diverse population of students. Humboldt State's Environmental Resources Engineering Department and Zane Middle School have worked together to tackle different projects on Zane's campus. As of Spring 2021, the Rectangle of Doom is a large space located in front of the gym and other academic buildings, where students get dropped off and picked up before and after school. The students will walk through the space and track mud and dirt throughout the rest of the campus. Zane Middle School wants this space to become an aesthetic and safe place for their students. Trevor Hammons is a counselor at Zane Middle School with an interest in solving this problem. He has worked with a number of teams who have tried to come up with solutions but few have been successful so far. Previous teams tried using planters and benches, but students continued to walk through the plants and the benches had sharp edges, so both were deemed unaesthetic or unsafe, and removed. While a couple previous projects were successes, the Human Sundial, from Spring 2017, for example, and are still present in the Rectangle of Doom today, the previous projects only take up a small portion of the Rectangle and have not completely solved the problem.

## 1.3 Objective

The objective of this project is to transform a portion of the "Rectangle of Doom" into a safe and aesthetic landscape. This objective is illustrated in the black box model below (Figure 1-1).

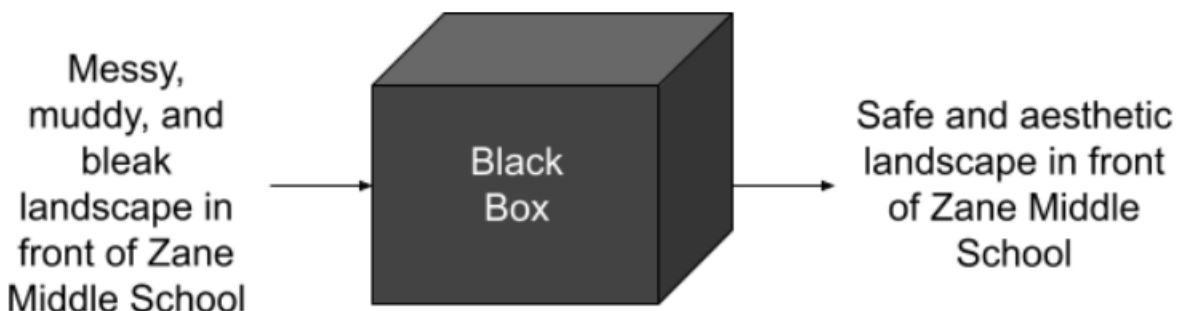


Figure 1-1: The Black Box model provides a simplified design process for the problem at Zane Middle School.

## 2 Problem Analysis and Literature Review

### 2.1 Introduction to Problem Analysis

The problem analysis categorizes each of the Rectangle of Doom criteria and reviews the identified constraints. The problem analysis covers specifications, considerations, criteria, usage, and production volume.

#### 2.1.1 Specifications

Team T.A.L.K. has to keep the following specifications in mind when creating something to go in the “Rectangle of Doom.”

- Recycled materials
- Red and gold
- Lightweight materials
- On-site construction/implementation

#### 2.1.2 Considerations

Considerations are specific measures that need to be taken into account when designing the project. These considerations are listed as such:

1. The project needs to maintain a certain level of environmental justice
2. The project must have a certain design to make it easy to implement in the school by other people than the team.
3. The project has a certain level of safety as not to harm the students

#### 2.1.3 Usage

Students will use the bench by sitting on it/them and/or placing their belongings on it/them. The project will be used every week day during the school year by the students and staff of Zane Middle School. Most of the students and staff will walk through and around the project in the morning before school and again after school lets out. The bench will be used the most by students in the mid-afternoon when the school day ends as they wait to be picked up from school. It will also be used throughout the day, though by fewer students than during drop-off and pick-up times. Usage will be much less frequent on weekends and during the summer months.

#### 2.1.4 Production Volume

Only one bench will be made by Team T.A.L.K. More benches could be built to the design specifications detailed in this document by Zane or other entities, but will not be built by Team T.A.L.K. for this project.

### 2.1.5 Criteria

The criteria and constraints listed in **Error! Reference source not found.** provide the standards Team T.A.L.K. need to meet in order for the project be considered a success. These criteria and constraints were talked about with the client. These criteria will help steer the team in the right direction to making something that will last a long time at Zane Middle School.

*Table 1: Criteria and Constraints that must be met for the project.*

Criteria	Constraints
Safety	Meets or exceeds existing safety standards at Zane Middle School.
Aesthetics	Fits or exceeds the existing entrance at Zane.
Durability	Should not be easy to break.
Cost	Does not cost more than \$100 per team member.
Low mess	Tracks less mud than previous systems.
Not difficult to remove	If the project fails, should not be hard to remove.
Ease of implementation	Should be easily replicated and transported to Zane Middle School.
Low maintenance	Project should not bring more work to students and staff for upkeep.

## 2.2 Introduction to Literature Review

The purpose of the literature review is to provide background information Team T.A.L.K. might not have known about before talking to the client, which is to be used to find a solution for the “Rectangle of Doom.” This section includes client criteria, materials, stuff about Zane Middle School, and location/past projects that have happened for the “Rectangle of Doom.”

### 2.2.1 Client Criteria

There were many ideas Mr. Hammons had that Team T.A.L.K. could use, as well as some things to look out for when planning what to do with the “Rectangle of Doom.”

#### 2.2.1.1 Landscaping with Native plants

The client had many ideas as to what could go in the empty space of the “Rectangle of Doom,” one of which being California-native plants. There are a ton of different plants that are native to California or even more specifically Eureka. It would not be that difficult to buy several different types of plants well suited for the area. There are plants like Blue Eyed Grass (*Sisyrinchium bellum*), Douglas Iris (Iris

douglasiana), and Western Columbine (*Aquilegia formosa*) that would work to liven up the barren rectangle.

#### *2.2.1.1.1 Positives of landscaping*

The benefit of putting plants in front of Zane Middle School is that it would be very aesthetically pleasing in the Spring. Giving the school a pop of color through native plants would be good compared to the current bare patches of dirt. Plants would also look good in planters. Team T.A.L.K. could find a way to incorporate plants into almost anything. It would be a quick fix, as well, because plants can be very low maintenance depending on what is purchased. Plants could also smell good and bring a nice aroma to the school. Or if a fragrance is not wanted, it would be just as easy to find plants that do not smell. Plants are very versatile in how they can be used. Aesthetics and aroma are just a few things. Aesthetics was Mr. Hammons' second priority, so plants also work to cover that aspect. By using plants that flower in the Spring or Winter, the number two priority at Zane Middle School would be covered.

#### *2.2.1.1.2 Negatives of landscaping*

One drawback to plants is that they can be potentially harmful to the students. Mr. Hammons informed Team T.A.L.K. that the students like to put leaves from plants and trees into their mouths. If Team T.A.L.K. implements harmful plants, students could get sick. Another drawback is that plants might not always look the best. If the plants die, they would be an eyesore and might have to be removed which brings the "Rectangle of Doom" back to square one.

#### *2.2.1.1.3 Benefits of a Green Space*

There are many benefits to incorporating green space into school campuses. Aside from the aesthetic advantages, plants would add to the "Rectangle of Doom," having access to greenery has positive impacts on the psychological health of teenagers. Being able to see plants from classrooms and cafeterias "may reduce student mental fatigue and stress levels, increase satisfaction with the school environment, and enhance overall student academic achievement and behavior" (Matsuoka 2010). More serious problems can also be helped by access to nature. Teenagers have a lowered risk of serious psychological distress when they have a greater exposure to green space (Wang et al. 2019).

While some middle schoolers' respect for property and growing things in past "Rectangle of Doom" projects has been somewhat limited, if greenery is successfully established, it could help improve mental health.

#### *2.2.1.2 Checkerboard*

Another idea Mr. Hammons had was to paint either a checkerboard or tic-tac-toe board in the empty area. An example of what the checkerboard could look like is in Figure 2-1. Team T.A.L.K. would first fill the area with concrete and then paint over it. With a checkerboard, the students could play chess or checkers, or something entirely different that they come up with. The students could use their bodies or backpacks to play. The concrete would also be a new place for the students to sit. Mr. Hammons said

the students are always looking for a place to sit, so more surface area would be great for accommodating sitting.



Figure 2-1: An example of what the checkerboard could look like (Hrnyak 2021).

#### 2.2.1.2.1 Positives of Checkerboard

An upside to having something the students can play on that is intended for playing, is students can engage in physical activity while waiting for their parents to pick them up. According to a study done in 2002, one of the simplest ways of increasing activity levels is by painting lines on a playground. While the front of the school is not a playground, it is still a place the students can play. The study concluded that by simply giving kids the tools to be physically active, many will do so of their own accord and the markings will have a positive influence on their energy expenditure (Stratton, Gareth, and Leonard 2002). By painting a few lines, or boxes in this case, the students will play and increase their activity levels which will in turn increase their health level. Whether the students use the checkerboard for checkers, chess, tic-tac-toe, or sitting, it will be beneficial to their health to have an option to play and expend energy.

Another source called “Painting Preschool Playgrounds for Movement” also wrote about playground paintings, but for younger kids. In this are more ideas of what can be painted in order to increase activity like hopscotch and bean bag toss (Buran 2015). This source also reviews the importance of physical activity to decrease the chances of health problems. Although the examples from the Preschool source might not fit well with middle schoolers, Team T.A.L.K. can still use some of the advice given to improve the design of the checkerboard.

#### 2.2.1.2.2 *Negatives of Checkerboard*

A disadvantage to the checkerboard idea is that it might not look the best. Team T.A.L.K. could paint it red and gold, Zane's school colors, but it might still stick out. Because aesthetics is one of the client's top priorities, it could be a bad idea having something in front of the school that looks odd at first glance. Being in front of the school could also be dangerous if the students are playing too close to the street. Because safety is Mr. Hammons' number one priority, having the intention for kids to play so close to cars might not be the best option.

#### 2.2.1.3 *Benches*

Our client's number three priority is durability. Mr. Hammons mentioned the idea of a bench and benches can be very durable when built correctly. A bench is an easy, sustainable, and replicable idea that Team T.A.L.K. can implement in front of the school. A bench would also provide students with a place to sit.

##### 2.2.1.3.1 *Positives of Benches*

Some advantages to benches are that some are moderately easy to make. If Team T.A.L.K. finds cheap or recycled wood, it would be a sustainable way to make the benches. Because Mr. Hammons mentioned that the students like to sit down, benches would be perfect for the front of the school. Aesthetics-wise, the benches could be painted red and gold, per school colors, or the wood could be stained a nice brown color to possibly match the surrounding trees. By having benches in front of the school, students could have a sufficient way to wait for their parents to pick them up. An idea combining both benches and plants could work if the sides of the benches were also planters. This would be very pleasing to look at and would also provide a place to sit. There are many styles of benches to choose from, such as the bench shown in Figure 2-2, or a Modern Platform Bench that *This Old House* contractors built that would have no backrest (Baker 2021).

