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1 Problem Formulation

Introduction

This section is focused on formulating the objective of a design project for the Engineering 215 class and defining the input and output of the project.

Objective

The objective of this project is to create two separate animal visitation centers for chickens and goats that will be made for Zane Middle School. The two animal visitation centers need to be able to temporarily hold the animals and provide a way for children to visually interact with both chickens and goats.

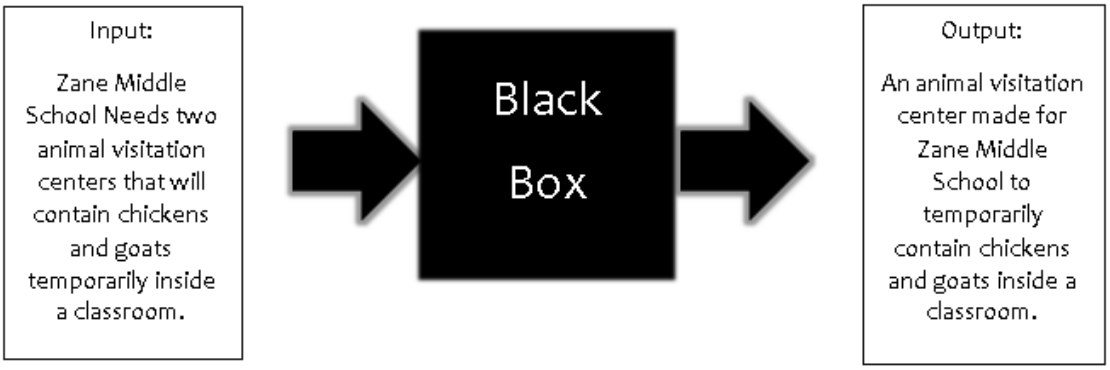

Figure 1-1 Black Box diagram showing the input and output for the Eng. 215 project

2 Problem Analysis and Literature Review

Introduction of Problem Analysis

The Problem analysis section identifies the client's specifications, criteria and constraints of the goat and chicken animal visitation centers. Both animal visitation centers will be used inside a classroom at Zane Middle School.

Specifications

Specifications are the detailed descriptions and identifications of the requirements of the two enclosures. The following are the specifications for Team Chickengies chicken and goat animal visitation centers.

Size – The chicken animal visitation center must be able to fit on a 2.0' x 3.5' countertop and the goat animal visitation center must be able to fit in a 3.0' x 3.0' x 11.0' floor space.

Weight – The chicken and goat animal visitation centers must be light enough to transport from classroom to classroom.

Criteria and Constraints

This section includes a list of the criteria, its constraints and the weight of the constraints that will be taken into consideration for the decision process. Criteria is the standard for evaluating the enclosures and the constraints are the restrictions on the criteria.

Table 2-1 the criteria, constraints and weight of constraint of the chicken and goat enclosure are as follows

Criteria	Constraints
Cost	Not to exceed $400.00
Portability	Each piece does not to exceed 25 lbs.
Ease of Use	10 minutes or less to set up
Durability	Strong enough to be leaned on
Educational Value	Able to be used in one lesson
Aesthetics	Professional look
Sustainability	At least 25% recycled
Ease of Cleaning	20 minutes or less to clean
Safety	Meets school safety policies

Usage

The goat and chicken animal visitation centers will be used to separately house chickens and goats in a classroom. The enclosures will be designed and manufactured for Zane Middle School.

Production of Volume

One chicken animal visitation center and one goat animal visitation center will be constructed for Zane Middle School. Due to both animal visitation centers having a criterion to be portable, only one of each is needed to be shared in-between classrooms.

Introduction to Literature Review

The literature review section includes Team Chickengies research for the Animal Visitation Project for Zane Middle School. Research includes types of animal visitation centers, animal behaviors, possible materials, animal and child interactions and school policies.

Examples of Animal Visitation Centers

This section includes visual examples and explanations of animal visitation centers that contain goats or chickens.

Chicken Tractor

A Chicken Tractor is a mobile chicken coop with no flooring. It is structured to keep chickens contained over specific spots of vegetation (Loyd, Cortney 2010) The bottomless design allows the chickens to access fresh forage. This is beneficial because the chickens will remove unwanted vegetation and fertilize the surrounding area with their fecal matter. It is designed with two wheels on one side, resembling a wheel barrel, making it easy to move. Depending on the size, chicken tractors can either be moved by using a vehicle or by hand. It should be moved often so that chickens will have access to fresh forage. (Husman, Gena online)

2.6.1.1 Heavy duty Chicken Tractor

As shown in Figure 2-1, a heavy duty chicken Tractor is made for about 6 to 8 chickens to live in. There is an area for them to nest and lay eggs. Its design is heavy and has to be moved by using a vehicle (Loyd, Cortney. 2010).

Figure 2-1 Heavy Duty Chicken Tractor <http://www.gardeners.com/on/demandware.store/Sites-Gardeners-Site>

2.6.1.2 Lightweight Chicken Tractor

Shown in figure 2-2, is a lightweight chicken tractor that is made for 2-4 chickens to live in and has an area for the chickens to nest and lay eggs. The lightweight design of the chicken tractor is ideal. Unfortunately, it does make the chickens less secure because it can easily be moved and manipulated by people (Gardener Supply Company, 2015).

Figure 2-2 Lightweight Chicken Tractor <http://kerrcenter.coml>

[redacted]Adjustable Animal Pens

An adjustable animal pen is a pen made out of meshed metal panels to keep animals contained. The metal panels are interchangeable and can be added or subtracted to create the desirable size that is wanted (Shean and Spector 1991). The panels have male connectors on one side and then female connectors on the other. This allows a person to put it together by hand. Adjustable animal pens are designed to be lightweight and portable. This is beneficial for storage and transportation (Light Livestock Equipment and Supply, 2015).

Figure 2-3 Adjustable Animal Pen <http://www.lightlivestockequipment.com/meshpanels&gates.php >

Goats

The following section includes the developmental stages, behavior and diet of goats. The recommended fencing are also included.

Developmental stages / Behavior

Goats are both social and intelligent animals. They wag their tails, know their names and form strong bonds with humans and each other. When separated they may wail very loudly or may even become severely depressed (Farm Sanctuary, INC. 2014). Goats have strong mouths that help them chew the harsh branches and leaves of shrubbery and trees. They will stand on their hind legs to reach tall branches and climb on whatever they can (US Fish and Wildlife Service 2009). Young goats, also called kids, tend to climb and play on raised objects, such as rocks or stumps. This should be taken into consideration when building a pen and special care should be used to ensure any rocks or fallen trees are clear of fence lines (Mitchell, Keains 1982).

Figure 2-4 Goat looking at the camera <http://i.ytimg.com/vi/OOI1HI7WmoY/hqdefault.jpg>

Description

“A goat is any ruminant and hollow-horned mammal belonging to the genus Capra. Related to the sheep, the goat is lighter of build, has horns that arch backward, a short tail, and straighter hair. Male goats, called bucks or Billys, usually have a beard. Females are called does or nannys, and immature goats are called kids” (Encyclopedia Britannica 2015)

Fencing

Goats tend to travel and feed over the entire paddock. This leaves any fault in a fence line noticeable to the goats and a breach is made possible. The bottom third of the fence is what is tested most and any gaps between the ground and the fence are constantly tried by them. This is why it is of such importance to keep the fence close to the ground with no gaps. Using correct wire tension is a good deterrent to goats going underneath the enclosure. (Mitchell, Kearins.

1982) Not only does fencing keep the goats from escaping but it also keeps them safe from predators. Temporary, portable fencing is sufficient for containment as long as it takes into consideration that goats are susceptible to predation. (Frost and Launchbaugh 2003, Tu et al. 2001, Coffey 2001).

Diet

Goats are ruminants. “Ruminants are mammals that are able to acquire nutrients from plant-based food by fermenting it in a specialized stomach prior to digestion, principally through bacterial actions. The process typically requires the fermented ingesta (known as cud) to be regurgitated and chewed again. The process of rechewing the cud to further break down plant matter and stimulate digestion is called rumination.” (Wikipedia 2015) Goats are browsing animals and will chew on almost anything resembling plant matter. They are very particular when actually eating something. They prefer woody shrubs, trees, weeds and love alfalfa. Goats usually won’t consume spoiled food or contaminated water unless they are starving. Some poisonous and harmful foods goats should not eat are nightshade, wilted fruit trees, corn stalk and mold in goats feed can. (Wikipedia for Schools. 2015) The proper nutrition of growing goats is essential to the health and future productivity of milk. Although a diet that is cheap and easily handled is desired for goats in confinement, the nutrient level of the feed should be carefully evaluated (Martinez Marin. 2007). Goats prefer woody plants over shrubs and are most tolerant of secondary plant compounds (Frost and Launchbaugh. 2003, et al. 2001, Coffey 2001).

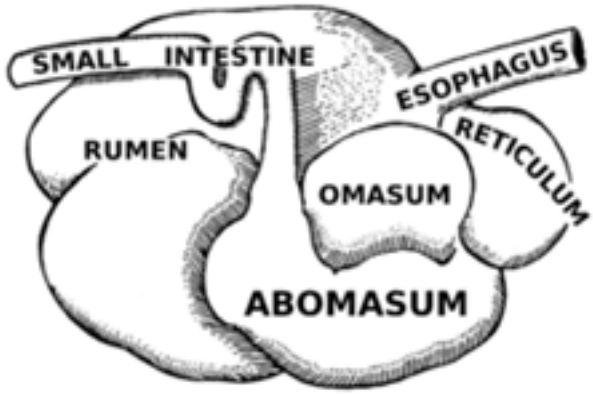

Figure 2-5 Goat Organs illustration of a ruminant digestive system (Wikipedia 2015)

2.8 Taking Care of your Chickens

The following section includes picking eggs, cleaning and maintenance, chicken coop ventilation, space, roosting perches, nest boxes, and chicken diet.

Picking Eggs

The time for picking up eggs should not interfere with the laying period of the hens. Constant interruption can cause less amount of eggs. Eggs should be collected 3 times a day (Backyard Chickens.2015).

Cleaning and Maintenance

Having a clean chicken coop prevents the spread of diseases in your flock as well as a better environment for your laying hens. It is recommended to clean once a week. It is important to keep feeders and water clean and disinfected and check daily.

