Sifty

Prepared for:

SueSan Chen (Client)

Evanston, IL

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Submitted By

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Executive Summary

Problem, Client, & Purpose

The Client, Sue San, needed a better way to remove castings from the composter. Her current method requires her to carry a large composter around, and spoon out the castings into her plants. As well as being hard to carry around, the composter also fails to separate the new food scraps from the castings, meaning they have to dig around to find castings. The purpose of this project is to develop a better way of removing the castings and distributing throughout her plants within her house. In addition, the odor and fruit flies should be addressed by being eliminated, or heavily reduced. Lastly the shape and size of the composter should look and feel pleasing, and whatever is being brought around the house to dump castings should be easy to carry.

Design Concept and Rationale

When designing the composter, the requirements we sought to solve were heavily influenced by SueSan's priorities. SueSan emphasized the importance of extracting worms castings so that became the top priority, while also keeping in mind the issue of flies, odor, and aesthetics. However, the worm castings are only extractable after four to six months of using the composter, so adjustments were made to the composter following that research.

For each iteration, the focus was on improving the filtering system: Beginning with a still filter, then a large sliding filter, then a spill-proof sliding filter.

Further Development

Any future design team should look to improve upon the dirt spillage issue, the bulkiness of the composter, and the friction created by moving parts. Solving these issues will lead to a better product and happier clients.

Conclusion

This design improves on several areas, including casting separation, casting transport, fly control, odor control, and footprint. These improvements allow the users to spend less time and effort on composting so that they can instead focus on the things they love doing.

Introduction

Keep your plants alive, prevent food waste, save the earth, and have a miniature ecosystem all in one. Composting is a great way to help the environment and reduce food you waste, and bonus points if you use the castings yourself.

Ⅰ) Users

The client, Sue San (they/them), lives in a 3rd floor apartment in uptown Chicago. They live with one partner, Beth Lester, and 2 cats. As a graduate from the McCormick School of Engineering, they knew of the DTC program, and was willing to go above and beyond in helping out the program. They have many plants around the apartment, matching their green thumb. Both Sue San, their partner, and the cats in the house should all be addressed when designing the composter. (Appendix A: Project Definition)

Ⅱ) Problem

For some, composting is just collecting food scraps and putting them inside a plastic bin for the city to pick up every Tuesday at 3pm. But this client needs the castings for their plants, so this requires us to have worms in the composter to collect the castings and put them in the plants. (Appendix B: User Observation Report) . The current composer, The Biovessel (Appendix E: Secondary Research Summary), has a few problems that should be addressed. First, the castings are hard to remove. To most effectively reach the castings of the worms one must push all the food scraps to the side and scoop out the castings with a spoon. This becomes more difficult when accounting for the worms that will be living in the castings, and should not be put into the plants with the castings. Secondly, the shape of the composter is undesired(Appendix B: User Observation Report). It is a kind of rectangular oval shape, with not smooth edges. In addition, the current composter has 3 holes in the lid, and a lid that comes off. Sue San uses only one of the holes, and has to frequently take off the entire lid and carry the whole composter around.

Ⅲ) Requirements

(Appendix I: Alternative Matrix) This new design should address removing the castings primarily, specifically making it significantly easier to remove the castings from the composter and get them into the plants. Next, the solution should address both the odor of compost and the fruit flies that are associated with gathering food. The windows in the house are often open, so that could make the odor problem easier to solve, but the fruit fly problem harder to solve. Lastly the aesthetic and size should be addressed after all other problems. This means the composter should fit conveniently in the kitchen, and shouldn't stand out or be hard to look at. Additionally, whatever is going to be carried around the house to all of the plants should be easy to handle, and not a burden to carry.

To summarize:

1) The removal of castings easily
2) Keeping odors in, and fruit flies out
3) Adjusting the shape, size, and color to look best, and still be easily maneuvered

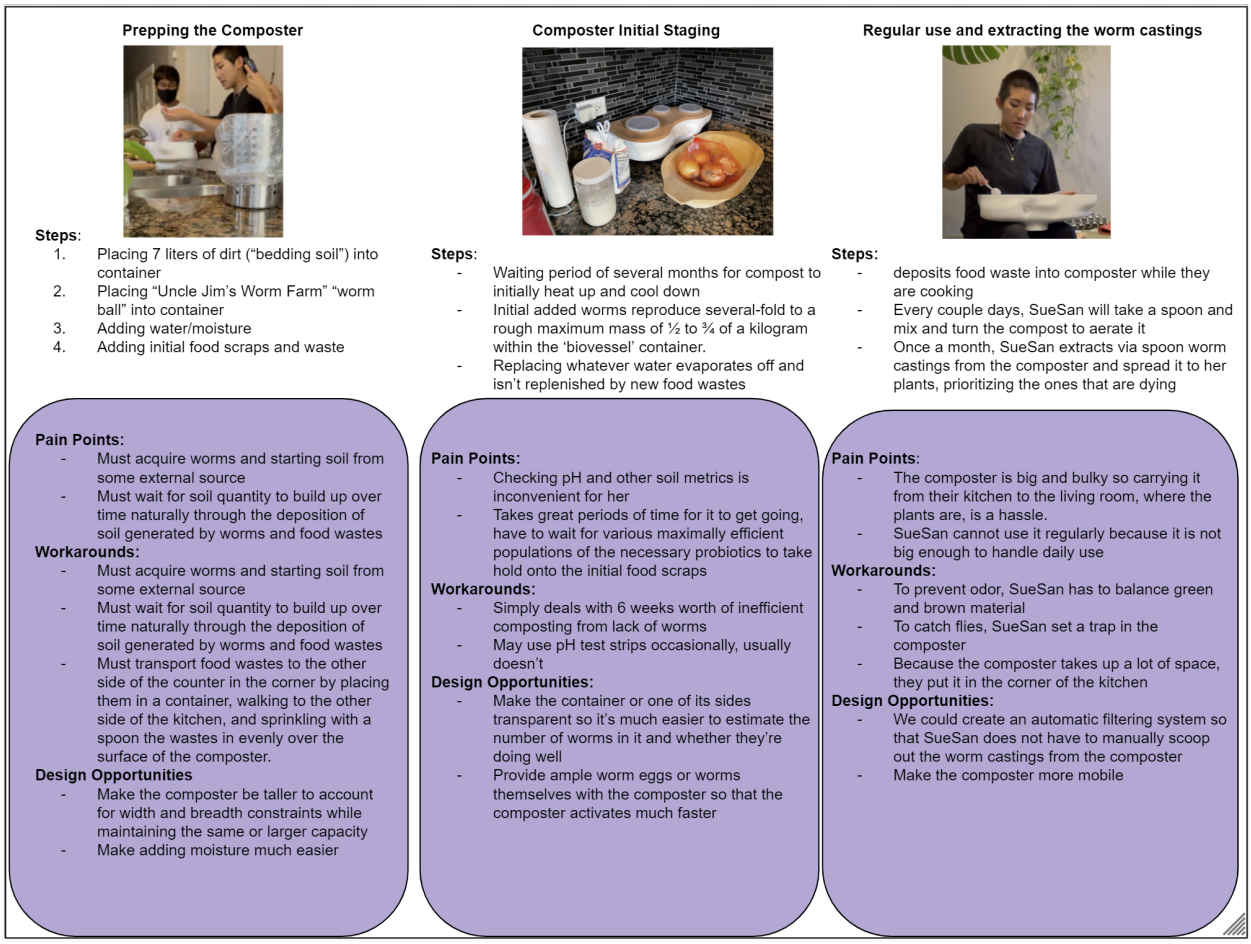
Ⅳ) Document Map

Figure: 1

Document Name	Description	Pages
Executive Summary	A short, streamlined version of the entire final report.	3
Introduction	AN overview of the users, problems, and requirements.	4-7
Design Concept and Rationale	A detailed explanation of the design and the rationale behind it.	7-15
Further Development	The next steps in the design for any future design team.	15
Conclusion	Closing statements that reiterate the benefits of the design.	16-18

Ⅴ) Journey Map

Figure: 2



The journey map highlights three major steps in using SueSan's current composter.

1. Prepping the Composter

   In this step, SueSan places the dirt and worms into the composter. The dirt and worms must be bought separately.

2. Initial Staging

   In this step, SueSan is regularly depositing food scraps into their composter but is unable to extract worm castings out because the castings are limited. The worms are still slowly turning the food scraps and dirt into castings. During this stage, the worms are reproducing, and time is necessary for them to do this. This stage requires SueSan to wait four months before extracting large amounts of castings because there are not enough castings or worms turning material into castings. While this is a major pain point for users, there does not seem to be a clean cut

solution unless the user opts to use worm castings instead of dirt in the prepping the composter process.

3. Regular Use and Extraction of Worm Castings

   In this step, SueSan is regularly depositing food, regularly aerating their compost, and extracting worm castings monthly. The biggest pain point we saw in this step is the extraction of worm castings. SueSan opens their composter and meticulously spoons out the castings and spreads them to their plants. While SueSan did not seem to mind the tedious extraction process, this is where we saw the most potential to make our user's lives easier. SueSan needed a better way to separate the worm castings from the rest of the food scraps, and this became a requirement/priority. Also, to spread castings to their plants, SueSan picks up the entire composter and walks over their plants. The bulkiness and weight of the composter makes this difficult. So, it is clear that SueSan needed a more mobile composter or a device that collects the worm castings that is mobile.

   During this stage, flies also start to emerge in the composter. While only speculation, SueSan suspects they enter through the holes in the cork lid; therefore, SueSan wanted a cork lid that would prevent flies from entering the composter. SueSan also wants a lid made from cork because cork was effective at absorbing odors from the composter.

Design Concept and Rationale

During the interview with the client, the focus was mainly on the processes and interactions they have with their current composter. When SueSan first got their composter, they filled it with dirt and 250 worms. Then, they began depositing food scraps over the course of 4 months. Towards the fifth month, all the dirt turned into worm castings, at which point, SueSan scoops out the castings with a spoon to spread to their plants. So their composter only becomes fully functional after 4 months of use (Appendix B: User Observation Report).

Also discussed were the pain points SueSan experiences with their composter: odors, flies, and manually scooping out the worm castings with a spoon. So, adjustments were made based on the requirements on the issues SueSan faces with the composter. A design was needed that could filter the worm castings from the food scraps, collect the castings in a single container for easy removable, control flies, and prevent odors.

Also, considerations were made for SueSan's timeline for using the composter, specifically the four-month wait before extracting worm castings, and based the design and features on the timeline they experienced.

The idea was based around design of the stopper on the timeline that follows:

1. Setting up:

   The user inserts the removable drawer into the composter and the stopper above the removables drawer. Then, the user puts in dirt and worms.

2. Depositing Food Scraps (4-6 months):

   For the next few months, the user will deposit food scraps, and the worms will eat the scraps and dirt and slowly convert all the dirt into worm castings. The process to turn all the dirt to castings takes 4-6 months.

3. Filtering:

   After a few months (when there is no more dirt and only castings), the user should take out the stopper so that the compost falls to the filter, and the worm castings begin to slowly filter into the drawer.