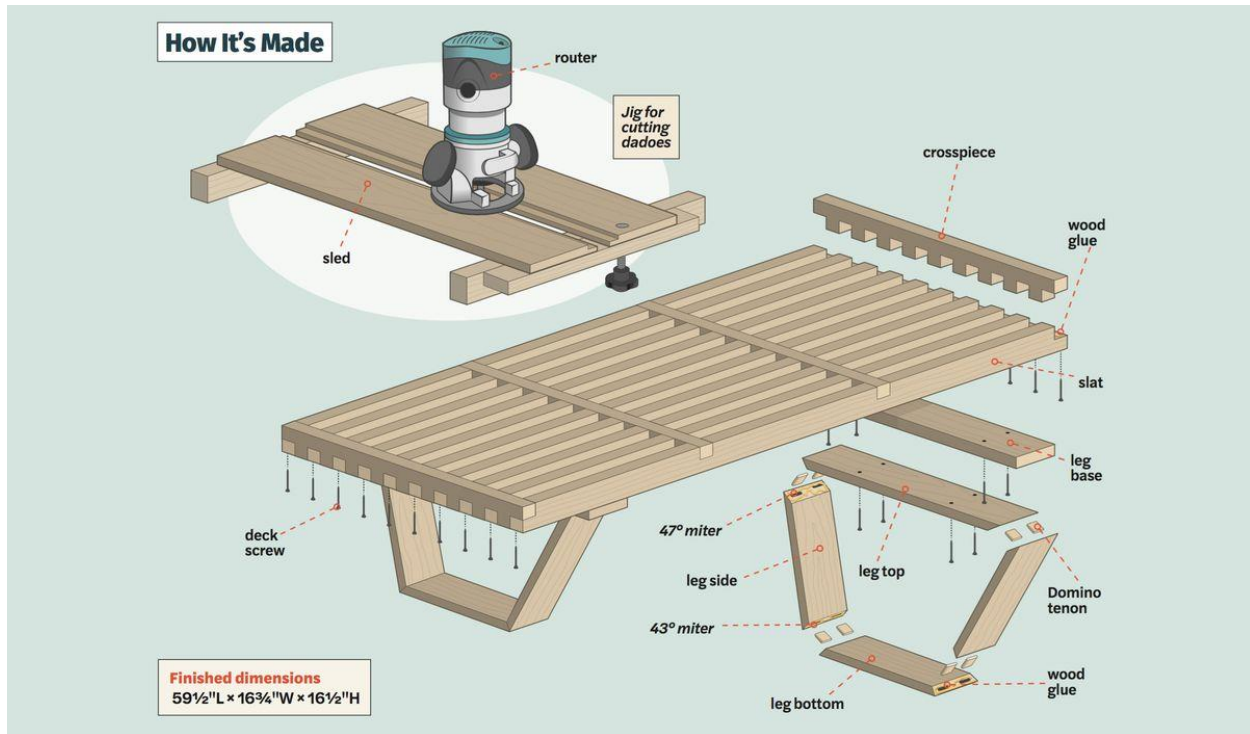


Figure 2-2: This is what the bench could look like if using “Modern Platform Bench” design (Sucheski 2021).

#### 2.2.1.3.2 Negatives of Benches

Some disadvantages of benches are splinters. It is possible for wood to splinter and that would hurt the students which would not be good. The students could also make poor decisions with the benches and possibly jump off of the backs and get hurt. 11–14-year-olds do not always make the best decisions, so benches might not be the best idea for the students. Team T.A.L.K. would need to be careful not to disturb the healthy soil that may be in the “Rectangle of Doom,” as dire as the name sounds. There are some precautions the team can take as listed by (Brown 2000), such as, establishing areas that are to remain untouched, save topsoil, and place all mineral soils back. Although some of these might not apply, it is always a good idea to have a plan.

#### 2.2.1.4 Pathways and Accessibility

One main concern our client would like to address is how students track mud from the Rectangle of Doom into their classrooms. A common solution to this problem is to build pathways. While building pathways, many public places follow guidelines outlined in the Americans with Disabilities Act (ADA) in order to ensure the path is accessible to those with disabilities. Since the “Rectangle of Doom” is a high foot traffic area, accessibility is even more important.

In regards to pathways, the ADA states that they must be at least 36 inches wide and “ground surfaces shall be stable, firm, and slip resistant” (Department of Justice 2010). Any running slope, a slope in the direction one is moving, must be at most 1:20 if it is not a ramp (Department of Justice 2010).

As long as the design does not obstruct an accessible route, a path to a necessary location (doors, drinking fountains, existing ramps, etc.), the design does not have to be accessible itself, though there would be benefits to making it so.

Because of the history of “Rectangle of Doom” projects being deemed “unsafe” and removed, following ADA regulations would make the project not only more accessible to every student at Zane Middle School, but will provide safety standards for the design.

## 2.2.2 Materials

### 2.2.2.1 Native Plants for Landscaping

There are many benefits to gardening with native plants. Native plants are better adapted to their climates than foreign species, making them easier to maintain (Schmidt 1980). Native plants also support native wildlife populations (“Native Gardening”). Of the hundreds of common plant species recognized as native to Eureka by the California Native Plant Society, Ceanothus mint, and Salal are good candidates for school landscaping.

#### 2.2.2.1.1 Blueblossom Ceanothus

A versatile shrub whose size is determined by pruning. Bunches of blue flowers are present in the winter and spring. Ceanothus is considered non-poisonous and is mildly prickly. It is deer resistant. Ceanothus will require little watering, though may need pruning in the dry season (“Calscape” 2021).

#### 2.2.2.1.2 Coyote mint

A small shrub that has purple flowers in the summer. It is edible and drought resistant. It is deer resistant and attracts butterflies. This type of mint requires almost no watering (“Calscape” 2021).

#### 2.2.2.1.3 Salal

A shrub that has medium sized dark green leaves and produces edible berries. The leaves are themselves edible. The plant produces small bell-shaped flowers ranging from white to pink in the spring (“Calscape” 2021). All three shrubs have the possibility of obstructing the line of sight, though this may be mitigated with pruning.

#### 2.2.2.1.4 Using Plant Boxes

Plant boxes are one of the biggest parts to a successful garden, no matter how big or small it is. The two main things to consider when planning out a plant box is what kind of soil and which material will be used to make the box. The plants that will go into these boxes will have to survive the small subtle change in seasons in Northern California. There will be a lack of sunlight depending on the density of building or forest around them. However, they will have an abundance of rain so the boxes must be able to let out excess water. The box will need to provide good protection from wildlife without blocking the

sunlight completely. The box would have to be large enough to hold multiple plants but not big enough for kids to want to climb into them. There are many factors that must be considered to create self-sustaining plant boxes. (Steiner 2012)

#### 2.2.2.2 Bench Materials

There are many different types of materials used when making benches, such as wood, aluminum, metal, and etc. Wood is a common material chosen because it is a durable material and brings natural look to their surroundings. There are many different factors that are considered when deciding which wood to use such as sustainable, durability and color.

##### 2.2.2.2.1 *Acacia*

The Acacia wood is great to use when there is a large emphasis on sustainability and living eco-friendly. This wood is available in large amounts due to its abundance in regions around the world. It is available at these amounts due to how fast it grows and how quick it spreads; it is viewed as an invasive species by many people. Acacia is a very heavy and durable wood that is known to withstand the worst elements will offer and offers a beautiful dark brown color. It is highly recommended to seal this wood to avoid any discoloring and warping caused by moisture. This wood has the ability to be used for benches, wooden boats, and even in construction. (Horst 2021)

##### 2.2.2.2.2 *Cedar*

The Cedar wood is great to use when wood rotting and insect damage is a concern. This tree survives in many different environments due to their natural resistance to insect and rot damage. This is very important to any bench that is located near a forest and is frequently exposed to water. This wood is also very lightweight allowing it to be moved or relocated with little effort. This is great for benches that will not be secured in a single spot. This wood needs to be stained every few years to prevent the wood from becoming rough over time. It is considered one of the easiest woods to stain and paint which makes it a great option for a school. Lastly, this wood is less prone to splintering because it retains any moisture and doesn't easily dry out. (Horst 2021)

##### 2.2.2.2.3 *Shorea*

A large group of trees that are located in Asian forests. This group of trees is known for its durability and dense wood that is great for any outdoor bench. It has natural safeguard against rot and insect damage. On top of this nature resistance, these trees are tightly-grained allowing them to endure rough daily use and the elements. This is a huge advantage to schools since the kids have a tendency to be destructive. These woods are heavily regulated and are typically less expensive than other types of wood. This a great option for anyone who wants a quality but doesn't want to pay premium prices. (Horst 2021)

#### 2.2.2.2.4 Redwood

The Redwood is arguably the most famous type of trees in the world. This wood is extremely durable and ages very well. It has a natural resistance to rot and insect damage. It is known to not warp or change shape due to how stable it is. It is highly recommended to seal this wood to prevent any dents or scratches. The sealing will help preserve the unique red brown color and avoids any stains from sitting on the bench. The largest drawback is its limited supply because it grows very slow. The Redwood is the least eco-friendly wood presented on this list. This is an option for Zane Middle School to show pride of this beautiful tree located all around them. (Horst 2021)

#### 2.2.3 Movability of Outdoor Furniture on Campus

These public spaces create an opportunity for people to be part of the public and have social interactions. This space is where faculty and students spend time getting around campus and socializing amongst each other. This students at Zane Middle School spend time at the “Rectangle of Doom” waiting for their busses or parents to pick them up after school. Making this space a great place to socialize is vital to the overall success of their Campus planning. (Pezeshkpoor 2020)

A bench in this space will provide students a comfortable sitting place while they wait for their rides. It will create an environment that will enrich the community with a place to socialize and something to look at instead empty space. A study shows that moveable furniture creates a deeper bond between the community and the surrounding environment. Any moveable furniture will allow students to form larger groups where everyone can have a place to comfortably sit. The bond is deepened because the moveable furniture gives the students the option to change their environment to increase their social and other interactions. (Pezeshkpoor 2020)

#### 2.2.4 Location

The Rectangle of doom is a giant rectangle covered with wood chips located at Zane Middle School, Eureka, where it stands in front of the school’s Gym and Music buildings and is located near the kid’s loading area. From its particular location the rectangle of doom is easily walked on. Even though there are a few paths going through it that clearly designate where the students can walk, teenagers do not listen to anyone, or anything, and they still walk through the rectangle, killing any unlucky plants or flowers planted in the rectangle.

#### 2.2.5 Past Projects

This is a fearsome project that many teams tried to take on, but most of them failed. Many different projects were proposed and installed but few survived long, resulting in an ugly and unpleasant rectangle sitting in front of the school. To improve team T.A.L.K. 's project's chances at succeeding, it is important to understand how and where these past projects have failed, and how and where other projects have succeeded.

### 2.2.5.1 The Mulch Makeover- Work

In the spring semester of 2017, team Work of the ENGR 215 design course designed a simple project, the Mulch Makeover, to improve the rectangle's landscape and beauty by planting flowers and plants and installing benches around the rectangle. Unfortunately, their project didn't last, and the plants were destroyed from the students walking and trampling on them. They had planned to install the benches to protect the plants, but they had decided to install them at a later date, and sadly the plants did not survive long enough to wait for the benches.

The advantage of team Work's project was that by putting plants and flowers the rectangle would have a more pleasing landscape. The students could also enjoy the smell of the flowers and possibly learn more about plants and landscaping from their school. Another advantage was the benches: they would provide a place for the students to sit while waiting for their parents to come pick them up after school, and they would also give protection to the plants as the students would walk around the benches therefore not trampling on the plants.

In contrast a big disadvantage of this project would be that the plants could potentially harm the students. Even when researching safe flowers to plant, kids tend to do stupid things: they can eat the plants or even use branches to attack each other.

### 2.2.5.2 Sundial Rectangle Benches- Sundial Society

Another failed attempt at the Rectangle of Doom was team Sundial Society's project: The Sundial Rectangle Benches. Their project had taken a different approach than team Work's project; instead of focusing on the "natural" landscape of the rectangle they instead focused on a more fun and useful object to help the kids: they designed a bench that would also work as a sundial using recycled materials. Sadly, this bench did not stick for long and was removed. The bench failed to engage the students with its secondary function: the sundial part, and it did not provide enough space for the students to sit on.

Though their projects failed it had some good ideas: using recycled materials to make that bench would teach kids how to recycle and about protecting the environment; the sundial would teach them about fun ways to tell the time and how a sundial works. The bench was also well designed and was pleasing to the eye.