Chicken Coop Ventilation

Chickens need to have a ventilated coop. Depending on the climate, you need to have different types of ventilation. In hot weather you need ventilation from all sides of the coop. Having open

areas throughout the coop is advised. In cold weather, the ventilation source should be high up, making sure that the wind is not coming directly to the chickens (Lesa.2014).

Space

The space recommended to give your chickens is at least two or three square feet of space per chicken inside a pen or any captive space. Overcrowding your chickens can result in stress which results in severe cases of pecking. Chickens need space to prevent health and/or behavior problems. When the hens are laying, they like to have about four feet between each other (Families Raising Chickens. 2012).

Roosting Perches

Chickens like to have a roosting perch where they can go to sleep. They like the perches to be high to feel secure from predators. A long perch is not necessary since chickens tend to sleep next to each other for warmth. Setting up perches at the same level could prevent fights. That way, there are no “upper” places for the dominant chickens in the hierarchy order. The perches are recommended to be about 2 feet wide and rounded (Jodie.2012).

Nest Boxes

Chickens need a nesting box where they have enough space to lay eggs. Chickens feel more comfortable laying eggs when the nest box is dark. Materials that can be used to fill up the nest box are: straw, hay, leaves, pine shavings, and wood shaving. Nest boxes should be ventilated in some way.

Diet

Chickens need a diet based on carbohydrates, fat, protein, vitamin and minerals. Chickens like to eat vegetables, fruits, grass, flowers, grains (oatmeal) and seeds. They also need to eat small rocks to have a healthy digestive system. Water should always be clean and accessible. Oyster Shell is also a good source of calcium for your laying chickens’ eggs. (Terry Golson.2012).

Taking Care of Goats

This section talks about the necessary things goats need in order to live healthy. It discusses the room needed, ventilation and their bedding.

Needed Room

Goats need adequate pasture for grazing in a permanent setting. Goats do not like to be wet so a suitable home should be provided to protect them against the rain. (Washington State University.1997). Goats should be sheltered from cold winds and need at least 15 ft. of bedded area as well as approximately 25 ft. of space per goat for exercise. (Capra hircus. 2004).

Ventilation

Goats need fresh air that can be mixed with warmer air before it is in contact with the goats. It should be directed from above the goats. Goats can get pneumonia if cold drafts are allowed to penetrate the pen (Penn State Extension.2015).

Bedding

Goats prefer a bedded area of at least 15 ft. per goat. (Capra hicus.2004). They like to sleep with their heads uphill and will sleep on raised surfaces if given the chance (Penn State Extension.2015).

Successful Petting Zoos

This section includes what petting zoos use to make their animal visitation centers successful. An explanation is given for each part of a successful petting zoo such as flooring, space, and fencing.

Flooring

Using metal mesh floors or wooden slatted floors does bother goat's feet at any age. Each gap in the floor should not exceed ½ square inches so that the stool may pass through easily but allow the goat to walk on top safely (Hinch, Comfortable Quarters for Sheep and Goats. Nd).

Space

Each goat needs an approximate amount of space of about 1 ½ square feet of space per goat inside a pen (Hinch, Comfortable Quarters for Sheep and Goats. Nd).

Fencing

Common fencing structure for goats are usually about 4 ft. high walls that are constructed with wood or metal supports and lined with a sturdy wire (Hinch, Comfortable Quarters for Sheep and Goats. Nd).

Figure 2-6 Fencing for goats <http://www.noble.org/ag/livestock/fences/>

Materials

This section includes a brief explanation of the major materials that will be used to construct the animal visitation center. The materials that will be described are vinyl records, redwood, trunk latches, hook locks, chicken wire, plywood, galvanized hardware cloth and hinges.

Galvanized Hardware Cloth

Galvanized hardware cloth is made up of meshed wire that is dipped in hot zinc protecting it from rusting. Hardware cloth is flexible and can be bent into a desired shape (The Garden Coop. 2009). It is commonly used for agricultural construction such as chicken coops and gardening (Aiji Chicken Wire Company.2015)

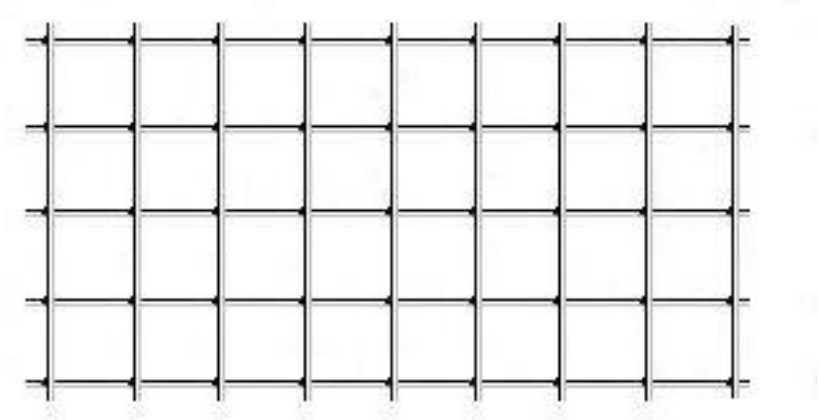

Figure 2-7 Galvanized Hardware Cloth <http://cdn2.hubspot.net/hub>

[redacted]Butt Hinge

The Butt Hinge have a pin that goes down the middle and is held in place by barrel knuckles. This hinge is commonly used on boxes and doors (Settich, Robert 2003).

Figure 2-8 Butt HInge <https://www.howdens.com/content/image/1877-3131-1.jpg>

[redacted]Vinyl Records

Vinyl records are made of polyvinyl chloride. Polyvinyl chloride, or PVC, records are strong, fire retardant and flexible. It will, however, melt under high temperatures (Water Treatment Solutions.2015).

Figure 2-9 Vinyl Records

Plywood

Plywood is a manufactured wood that comes in bulk sheets. Thin layers of ply are glued together to create the sheets of plywood. Depending on what it will be used for, the sheets differ in size and the range of thickness. It is commonly sold at 1/8 in. to 1 in. thick (Huntington W., & Mickadeit, R.1975).

Figure 2-10 Sheets of Plywood <http://www.locationequipmentsupply.com/img>

Redwood

Redwood is a type of wood that is used for constructional purposes. It is mainly used to construct outdoor products such as decks and fences because of its strength and weather resistance. As shown in figure 1-11, the common characteristics of redwood is a pale to darkish reddish brown and it has a smooth texture (wood solutions, 2013).

Figure 2-11 Redwood used on a deck http://www.deckstainhelp.com/wp-content/uploads/2014/02/Redwood_Deck_Stain.jpg

Children Animal Interaction

This section describes the interaction between animals and children. In it is about how children develop differently when exposed to live animals as well as their psychological interests.

Children and Animals

Bonds created by children and animals greatly help children in times of stress and worry. It allows the children to create a sense of empathy and the feel for others. Having an animal to care for helps develop an understanding for that living creature. The children also learn how the animals are different from themselves.

Figure 2-12 A child next to a fence with a goat behind it <http://www.theveganwoman.com/mother-are-you-telling-your-children-the-truth/>

Toddlers' Interest in Animals

Studies from Rutgers University and the University of Virginia have shown that toddlers have a genuine attraction to animals. The interests of toddlers to animals are so strong that they may lack interest in toys designed for their age groups but will be drawn to live animals. If there were no live animals at the time, it has been studied that the toddlers would play with the animal shaped toys more often.

2Children Groups

Children in between the ages of eleven and fourteen are in the age group referred to as early adolescents. At this age, children start to understand cooperative learning. This allows them to be in small groups and work towards a common goal. (Berk, 2012)

Figure 2-13 Children working together on a project

The Developmental Stages of Chickens

Introduction

Following there is a description of the different stages throughout the life of a chicken. The different stages are the incubation stage, early life stage, and the maturity stage

Incubation Stage

There are three main phases in the incubation stage for the development of the main organs of chickens. These phases are the early, middle, and late stages. In the first two stages, the majority of the organs are being formed. In the last stage, the organs that were formed during the first stages, grow stronger to be fully functional and mature. It is important to mention that the rate of the developmental changes can vary from species to species. Before the hatching period, all of the organs are fully mature, only then are they ready to come out from their eggs. Throughout the 21 days of incubation, the embryos develop important features such as: mobility, nervous system, heat production, auditory development, hatching behavior, vocalization, thyroid and adrenal hormone changes (Q. Tong. 2015).

Highlights about the Incubation Stage

Many considerations have to be clear before deciding between having an artificial incubation system or a hen. If you decide on a hen, you do not need to worry about the right temperature, humidity or special equipment for the eggs. The hen will provide that to her eggs. A negative fact about having a hen as your incubation method is that the hen needs to be “Broody” (a hormone condition) in order for them to incubate her eggs. Having a chicken coop with a high amount of chickens can cause the hens to not incubate the eggs in the appropriate way. A crowd of eggs can cause them to break before the hatching time. A certain number of eggs (approximately 7) per hen is important for the effective incubation.

If you choose to have an artificial incubation system, you do not need to worry about whether the hens will become broody or not. When using an incubator, you need the right temperature which depends on the incubator that it is being used (Cochins 1088. 2012).

Early Life Stage

The right temperature for the chicks that are one to seven days old is from 31-32 °C. It has been found that there are behaviors that have to be taught by the mothers, or the flock, while some

others are naturally within the chicks. One of the behaviors that have to be taught to the chicks is how to drink water. The hens have to teach their chicks how to peck at the water container.

There are interactions between the hen and the eggs. They interact through vocalization and are more active as the hatching approaches. Embryos also tend to give distress calls or pleasure calls to their mothers depending on how they feel. Chicks can identify their mothers by many ways but one of the most important ways is through means of vocalization. Chick and hen relationships are very strong in the first ten to twelve days after hatching. Chicks are very attached to their mother hens between this periods of time. After that, they become more independent. The chicks start feeding themselves but are still close to the hen for warmth. When they want to sleep, they go under the hen to cover themselves from the cold. Chick-to-chick behavior is different. They do not have any competitive skills until four days of age. Fighting becomes more common as they grow and they tend to set a pecking order ("a social hierarchy within chicken flocks"). (Q. Tongs, 2015)

[redacted]Maturity Stage

Chickens that have reached the maturity stage have already established a pecking or hierarchy order among them. To establish a pecking order, they tend to fight. When a new member is introduced to the flock a new pecking order is established by a fight between the chicks. When chickens do not like the pecking order position in which they are in, they will fight with chickens that belong in a higher hierarchy.