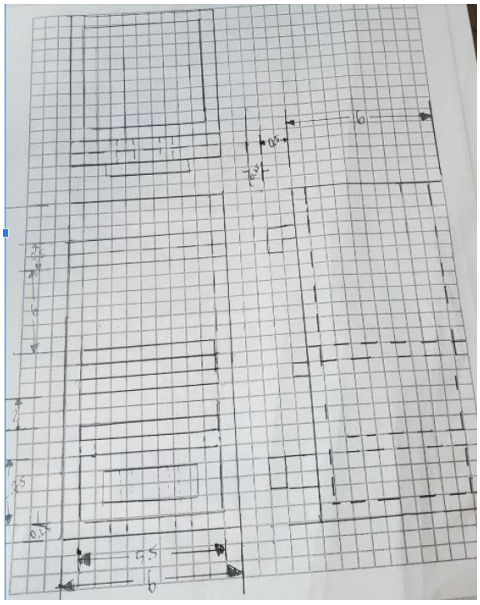
4. Spreading Worm Castings:

   When the drawer has a decent amount of castings in the drawer and the user wants to use their castings, they can insert the stopper back into the composter, remove the drawer, and spread the castings as they wish. After spreading the castings, they should put the drawer back into the composter and take out the stopper so that the castings filter again naturally.

Overview of Design

This composter design is a tall rectangular box shape with the opening at the very top built out of white acrylic. It features a sliding filter that moves back and forth inside the composter 3.5 inches from the bottom of the compster. The sliding filter is right above the removable drawer, which holds all of the filtered castings and can be removed for easy transportation and dispersal of said castings. Above the sliding filter is a plate that blocks the whole lower half of the composter. This is used at the very beginning of the composting process to let dirt, food scraps, and worm castings build up without letting the dirt get filtered through the slider. In the secondary research it was found that dirt is smaller and clump together less than worm castings, so they filter through the slider without external effort while filtering castings requires effort from the user. So, the stopper is used at the beginning and can be removed when all dirt turns into worm castings, which according to the secondary research is around four months. (Appendix K: Feedback Summary).

Figure: 3



a. **Requirement 1: Easy Casting Removal**
    i. **Feature: Sliding filter**
        1. **Design**

The sliding filter consists of a Rectangle made of acrylic, 5.5 in wide,9.5 inches long, 0.25 in. thick. It has a hole in the center that is 4.5x7.5 in. With 4.5 mm steel mesh covering it. It also features a handle that is a hole that is .5 in. from the end, 3.5x2 in. And is used to hold onto while sliding the filter.

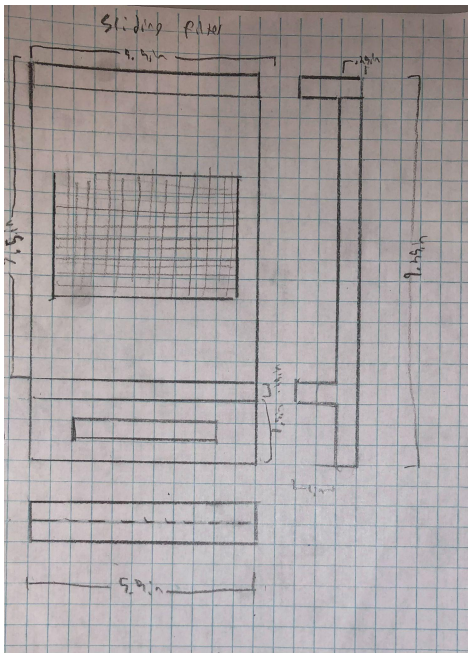
2. Rationale

The sliding filter allows the user to slide the compost back and forth in order to filter the worm castings from the rest of the compost. This design allows for very quick and easy casting separation as shown in the feedback summary(Appendix K: Feedback Summary). The slider has a filter that is inside the composter and is stopped from sliding outside the body of the composter by two borders on either end that sit outside the composter. The borders prevent the filter from exiting out of the body of the composter, and thereby, preventing any dirt, food scraps, or worm castings from exiting the composter.

This rationale was justified through the interview with Cora (Appendix G: Interview Summary). They composted for 2 years on Northwestern campus with a similar composter that was in her room. They told us that after a while, dirt did not need to be added to the composter, and the castings served as dirt for the worms to live in. This was further justified through secondary research confirming what they said was true (Appendix E: Secondary Research Summary). After the initial dirt requirements, there will be nothing else other than worms, food scraps, and castings. Therefore, the only thing needed to keep out

of the filter is the worms and the scraps, and after measuring the size and worm size, the 4.5 mm hole mesh would work best.

Figure: 4



ii. Feature: Removable Drawer

1. Design

The drawer is made up of several pieces of acrylic. One 5.5x5.75 in. base-piece of acrylic is joined with two 2.5x5.25 in. side-pieces and two 2.5x5.5 in. side pieces. Joining these pieces together forms a square based rectangular prism, which is 5.5 in. wide by 5.75 in. long by 2.75 in. tall.

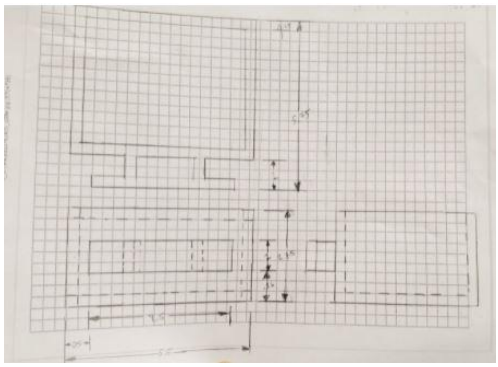
2. Rationale

The removable drawer allows the separated castings to be easily removed from the composter and then moved around to plants that need castings. The drawer is small and lightweight, and is very mobile. It slides flushly into the body of the composter at the bottom. The top of the drawer is open, so a spoon can be used to transfer the castings from the drawer into the plants or one could simply dump the contents of the drawer into the plants.

This feature was necessary because a major requirement of the design is easy casting distribution. In the interview and user observation with Sue San they explained and showed us how difficult it is to carry their big and bulky composter throughout their house

to each plant(Appendix C: SueSan User Data, Appendix G: Interview Summary). The usefulness of this idea was also confirmed by Sue San when it was explained and showed the mockups to them. They liked how much easier it was to use than their current product(Appendix K: Feedback Summary).

Figure: 5



iii. Feature: Stopper

1. Design

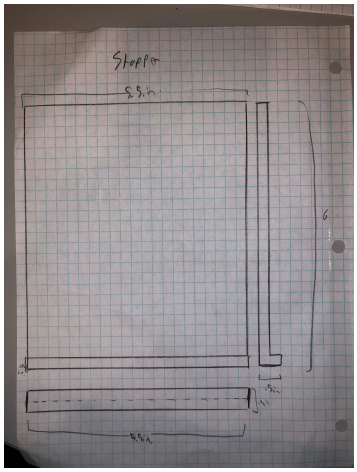
The stopper is made up of a 5.5x5.75 in. acrylic sheet with a 0.5x6 in. piece attached.

2. Rationale

The stopper is used to stop castings from reaching the filter until the user is ready to start separating castings for the first time. When they are ready to separate castings, they can remove the stopper, allowing the castings to fall onto the filter. After the first time separating castings, castings won't fall through the filters without sliding the filter back and forth, so the stopper is then obsolete. Next, the stopper is permanently removed from the composter, and then it slides parallel to the side of the compost so that it can cover the hole that removing it creates in order to keep the composter compact.

The stopper is required for the initial composting process. Since dirt is smaller than the filter, as designed, the dirt you initially put into the composter would just fall right through. To solve this problem, there was a need for a stopper so the dirt can turn into castings, and the compost can start being built up. After this, there is no need for the stopper, hence a little place for you to put it on the body of the composter too.

Figure: 6



b. Requirement 3: odor and fruit fly control.

i. Feature Lid

1. Design

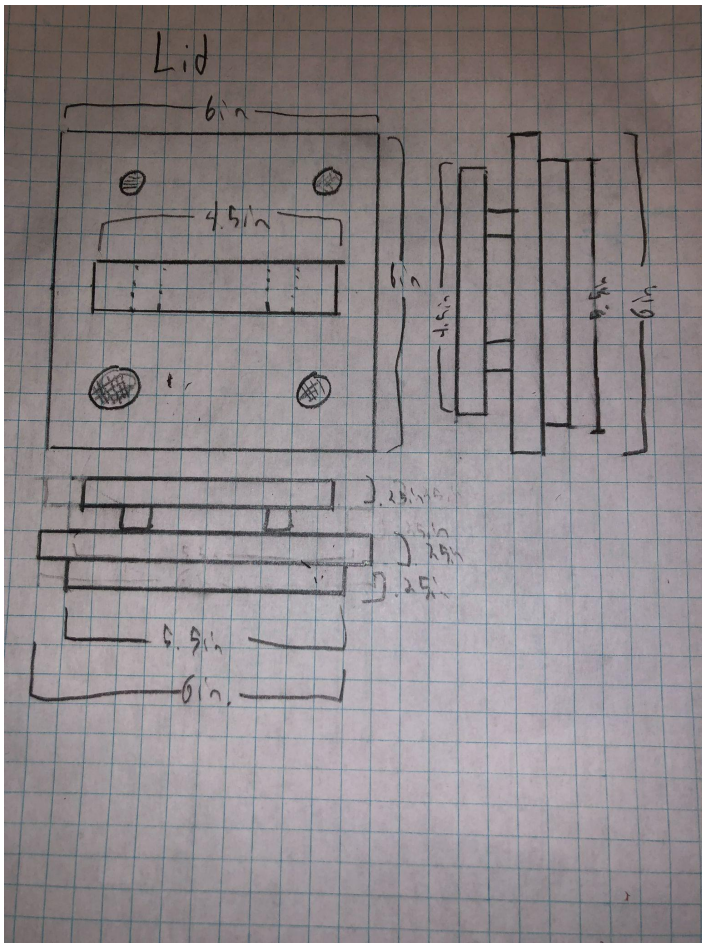
It is made up of a 5.45x5.45 in. piece of cork attached to a 6x6 in. piece of acrylic, with air holes drilled using the drill press.

2. Rationale

The lid is made up of a square of acrylic attached on top of a smaller piece of cork, with air holes drilled through at regular intervals with mosquito netting covering those holes. It is designed so that its friction fits into the top of the composter. The cork piece of the lid helps to absorb any odors that may arise in the composter.

The lid is necessary in order to keep odor in and fruit flies and cats out. When conducting the interview and user observation with Sue San, some major requirements that they told us to consider in any design are keeping flies out and keeping the smell down. Also, Sue San had multiple cats, which also needed to be kept out of the composter. The best approach to keep out fruit flies is to cover all the air holes with mosquito netting so that the flies cannot enter. According to secondary research, cork can be used to absorb odors. This concept is also proven by SueSan's current composter, the biovessel, which utilizes a cork lid to absorb odors. They have not noticed any foul odors, which shows that the cork does its job.