A disadvantage of the bench would be that it is too unique in its form and making multiple copies of it around the rectangle would only look weird. But leaving only a single bench would not be comfortable for the students, they would need a lot of space to sit and relax when waiting for their parents.

### 2.2.5.3 Native Memorial Garden- The Gardiens

A project that was successful at Zane middle school was the Native Memorial Garden, designed by the team The Gardiens. Although this project was not for the Rectangle of Doom, the goal and situation of this project was similar to that of the rectangle. The plan was to restore a memorial garden located at the school so it would look pretty, and it would have educational significance behind it. The team successfully installed their Garden to the school and it still stands to this day, as we can see from a satellite view: it would seem that The Gardiens succeeded where team Work failed.

In contrast to Team Work where they only planted trees and installed benches, The Gardiens installed a pathway around the plants so they would not get walked on. But they did not just install a normal pathway, they drew a curve around the planters making the garden more pleasing and pretty. In contrast, Team Work only planted their flowers and plants on the rectangle, making it easy for the students to walk on them. Function cannot be the only theme the project should have focused on; the art of landscaping is a powerful tool that can make any sad looking block into a beautiful natural garden (Spirn 2000).

## 3 Search for Alternative Solutions

### 3.1 Introduction to Alternative Solutions

Section 3 summarizes the alternative solutions to the Rectangle of Doom. It also explains the Brainstorming session that led to the alternative solutions. Team T.A.L.K. produced nine alternative solutions from that brainstorm. All of the alternative solutions satisfy the criteria and considerations described in section 2.

### 3.2 Brainstorming

One brainstorming session was held for 2 hours. We met via Zoom and utilized Jamboard (can be found in Section 6

B. Brainstorm Documents) to organize our thoughts in a clean manner. Jamboard is a Google provided whiteboard that gives the option to use “sticky notes,” text boxes, a pen, or images. The purpose of the brainstorming session was to come up with design ideas and elaborate on them to find out how each could be developed further. There were many ideas discussed, such as benches, planters, benches with planters, swings, different types of pathways, etc. Team T.A.L.K made use of some computer programs to sketch out some of the ideas discussed in our brainstorming session.

### 3.3 Alternative Solutions

Below is a list of 9 alternative solutions that Team T.A.L.K. decided on during brainstorming. Each solution has its own section and sketch to accompany it.

1. Not a Bench Bench
2. I Got Your Back
3. I’m So Tire
4. Planter Tush Here
5. Planter Backside Here
6. Save a Plant, Eat a Vegan
7. Pathage of Time
8. Paw Path
9. Porous Some More Pavement

#### 3.3.1 Not a Bench Bench

Not a Bench Bench, as shown in Figure 3-1, shows a kind of bench that Team T.A.L.K. is thinking of making out of wood to put into the “Rectangle of Doom”. It would be a safe alternative to having a bench with a backrest because students can hang or jump off of backrests and that would not be safe. Since safety holds the most weight in the Criteria list, with this solution, students at Zane Middle School get to rest while not being dangerous. This bench would be durable because there is not much to be destroyed on it or hung off of. This is good because durability is high on the list of Criteria. Another Criteria is aesthetics, which would be solved by staining the wood a reddish-brown color to match the surrounding trees, or painting the wood red and gold to match their school colors. Installation would not be too difficult, although we might have to set the bench in concrete to make it as durable as we can. The maintenance for this bench would be minimal, because there might be light cleaning of trash. The students would have to walk around the bench to get to class which means they might walk through the mud or on the pathway already in the “Rectangle of Doom.”

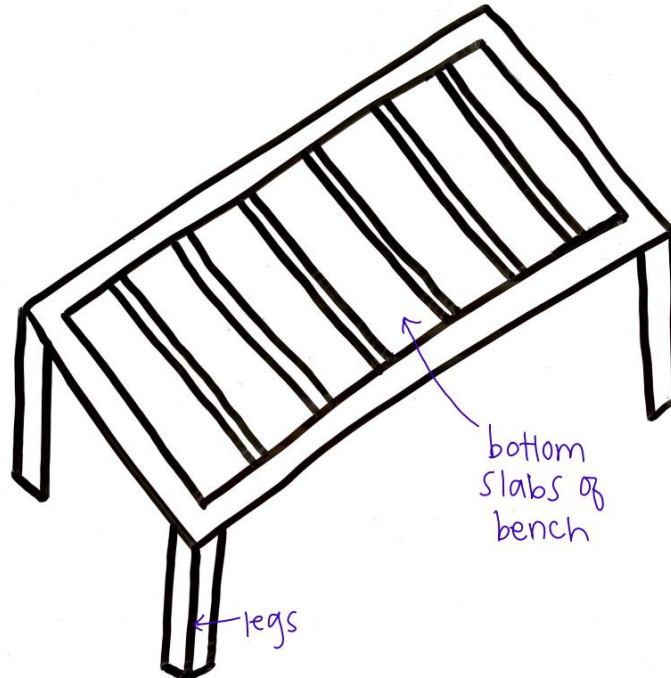


Figure 3-1: Angled view of bench without a backrest.

### 3.3.2 I Got Your Back

I Got Your Back, shown in Figure 3-2, would have a backrest on it. This allows for more comfort when sitting. The seat of the bench would have a similar design to the Figure 3-1, in having slabs of wood as the seat. This solution would take more time to make, and more money to build because we would use sturdy material to make the legs and attach the seat to the backrest. We would spend time making sure it is durable because safety and durability are very high on the Criteria list. This bench would not be too difficult to install, but we might have to put the bench into concrete in order for it to be as stable as it can be. We could stain the bench a nice reddish-brown color to match the surrounding trees, or we could paint it the school colors. The maintenance for this bench would be minimal, because there might be light cleaning of trash. The students would have to walk around the bench to get to class which means they might walk through the mud or on the pathway already in the "Rectangle of Doom."

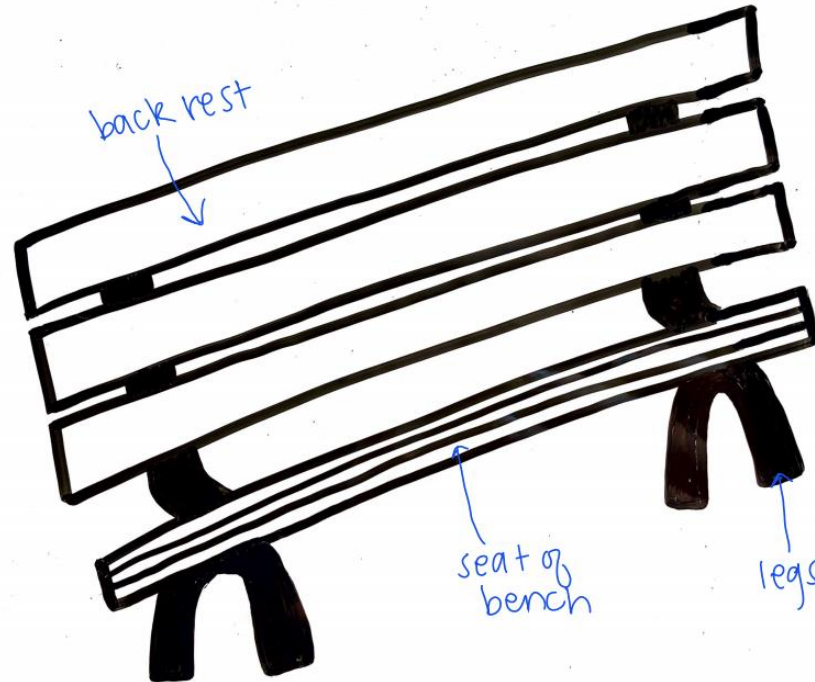


Figure 3-2: Angled view of bench with backrest.

### 3.3.3 I'm So Tire

I'm so Tire is an upcycled bench with a planter inside as shown in Figure 3-3. It is made with an old car tire of at least 15" of length and 12" of width. Tires are impermeable making them strong against the tough weather of Humboldt. It is filled with soil, giving it structure and making it strong enough to be seated on. It provides a space for local plants and flowers in the middle, so as to give it a nice aesthetic. The plants and flowers are local and are safe for young children to be around with. The Tire is provided by the team, but it is found around Humboldt to make it easy to implement. The soil and seeds for the plants is also provided by the team but the school will have to implement all of it.

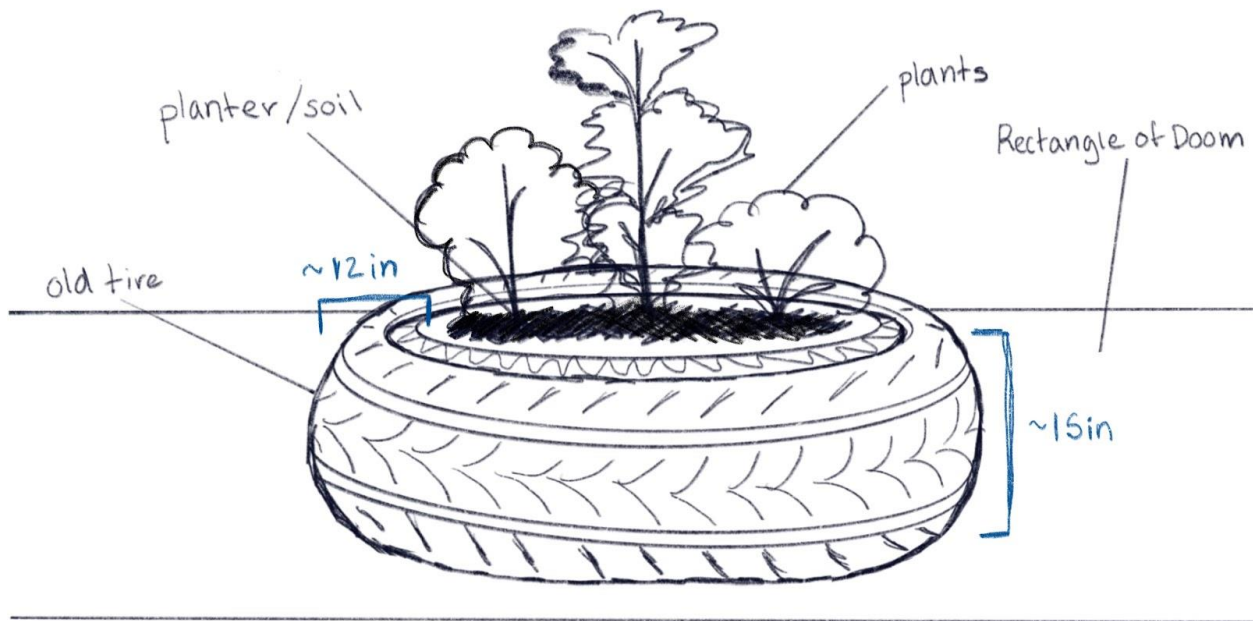


Figure 3-3: Drawing of a tire with plants inside.

### 3.3.4 Planter Tush Here

The Planter Bench is a bench with planters located on both ends. It is made out of teak wood due to the woods' durability. This wood is naturally water and sunlight resistant making it ideal for Humboldt's weather. As shown in Figure 3-4, a backless design that gives a more open feel. This design is a safe for students because they won't be able to sit or hang off of the back and possibly hurt themselves. With a safer design, this solution satisfies Zane Middle School's top priority of student safety. This bench would bring a nice aesthetic to the front of the school with the addition of plants naive to Humboldt. The plants are high enough from the ground where students cannot trample them. The students have reportedly eaten leaves and other parts of the plants in the past. Our plants are edible so no student can be harmed. The bench itself needs to be sealed every few years to help prevent any rot or insect damage. The plants require the most maintenance. They must be watered frequently and have weeds pulled from the boxes when necessary. There will have to be picking up of any trash found under the bench or inside the planter boxes.