Hens start to breed at different times but most of them are fertile at 16-20 weeks of age. Mother hens will be with their chicks until they have reached a certain maturity, which is usually after the chicks are about 12 to 16 weeks old. After the hen is no longer attached to the already-matured chicks, it rejoins with the rest of the chickens in the flock. (Q. Tongs, 2015)

[redacted]Social Behavior of Chickens

In this section the behavioral aspect of chickens are discussed such as sociology, ranks and maturity.

[redacted]Behavior

Chickens in general are social animals. The pecking order is one social rule they settle. This rank depends on feathers, size, color, and the demographic environment. They start maturity at one year of age.

[redacted] School Policy

This section discusses the laws that are placed by both the federal government and Humboldt County on the topic of keeping animals inside the classroom

[redacted]Housing Animals in Class

Any live animals inside a public school must be housed and taken care of in an appropriate and safe manner. Teachers must give instruction on the various topics of using the emergency first aid, hemorrhage control and be able to treat poison (Education Code Section 51540.1976).

Figure 2-14 Children around classroom pet < http://www.scholastic.com/teachers/top-teaching/2013/01/welcoming-class-pet-living-mascot>

Humboldt County Animal Policy

Any live animals brought into a classroom must be kept in a cage or given a space that provides necessary containment of the animals. I must be in clean and sanitary conditions, must be weatherproof, be the correct temperatures for suitable living conditions and must be safe for all students and animals. (Humboldt County Office of Education, 2013).

3 Alternative Solutions

Introduction

Alternative solutions are the possible solutions for the design of the goat and chicken animal visitation centers. During the brainstorming meetings, multiple solutions of an animal visitation centers were formulated. This section includes a compilation of eight alternative solutions with a diagram of its functions and a description for each solution.

Brainstorming

Team Chickengies brainstormed during its team meetings at Humboldt State University. Brainstorming was done through a process of collaborative discussions and sketching of ideas for the solutions. Together eight alternative solutions were created for the goat and chicken animal visitation centers. Each alternative solution was created by following the criteria and specifications that were created based off the client's needs for the goat and chicken animal visitation centers.

Alternative Solution

This is a list of the alternative solutions that were created by Team Chickengies during the brainstorming sessions.

1. The Friendship Triangle
2. The Square Chicken Tractor Stacker
3. Wheeled Enclosure with Fencing
4. Tall Cart with Fencing Underneath
5. Simple Visitation Center
6. The Two for One
7. Expandable Chicken Tractor with Attached Goat Enclosure

8. Expandable Chicken Tractor with Separate Goat Enclosure

The Friendship Triangle

The Friendship Triangle is an enclosure made to contain goats and chickens together. This design is made so that both, the chickens and the goats are enclosed in the same area but are separated by a wall. As shown in figure 3-1, a triangular chicken tractor is a triangular prism designed to hold the chickens. The detachable rectangular panels can then be attached to the triangular chicken tractor to create an enclosure for the goats. The triangular chicken tractor has panels that swing out from both sides of the chicken tractor. This allows the triangular chicken tractor to have straight sides for the detachable panels to be attached to. Each panel is connected to another panel by female and male connectors. The goat enclosure can then be made into different shapes and sizes.

The triangular chicken tractor is designed so that it is part of the goat enclosure. As shown in figure 3-1 the triangular shape allows for the goats to interact with the chicken tractor. The goats are able to partially climb on the side that is enclosed in the fencing. For durability, this side of the chicken tractor will be made out of wood. The top of the chicken tractor has a wooden barrier that goes straight up to add height to the chicken tractor so that chances of a goat jumping out are reduced. The other side of the chicken tractor is covered in galvanized hardware cloth so the chickens get fresh air and can be viewed by people. Also, the panels that enclose the goats are structured out of wood and covered in galvanized hardware cloth to make the goats easily visible.

To make the Friendship Triangle portable, the chicken tractor has two wheels on one side and two handles on the other. A person can pick it up by its handles and move it to another location. The detachable panels are designed to be the same size as the sides of the chicken tractor. This allows for the panels to be cleanly attached to both sides. The Friendship Triangle can then be transferred as a unit when both the chicken tractor and the detachable panels are connected.

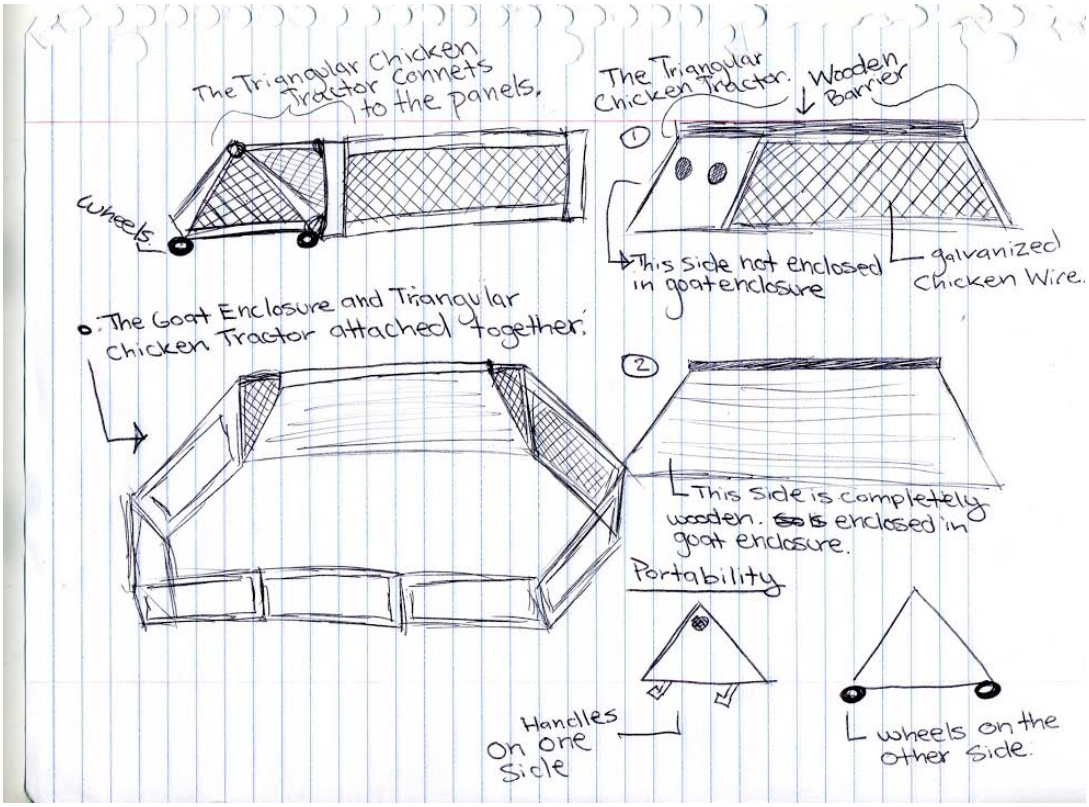

Figure 3-1 Illustration of Friendship Triangle (By: Brynna Frace)

The Square Chicken Tractor Stacker

The Square Chicken Tractor Stacker is made to keep chickens and goats enclosed in the same area but separate. As shown in figure 3-2. The Square Chicken Tractor Stacker includes a rectangular chicken tractor to hold the chickens and detachable panels to create an enclosure for the goats. The detachable panels are put together by connecting the male connectors to the female connectors. A variety of different shapes and sizes can be made with the detachable panels. This allows for the size of the goat enclosure to adapt to the amount of space that is provided for it. The rectangular chicken tractor is designed to be included inside the goat enclosure. The top of the chicken tractor has a wooden top, to allow it to be sturdy enough for the goats to stand on it. Since it is half the height of the panels, goats won't be able to jump from the top of the square chicken tractor and out of the enclosure.

The design of The Square Chicken Tractor Stacker is made to be portable. The square chicken tractor is made moveable by having two wheels on one side and two handles on the other. A person can pick up the handles and move the square chicken tractor to the desired location. The detachable panels are the same size as the top of the square chicken tractor. This detail allows for the panels to be cleanly stacked on top of the chicken tractor.

The materials used to design The Square Chicken Tractor Stacker ensure that the animals are easily visible. Both enclosures are structured out of wood and covered in galvanized hardware cloth, which allows for the goats and chickens to be seen.