Figure: 7



Ⅳ) Iteration D:

a. Design

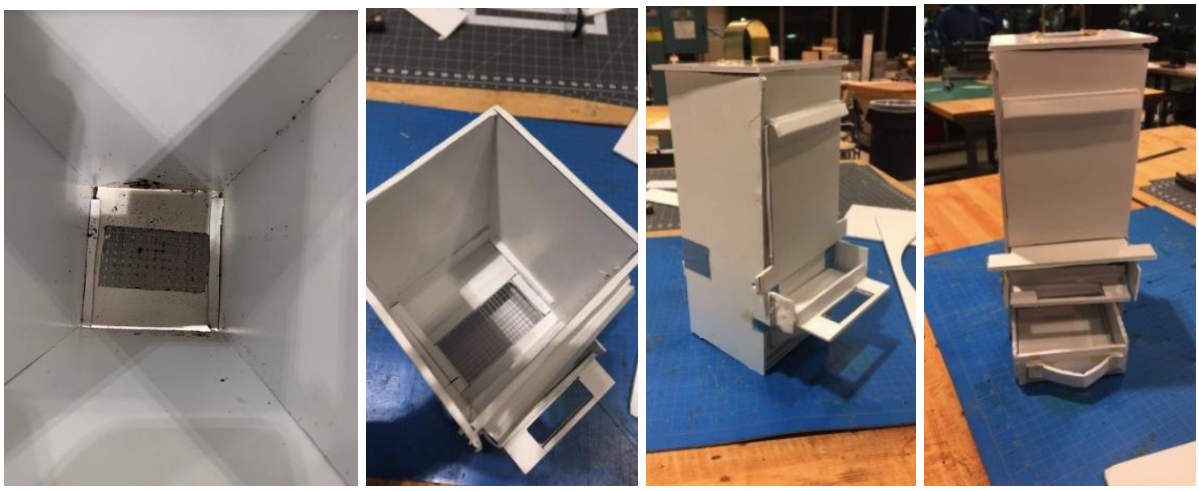
For this iteration, improvements were made for the sliding casting filter. The overall length of the sliding filter stayed the same, but the actual mesh part is much smaller, and it always

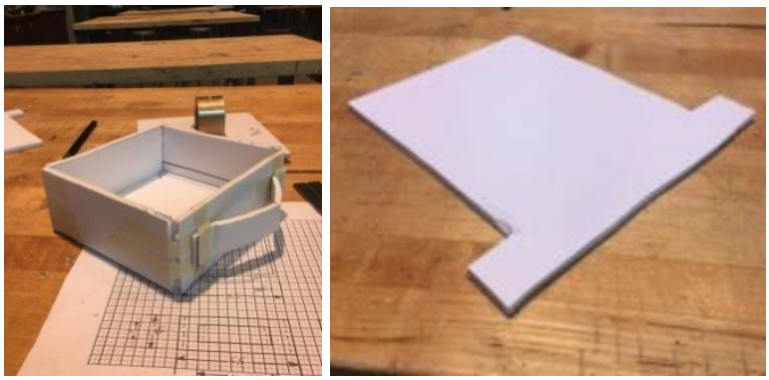
stays inside of the composter to prevent mess. In order to keep the filter inside of the body of the composterm, stoppers were added on either end of the sliding filter. Also, changes were made to the stopper so that it is above the sliding filter, and is only to be inserted until the compost is ready to filter. Once the stopper is obsolete, it is placed in a ridge that allows it to slide over the hole that removing it creates in order to keep the composter air tight.

b. Testings

The same method was used as outlined in part b of iteration III. After completing this testing, there was a large mess created when using the sliding filter. This was because the sliding filter was not perfectly flush with the opening that it fits into, which allowed dirt to escape. This problem was solved with cleaner and better measured cuts in the final iterations.

Figure: 8,9,10,11,12,13





Further Development

The Following shortcomings of our design should be the focus of any future design team looking to improve on our design. These problems are based on feedback in our design review summary(Appendix K: Feedback Summary).

I) Dirt Spillage

In prototype and mockup testing, the sliding filter is not perfectly flush with the side of the composter body, as a result, small amounts of dirt occasionally spill out of the composter. This is obviously very problematic as it represents a cleanliness issue when dirt is loose on a kitchen counter where food is prepared.

II) Bulkiness

While the design is significantly less bulky and smaller in footprint, it is still an awkward shape. Particularly, the sliding filter sticks out awkwardly when in operation, so the composter cannot sit against the back wall without the slider bumping into the wall and risking breaking.

III) Friction

The moving parts of the design, particularly the sliding filter generate a lot of friction when in use. This friction makes it more difficult to use the mechanism, which is frustrating for the user. It also makes it so there will be more wear and tear on the components of the composter which could result in poor performance in the future.

Conclusion

I) Benefits

This design includes several advantages over SueSan's current composter

(Appendices K, E,D):

- This design has a much smaller footprint than the biovessel and takes up less space
- The removable casting drawer is much easier to carry around to plants and remove castings from
- The sliding filter allows for easy casting removal
- The cork lid absorbs odors that originate during composting
- The mosquito netting prevents fruit flies from entering the composter
- The sleek design creates a beautiful view in SueSan's kitchen

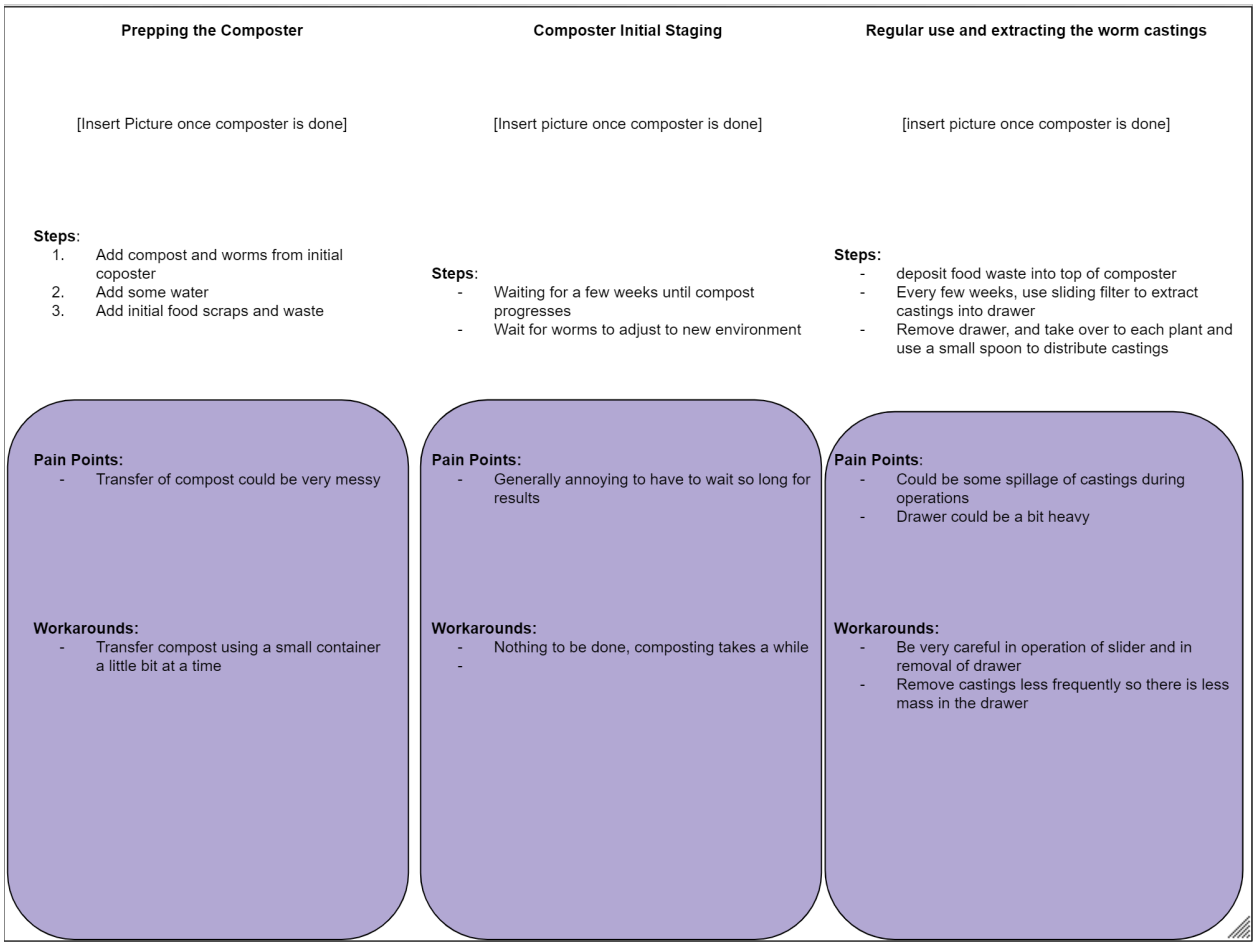
II) Life Improvements

ueSan's life will improve as a direct result of the composter in the following ways(Appendix K: Feedback Summary):

- There should be no more pesky fruit flies in the kitchen
- A lot less time and effort will need to be spent to separate castings
- A lot less effort will be needed to distribute castings to plants
    - Drawer is less bulky and lighter than biovessel
- More counter space due to smaller footprint of the design

III) Revised Journey Map

Figure: 14



The journey map highlights three major components for our composter:

1. Prepping the Composter

   The user adds dirt, worms, and a little bit of water. This process is normal for setting up most composters, so users should not have a large issue or pain point with the initial set up. The only issue could possibly be the user accidentally spilling dirt onto the counter when trying to put it into the composter.

2. Composter Initial Staging

   At this stage, the user adds food scraps regularly. The worms begin reproducing and break down the dirt and food scraps into castings. While castings are being produced the user should not begin filtering the castings into the drawer because the worms live in their castings, and filtering the castings out too fast deprives the worms of shelter. The casting filtering process should not start until all the dirt becomes castings. The biggest pain point with this stage is the wait- the worms have

to turn all the dirt into castings, which can take up to four months. There is no solution/workaround as it takes time to produce castings. SueSan also experienced this when they started composting, so it is a familiar issue that comes with most vermicomposters.

3. Regular Use and Extraction of Worm Castings

   After four months, when all the dirt becomes castings, the composter is ready to be fully used. Worm castings can be filtered regularly (monthly is best to keep a replaceable rate of castings), and food scraps can be continued to be deposited regularly. While the slider and drawer fixes pain points of filtering the worm castings and spreading them to plants, there is a pain point that emerges from the sliding filter mechanic. There is a chance that dirt could spill out of the composter. However, during the construction process, the composter was designed to be flush with all its moving parts, so the amount of dirt that should escape from the composter should be incredibly minimal.

Appendices:

Appendix A: Project Definition

Project Name: NUKids™ Composter

Client: SueSan Chen

Team Members: Blake Thompson, Siby Suriyan, Yanni Wilcox, Mark Winick

Date: 10/26/21

Version: 2

Mission Statement:
Our project is to design a new and improved composter to replace SueSan's current composter in order to address the multitude of fruit flies, difficulty collecting castings, and the bulkiness.

Project Deliverables:

- Final report (printed and bound)
- Presentation and Poster during the DTC Fair
- Final [Composter] Prototype

Constraints:

- ➢ Final prototype, report, and presentation are due on December 4th
- ➢ Spatial Dimensions
- ➢ Making castings easier to remove
- ➢ $100 limit

Users and Stakeholders:

- ➢ SueSan Chen, user and stakeholder, will utilize composter to convert food waste to potting soil
- ➢ Beth Lester, most likely a user who will also use the device to dispose of food waste and generally be within its presence

User(s) Profile:

SueSan is a Northwestern alumni in their twenties who lives in an urban apartment building. They frequently cook with fresh foods and value their time and degree of movement while doing so. Works as a professional designer and most likely lives a fast-paced lifestyle where going out of their way to transport food compost materials heavily detracts from their overall culinary and horticulture activities.