Figure 3-4: A straight-on view of the bench.

### 3.3.5 Planter Backside Here

The Planter Bench is a bench with planters on each end and a back that provides more support while sitting. The overall design is similar to Figure 3-4 with an addition of three horizontal and three vertical pieces of wood forming the back of the bench. The planter box details are the same as written above in “Planter Bench without Back”. Please refer to Figure 3-5 for the updated design. This design allows students to sit more comfortably and encourages better posture while waiting to be picked up. With this design, there is a plaque located on the front of the bench. Refer to Figure 3-5 for exact location. The Plaque is dedicated to a person of the school’s choosing. This design will bring a new aesthetic that is needed at the front of their school. With a back, the bench may be considered unsafe because of students sitting on the back and possibly harming themselves. This design requires more money because of the additional materials required. More time will have to be spent building as well.

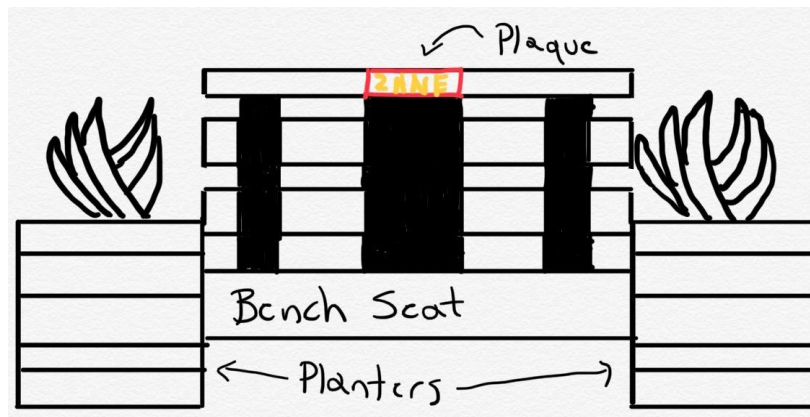


Figure 3-5: A straight-on view of bench with a back.

### 3.3.6 Save a Plant, Eat a Vegan

Save a Plant, Eat a Vegan is a landscaping plan. Three kinds of plants are planted in the Rectangle of Doom to make it prettier. Each plant is safe for kids and adults and can withstand the harsh weather of Humboldt County. They are planted in a way to make it pretty around the school. Blue Blossom Ceanothus is a big plant which is less likely to be trampled on by the students. Coyote Mint and Salal on the other hand are safer for kids but more likely to be trampled on, as they are small. These plants, as

seen in Figure 3-6, are planted by the school in the Rectangle of Doom. All three plants need little watering and not much of maintenance. This solution would meet the criterion for safety and aesthetics because plants are pretty.

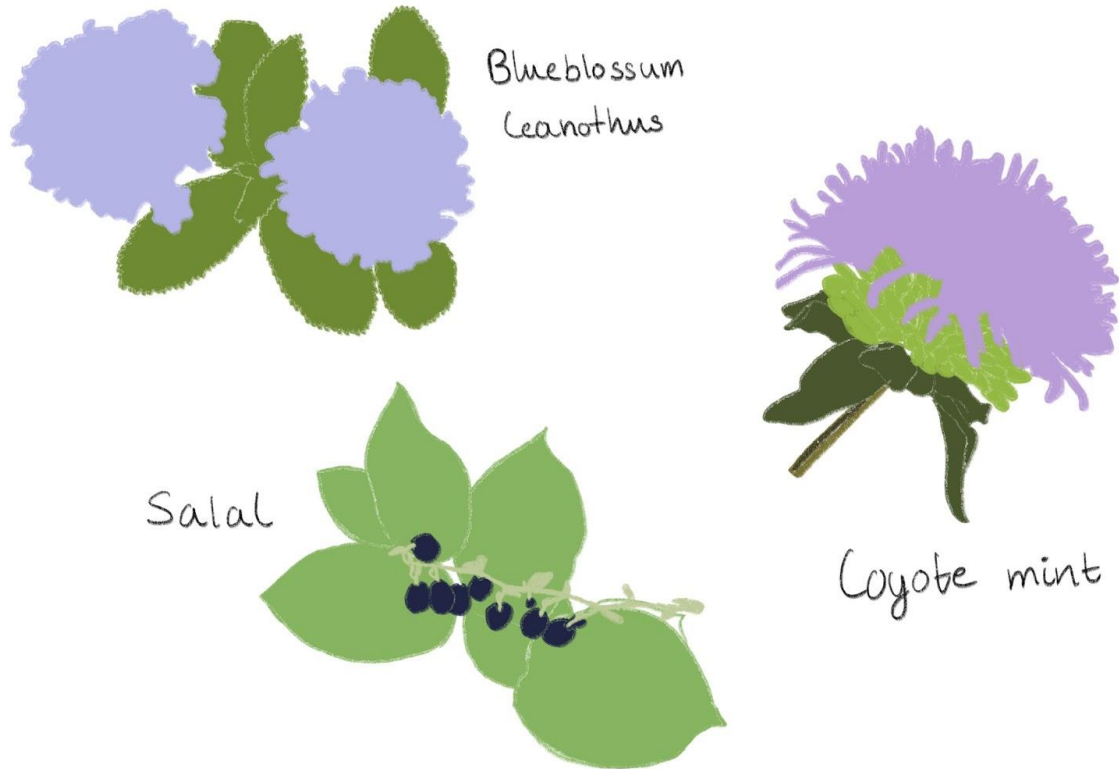


Figure 3-6: Examples of plants that could be used.

### 3.3.7 Pathage of Time

The “Pathage of Time” is a plan to pave over part or all of the mud pits in the Rectangle of Doom creating pathways on which an educational design is painted. The design, as seen in Figure 3-7, is a visual representation of the timeline of human evolution through footprints, starting with fish. The educational design makes the path more appealing to walk on, incentivizing students to walk on the paths and not through the mud. To implement this design, stencils could be made of the footprints ahead of time and then be shipped to Zane Middle School. The stencils could then be used to paint the design. The stencils can be kept at the school to paint the pattern again if the paint fades over time.

This design is very safe and would not obstruct the line of sight of teachers or staff. It is educational and colorful, though may not be as aesthetic as introducing plants to the Rectangle of Doom.

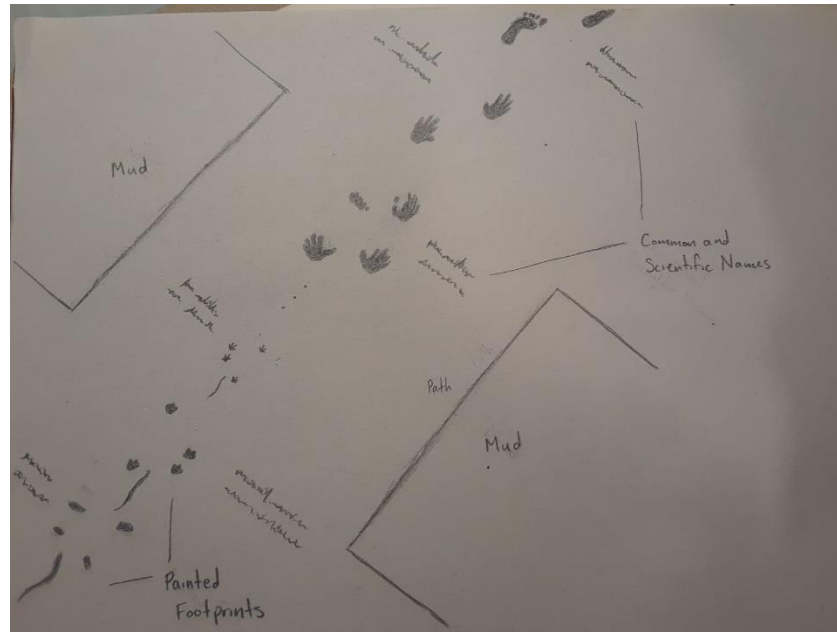


Figure 3-7: Overhead view of the Pathage of Time.

### 3.3.8 Paw Path

The “Paw Path” is a plan to pave over part or all of the mud pits in the Rectangle of Doom creating pathways on which an educational design is painted. The design, as seen in Figure 3-8, is composed of painted animal tracks of animals that are native to the Eureka area with the common and scientific names written beside them. The educational design makes the path more appealing to walk on, incentivizing students to walk on the paths and not through the mud. To implement this design, stencils could be made of the footprints ahead of time and then be shipped to Zane Middle school. The stencils could then be used to paint the design. The stencils can be kept at the school to paint the pattern again if the paint fades over time.

This design is very safe and would not obstruct the line of sight of teachers or staff. It is educational and colorful, though may not be as aesthetic as introducing plants to the Rectangle of Doom.

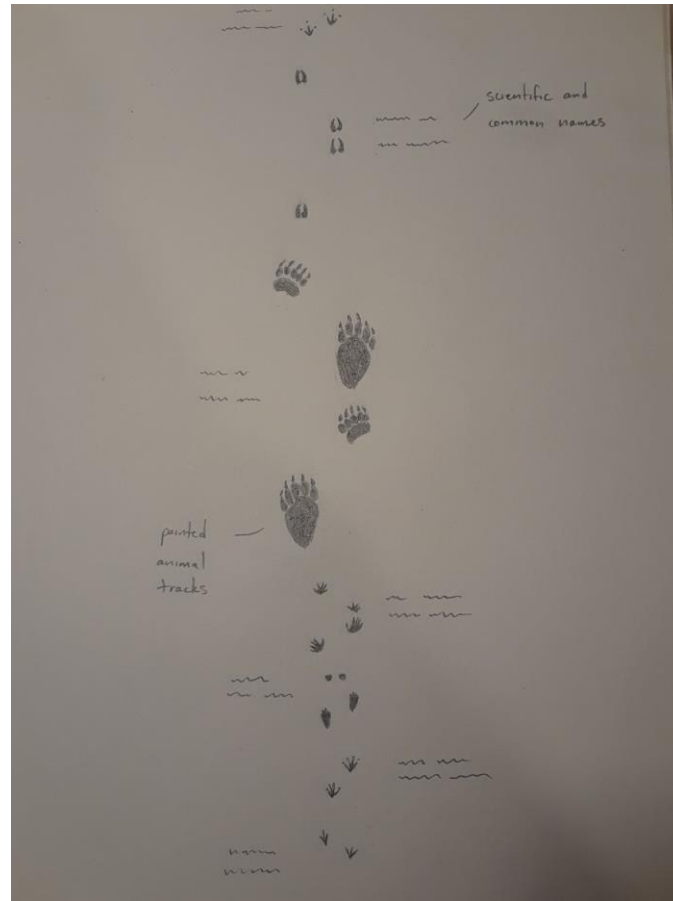


Figure 3-8: An overhead view of the Paw Path.

### 3.3.9 Porous Some More Pavement

Bound recycled glass porous pavement is a type of permeable pavement that is made from recycled glass. It is permeable, so water is let through the pavement preventing pooling water on the surface. This type of pavement comes in every color, muted or vibrant, and can be used to create designs. It can be used in high foot traffic areas or parking lots.

This design, seen in Figure 3-10, is to pave over the mud pits with bound recycled glass porous pavement. This is a colorful alternative to paving the area with traditional pavements. Artistic designs can be incorporated into the paving process to create art. A possible design is a tessellation of falcons (see Figure 3-9), with the falcons being the mascot of Zane.