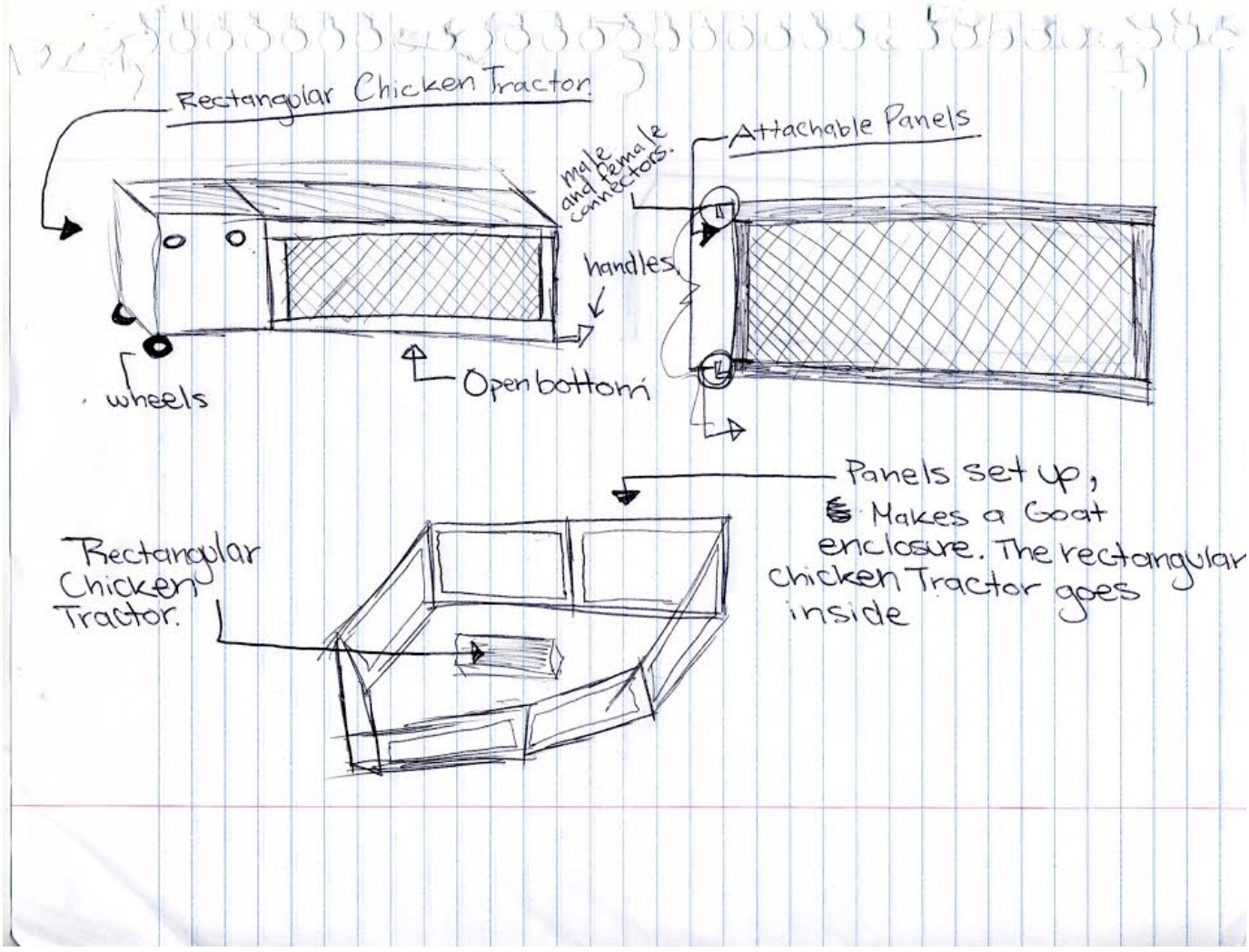

Figure 3-2 Illustration of Square Chicken Tractor (By: Brynna Frace)

Expandable Chicken Tractor with Attached Goat Enclosure

The Expandable mobile is designed to keep goats and chickens enclosed in a way that is convenient and portable. As shown in Figure 3-3, this enclosure is a nesting box attached to an outside enclosure. The outside enclosure is made of chicken wire, PVC piping and lightweight wood. The chicken tractor is attached to wheels for convenient mobilization and the nesting box is vented for the comfort of the chickens (Figure 3-3). When needed, the chicken tractor's "suicide" doors can be opened and additional panels can be added to make an enclosure that would contain the goats. When ready to transport, just attach the panels to the nesting box and secure with hooks (Figure 3-3).

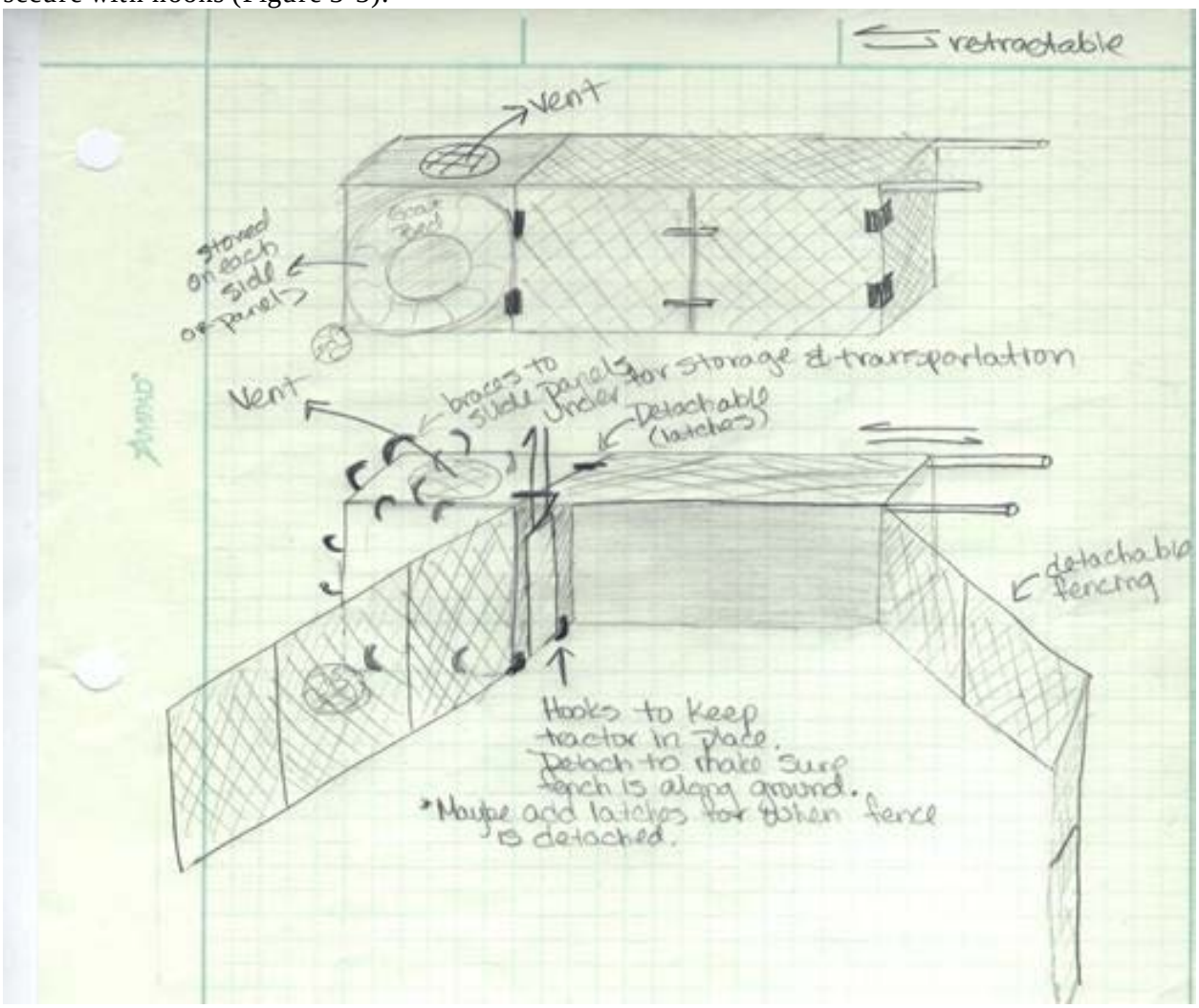

Figure 3-3 Illustration of the Expandable Chicken Tractor with Attached Goat Enclosure (By: Elizabeth Jurkoic)

Expandable Chicken Tractor with Separate Goat Enclosure

The Expandable Chicken Tractor with Separate Goat Enclosure is a convenient and portable enclosure for chickens and goats. There are two parts to this design. The chicken tractor is designed to hold the chickens. The portable goat enclosure is designed to hold the goats. Both parts have wheels for easy transportation and can be minimized for storage.

As shown in Figure 3-4, the chicken tractor is a nesting box with a vent on top and a door that opens to the fenced in area. The fenced in area expands from 18.0" to 36.0" and has handles that

expand 18.0". The expandable handles, along with the attached wheels, make the chicken tractor easy to move.

The chicken tractor is designed to retract and expand. As shown in Figure 1-4, the outside part of the chicken tractor is on a track that slides over the middle portion. The end part can be pushed in or out to make the chicken tractor big or small. When indoors, a convenient poop catch can be attached to the bottom to keep the poop under control. Cleaning is easy and can be done by removing the poop catch and hosing it off with water.

Along with the expandable chicken tractor is a portable goat enclosure. The portable goat enclosure is structured out of simple paneling that is made of PVC pipes, chicken wire and lightweight wood. Each is panels is 4.0' x 4.6'. The paneling connects to one another and can be made into a very small or extremely large enclosures.