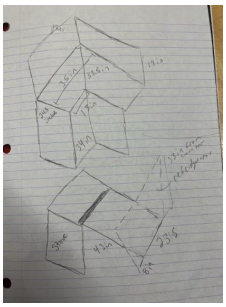
Illustrative User Scenario:

SueSan arrives home after a day of work and does their usual routine of preparing a meal with fresh foods to try to stay healthy despite being constrained by a limited schedule. As Suesan minces vegetables on their cutting board to the right of their stovetop, they pushed them to one side of the board to make more room. As the space left gradually decreases, they go over to their tabletop composter in the left corner of their kitchen under overhanging cupboards and open one of the three lids to carefully mix around the top layer of compost and worms in an effort to make room for more food waste. They then pick up the container and walk to the *other* side of the kitchen and swipe the unused vegetable cuttings into it, trying as best they can to evenly distribute them over the top by looking in at a sideways angle to compensate for the container blocking sight from everything except the lid port. SueSan then takes it back to its initial location and goes back to their normal cooking activities. As their food preparation proceeds, they might have to load more food wastes into a bowl as they accrue and repeat the process potentially multiple times depending on the size of the meal and the available containers they might have on hand.

Later in the week, SueSan picks up the composter and walks down their hall to their room full of potted plants. They open up a few lids or laboriously undos the entire top of the container and with a spoon, deposit the processed compost into various potted plants as they see fit. Some

large plants can only be stored on the ground, and thus SueSan might have to kneel down, snaking their body away from leaves and branches in order to awkwardly transfer compost to the inconvenient location. They then put all the lids and top to the composter container back on, walk all the way down the hall to the kitchen, and set it down in the left corner of the counter.

Project Requirements:

Needs	Metrics	Units	Ideal	Allowable Value
Easily portable with one hand	Weight Max length Max width Max height	Lb In In in	(take measurements from people of similar weight and stature to arrive at this value)	3.3 pounds 17.7 8.7 6.5 (all values from current solution)
Shape	Must fit dimensions of kitchen cabinets	feet/inches	 (see picture)	
Ease-of-use (for castings)	Time to remove	seconds	(<10s) (experimentally determined to be the least frustrating)	45s (current solution)
Sufficient Composting Rate Capacity	Weight/Week	lb/week	(tbd via experimentation) handle all her food waste	2lb (fr. current solution)
Low Odor	Proximity to noticeable smell	ft	No odor at 0ft	1.5 ft (current solution)
aesthetics	“Presence” held on countertop	“Emotional response”	unnoticeable	inoffensive
Keep worms safe	Number of dead worms	Dead worms	0	All but 2

Lower flies	Flies in space	Flies/m^3	0	8 (current solution)

Appendix B: User Observation Report

Preparation

For each person/area we plan to observe, we will ask for consent from the users to record video and audio of them, their settings, and, in the case of SueSan, how they use the composter. And we will ask for consent to write down the answers to the questions we ask them and ask for consent to use their information during our design process for our composter. In the future, if a user does not offer consent to be recorded, we will write down our observations, and if they do not consent to us writing down information, we will try to remember the observations we make, and if they do not consent to us using their information during our design process, we will disregard their information entirely. When we observed SueSan at their house, they consented to being recorded and to having their information used during the design process. In the future, we plan to interview Scott Simpson, the shop director, and Cora, a student living in the Greenhouse. She has prior experience building composters, as she built one herself. We will ensure to receive their consent in every step of our observation process.

During our interview with Scott Simpson, we will ask questions on the materials available to us in the shop and use his expertise and knowledge to determine what is the best material to build our composter. The material(s) should be waterproof, odor absorbing, cheap, and easy to build with. We also plan to go over some preliminary designs with him to see what designs are possible within the limitations of working at the shop. Pertaining to our design, we plan to ask him about...

1. A filtration system to separate food waste from the worm casting.
2. A drawer/shelf system that will gather the worm castings for easy removal as it is filtered from the food waste.
3. A mesh guard covering openings in our composter to keep flies out of the food waste.
4. An automatic sprinkler system

This is a tentative list and will expand as new questions arise, but our purpose for meeting with Scott Simpson is to share our initial design ideas with him and to see the design opportunities and limitations in the shop.

During our interview with Cora, we will discuss her composter, as she has experience in design and building composter. We plan to ask her questions about conflicting information we found when conducting our research; for example, should we turn the compost to aerate and mix it? Turning the compost destroys the worm tunnels, which naturally aerates the compost

and harms the worms, which naturally mixes the compost. Then, we plan to ask her questions about general functionality, such as...

1. How they concealed odors
2. How to use worms?
3. How often to water the compost?
4. How did you design your composter?
5. General tips for making good compost?

WHile we have research regarding most of this information, it will be helpful to have a physical, working model instead of just theoretical information. While research suggests that a certain material or design should theoretically function in a certain way, it may not function how we intended it to in real life. So, seeing another composter can give us better insights into what information is worthwhile in using during our design process and what we should research more into.

Sensing

We have not yet conducted our observations with Scott Simpson and Cora, so we will update our user observation report after our meetings with them.

During our observation at SueSan's home, the first thing we noticed were the many plants SueSan had in their home. In the living room, there are about 15 plants, and in the kitchen, there are about 4 plants. It is clear that SueSan values their plants, which is why they place a large emphasis on the worms and worm castings. From our observations, it seems to us that composting is more of a means to an end than the end itself. They are using the compost to generate worm castings so that they can use it for their plants. SueSan does not deposit the actual compost into the plants.

Also, when SueSan showed us the inside of their composter, we were surprised by the amount of worm castings present. There was no dirt, as the worms ate through all of that and lived in their own castings. Seeing this, we realized that our filter system only needs to separate between the food waste and the worm castings, not the dirt, which makes designing the filter system easier. However, SueSan informed us that it took about six months before the composter contained only worm castings and food waste. But, the worm castings cannot be filtered out too quickly because the worms live in their castings.

Some other surprising aspects of the observation was how the composter wasn't necessarily stationary— in order to spread the compost generated from the device, they would pick it up, bring it to different plants they were growing, and manually use a spoon to transfer compost into plant pots. For some especially large plants, this meant they had to crouch down and hold the composter in one hand while transferring the organic matter with the other. So, the composter has to be more mobile. I had the expectation that there would be some kind of scent

and that there would be flies. There were flies, but this was despite there being no noticeable odor.

Last, SueSan discussed briefly her version of an ideal composter. It would be half the size of her current one and be taller. Their current composter takes up too much space in their kitchen. And the composter should be able to gather all the worm castings in one spot so that they can easily remove it and disperse it to their plants. Flies are also a problem, so the composter should have a way to repel or catch flies.

Overall, SueSan said her current composter was good and that there were only a few tweaks that they would make to suit all their needs. So, we think it would be in our best interest to work closely with the design of their current composter and fix certain issues that SueSan complained about, namely the size, its mobility, and the flies.

Analysis

Chronological Category (include image)	Prepping the Composter 
List of sub-steps	- Placing 7 liters of dirt (“bedding soil”) into container - Placing “Uncle Jim’s Worm Farm” “worm ball” into container - Adding water/moisture - Adding initial food scraps and waste
Pain Points	- Buying worms from some other source may have mites, unsure when buying them whether they are healthy or not, have to somehow get lucky when buying them as they aren’t provided with the composter

	- Soil seems to be provided for by the Uncle Jim's worm container, and may only be for the purposes of transport and not optimal for the task of initial staging - Would like to have the container be located on the right side of her counter, where depositing food wastes is much easier, but the size of the container is too large for this to be the case - Has to manually move water into the container
Workarounds	- Must acquire worms and starting soil from some external source - Must wait for soil quantity to build up over time naturally through the deposition of soil generated by worms and food wastes - Must transport food wastes to the other side of the counter in the corner by placing them in a container, walking to the other side of the kitchen, and sprinkling with a spoon the wastes in evenly over the surface of the composter. - Uses spray bottle or water from tap
Design Opportunities	- Simply provide a starter kit of either worms themselves or uncontaminated red wiggler worm eggs - Provide either pretreated compost soil or bedding soil with packets of necessary microorganisms - Make the composter be taller to account for width and breadth constraints while maintaining the same or larger capacity - Make adding moisture much easier (maybe a rubber sphere pump connected with a container of water which can easily be filled up, so all that needs to be done is squeezing the pump once a week)

Chronological Category (include image)	Composter Initial Staging and Establishing Stable Environment (Initial mesophilic to thermophilic, and back to mesophilic curing phases

	
List of sub-steps	- Waiting period of several months for compost to initially heat up and cool down - This step requires relatively little maintenance, simply adding food wastes to the top every once in a while - The worms do most of the work in breaking down the wastes and spreading it through the container and letting necessary microorganisms colonize the container as it reaches optimum efficiency - Initial added worms reproduce several-fold to a rough maximum mass of ½ to ¾ of a kilogram within the 'biovessel' container. - Replacing whatever water evaporates off and isn't replenished by new food wastes
Pain Points	- Difficult to count how many worms are taking hold in the container, unsure if they are making use of it well or are having issues reproducing (says they doesn't really count) - Either requires adding nearly a kilogram of worms or waiting several weeks for them to naturally increase their population from starter amount - Checking pH and other soil metrics is inconvenient for her - Takes great periods of time for it to get going, have to wait for various maximally efficient populations of the necessary probiotics to take hold onto the initial food scraps
Workarounds	- Must sort of generally guess whether the worms are doing fine and if necessary action needs to be taken only based on

	a cursory view of their livelihood - Simply deals with 6 weeks worth of inefficient composting from lack of worms - May use pH test strips occasionally, usually doesn't - Also waits for composter to cure naturally in terms of its bacterial and fungal cultures
Design Opportunities	- Make the container or one of its sides transparent so it's much easier to estimate the number of worms in it and whether they're doing well - Provide ample worm eggs or worms themselves with the composter so that the composter activates much faster - Have some sort of built-in pH mechanism so it's possible to notice significant deviation in biological metrics so it's easy to plan ahead in the event of catastrophic failure (even if it seems unlikely to happen) - Provide packets of probiotics and or quickening catalysts and nutrients for probiotic colonies to ease into the artificial environment and let the composter work maximally efficiently sooner

Chronological Category (include image)	Regular use and extracting the worm castings

	
List of sub-steps	- SueSan deposits food waste into composter while they are cooking - Every couple days, SueSan will take a spoon and mix and turn the compost to aerate it - Once a month, SueSan will extract via spoon worm castings from the composter and spread it to her plants, prioritizing the ones that are dying
Pain Points	- The composter is big and bulky so carrying it from their kitchen to the living room, where the plants are, is a hassle. - The composter does not have a good grip to where you can hold it. It was not designed to be mobile. - SueSan could not see how many worms were in the composter - SueSan cannot use it regularly because it is not big enough to handle daily use
Workarounds	- To prevent odor, SueSan has to balance green and brown material - To catch flies, SueSan set a trap in the composter - Because the composter takes up a lot of space, they put it in

	the corner of the kitchen
Design Opportunities	- We could create an automatic filtering system so that SueSan does not have to manually scoop out the worm castings from the composter - Make the composter more mobile

Appendix C: SueSan User Data

Link

Appendix D: Primary Research Plan

Part 1

Our primary discovery research will include a virtual zoom interview and in-person interview and house visit observation that will be conducted simultaneously.

We will be recording our observations about the space, area, and any other factors about her home we may need to account for when building this composter. And we will record our client's answers when asking questions if they consent to their answers being recorded.

The virtual zoom interview will be recorded with the consent of our client, and their answers will be written down. If our client consents, we will use the information and data they provide to aid us in the design process of the composter. We will also be gathering private information about the client because a large part of the design process is based on specific needs of the client. The more information we gather about the client, the better we can build a composter that fits the desires of our client.