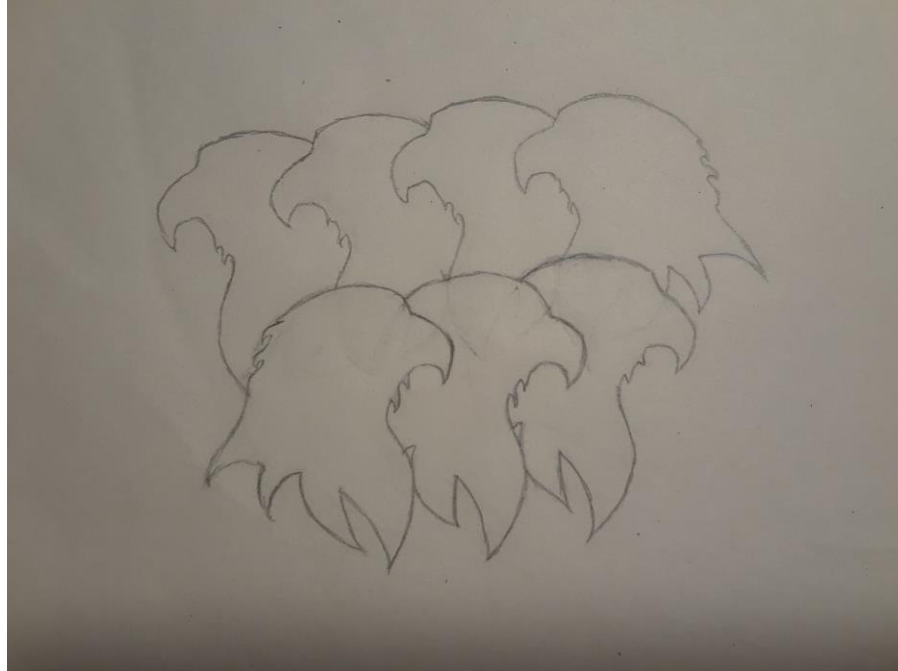


Figure 3-9: Falcon tessellation design.

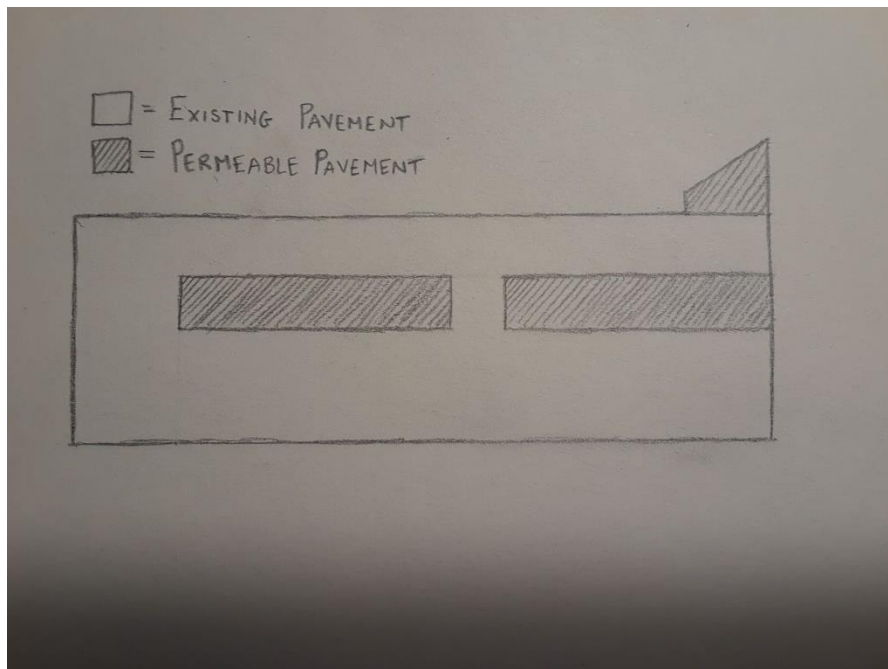


Figure 3-10: An overhead view of the Rectangle of Doom with permeable pavement.

#### 4 Final Decision Phase

## 4.1 Introduction

The Final Decision is the process where the final solution is chosen from the alternative solutions stated in Section 3. The criteria, Delphi Method, and a Google Form Survey was used to select the best solution to the Rectangle of Doom.

## 4.2 Criteria Definitions

This section covers the criteria mentioned in Section 2.1.5 Criteria and gives definitions to each.

**Safety:** how unlikely it would be for students to be injured by the project, use the project as a weapon, or block the line of sight of staff members.

**Aesthetics:** how appealing the project is to look at.

**Durability:** the amount the project resists destruction and the length of time the project retains its original quality.

**Cost:** the total amount of money spent on the building and implementation of the project at the middle school.

**Low mess:** how much the project decreases the amount of mud being tracked into classrooms by students.

**Ease of implementation:** the level of skill required to build the project, the cost of shipping or otherwise transporting the components, and the number of people needed on site to implement the project.

**Low maintenance:** the amount of time and energy spent by maintenance staff on the upkeep of the project for the lifetime of the project.

**Not difficult to remove:** how much time, energy, and money would need to be spent to remove the project from Zane in the case of project failure.

## 4.3 Alternative Solutions

A comprehensive list of alternative solutions is in Section 3. There are a total of nine alternative solutions listed below:

- 1.. Not a Bench Bench
- 2.. I Got Your Back
- 3.. I'm So Tire
- 4.. Planter Tush Here
- 5.. Planter Backside Here
- 6.. Save a Plant, Eat a Vegan
- 7.. Pathage of Time
- 8.. Paw Path
- 9.. Porous Some More Pavement

## 4.4 Decision Process

The decision process included reviewing criteria with the client, using the Delphi Matrix method, and using Google Forms. First, we emailed our client, Mr. Hammons, to see if he agreed with our weighting of the criteria, as seen in Table 2. We got the weights for the criteria from our original conversation with Mr. Hammons when we went over everything he wanted in the project. Then we took his feedback and

used it to create our Delphi Matrix as seen in Table 3. In the Delphi Matrix we listed each of our Alternative Solutions from Section 3 and gave each solution a ranking out of 50. In doing so, the weight and rank formed overall scores we could compare. The highest scoring solutions were Not a Bench Bench, Paw Path, Save a Plant, Eat a Vegan, and Pathage of Time. Paw Path and Pathage of Time got the same score. We eventually combined them into “Concrete Path” to help narrow down our options and to help our process go faster.

*Table 2: Weighted Criteria.*

<b>Criteria</b>	<b>Weight (0-10 high)</b>
Safety	10
Aesthetics	10
Durability	10
Cost	9
Low mess	10
Ease of implementation	9
Low maintenance	10
Not difficult to remove	7

Table 3: Delphi Matrix used in Decision Process.

Criteria	Weight (0-10 high)	Alternative Solutions (0-50 high)									
		Not a Bench	Planter Tush Here	Paw Path	Porous Some More Pavement	I Got Your Back	I'm So Tire	Planter Backside Here	Save a Plant, Eat a Vegan	Pathage of Time	
Safety	10	40	40	50	50	35	35	35	45	50	
		400	400	500	500	350	350	350	450	500	
Aesthetics	10	40	45	37	35	40	40	45	40	37	
		400	450	370	350	400	400	450	400	370	
Durability	10	35	32	40	42	35	30	32	27	40	
		350	320	400	420	350	300	320	270	400	
Cost	9	35	32	20	10	35	45	32	40	20	
		315	288	180	90	315	405	288	360	180	
Low mess	10	10	10	37	50	10	10	10	15	37	
		100	100	370	500	100	100	100	150	370	
Ease of implementation	9	35	25	30	20	30	40	25	45	30	
		315	225	270	180	270	360	225	405	270	
Low maintnence	10	50	35	47	40	50	35	35	25	47	
		500	350	470	400	500	350	350	250	470	
Not difficult to remove	7	40	35	20	10	40	40	35	45	20	
		280	245	140	70	280	280	245	315	140	
<b>Total</b>		<b>2660</b>	<b>2378</b>	<b>2700</b>	<b>2510</b>	<b>2565</b>	<b>2545</b>	<b>2328</b>	<b>2600</b>	<b>2700</b>	

After creating our Delphi Matrix, it was up to us to pick a final solution. Our client had not emailed us back about the dimensions of the “Rectangle of Doom,” so we made our decision without precise costs in mind. We used Google Forms to anonymously come to a decision. We used the top three solutions to pick from. We voted on Not a Bench Bench, the combined Concrete Path, and Save a Plant, Eat a Vegan. The results were compiled into a pie chart, shown in Figure 4-1.

Favorite solution

4 responses

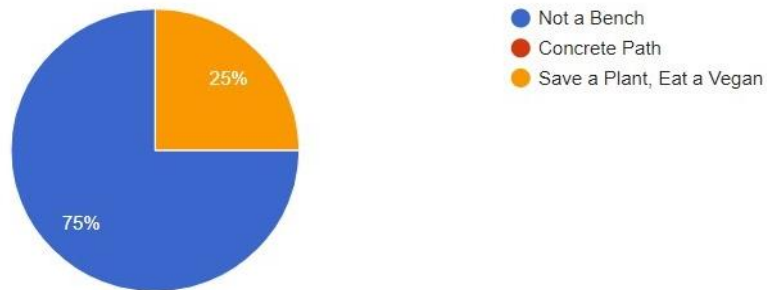


Figure 4-1: Pie chart of Final Decision vote.

#### 4.5 Final Decision

The Delphi Matrix method and the Google Form voting system helped us choose our final solution. The Not a Bench Bench did not have the highest score on the Delphi, but it was still in the top 3. Even though the pathways had a higher score, they were not chosen because of the uncertainty of the cost. Not everyone in the team voted for the Not a Bench Bench solution, but we talked about it and all agreed

that it would be the best solution. Out of all of the solutions, apart from the pathways, it is the most durable. It is also one of the easiest solutions to implement.

## 5 Specification of Solution

### 5.1 Introduction

This section describes the Final Solution chosen in Section 4, a backless bench “Not a Bench Bench.” This section details a description of Not a Bench Bench, analysis of the different costs of the project, prototyping, and implementation details. At the end of Section 5 is the results of Team T.A.L.K.’s Not a Bench Bench solution to the Rectangle of Doom.

### 5.2 Description of Solution

#### 5.2.1 Top View

As seen in Figure 5-1, the bench will have a ring-like structure with two planks in between that will serve as support for the two snowboards that will be placed and screwed on top. The two planks are positioned under the snowboards to give support and strength. The structure underneath the snowboards in this AutoCAD drawing is shown to give a more accurate look at the top view of the bench. The dimensions of the Top View are 64” x 25”

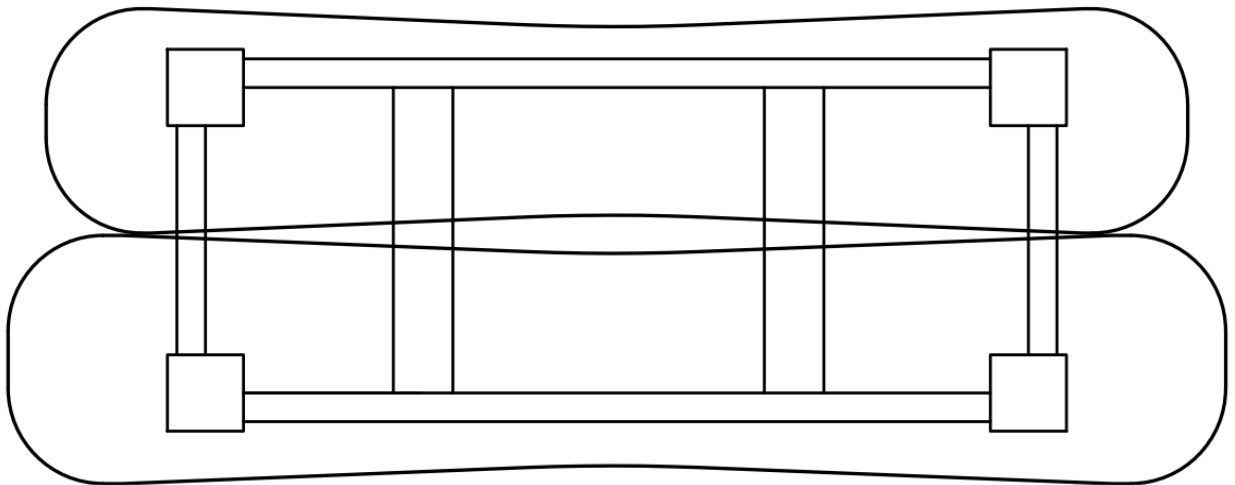


Figure 5-1: Top view of bench solution. (Made by Lacey Harrigan)

#### 5.2.2 Front View

The front view of the final solution can be seen in Figure 5-2. This AutoCAD drawing shows what people would see when walking up to the bench from the parking lot or from the school. The legs can be seen as the tall and thick vertical pieces, in between the legs are the support piece in the middle and the

bench top supporting pieces. The snowboards can be seen at the top of the drawing, although only one of them is shown in this view.