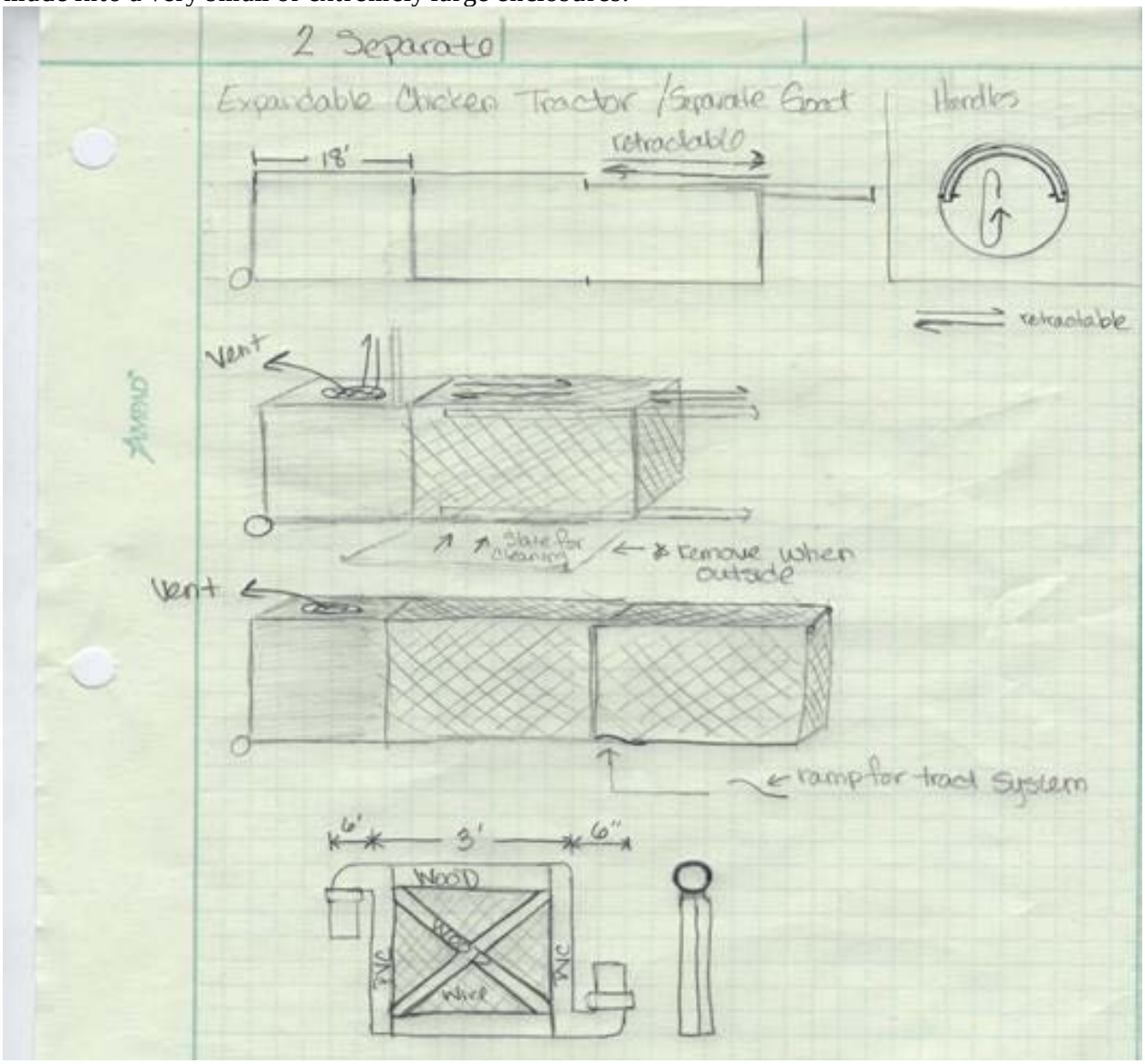

Figure 3-4 Illustration of Expandable Chicken Tractor with Separate Goat Enclose (By: Elizabeth Jurkoic)

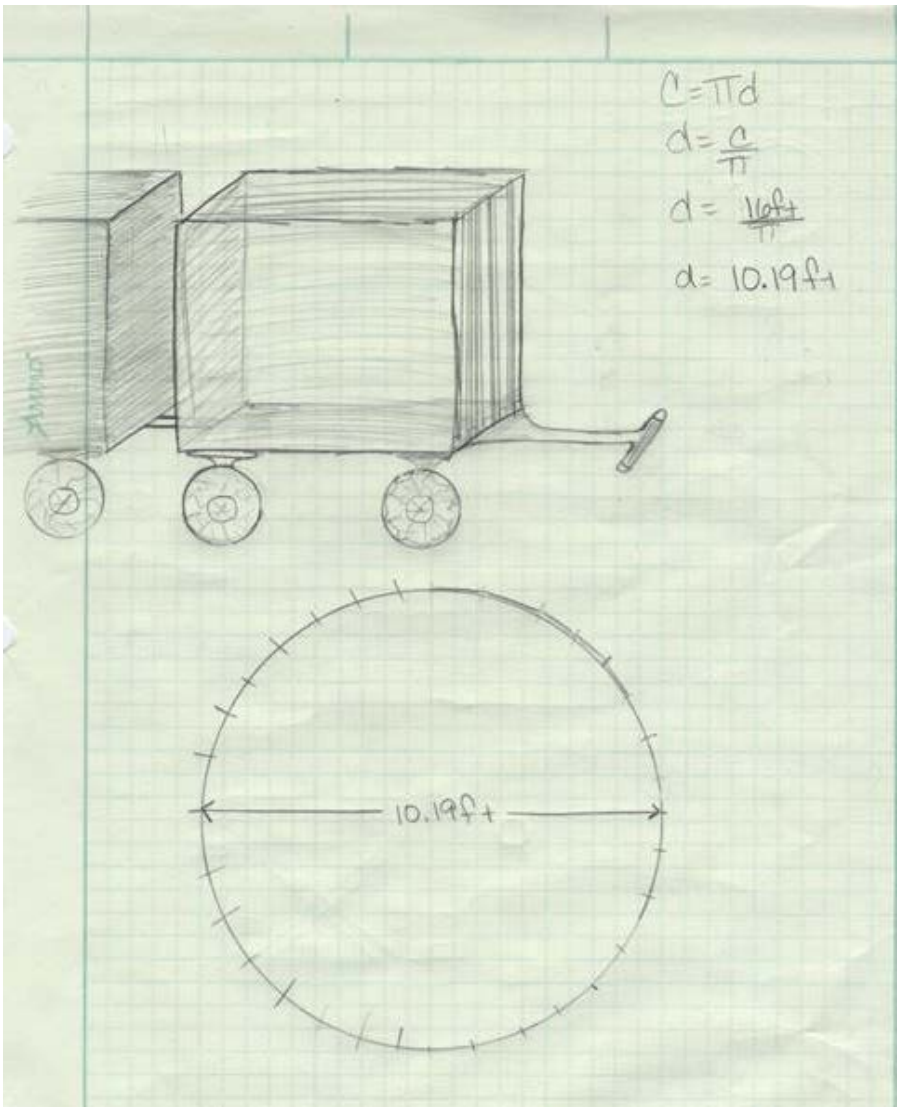

Figure 3-5 Illustration of Goat Enclosure Transportation System (By: Elizabeth Jurkoic)

[redacted]Tall Cart with fencing underneath

The Tall Cart with Fencing Underneath is an enclosure that stores both chickens and goats. As shown in Figure 3-6, the cart has two different sections which consist of the top section and the bottom section. The top section can be detached from the bottom section. Its roof is made out of corrugated metal panels for protection against the rain. The top section has three nesting boxes and a stairway that leads to the bottom part. Next to the nesting boxes, two roosting perches are placed parallel to the left side of the wall. The floor for the top part is removable and is made out of treated wood. On the sides, there are two pieces of wood that can be opened or closed. The back and front side are completely covered with wood. The front has a window to allow ventilation.

The bottom section consists of a fence made out of chicken wire. As shown in figure 3-6, each of the four corners pieces of wood are placed vertically to hold the fence. The bottom section is settled to the ground.

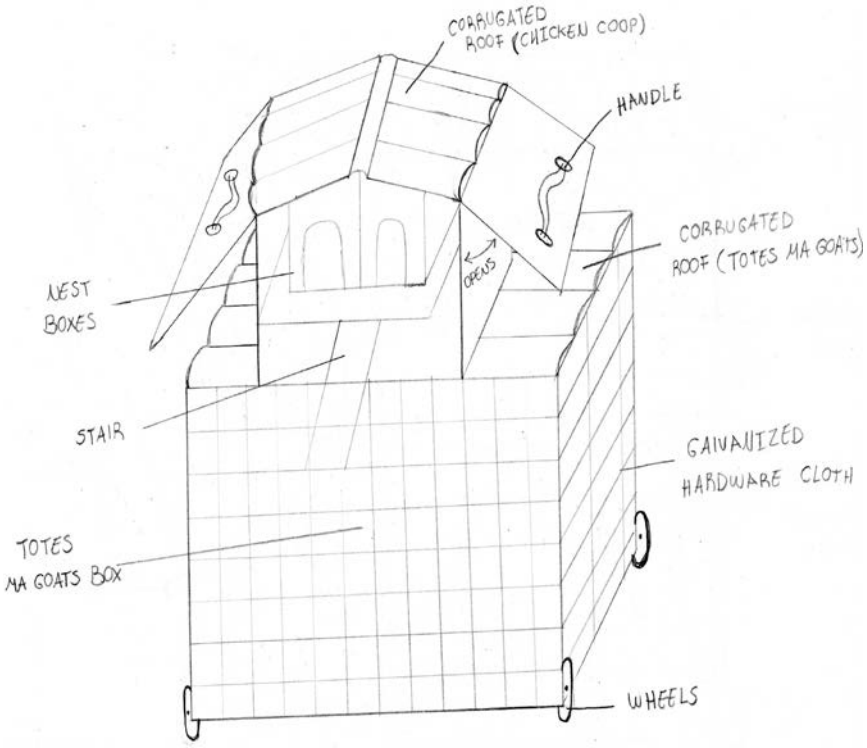

Figure 3-6 Illustration of Tall Cart with Fencing underneath (By: Delfina Navarro)

[redacted]Wheeled Enclosure with Fencing

The Wheeled Enclosure with Fencing is designed to contain goats and chickens. It consists as a whole unit but has different sections inside the unit. One of the sections is the chicken coop area. As shown in Figure 3-7, the chicken coop area is taller than the bottom section that is fenced. The whole unit is attached to wheels that are located on the back of the enclosure to make it movable. By looking at Figure 3-7, in the front, there are handles attached to the unit that allow someone to lift the enclosure and move it. The roof on the chicken coop and goat fence is made out of corrugated metal panels. The fence has an open perimeter that is equal in measurement to the nesting boxes to be on the outside of the fence. The nesting boxes will have a handle on the front edge to be able to lift and have access to the eggs.

The chicken coop is taller than the fence to leave a space underneath. The walls of the chicken coop are made out of wood panels and has windows on the right and left side. There is a staircase to allow the chickens access the bottom part (the fence). The floor of the whole unit is removable for easy cleaning. The inside of the chicken coop has a roasting perch made out of wood and is placed parallel to the inside of the wall.