The client is SueSan Chen. They have a day job from 9 to 5, so they have time and energy restrictions when dealing with the maintenance of the composter. They have a partner

In terms of restrictions, our research revolves around SueSan Chen. SueSan, presumably, has specific foods they like to cook and specific ingredients they like to use. Since different foods and ingredients break down differently, we cannot assume everyone's food waste will break down the same way. We would have to have more clients, examine the food wastes of multiple people, and see how different food wastes break down. And, SueSan and our research is based in Chicago which has a specific climate. So, we are restricted in analyzing how our composter

would break down food in Chicago, so we cannot test if the composter would perform the same in different climates.

Another source of primary research we will look into is the different materials available to us for building our composter. During our research, we learned that we need materials that are capable of absorbing odor while also being worm resistant (worms have a tendency to eat everything in their path). We learned that charcoal is capable of absorbing foul odors, but we will need to envelope it in something that is worm resistant. As for the body of the composter, we need to see what materials we can use that are cheap and sturdy. Our client placed a large emphasis on price because they do not want to spend too much money on a composter, but the composter also needs to be sturdy enough so that if their cat knocks it over, it won't break. And last, as part of our early designs, we decided that we could use a rotating blade to aerate and mix the compost. We will need to see what materials are available, like a motor and a spiral blade, in the shop and learn how to incorporate the electrical work into our design. The person we plan on talking to about these material and design questions is Scott Simpson. He is the senior design and prototyping specialist at the Segal Design Institute. But before we go to Dr. Simpson, we plan to sketch out a few preliminary designs to show him so that we can have a better understanding of what designs are possible and the most cost effective. And, he can show us how to incorporate the different electronics into our design.

We plan to meet with Dr. Simpson in person, hopefully at Segal so that he can show us what materials are available there, and we can see which ones we like. We will ask him if we can write down the information he provides us and also ask for his consent to use his information when building a prototype of our composter. We will not be asking for his personal information like we would with SueSan because our design does not revolve around his needs.

When talking with Dr. Simpson, we believe a possible source of bias could be him being partial to certain materials over others and certain designs over others. So, while we will use the information Dr. Simpson provides us about our design and available materials, we will make the final decision on everything.

Part 2

Interview with SueSan(project partner) :

- Interview Type:
    - On zoom
    - Zoom link

- Goals of interview:
    - Get to know background information about SueSan
    - Get to know their reasons for composting
    - Get to know their problems with their current composter
    - Get to know general requirements for the composter
- Questions:
    - Motivations for composting:
        - Why are you invested in composting?
        - Is the environment important to you?
        - Tell us an example of when you wanted to compost?
        - What are your intentions specifically for choosing composting?
        - How do you want to compost, why is organic composting the solution you want to pursue?
    - Current Composter:
        - Do you have any specific times or examples of issues with your current composter?
        - Where is your current composter?
            - Why did you choose that location?
            - Has that location caused any frustration?
            - Have you tried any other locations, if so, why did you move it?
            -
    - Composter Specifics?
        - Why have you chosen to use a worm based composter over other options?
        - Are you opposed to other composting options, if so, why?
        - What kind of food wastes do you have in mind for breaking down?
        - What kind of food wastes do you have in mind for breaking down?

Interview With Scott:

- Interview Type
    - In person
    - Date and time not yet set
- Goals of interview
    - Get insight on what materials to use overall (durability, weight, different applications for various materials, even ones that may seem unnecessary or inapplicable)
    - Get insight on specific materials that could be used to prevent smell
    - Get insight on watertight materials and preventing leaks
    - Get insight on building techniques
- Questions:
    - Do you have any general advice or knowledge on composting in general?

- Do you have any experience with odor managing materials
    - If so, what materials work best to contain odors?
- Do you have advice on staying on budget?
- Do you have any material recommendations for waterproofing a design?

<u>Part 3</u>

Online Video: We plan on asking these series of questions on our zoom call

Why are you invested in composting

> What are your intentions specifically for choosing composting

> Tell us an example of when you wanted to compost

> Is the environment important to you

How do you want to compost, why is organic composting the solution you want to pursue

>Why have you chosen to use a worm based composter over other options?

>Are you opposed to other composting options, if so, why?

Do you have any specific times or examples of your current composter?

What kind of food wastes do you have in mind for breaking down

Where is your current composter?

> Why did you choose that location?

> Has that location caused any frustration?

> Have you tried any other locations, if so, why did you move it?

> How much space do you have on your countertop, how much room available

> Where and how stable is your countertop -> weight concerns

Visit to House:

Mark will be going to the house Wednesday to scout the field. With many groups on this trip, it is important to ask very in depth questions so as to not waste everyone's time. We won't have a big share of time so we need to take advantage of it well.

When Mark gets there he should start with pictures of the kitchen. Trying to find an optimal place for this product is very important, as it may require electricity and/or a very small place under the sink or covered somewhere as it is better for the worms.

In addition to pictures and measurements of the space underneath her sink, we will need to ask a few questions.

- Why would you prefer a countertop worm composter compared to one outside
- What will you be doing with the worm castings? How sensitive are your plants to dirt getting in with the worm castings?
- What does your ideal composter look like aesthetically?
- What time, money, or effort restrictions would you like us to consider?
- Anything else you would like to mention about your current composter, and why do you want this new one in this style?
- If you are comfortable with answering, what does your diet look like? What will you be putting lots of in the composter?
- Are there any features that you think should be included? Anybody that will be using this composter that has any kind of disability or difficulty using your current composter?

  <Miscellaneous>
- What does your diet look like, do you cook your own dinners? Do you have any dietary restrictions?

  <Other mannerisms>
- Dressing for the occasion, looking the part and exuding professionalism can make them more open to divulging details that they may not have considered otherwise.

On this excursion, collection of quantitative data is vital to the success of the design, points such as the following are of great importance:

- Measurement of countertop space (specifically: the length and width, as well as vertical space above it, including how high it is from the floor (which could influence the usability of the device if it's too hard to reach certain parts)
- Noting the materials comprising the countertop (a stone versus a wood counter may influence the viability of the weight and materials used for the composter)
- Take note of their ventilation, location of AC, windows which could potentially assist in odor dispersion

Qualitative Analysis of the data (psychological breakdown):

- Make note of the general ambience of the place (things not conveyed through imagery, lighting, smell (candles) in order to get a better understanding of their particularities which could potentially unconsciously enhance their bias towards the device
- Ask for a recording, look back and review on the intonation in response to various questions
- Note their body language in response to different questions (do they get defensive or quiet in response to different questions, do they get excited and spark up in response to certain things, analyze whether their behaviors contradicts their words and think about why this may be)
- Be remind of the *Primary Perspective* chart, as it helps organize thoughts, but mostly focus on data collection
- State things out loud in the video so others have a general idea of what's going on
- Make small sketches of the environment

Appendix E: Secondary Research Summary

Background Research Summary

In this project, our goal is to create a specially designed composter that fits all of the needs and specifications of our client. They are unsatisfied with their current composter, and want a better designed one. It needs to be a 1-2 gallon container that can easily be maintained, houses worms, and can get the worm castings out easily. It needs to aerate easily, and contain smells, and repel any bugs. Our research kicked off with (a) in depth research into alternatives on the market already from many different sources; (b) some must-have aspects in the composter as to build around those first; (c) the environmental effects of composting this way and the best

method of doing so; (d) the environment of the composter we need in order to keep the worms alive.

Design constraints and requirements:

Our composter needs to fit on a countertop and have a small footprint, so our design cannot be too large or heavy. Our composter is also a vermicomposter, so our design will need to accommodate the requirements worms have to survive. According to Sydney Bosque, a writer for the gardening website Thriving Yard, composting requires carbon rich materials in order to function properly, such as napkins, coffee filters, and shredded paper. Another constraint that is specific to an indoor composter is that there needs to be a ventilation system in the composter because without oxygen, the scraps will rot instead of be composted, so there will be a foul odor produced and the food scraps will not be composted efficiently. Aeration in the absence of an electric fan or electrical ventilators will be difficult. Incorporating electrical components into our design will be difficult because they could harm the worms. Most electric composters on the market use an aeration system of heating, cooling, and chopping. This would obviously harm the worms. So, our design has to be able to aerate without harming the worms. In conjunction with aeration, our design must also have a system that can mix the compost throughout the composter. The mixing system could, in fact, also be the aeration system, but the mixing is designed to spread nutrients throughout the compost while the aeration is designed to spread oxygen.

And since our design includes worms, we should also include some form of temperature control as worms thrive in a cool, damp environment. And we need a filter system in the composter to gather worm castings. Having a system to retrieve worm castings is crucial because worm

castings are an amazing natural fertilizer for plants. Worm castings improve seed germination, plant growth, and flower production. Worm castings are better than regular fertilizers because they won't burn the roots of the plants.

To limit the smell of the composter, we need a device that absorbs odors from the composter. Two possible solutions from our research are carbon filters or charcoal odor-absorbing bags. The charcoal bags would allow better aeration for the compost because the composter would not need a lid. The carbon filter would be a lid that traps odors from escaping the composter, but it would also inhibit natural aeration in the composter. However, if we were to use the charcoal bag design, we would have to design a bag that is worm resistant. Most charcoal bags on the market are made from an organic matter, which worms will eat through.

Environmental benefits of composting

According to the Environmental Protection Agency: composting can reduce the amount of food waste that enters landfills. This is important for combating climate change because when food decomposes in landfills, it gives off much more methane gas, a potent greenhouse gas that leads to climate change, than if it were to be broken down through composting. Another benefit of composting is that when using compost to fertilize plants, it can improve the water retention of said plants which reduce the water usage of said plants and help to combat water shortages that are going to become increasingly common with climate change in the future. A countertop composter operates at a small scale. It can help eliminate food waste at an individual or household scale and the worm castings harvested from these composters can also affect the plants that someone cultivates at a similar scale. Also, since we plan to develop a vermicomposter, the worm casting that are produced will help naturally fertilize plants, avoiding

the harsh chemical fertilizers people normally use. However small the environmental benefits of each individual countertop composter, if enough people begin to compost this way, it can have much larger positive impacts on our environment and make the world a better place.

The environment of the worms

The best worms to use are the red wigglers, according to “Jackie Carrol” from gardeningknowhow.com, as well as many other sources. These worms prefer organic material more than just dirt, and are commonly found eating dead animals, or dead trees or other plants. Their castings are more nutrient-dense than that of other species, and are easier to keep in captivity. Additionally, they are much more thermophilic, and can thrive in the higher temperatures generated from the decomposition

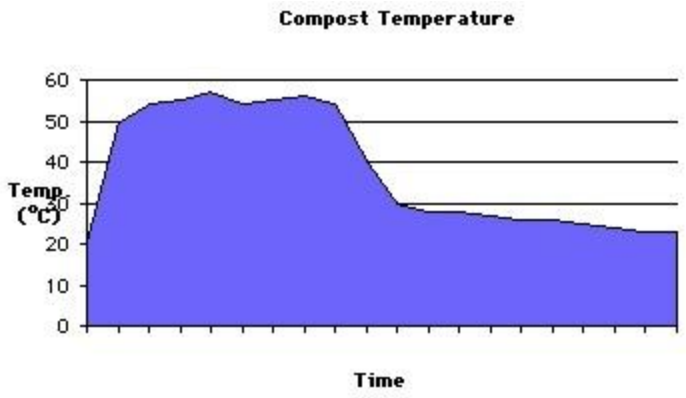


Figure 1: Optimal Compost Temperature

Composting Microorganisms by Nancy Trautman

And Elaina Olynciw of Cornell Composting, Science, and Engineering

As you can see from the graph above, to reach optimal standards for composting, we are gonna need some form of temperature control in our composter. This is the first of many reasons we may need to consider having an electric aspect of our composter. Without a balanced climate for the worms, there is no guarantee the worms will stay alive, especially with the drastic weather changes throughout the year in Chicago.