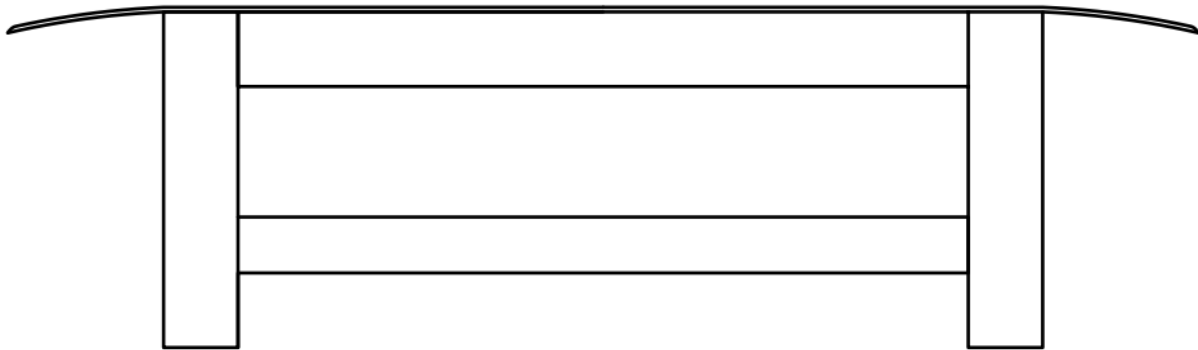


Figure 5-2: Front view of bench solution. (Made by Tyler Runyan)

### 5.2.3 Side View

Figure 5-3 portrays the bench from the side view. Shown in the image are the two side supporting planks with the snowboards on top. This view shows the downwards curve of the snowboards. This bench has a nice structure which gives it a pretty aesthetic to it.

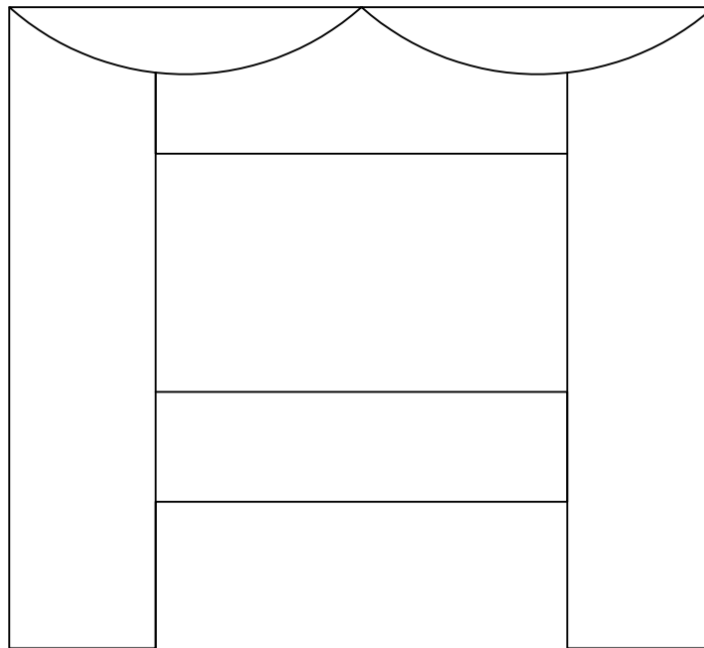


Figure 5-3: Side view of bench solution. (Made by Katie Blackadar)

### 5.2.4 Exploded Front view

The Front Side view of the exploded bench can be seen in Figure 5-4. The bench is composed of 13 planks in total, all screwed in accordingly, so the bench has structure and strength. On top of the structure, there will be two snowboards. The top two planks are screwed into the structure, so they are

strong enough to support heavy weight. Three planks in the shape of an “I” are implemented near the bottom to prevent against torque.

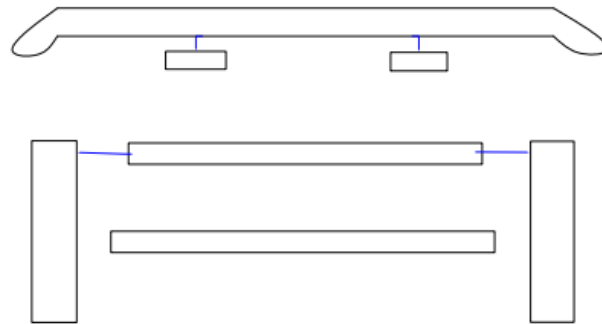


Figure 5-4: Exploded Front side view. (Made by Alice de Lescure)

### 5.3 Costs

This section contains the following subsections: Design Cost, Implementation Cost, Maintenance Cost, Prototyping, and Instructions for Implementation and Use.

#### 5.3.1 Design Costs

The design cost pie chart (Figure 5-5) shows the number of hours that Team T.A.L.K. put into the design project. There was a total of 409 hours spent on the project. Phase 1 took the least amount of time, phases 2 through 4 took around the same amount of time, and phase 5 took up most of the team's time.

**Design Cost Chart (hours)**

Total Hours: 306

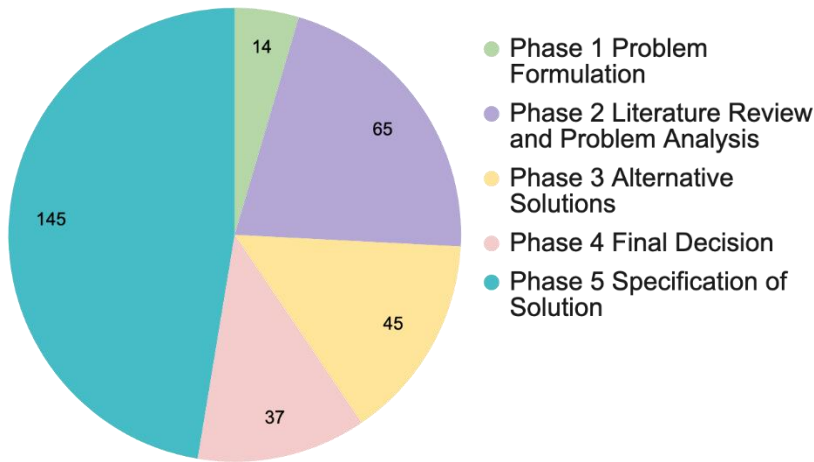


Figure 5-5: Pie chart of total design hours.

5.3.2 Implementation Cost

The implementation cost table in Table 4 shows a complete list of materials used and their total cost. Team T.A.L.K spent a total of \$145.86. The team saved \$461.33 by using recycled snowboards, lumber, and screws.

Table 4: Table of costs.

Material	Cost	Total spent	Up-cycled or recycled? (Y/N)	Cost if not re-used
M6 machine screws	\$1.69	\$1.69	N	N/A
snowboard 1	\$10.00	\$11.69	Y	\$209.99
snowboard 2	\$10.00	\$21.69	Y	\$209.99
lumber	\$0.00	\$21.69	Y	\$36.86
more machine screws	\$8.00	\$29.69	N	N/A
kreg pocket hole screws	\$0.00	\$29.69	Y	\$4.49
wood glue	\$11.60	\$41.29	N	N/A
spray paint (red)	\$3.98	\$45.27	N	N/A
spray paint (gold)	\$3.98	\$49.25	N	N/A
clear coat	\$3.98	\$53.23	N	N/A
wood sealant	\$36.00	\$89.23	N	N/A
mask for spray paint	\$7.97	\$97.20	N	N/A
gloves for spray paint	\$3.49	\$100.69	N	N/A
sanding block	\$4.97	\$105.66	N	N/A
L-brackets	\$28.26	\$133.92	N	N/A
spray paint red	\$3.98	\$137.90	N	N/A
clear coat	\$3.98	\$141.88	N	N/A
clear coat	\$3.98	\$145.86	N	N/A

### 5.3.3 Maintenance Cost

The Not a Bench Bench was created out of durable wood and snowboards, which will require little maintenance. A protectant spray will have to be applied to the bench every 2 years. This is suggested to prevent any cracking or other damage to the bench. Table 5 shows that the total maintenance cost of Not a Bench Bench will be less than 50 dollars every two years.

Table 5: Maintenance cost.

Maintenance Task	Frequency	Projected Costed per year (\$)
Wood protective coat	2 years	20

### 5.4 Prototyping

Team T.A.L.K. went through many prototypes to come to a closer solution to the Rectangle of Doom. During the first round of prototyping, there were tests for function and desire. The first prototype for function can be seen in Figure 5-6 and Figure 5-7. This test was to learn if a bench would look good in the Rectangle of Doom, as well as seeing if the bench would work as a seat.

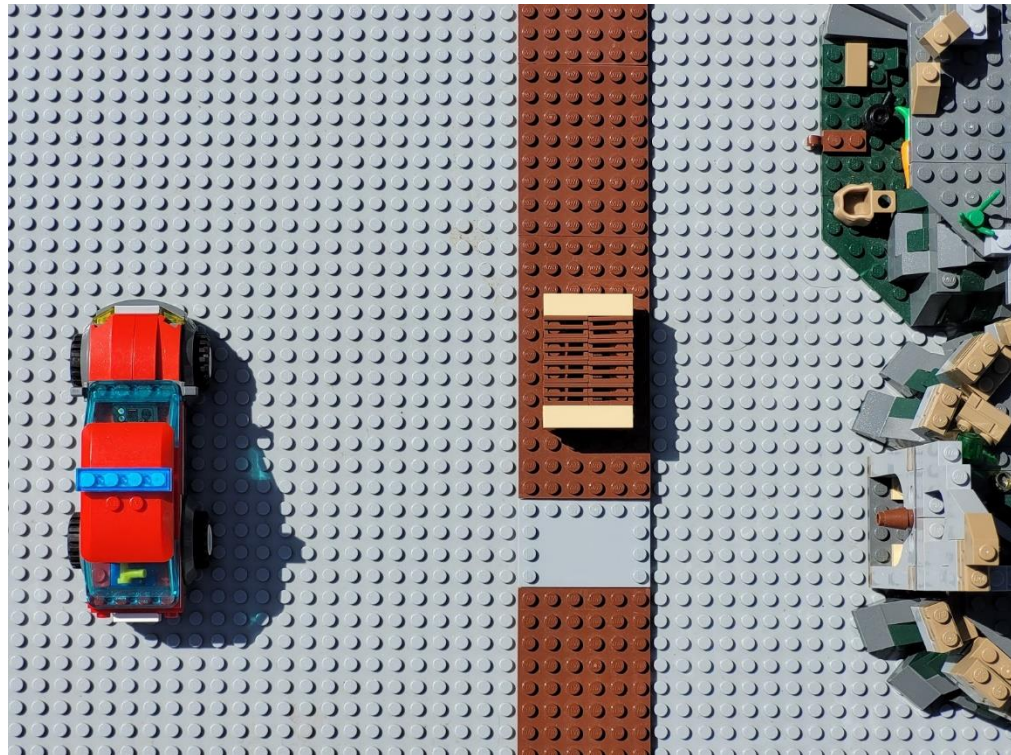


Figure 5-6: Top view of First Prototype for Function.