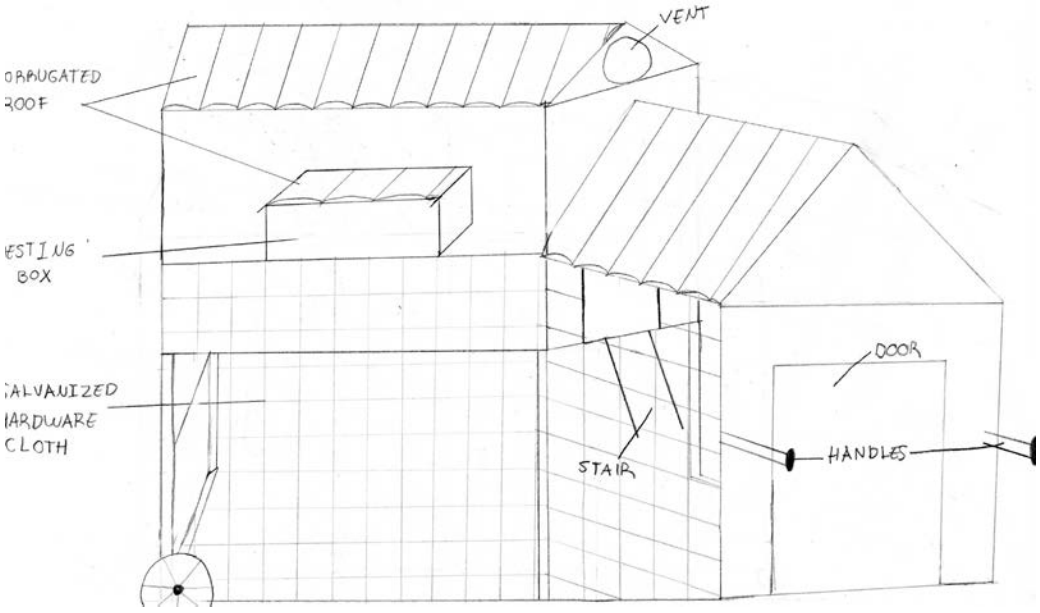

Figure 3-7 Illustration of Wheeled Enclosure with Fencing (By: Delfina Navarro)

Two for One

The Two for One animal visitation center is a compilation of two separate pens for the chickens and goats to be enclosed in. In figure 3-8, it can be seen that the indoor pen has panels that are locked in place with two corner braces at each connection. The frame of a single panel is made up of sturdy wood and hardware cloth. The end of the indoor pen is an interaction center with a chalkboard, drawer, and place to store necessary objects. The interaction center is attached to the pen by an internal hooking system.

The outside pen is made up of multiple panels that must be assembled prior to use. At the bottom of figure 3-8, there is an example of a single panel that has a locking mechanism to attach multiple panels together and create different shapes and sizes. The frame is made up of wood on the top and bottom of each panel and PVC pipes on the right and left. On the top right and bottom left there are fixed hooks for each panel.

In figure 3-9, it shows a portable chicken coop that can be placed inside of the indoor and outdoor pen. It is made of compressed wood except one side panel. This side panel is substituted with clear acrylic material and is used as a window. Inside there are separate roosts and the floor is lined with two layers of hardware cloth, and bottom is a tray to catch chicken poop. The roof is hinged and may be propped open with an attached wooden wedge for ventilation. The ramp is hinged and is dual purposed to function as the door during transportation and storage. It all stands on top of wooden supports.

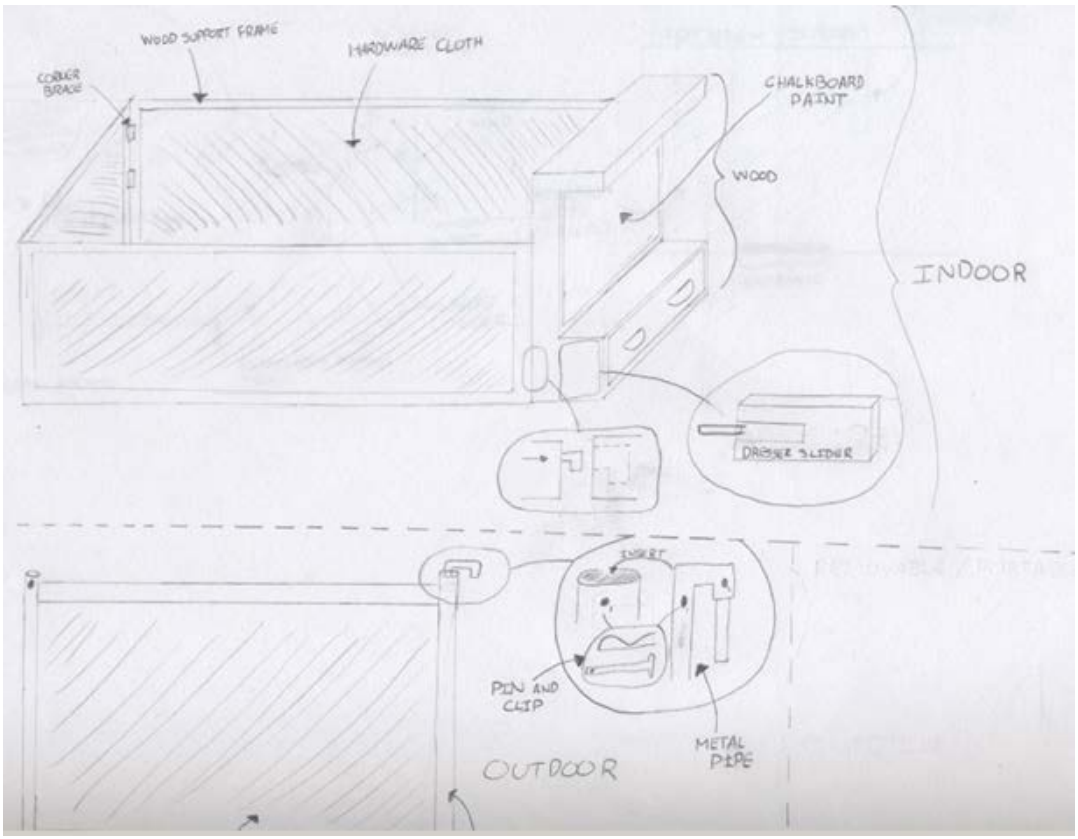

Figure 3-8 Illustration of Two for One (By: Marco Gonzalez)

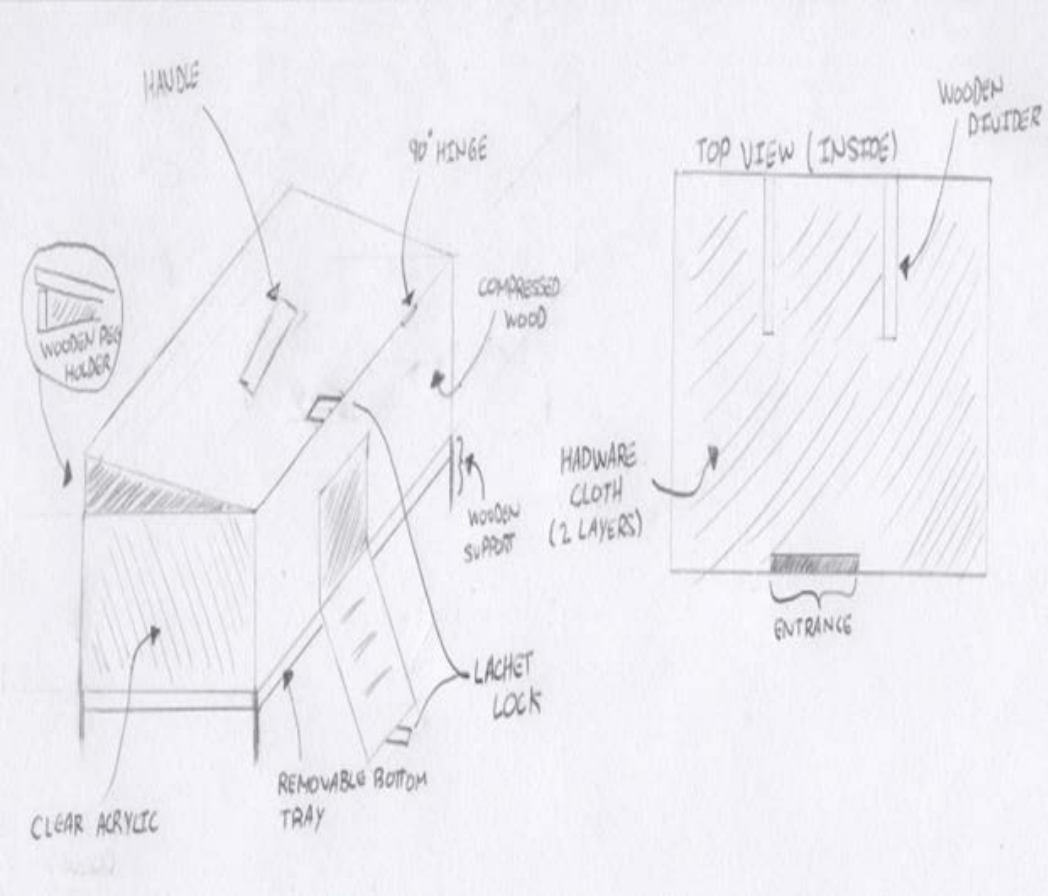

Figure 3-9 Illustration of Portable Chicken Coop (By: Marco Gonzalez)

Simple Enclosure

The Simple enclosure is built to contain goats and chickens inside and outside. Its panels are built with a wooden frame, has hardware cloth hammered onto it and small hat hooks on each outer corner. As seen in figure 3-10, each panel is attached differently. The front panels uses as slide bolt lock and a hinge to attach to another panel on the left. The second panel also is attached to another by a hinge. All of the panels are attached that way until the end when it is finished with the second part to the slide bolt lock. To put away the panels, it can be folded in an accordion like fashion. As shown in figure 3-10 the roof is a tarp that has loaded ends. There are four holes inside the tarp to be attached to the pen while it is outside.