Other Products and Takeaways

Through a long process of going through many different composters online, usually the top selling ones on big name websites such as amazon or walmart, we discovered these points to be the most important things to consider when making the composter.

- most important factor is the smell
- Have to significantly reduce the amount of fruit flies
- A lid that is heavy enough to keep fruit flies out, but light enough to open with one hand
- Easily accessible
- Basic is better for design
- Charcoal filters
- Enough space to hold days of waste (around 1.25 gallons)
- Light enough to easily empty without spillage
- Secure and easy to hold handles
- Probably avoid buttons

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Appendix F: Ram Chart

Task	Due Date	Blake	Siby	Yanni	Mark		Green = done
Finish secondary research report	9/30						Red = planning on doing it
Signed Student/Project Partner Agreement	10/5						
Team Charter	10/5						
Contact Garden Store	10/4						
Contact Scott	10/4						
Draft User observation Report	10/7						
Draft Interviews Summary	10/7						
Draft Questions for interview with scott	10/7						
Feed back summay							
project summary							
Initial Mock Ups	10/19						
Discussion Reflection	10/21						
Project Deffinition V2	10/26	Primary		Secondary			
Peer Review and Meeting	10/26						
Draft of Feedback summary	10/28		Primary	Secondary			
Draft of Purchasing Records	10/28	secondary		primary			
Design review materials	11/2	secondary	secondary	primary	secondary		
Discussion Reflection 2	11/5						
Design Review Summary	11/5		secondary	primary			
Final Design Concept	11/9	Primary	Primary	Primary			
Public Disclosure Form	11/9	Primary					
Draft of Final Report Sections	11/11	Primary	Primary	Primary			
Revised Draft of Entire Final Report	11/15	Primary	Primary	Primary			

Draft Interview Summaries

SueSan

Introduction:

We chose to interview SueSan because they are our project partner. SueSan requested that we construct a new composter for them because they were having issues with their current composter, so they will have the most useful and tangible information regarding specific design constraints and challenges to overcome in constructing a composter. The goal of this interview was to gain concrete information regarding SueSan's issues with their current composter and what exactly they are looking for in a new composter.

Methodology:

The interview with SueSan took place over zoom on Friday, September 24,2021 at 9am. Siby and Yanni attended the meeting while Blake and Mark watched the recording at a later date. The interview consisted of most of our DTC class asking numerous questions to SueSan, as well as a short demonstration of SueSan's current composter.

Results:

SueSan discussed their numerous issues with their current composter. These include: a fruit fly infestation, an awkward shape, and no efficient way to collect worm castings. In the interview, it was made clear that SueSan is very attached to a verma composter and would not likely consider a mechanical composter or a standard, non worm based composter. Multiple students asked them about other composters and their answer was always that they preferred worms because they had been working decently well for them. SueSan also detailed how they use their current composter. They Started with 250 worms initially, and they collect worm castings on an irregular basis, usually every several months. SueSan also noted that the problems with the fruit flies have gotten worse recently and that they are not willing to invest a lot of time or money into composting. They also stated that they use the worm castings to fertilize their plants that they have in their house.

Discussion:

The interview with SueSan revealed some clear issues with their current composters, as well as some things that we expected to be an issue that weren't. For example, based on our secondary research we thought that the smell would be a major issue but SueSan said that

smell hasn't been a concern. SueSan also detailed some design constraints that we should adhere to. First, they made it clear that we need to use worms and not another method of composting, second, they made it clear that we need to design a better method of collecting casting, and third, we need to come up with a solution for the fruit fly issue. SueSan has already implemented a fruit fly trap into their composter, so we should expand on this solution as well as implement other solutions so that the problem can be minimized.

Scott Simpson

Introduction:

We will be interviewing Scott Simpson, our designated shop professional, and senior design and prototyping specialist. We decided to interview him because the shop here at Northwestern is our biggest limitation when it comes to designing this project. All ideas, prototypes, and solutions are bound by what we have available at the shop. It doesn't matter if our genius idea will solve all of our problems if we can't build it for any reason. In addition, we can use his expert opinion on materials from the shop to help choose what materials to use for our composter. We also need to learn a bit more about making waterproof chambers and drawers to get the worm castings.

Methodology:

Our research was collected by an interview with Scott Simpson on 10/07/21 at 12:30pm in the design shop in the basement of the Ford Design Center. We collected our data by one member asking questions, and the other member taking notes. If we did not record the interview. Finally, we took a short tour of places of interest in the shop and received some materials to experiment with.

Results:

Our interview with Scott Simpson was very helpful in regards to the design process. He emphasized that it is important that we make some quick drawings and mock ups so that we can make several simple prototypes. He explained that we should make easy to construct and disposable prototypes and that we should go through several iterations before we make a high quality, functioning prototype. He gave an idea of a timeline, saying that we should start working on mock-ups soon and we should start working on simple prototypes and by week six we should have a functional prototype. There is a design freeze in week 8 so we need to have a final plan by then. He also showed us some useful tools to use, as well as the materials that we have easy access to. He also showed us the MCmaster carr catalogue that we can use to look up certain materials that we could use.

Discussion:

Our interview with Scott Simpson gave us some clear steps to take in the near future. He gave us a plastic container that we can begin composting in so that we can be ready for testing because composting takes a long time. We also need to explore the shop once we are shop certified in order to get some simple prototypes ready so that we can get a good start before the shop gets packed. He showed us some helpful tools and showed us materials like foam board, cardboard, wood, plastic sheets, pvc pipe, and wood that we can incorporate into our design. Overall, we gained a much better understanding of the design process and how to proceed with our designs.

Cora

Introduction:

Cora is a friend of someone who gave a composting presentation at a Greenhouse dorm meeting, which is where one of our members, Blake, lives. We decided to interview her because she has had experience building composters and will provide us the details we need to get started. The interview will be conducted by Blake, and someone else will be recording the answers to the questions. If we can get permission to record the interview, we will.

Questions

- What is your experience with composting, specifically with worms?
- We have multiple sources saying different things about rotating the compost, but we think we shouldn't for the worms, do you have any knowledge about that?
- Watering tips for composting?
- What was the most successful smell concealing technique?
- Did you ever have a worm composter? How did you remove worm castings?
- Any other tips or tricks you have about composting?
- Anything else you would like to share or suggest for us?
- Maybe pictures of past composters?

Notes:

- She built non verma composters back home
- Built a small verma composter in her room
- Need a system to filter out the extra water

- Need to have ventilation
- Need to mix/aerate the compost
- Cedar gel things to absorb the smell
- Carbon mesh can work to absorb smells
- She did not have fruit fly issues
- Castings are liquid and will filter out over time
    - Can be used as additional fertilizer
- Don't put orange peels(check) citrus
- When starting the composter, put some dirt and shredded paper
- Make sure worms can't escape

Methodology:

Our interview will be conducted on 10/08/21 with an in-person interview. We plan conducting the interview with one person asking questions, and others recording the answers so as to not overwhelm the girl. We may ask for any pictures of her designs to help influence our design. Though we may ask for pictures, we should be clear we will not be copying her composter in any way. Not only would that be unethical, but also she doesn't have the same goals as we do.

Results:

Our interview went very well with Cora. We took about 20 minutes and she provided a lot of great information and data for us. She mostly talked about her experience with vermicomposting, while also providing some details about her other composters. She explained the techniques we should use, and things we should look out for when building our composter. The smell, like we predicted, is gonna be one of the most challenging factors. Also, we didn't really think about it until she mentioned it, but we have to have drainage that lets out water, but not the worms. She provided some details about how to treat the worms, and how to get started with the whole process. It's good to hear this from someone who has experience, especially in Chicago, as every place is different. Lastly, we have a good idea of some features we should include, but aren't mandatory, like a way to rotate the compost.

Discussion:

Our interview had a lot less concrete steps we could take compared to the interview with Scott Simpson. The notes we took away are going to be very helpful when narrowing down ideas next week, but they don't provide any immediate action or anything. Still, it's good to get this interview early because this will let us review and reiterate our ideas through the information already provided.

Appendix H: Project Definition V1

Project Name: NUKids™ Composter

Client: SueSan (& co. ?)

Team Members: Blake Thompson, Siby Suriyan, Yanni Wilcox, Mark Winick

Date: 10/12/21

Version: 0.00

Mission Statement:
Our project is to create a food waste to loam converter to replace SueSan's current composter in order to address the multitude of fruit flies, difficulty collecting castings, and the spatial position and bulkiness, as well as preventing any new problems from arising after switching to the new composter.

Project Deliverables:

- Final report (printed and bound)
- Presentation and Poster during the DTC Fair
- Final [Composter] Prototype

Constraints:

- Final prototype, report, and presentation are due on December 4th
- Spatial Dimensions
- Weight
- Food waste to potting soil mass-time conversion rate
- Odor
- Fruit fly control
- Aesthetics
- Ease-of-use
- Emotional satisfaction

Users and Stakeholders:

- SueSan, user and project partner, will utilize composter to convert cooking-activity byproduct waste to potting soil

- SueSan's partner, most likely a user who will also use the device while cooking and generally be within its presence

User(s) Profile:

SueSan is a Northwestern alumni in their twenties who lives in an urban apartment building. They frequently cook with fresh foods and value their time and degree of movement while doing so. Works as a professional designer and most likely lives a fast-paced lifestyle where going out of their way to transport food compost materials heavily detracts from their overall culinary and horticulture activities.

Illustrative User Scenario:

SueSan arrives home after a day of work and does their usual routine of preparing a meal with fresh foods to try to stay healthy despite being constrained by a limited schedule. As Suesan minces vegetables on their cutting board to the right of their stovetop, they pushed them to one side of the board to make more room. As the space left gradually decreases, they go over to their tabletop composter in the left corner of their kitchen under overhanging cupboards and open one of the three lids to carefully mix around the top layer of compost and worms in an effort to make room for more food waste. They then pick up the container and walk to the *other* side of the kitchen and swipe the unused vegetable cuttings into it, trying as best they can to evenly distribute them over the top by looking in at a sideways angle to compensate for the container blocking sight from everything except the lid port. SueSan then takes it back to its initial location and goes back to their normal cooking activities. As their food preparation proceeds, they might have to load more food wastes into a bowl as they accrue and repeat the process potentially multiple times depending on the size of the meal and the available containers they might have on hand.

Later in the week, SueSan picks up the composter and walks down their hall to their room full of potted plants. They open up a few lids or laboriously undos the entire top of the container and with a spoon, deposit the processed compost into various potted plants as they see fit. Some large plants can only be stored on the ground, and thus SueSan might have to kneel down, snaking their body away from leaves and branches in order to awkwardly transfer compost to the inconvenient location. They then put all the lids and top to the composter container back on, walk all the way down the hall to the kitchen, and set it down in the left corner of the counter.