*Figure 5-7: Angled view with Lego people testing function.*

The first prototype for desire was not about a bench, but rather if Team T.A.L.K. went the concrete “Paw Path” route from Section 3.3.8 Paw Path. This test, as seen in Figure 5-8, tested which colors of paint would look good against a concrete-colored background. The test was executed by using clay and Play-Doh to see if any one color looked better than others. The results were darker colors looked the best.



*Figure 5-8: Paw Path Prototype for Desire.*

The next prototype was not a test for function or desire specifically, it was a general test for dimensions and aesthetics. Seen in Figure 5-9, is a prototype for another kind of bench with planters, called “Planter Tush Here” from Section 3.3.4. This was constructed out of cardboard and packing tape.



*Figure 5-9: Planter Tush Here Prototype.*

The final prototype for Team T.A.L.K.'s first round of prototyping is another nonspecific test for the Paw Path. This design, shown in Figure 5-10, was to test how well animal footprints can be drawn on concrete and to learn what animal tracks could be included if Team T.A.L.K. went this route. The test was implemented by using chalk to draw on pavement. The conclusion was the tracks were the clearest when drawn on a smooth surface, so the concrete that would be poured, had this been the route taken, should be as smooth as possible.



*Figure 5-10: Another prototype for Paw Path.*

In the second round of prototyping, there were two more tests each for function and desire. The second round's test for function included building a life-size backless bench, Figure 5-11, to learn how a bench is constructed. The results of the test were that it is more difficult to build a bench than what was originally thought. There is also a lot of planning and materials that go into making a bench, so it does not turn out bad looking.



*Figure 5-11: Four image blocks of the bench prototype.*

The next test for function was another bench prototype, but not life-sized. The test was conducted to see if the original Not a Bench Bench design looked enough like a bench to not be mistaken as something else. The model in Figure 5-12 and Figure 5-13 was built with cardboard and hot glue and was run by family members. Two-thirds of the people asked said it looked like a bench and the other person thought it looked like a table. This led Team T.A.L.K. to work on dimensions and the style of bench.



*Figure 5-12: Angled view of cardboard bench prototype.*



*Figure 5-13: Front view of cardboard bench prototype.*

The next two prototypes were tests for desire. The first test in the second round of desire prototyping was a test for seat height. There were three heights being compared with a tape measure and a swivel chair, each height can be seen in the three figures below: Figure 5-14, Figure 5-15, Figure 5-16. The test concluded the height in Figure 5-15 was the best, at 17 inches off the ground. This conclusion came from looking up average bench height, getting a rough frame of heights, adjusting the seat height to test comfort levels, and finally, considering middle school student height.



Figure 5-14: 16-inch seat height test.



Figure 5-15: 17-inch seat height test.



Figure 5-16: 18-inch seat height test.

The final test for desire was prototyping different seat depths. There were two depths to choose from, 17-inches (shown in Figure 5-17) and 18-inches (shown in Figure 5-18). The goal was to learn if an 18-inch seat depth would be more comfortable than a 17-inch seat. This test was done using cardboard and a tape measure. A middle school student sat on each cardboard cutout and concluded the bigger the depth the better. The results were that an 18-inch seat depth would be better than a 17-inch depth.



Figure 5-17: 17-inch seat depth prototype.



Figure 5-18: 18-inch seat depth prototype.

The second round of prototyping was more helpful for the final bench design because Team T.A.L.K. decided on which route to take. All the prototypes were helpful in their own ways and will be useful when building the final bench to put in the Rectangle of Doom.

## 5.5 Instructions for Implementation and Use

### 5.5.1 Implementation

To implement this project, holes will have to be drilled into the concrete at the permanent location of the bench. The bench can then be bolted in place utilizing the L-brackets attached to the four legs.

### 5.5.2 Use

The bench can be sat on from either or both sides. Only sit on the snowboard seats. One should avoid applying excess weight on the seat's curving ends to prolong the life of the bench because this is the area least supported by the wood frame.

### 5.5.3 Maintenance

Apply Helmsman Spar Urethane Clear Satin wood sealant to all exposed wood every two to three years. Spray paint may need to be purchased if the bench is defaced or damaged.

## 5.6 Results

The results showed that an empty spot can be made prettier with a single bench. It is simple, sturdy, and inexpensive: since it is made from recycled materials. The bench has a basic skeleton made of wood with sufficient structure to hold enough weight, and on top it has two nice snowboards to compliment the look. The students and the staff both seem to like the bench and use it regularly. It holds at least four

middle schoolers or two adults. The bench provides a useful and pretty way to “cover” or “replace” the rectangle of concrete, which completely erases the dirt rectangle that used to dominate the street.

## 6 Appendices:

### A. References

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### B. Brainstorm Documents

A bubble chart is shown in Figure 6-1 that we used to research different sections in our Section 2.2 Literature Review.

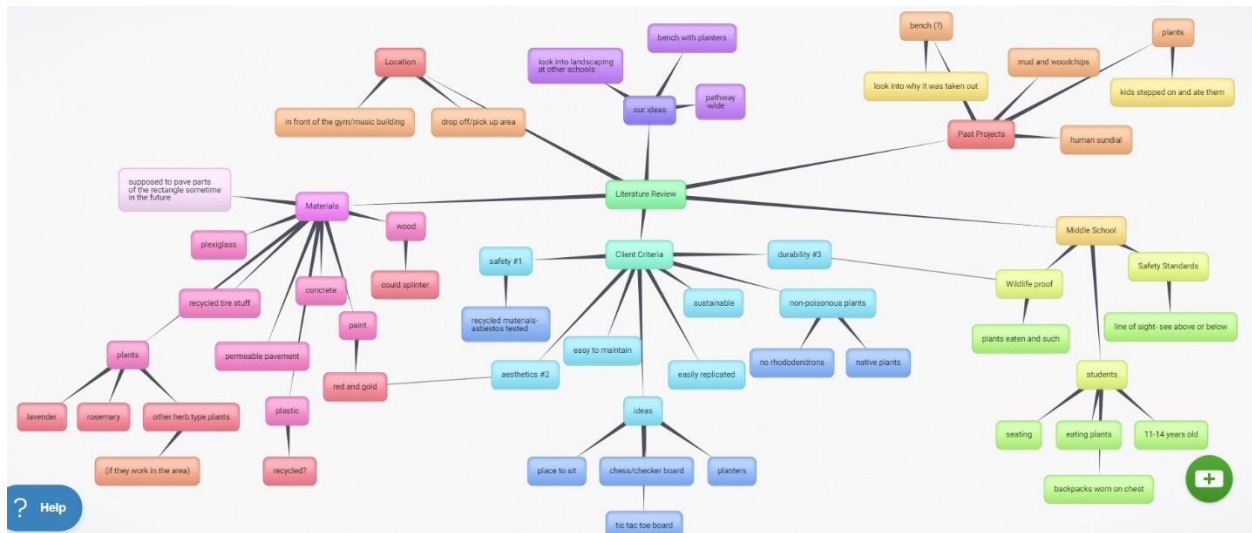


Figure 6-1: Bubble chart used for planning.

Below, from Figure 6-2 to Figure 6-7, are the Jamboard pages mentioned in Section 3.2 Brainstorming, that we used to think of alternative solutions.

### Jamboard brainstorming page 1

<b>bench</b>	<b>tire benches</b>	<b>bookshelf benches</b>	<b>hollowed tree to make bench shape</b>	<b>water bottle trash brick bench</b>	<b>spiderweb shape bench</b>	<b>mosaic bench</b>
<b>planter benches</b>	<b>recycled street sign benches</b>	<b>beanbags filled with recycled paper</b>	<b>grown tree benches (like bridge)</b>	<b>electricity-generating bench</b>	<b>floating rock bench</b>	<b>birdhouse bench-shaped like a birdhouse, you are the bird</b>
<b>fish tank bench</b>	<b>terrarium bench</b>					

Figure 6-2: Jamboard brainstorm for bench ideas.

Jamboard brainstorming page 2

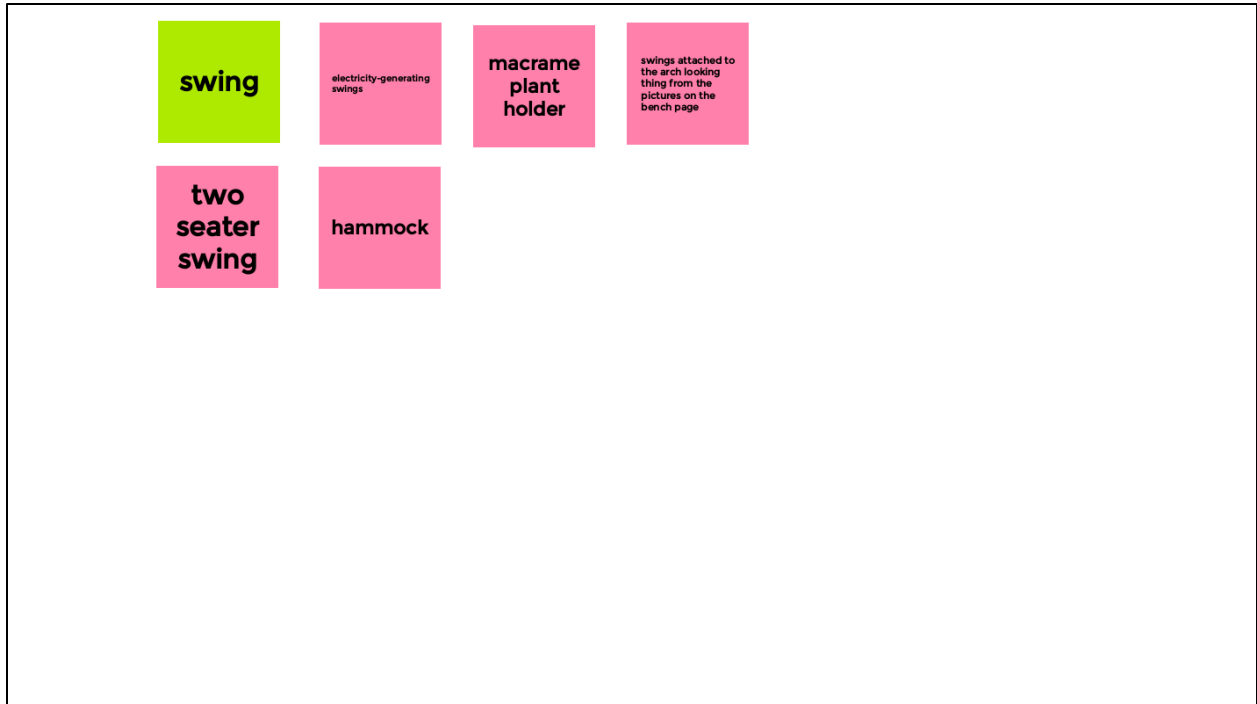


Figure 6-3: Jamboard brainstorm for swing ideas.