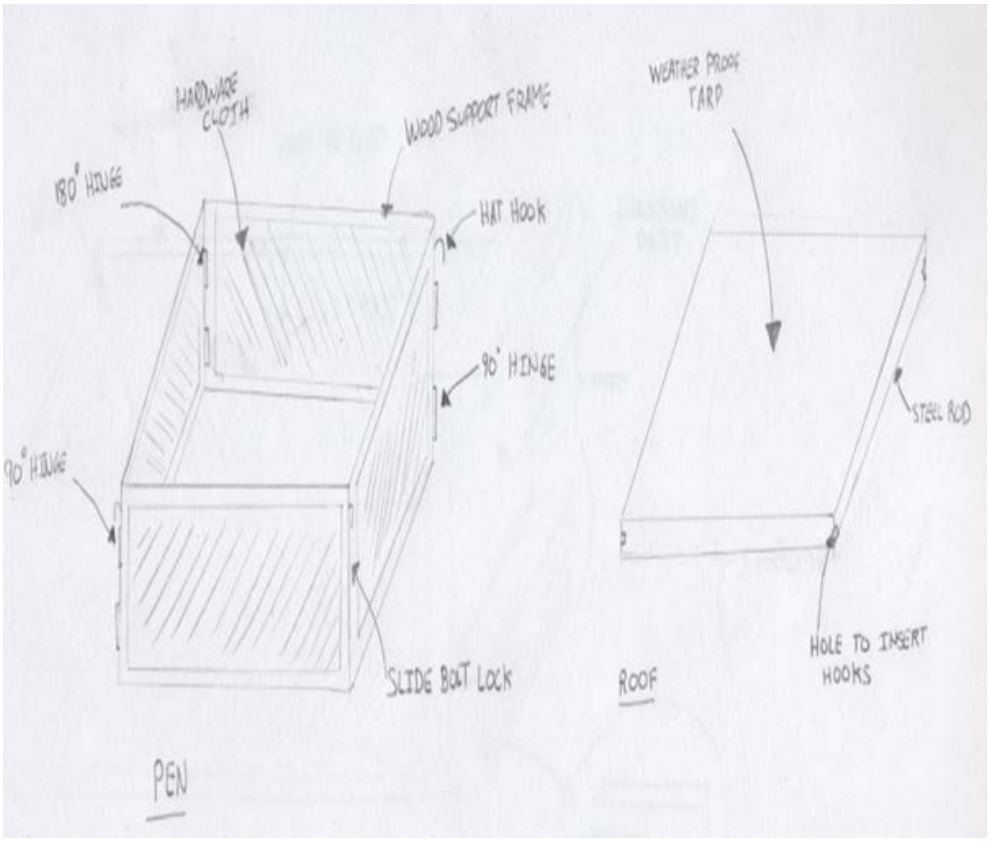

Figure 3-10 Illustration of Portable Chicken Coop (By: Marco Gonzalez)

4 Decision Process

Introduction

Section 4 is the decision phase which consists of all the alternative solutions that are assessed by the criteria. The criteria can be found in section 2. Each alternative solution has been weighed against the criteria using the Delphi method to select the most applicable solution.

Criteria

The following are criteria from section 2 to be used to assist with the decision of the final design.
Ease of Cleaning- The visitation center should be easy to clean in a short amount of time. .
Sustainability- The visitation station should be built from reused, recycled and/or upcycled materials.
Aesthetics-The visitation station must be visually pleasing and appeal to children.
Educational Value- The visitation station should allow animals to be visible.
Durability- The visitation station should be able to withstand damage done by the animals and children.
Ease of use- The visitation station should be easy to assemble and use.
Portability - The visitation station should be lightweight and easy to move.
Safety- No animal, child or adult will be in harm when the visitation center is in use or in storage.
Costs- The money spent, excluding donations, is not to exceed a specific amount.

Solutions

The following solutions are described in section 3. A table of criteria and their weights are also included

- Friendship Triangle
- Square Chicken Tractor
- Expandable Chicken Tractor with attached goat enclosure
- Expandable Chicken Tractor without attached goat enclosure
- Tall cart with fencing underneath
- Wheeled enclosure with fencing
- Two for one
- Simple enclosure

Decision Process

During the decision making process, Team Chickengie decided on a final decision. While making a decision for the final solution, the client changed some of the specifications of the design and the criteria. The previous alternative solutions, prior to the clients change, no longer meet the new specifications and criteria. The process of making a Delphi Matrix of the alternative solutions from section 3.3 was still continued with the new criteria. The Delphi Matrix shown in Table 4-1 below, rates each alternative solution on a scale 0-50 for each of the specified criteria in section 4.1. The criteria was weighted on a scale from 0-10, 10 meaning most important. Team Chickengie worked together to decide the ratings for each criteria and entered it into the Delphi Matrix. Parts of the highest ranked alternative solutions were considered for the final decision. The alternative solutions that were used in making the final decision were the Simple Enclosure and the Wheeled Enclosure with Fencing. Both of these designs don't exactly match what the client's new needs are but both do have ideas, which if modified, will fit the client's new specifications and criteria completely.

Table 4-1 Criteria with weights

Criteria	Weight (1-10 High)
Durability	9
Safety	9
Cost	8
Ease of Use	8
Aesthetics	7
Portability	7
Sustainability	7
Educational Value	6
Ease of Cleaning	5

Table 4-2 Delphi Matrix

Criteria	Weight (1-10 High)	Friendship Triangle		Square Chicken Tractor		Expandable Chicken Tracotr w/Attached		Expandanble Chciken Tractor w/out Goat		Tall Cart w/ Fencing Underneath		Wheeled Enclosure w/ Fencing		Two for One		Simple Enclosure	
Costs	8	17		35		25		20		20		15		25		40	
			136		280		200		160		160		120		200		320
Portability	8	30		35		30		40		35		30		0		45	
			240		280		240		320		280		240		0		360
Ease of Use	5	0		30		0		30		40		0		30		35	
			0		150		0		150		200		0		150		175
Durability	4	35		30		35		25		35		35		35		27	
			140		120		140		100		140		140		140		108
Educational Value	7	25		40		35		35		30		30		25		40	
			175		280		245		245		210		210		175		280
Aesthetics	7	20		30		25		25		35		40		25		20	
			140		210		175		175		245		280		175		140
Enviro. Justice	7	25		20		20		30		25		25		20		40	
			175		140		140		210		175		175		140		280
Ease of Cleanliness	6	15		25		20		35		25		30		35		25	
			90		150		120		210		150		180		210		150
Safety	8	35		40		35		35		40		40		35		40	
			280		320		280		280		320		320		280		320
	Total	1096		1610		1260		1570		1560		1345		1190		1813	

[redacted] Delphi Matrix

In the Delphi Matrix (Table 4-2) each alternative solution is rated by how well it meets the required criteria. The total is then tallied and given at the bottom. The color of the totals are to represent the scale of the highest total (highest being dark green) to the lowest total (lowest being light red). The final decision is then made based off of the totals.

[redacted] Final Decision

The Delphi matrix and alternative solutions were made after meeting with the client but prior to the final change in specifications. The criteria were changed and a new alternative solution was made. The new criteria that was taken into consideration is as follows: to have two separate enclosures, it must be able to fit on a countertop, have a heating lamp and a sliding base. Along with new criteria, the weight on the constraints also changed. Some of the weights that changed are: durability and portability. Some of the previous ideas from alternative solutions that still

apply are: portability, lightweight, educational value, and ease of cleaning. Using input from the client and ideas from the original alternative solutions, our final decision is a countertop chicken enclosure with a separate goat enclosure called the Totes Ma Goats box.

5 Final Solution

[redacted] Introduction

The purpose of section 5 is to describe the details of the final solution and use of a countertop chicken enclosure and of a Totes Ma Goats box. In this section is a detailed description and pictures of the final solution, an outline of costs, instructions for implementation and use of the model. Results of testing and any issues will also be included in this section.

[redacted] Description of solution

For the 6th grade class at Zane Middle School, Team Chickengies has constructed a Chicken Keeper and Totes Ma Goats Box. Both designs were created to allow children to interact with baby goats, baby chicks and chickens safely inside the classroom. Students will be able to easily view the animals and learn about their behaviors. Also, both designs are lightweight and portable so that the experience of having animals in the classroom can be shared with other classrooms around Zane Middle School.

[redacted]The Chicken Keeper

The Chicken Keeper is a chicken coop that's purpose is to contain chickens. It is a 3.0' x 2.0' x 7.0' enclosure. As shown in figure 5-1, it is designed to these exact dimensions so it would fit on a 2.0' x 7.0' countertop space in a classroom. It has two components, the nesting box and the roaming enclosure. Both components are made to be detachable from each other as shown in Figure 1-2. The nesting box and roaming enclosure are connected with hook locks. Both components can be disconnected by unlocking the hook locks (Figure 5-3).

Figure 5-1 Chicken Keeper being used on a counter

Figure 5-2 Nesting box detached from Roaming Area

Figure 5-3 Up-close photo of hook lock

5.2.1.1 The Nesting Box

The nesting box is an area for the chickens to nest. As shown in figure 5-4 and 5-5, the frame is structured out of redwood and the shell of the frame is upcycled with vinyl records. This section includes an explanation of the nesting box doors and roof.

Figure 5-4 Chicken Keeper's Nesting box

Figure 5-5 Nesting box before vinyl records were attached

5.2.1.2 Doors

The nesting box has two doors. As shown in figure 5-6 and 5-7, there is a door located on the back and a door located in the front. The purpose if the back door is to give easy access to the nesting box for maintenance of the chickens and for ease of cleaning. This door is attached with two hinges and swings open in a sideways motion. The door is kept secured with hook locks on the top and bottom. The front door is the gateway door between the roaming enclosure and the nesting box. This door is open and does not have any way of closing.

Figure 5-6 Backdoor to Nesting Box

Figure 5-7 Photo through entire Chicken Keeper

5.2.1.3 Roof

As shown in Figure 5-8, the roof goes on top of the nesting box. It is framed out of redwood and vinyl records. Included in the roof is an open storage unit. The storage unit is made for venting and storing light items. As shown in figure 5-9, the bottom of the storage unit is made out of galvanized hardware cloth. The storage unit is meant for the containment of light items with a maximum weight of about 10 lbs. By making the roof's bottom out of galvanized hardware cloth, allows for ventilation in the nesting box.

Figure 5-8 Nesting Box with vinyl records on roof

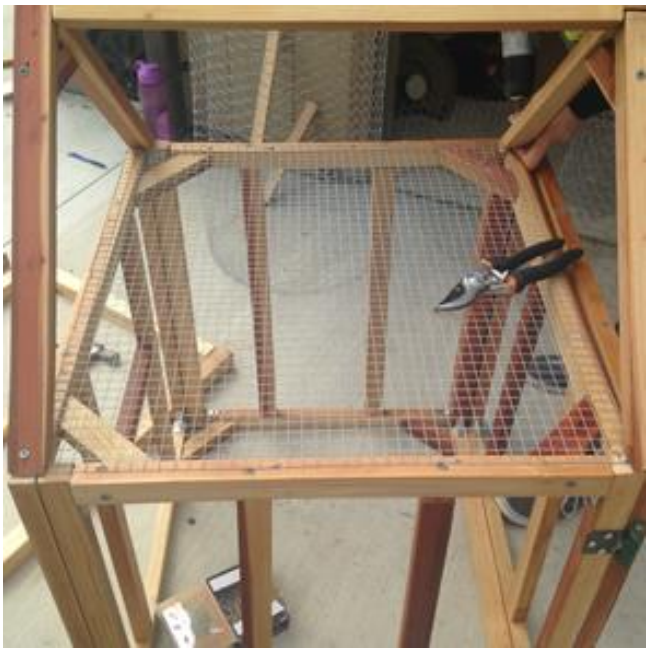

Figure 5-9 Nesting box storage unit framing

Roaming Area
The roaming area is a space for the chickens to move around. As shown in figure 5-10, it is structured out of redwood and is covered by chicken wire. In this section, an explanation of the perch and front maintenance door will be given.