Project Requirements:

Needs	Metrics	Units	Ideal	Allowable Value
Easily portable with one hand	Weight Max length	Lb In	(take measurements	3.3 pounds 17.7

	Max width Max height	In in	from people of similar weight and stature to arrive at this value)	8.7 6.5 (all values from current solution)
Shape	Interlocking value to the surroundings			
Ease-of-use (for castings)	Time to remove	seconds	(<10s) (experimentally determined to be the least frustrating)	45s (current solution)
Sufficient Composting Rate Capacity	Weight/Week	lb/week	(tbd via experimentation) handle all her food waste	2lb (fr. current solution)
Low Odor	Proximity to noticeable smell	ft	No odor at 0ft	1.5 ft (current solution)
aesthetics	“Presence” held on countertop	“Emotional response”	unnoticeable	inoffensive
Keep worms safe	Number of dead worms	Dead worms	0	All but 2
Lower flies	Flies in space	Flies/m^3	0	8 (current solution)

Appendix I: Alternative Matrix

Feedback: Add no harm to worms and casting removal

Weights	Design Requirement	Solution #1 “Compostinater”	Solution #2 “Casting Tumbler”	Solution #3 “Crank that soulja boy-inator”	Solution #4 “Joe Spivak juice-inator”
Description		- netting for flies - filter and removable drawer	-Cylindrical casting vessel embedded into	-Cylindrical design with a hand held crank	-netting for flies -filter and removable drawer

		for worm castings - no extra aeration system(worms only) - cork lid - tall, thin body	the side of a cubical composter -The tumbler has a knob which allows two directions of movement, along the long edge and rotational about the center of the cylinder -This allows for it to be pulled out, twisted and have the dirt sifted out onto a waste basin, and pulled out and the castings retrieved.	that operates as a mixer to aerate the compost. -contains a filter and drawer system similar to that of the “compostinater” -cork lid	for castings - spray bottle to be used to water compost so castings filter out more efficiently -no aeration system -cork lid -tall, thin body
3x	Casting Separation	X	X	X	X
2x	Fruit flies	X		X	
2x	Odor	X		X	
x	Aeration		x	X	X
x	Easy Use	X	X		X
x	Portability	X	X		
0.25x	Aesthetics			X	X
x	Spatial Footprint	X		X	X
	Totals	9	6	9.25	5

Problem: Fruit Flies

Aspects	Description	Pros	Cons	Other
Solution #1	Fly traps using apple cider vinegar	Cheap, easy to build	May have to be maintained, spills, not 100% effective	May use any other fly attracting liquid
Solution #2	Netting	Keeps all bugs out, replacebal	Expensive, may tear	
Solution #3	Air tight container	Keeps all bugs out, easiest to maintain	Composter would have to be aired out manually	Prob not viable

Problem: Removing castings				
Aspects	Description	Pros	Cons	Other
Solution #1	Filter at bottom	Ideally is automatic	May not get all castings out, or back up composter	Needs testing
Solution #2	Side/bottom chambers to remove castings	Would get all castings	Requires work, build needs to be stable being turned	Check exact project description
Solution #3	Removal by water	Automatic, also waters compost	May drown worms, may not get all castings	Hard to check if it works, but that may be a benefit

Problem: Watering compost				
Aspects	Description	Pros	Cons	Other
Solution #1	Automatic water	Automatic, no	May overwater,	Requires many

	disposal	work, same amount every time	no way of evaluating beforehand	tests and research
Solution #2	Spray bottle	Can easily water, low work, good quantity of water	Requires labor, requires Sue San to know what it should look like	maybe
Solution #3	No water	No labor, except careful planning on what to put in	May kill composter, requires planning of disposal items	

Problem: Aeration				
Aspects	Description	Pros	Cons	Other
Solution #1	Electric fan that will turn the compost	Soil will aerate well when the fan is in use Easy, efficient way to aerate and spread nutrients	Could potentially harm worms if they get caught in the fan or in the joints of the fan Could destroy worm tunnels Makes removing worm castings harder Requires an outlet nearby	Electric fan will be automatic and labor efficient for the user, but will require electrical work, which will be difficult for us
Solution #2	Mechanical fan	Requires no electrical work Easy way to aerate and	Could be labor intensive for the user Destroys worm	

		spread nutrients Requires no outlet nearby	tunnels and could potentially harm worms	
Solution #3	No aeration system	Worms castings will be not be spread throughout the compost Requires no extra design, makes product cheaper	Only aeration comes from the worms tunnels	

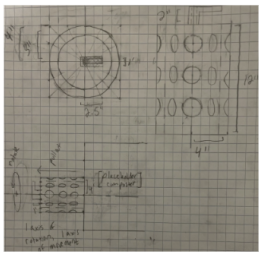
Problem: Smell				
Aspects	Description	Pros	Cons	Other
Solution #1	Cork lid	What our client currently has and is effective	Flies can enter the composter through the air holes in the lid Aeration is limited to the air holes	During the design process, we will have to consider the restriction and limitations with having a lid made up of cork
Solution #2	Odor absorbing charcoal bag	Less design restrictions concerning the body of the composter	Worms might be able to eat through the bag, as most bags are made of organic material	Is not subject to the same limitations as a cork lid during the design process

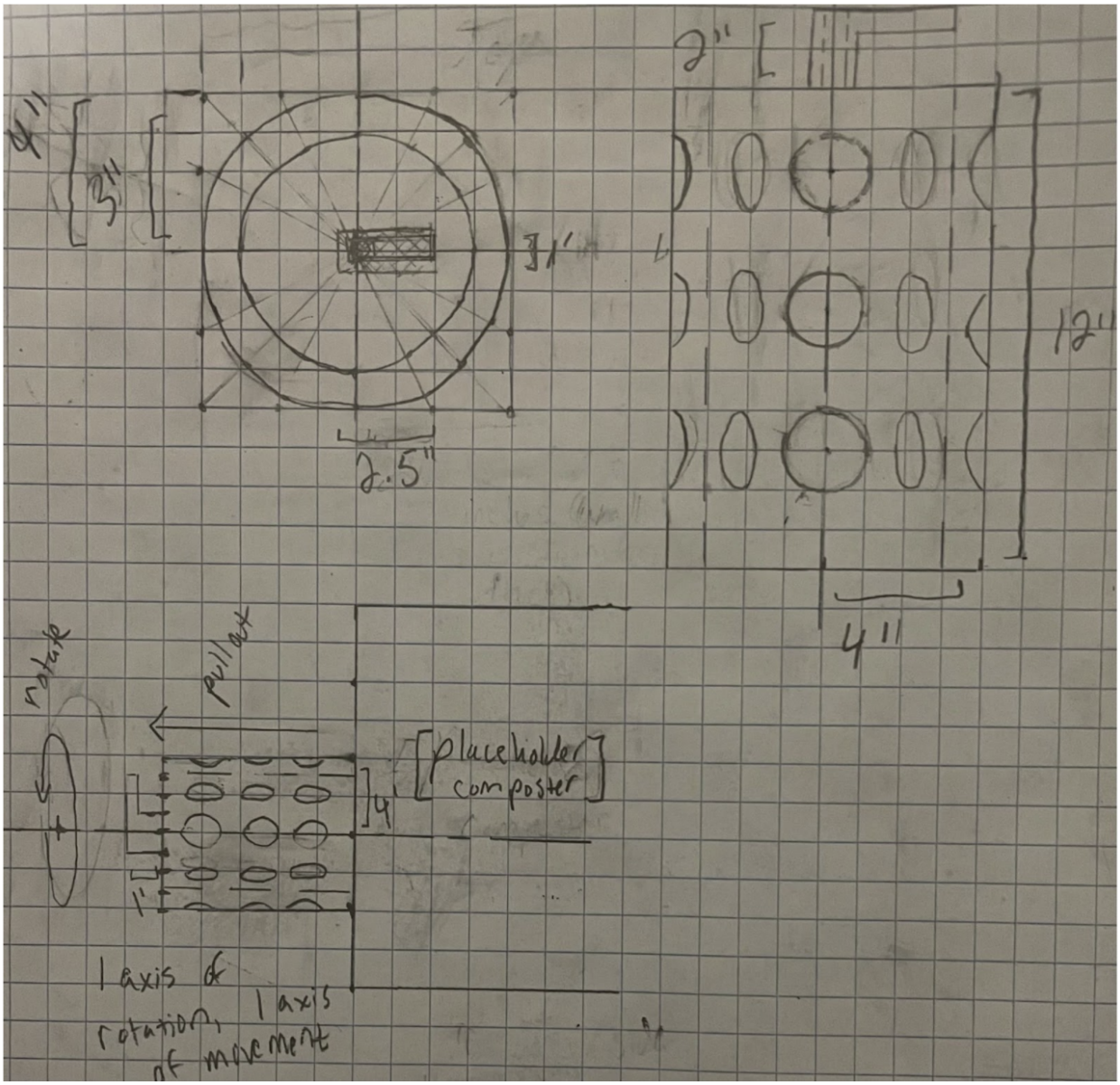
				Need to test bag to evaluate its effectiveness
Solution #3	Air-tight lid	Will contain all the smells within the composter	aeration will be limited Labor intensive to manually open lid and deposit food waste	Designing an effective air-tight lid will be difficult

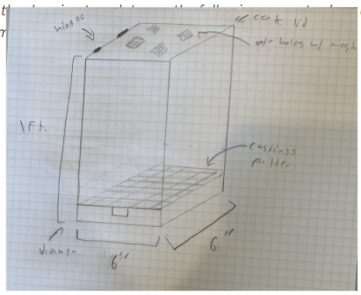
Problem: area footprint				
Aspects	Description	Pros	Cons	Other
Solution #1	A body more tall than wide	Design will utilize volume between the counter and the cabinets, taking less space on the counter	Less aerate as compost is stack more on top of each other	Need to test the best shape the body should be; rectangular, cylindrical, irregular, ectc
Solution #2	Composter design to be attached or hanging from a cabinet or edge	Takes up minimal countertop space	Requires extensive research on the best method/materials to attach a composter to a cabinet or countertop edge Different users will have various different cabinet and countertop styles; need to make a design feasible for	Processes for natural aeration need to be evaluated