Jamboard brainstorming page 3

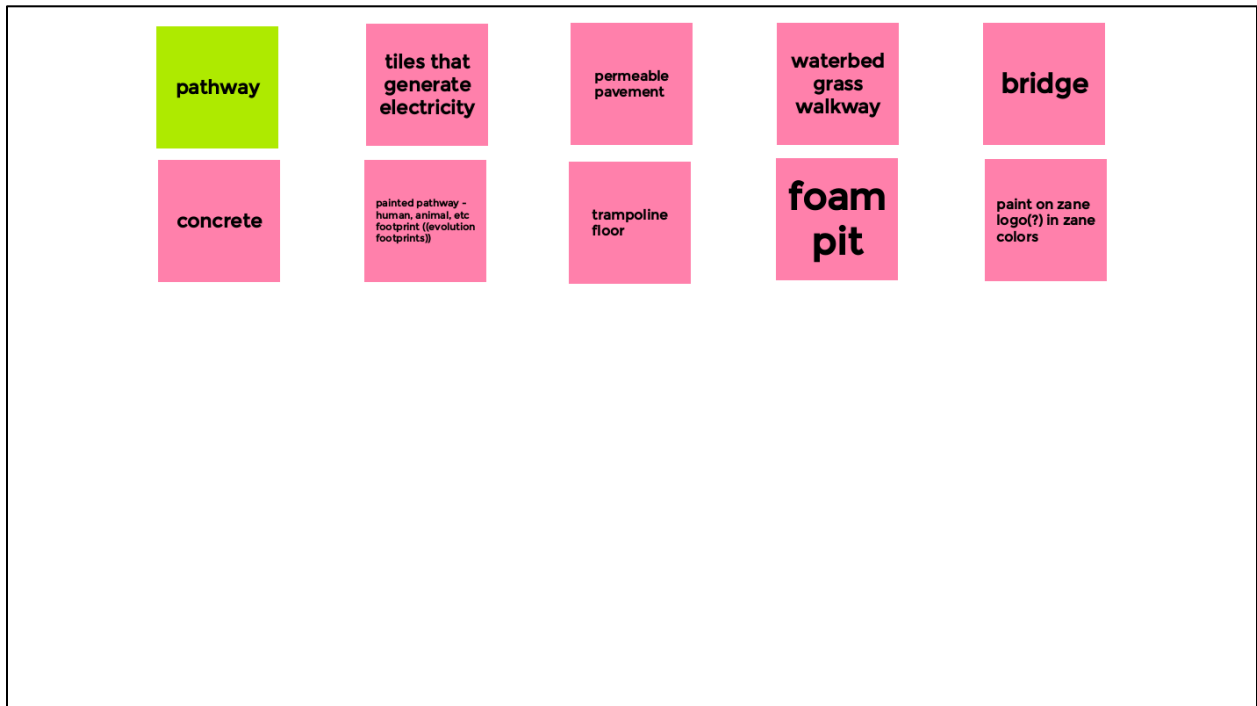


Figure 6-4: Jamboard brainstorm for pathway ideas.

Jamboard brainstorming page 4

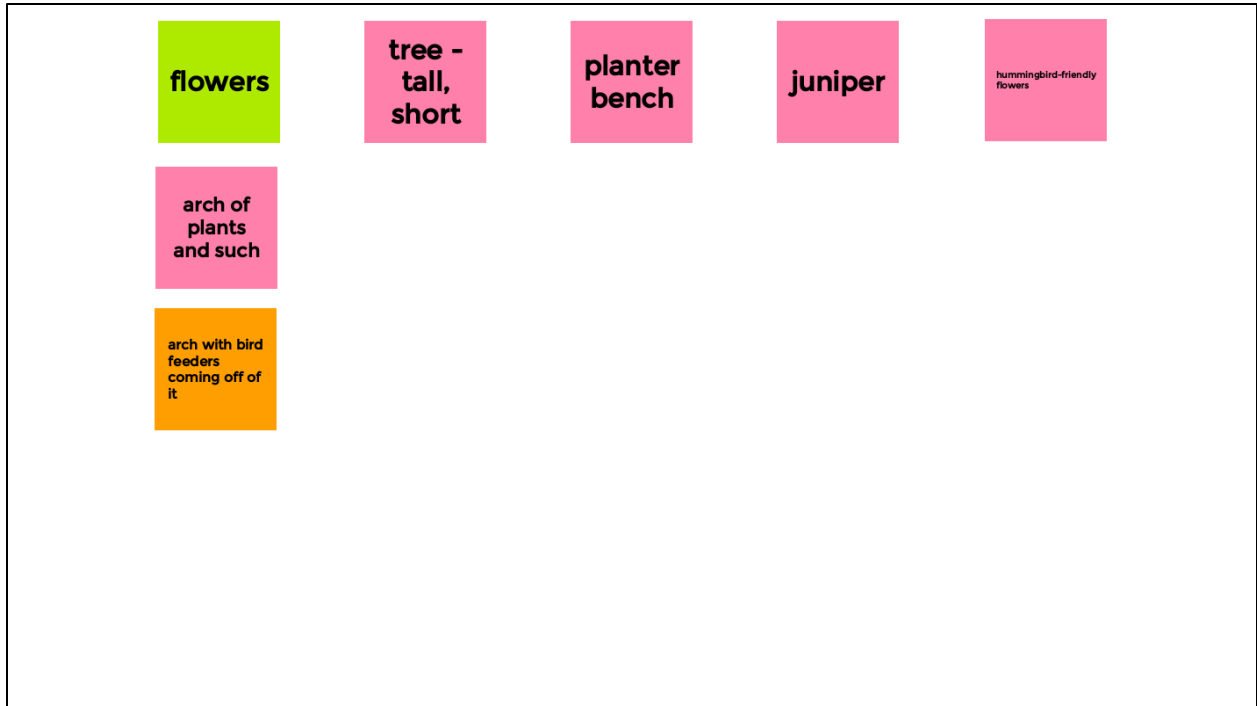


Figure 6-5: Jamboard brainstorm for flower ideas.

Jamboard brainstorming page 5

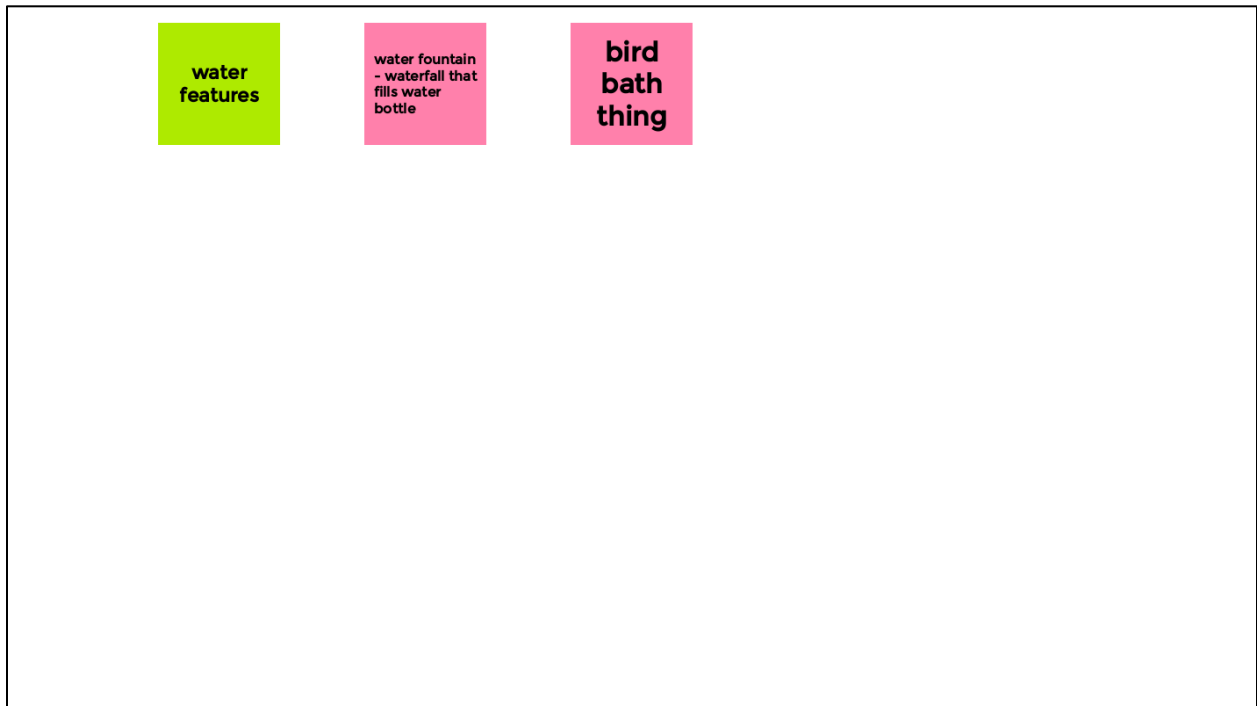


Figure 6-6: Jamboard brainstorm for water feature ideas.

Jamboard brainstorming page 6

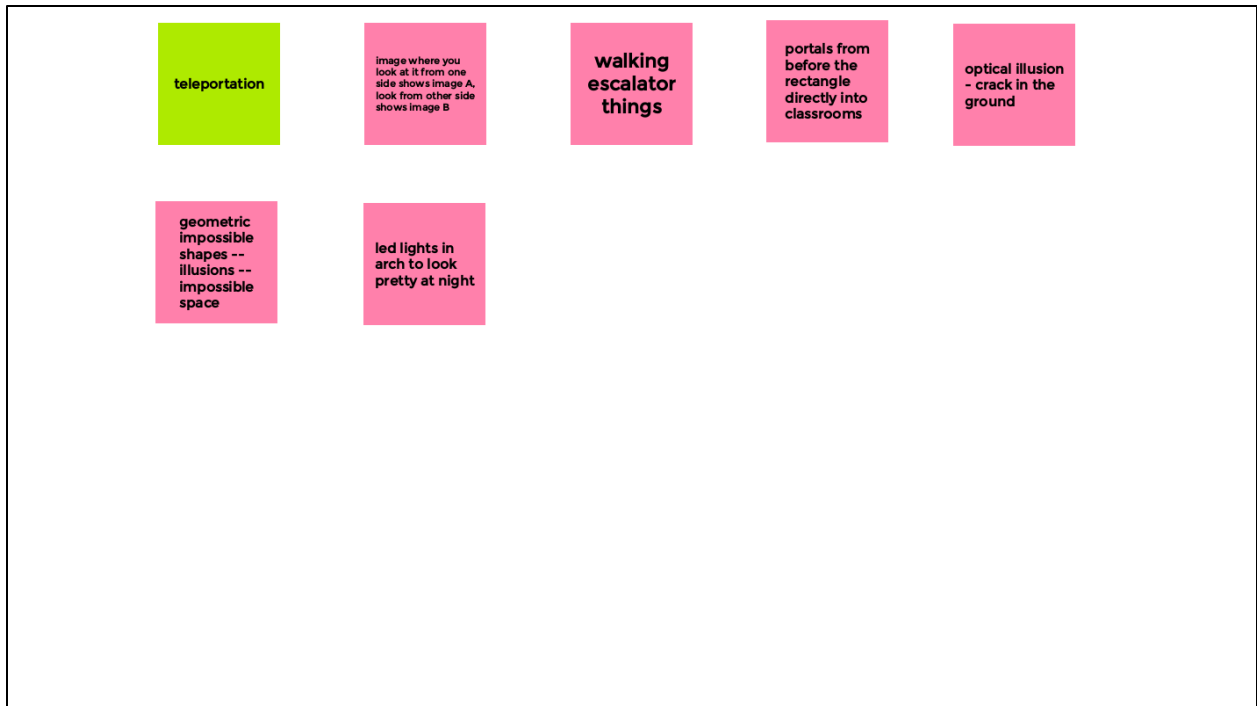


Figure 6-7: Jamboard brainstorm for teleportation ideas.