5.2.1.4 Perch

The perch is an area for the birds to perch on in the roaming area. As shown in figure 5-10, it is structured out of redwood and is located in the back of the roaming area.

Figure 5-10 Skeleton of the Roaming Enclosure with perch (horizontal)

5.2.1.5 Front Maintenance Door

The front maintenance door is located on the end of the roaming enclosure. It is attached on hinges and swings open sideways. The door is secured with hook locks on the top and bottom.

[redacted]Detachable Trays

The bottoms of the nesting box and roaming area are detachable. As shown in figure 5-11, the bottoms are made out of plywood and framed with wood to create a tray. For durability the plywood is varnished with Shellac to make it waterproof. As shown in figure 5-12, the trays are then secured to the bottoms with trunk latches. The bottoms can be disconnected by unlocking the trunk latches. After unlocking the trunk latches, the bottom can be easily slide out.

Figure 5-11 Roaming Enclosure detached from tray

Figure 5-12 Up-close photo of trunk lock

[redacted]Totes Ma Goats Box

The Totes Ma Goats box is an animal visitation center for goats. It is a 3.0' X 9.0' rectangular pen that consists of eight panels. As shown in figure5-13,the dimensions of the Totes Ma Goats box allow it to fit cleanly in the corner of Joan Crandell's classroom at Zane Middle School.

Figure 5-13 Totes Ma Goats box with students sitting next to it

5.2.3.1 Panels

As shown in figure 5-14, the panels are structured out of redwood and galvanized hardware cloth. Each panel is connected to another panel with hinges. As shown in figure 5-15, two, 4 paneled units were made. Both units are connected to each other at the top and bottom of the end corners with hook locks to create the rectangular pen shape and to keep it secure.

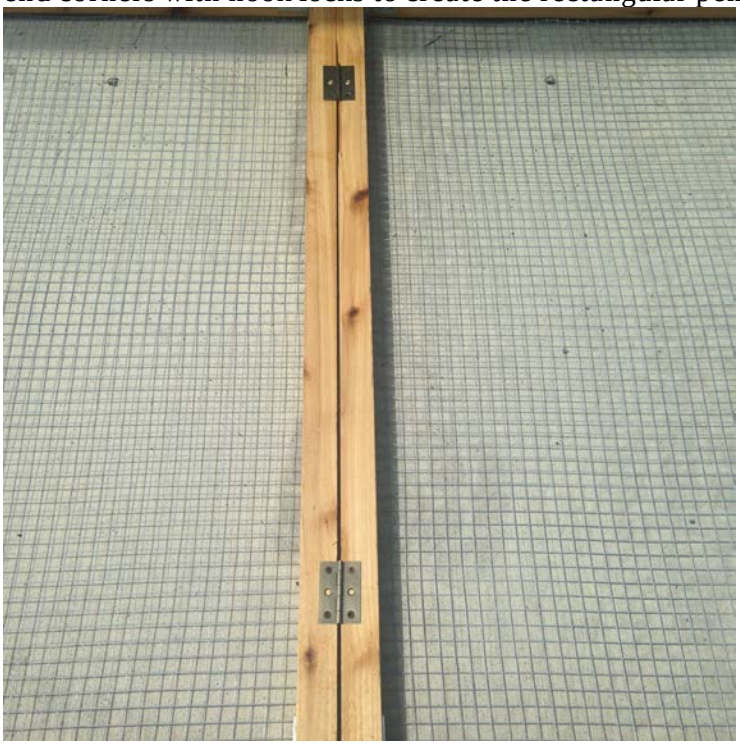

Figure 5-14 Hinges on the Totes Ma Goats box

Figure 5-15 Both four panel sections pulled apart

5.2.3.2 Portability

The panels are connected with hinges in such a way that makes the Totes Ma Goats box foldable. As shown in figure 1-16, when both four paneled units are separated, they can be folded into neat compact squares. This allows the Totes Ma Goats box to be easily stored and transported.

Figure 5-16 Process of taking down the Totes Ma Goats box

[redacted] Cost

The cost analysis shown in the three sections below, explains how money and time were allocated into each phase of the project.

[redacted] Design Cost

The design cost specifies the amount of time that was spent as a group towards the completion of the project. Figure 1-24 shows the main categories for the five different sections for the time that was spent.

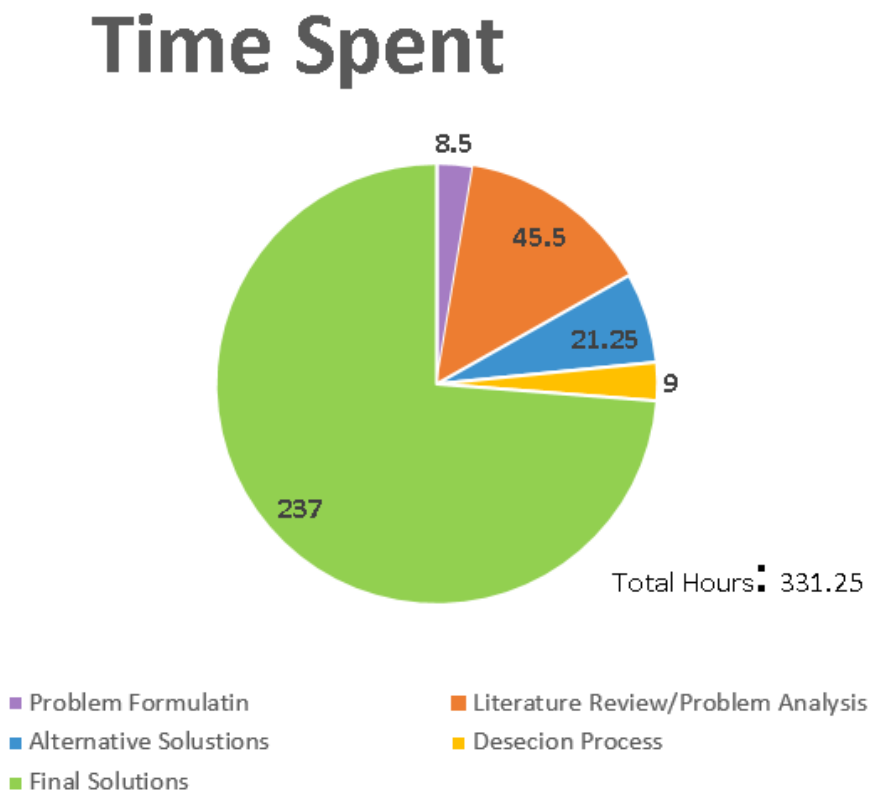

Figure 5-17 Pie chart as to how much time was spent on entire project

[redacted] Implementation of Cost

A total of $127.64 was spent on the materials to build a chicken coop and a goat enclosure. The costs of these materials are shown in table 1. The materials that were donated are also included in Table 1.

Table 5-1 Total cost to build the Totes Ma Goats box

Implementation Cost			
Materials	**Quantity**	**Cost**	**Donated?**
Records	60	16.24	no
Records	8	12.18	no
Flat Screw	200	8.78	no
Corner Brace	56	27.44	no
Chicken Wire	21 ft.	10.29	no
Hinges	2	5	no
Street Sign	1	0.41	no
screws	32	3.79	yes
Corner Brace	32	0.59	yes
Galvanized Barrel Bolt	3	5.99	yes
Sandpaper 80D	3	0.89	yes
Sandpaper 50D	3	0.95	yes
Hardware Cloth	27 ft.	3.29	yes
Phil Screws	1	4.39	yes
Hole Saw 3/4	1	3.99	yes
Hinges 2"	7	4.79	yes
Draw Catch	5	4.99	yes
Total		80.34	

Maintenance Cost

The cost of maintenance is projected to be low, taking into consideration that the Chicken Keeper and the Totes Ma Goats box are for temporary use. If the design is projected to be used for the long-term, maintenance cost can range from as low as $30.00 to medium prices. If used for the long-term, it is recommended that the shell of the Chicken keeper to be replaced with a stronger material than the vinyl records that were implemented. Along with the shell, the frames of the Chicken Keeper and Totes Ma Goats box can be replaced with a studier type of wood to make both, the Chicken Keeper and Totes Ma Goats box stronger and durable.

Table 5-2 Maintenance cost

Maintenance Cost		
Replacement tasks	Labor Time (hrs.)	Cost of materials ($)
Wall material	2.5	30.00
Frame	4.0	35.00

Instructions, Implementations and Use of Model

Instructions, implementations and use of model are described throughout the next portion of Section 5. The portability, cleaning maintenance and odor control are included.

Chicken Enclosure

The chicken enclosure is intended to hold up to 3 adult chickens. It is built to be stored on a countertop to ensure high visibility and the interaction with children in a classroom setting. The floor should be removed twice a week for disposal of waste to help control odor. The nesting box should be removed and sprayed out with water twice a month. The storage area is intended to store no more than 10 lbs. The nesting box and the roaming area are intended to be detached and moved separately.

Totes Ma Goats Box

The setup for the Totes Ma Goats box is quick and easy. Just unfold the hinged panels to the desired dimensions and clasp shut. There is enough space for two adult goats or 3 kids (baby goats...not the children). Hay should be added to cover the floor to help assist in waste removal and the comfort of the goats.

Results

Testing has been analyzed for the sturdiness of the paneling and the strength of the frame. Both the Chicken Keeper and the Totes Ma Goats were found to be of the utmost quality. The testing included kicking the hardware cloth, dropping the frame 6" and shaking and twisting the frame and panels. All testing held up to our teams standards. Further testing will be applied upon completion.

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