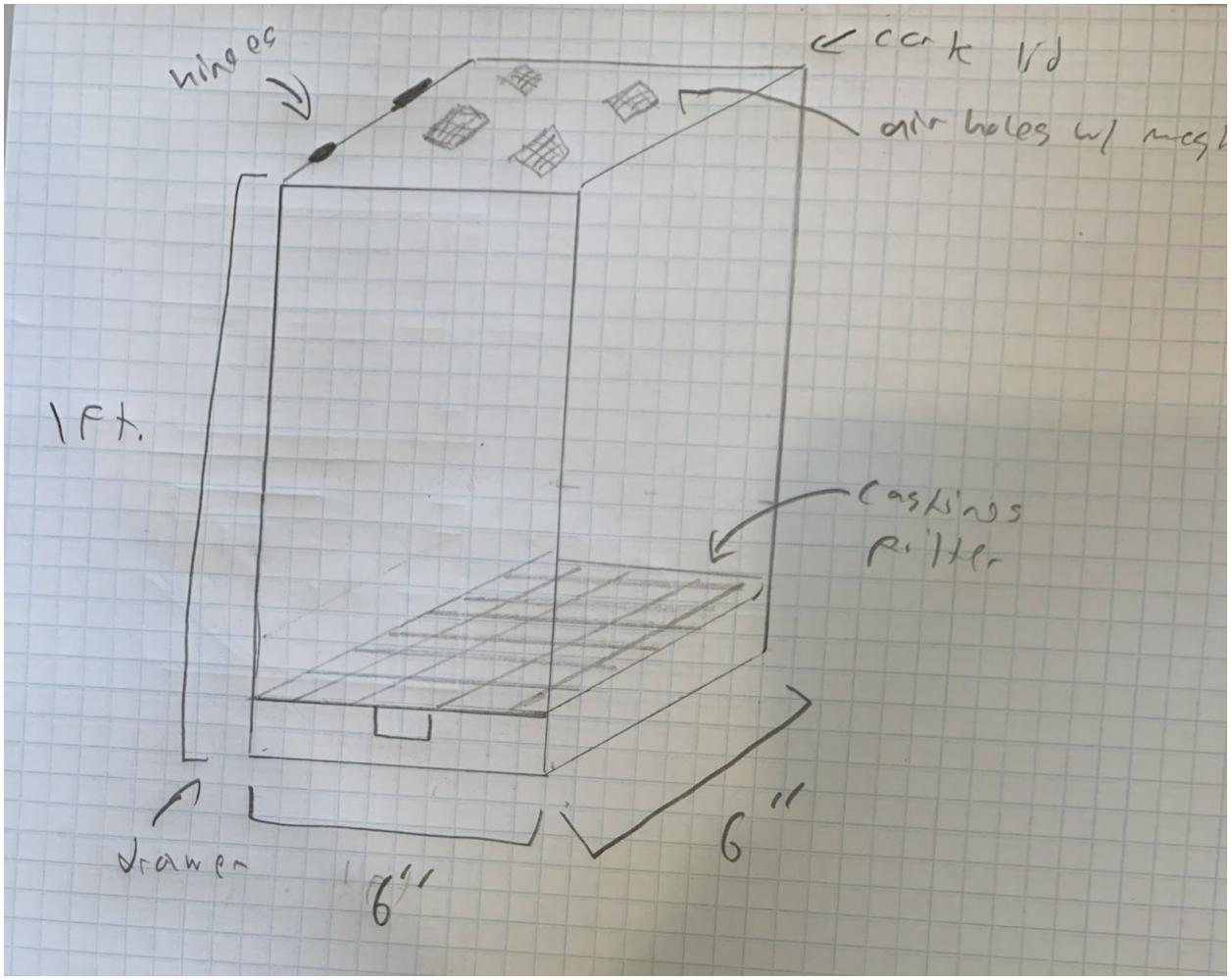
			everyone	
Solution #3	A short, wide body	Best body for natural aeration	Takes up a large area footprint on counter	Again, need to test which is the best shape for the body

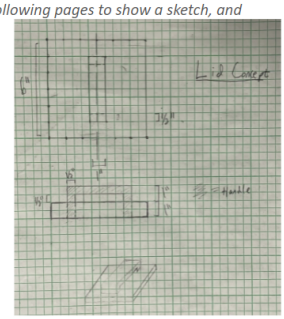
Appendix J: Mockup Plan

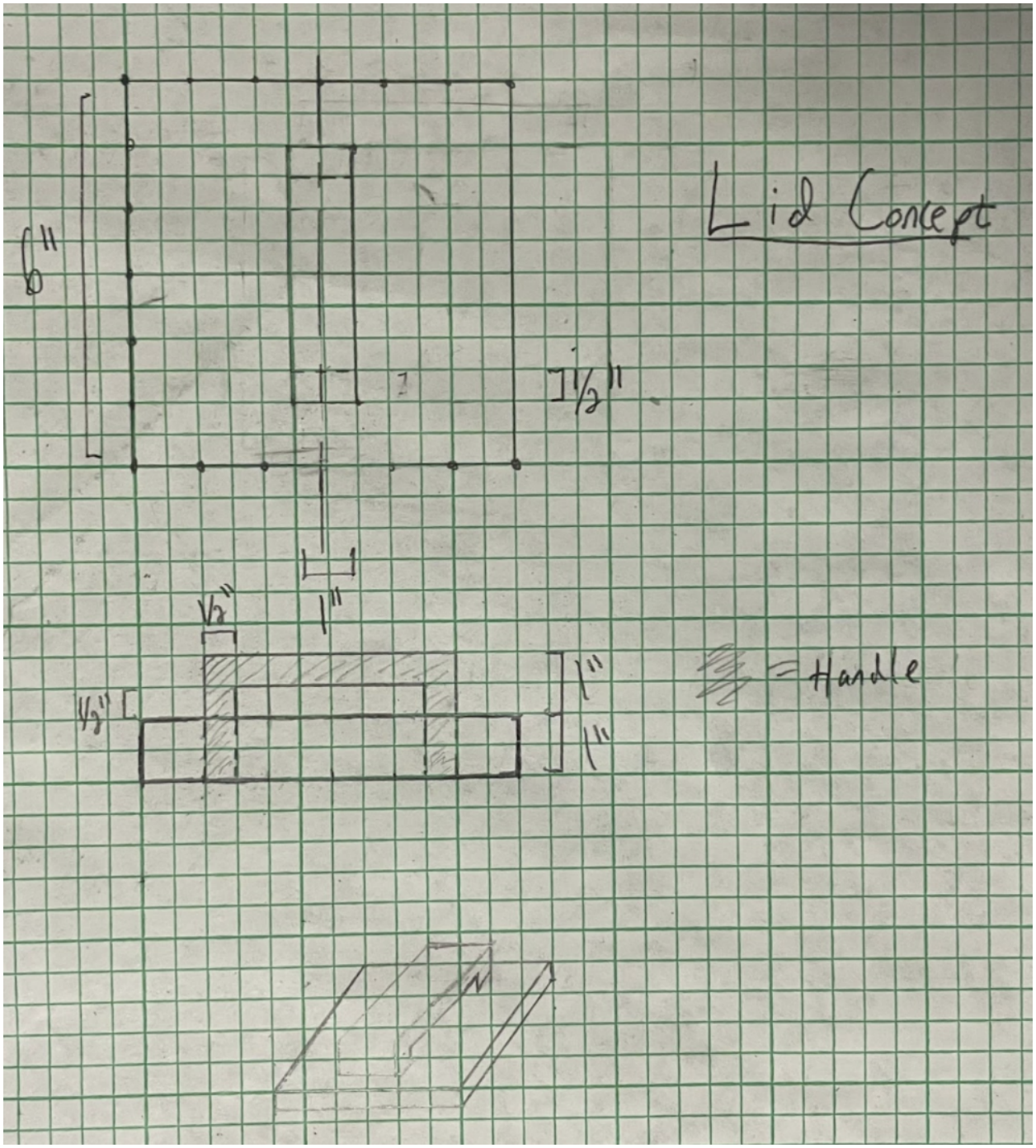
Concept name Removable Castings Chamber	Sec 1 Team 3
Concept description Handled cylindrical vessel with two axes of movement, one rotational, the other parallel with the long edge. Perforated with semi large holes which allow movement of worms and transference of soft organic material. Slots into side composter.	**Team members** Blake Thompson Siby Suriyan Mark Winick Yanni Wilcox
Key questions to answer with this mockup *Consider the design requirements you identified earlier, as well as what makes this particular concept different from your other concepts* ➢ What will the material(s) be of? ➢ Will there be frictional issues with the side of the composter (turning or pulling it out)? ➢ How will the worms be attracted to putting most of their castings there (aside from it being close to the bottom)? ➢ How will this limit potential composter shapes and dimensions? ➢ How will it be secured/embedded in the composter? ➢ What side of the composter or way will it go on (any of the 6 sides assuming cubical)?	**Plan for creating the mockup** *Describe how the team can create one or more mockups to help answer those questions* Create a storyboard of multiple angles and specific enlarged sections of it (at tilted angles so the shape of the perforation inside edges is shown) to analyze how it might fit into a theoretical composter design and how it might influence the overall structure. (Maybe) Make a CAD design of the general shape as well as demo blank cube composter with slot Fold construction paper with appropriately spaced circles cut out of it and paper towel tube sections as the handle.
Sketch of this mockup *Use one of the drawing templates on the following pages to show a sketch, and include a small copy of that here* 	**Approach for testing this mockup** *Describe who should interact with the mockups and how* We might have a member print out a scale model of the mockup via a 3D printer if a suitable drawing is made via CAD; have them handle it and embed it into the demo cube with matching shaft to see logistics and seeing adjustments to the shape or fasteners. -> perhaps have end user see how well they like the design and how intuitive using it practically is. See if the size of the demo cardboard model seems right or if certain dimensions need adjustment, as well as general usage by slotting it into a cardboard box with a shaft that can fit it also embedded into the box


4"
3"
3"
2.5"
2"
12"
4"
rotate
pullout
placeholder
composter
4"
1"
1 axis of rotation, 1 axis of movement

Concept name Vertical composter with auto filtering of castings and self aeration	**Sec** 1 **Team** 3
Concept description A vertical, rectangular prism with a filter towards the bottom to passively separate the worm castings, as well as a cork lid that opens with hinges and has several air holes covered by a mesh to keep flies out. The design also has a small, pull out drawer at the bottom for easy casting removal.	**Team members** Blake Thompson Siby Suriyan Mark Winick Yanni Wilcox
Key questions to answer with this mockup *Consider the design requirements you identified earlier, as well as what makes this particular concept different from your other concepts* ➢ What will the material(s) be of? ➢ How selective should the filter be, how small will the gaps be? ➢ How will we be sure that castings will actually be filtered out and not just dirt)? ➢ How large will this composter be	**Plan for creating the mockup** *Describe how the team can create one or more mockups to help answer those questions* The mockup could be created out of primarily foam core or cardboard. We could use duct tape instead of actual hinges and cardboard instead of the cork. We could look for some mesh to make the filter and the mesh to keep flies out. If that does not pan out, we could use different cardboard to keep the flies out and make a makeshift casting filter out of some string or thin cardboard pieces.
Sketch of this mockup *Use one of t… a sketch, and include a sm…* 	**Approach for testing this mockup** *Describe who should interact with the mockups and how* Our team should make sure the proportions of the mockup seem right by comparing it to the dimensions and images of SueSan's kitchen. We should also simulate actually using the composter, for example, opening the lid, pretending to insert food scraps, and pulling out the drawer to see if the design is inherently user friendly or not.


hinges
cork lid
air holes w/ mesh
1ft.
castings
filter
drawer
6"
6"

Concept name Handled Lid	**Sec** 1 **Team** 3
Concept description A lid with a interlocking handle interlaced with a square prism lid which sits atop the composter.	**Team members** Blake Thompson Siby Suriyan Mark Winick Yanni Wilcox
Key questions to answer with this mockup *Consider the design requirements you identified earlier, as well as what makes this particular concept different from your other concepts* ➢ What kind of adhesive will the handle be connected to the top with? ➢ What will the top be made of? ➢ Will the handle and main lid body be composed of different materials? ➢ How heavy will the lid be and how will the handle be able to support the weight without detaching? ➢ How will the lid connect to the composter?	**Plan for creating the mockup** *Describe how the team can create one or more mockups to help answer those questions* Simple cad designs for the interlocking lids can be used to mockup for close to prototype stages. As well as later drawn diagrams and specifications for exact measurements to be milled/cut/detailed from certain materials. That is, their cross sections being drawn onto a certain material and being embossed from such a spec.
Sketch of this mockup *Use one of the drawing templates on the following pages to show a sketch, and include a small copy of that here*  	**Approach for testing this mockup** *Describe who should interact with the mockups and how* Performance testing could be putting heavy weights upon the lid and seeing whether the interlocking handle slides out. This can be extended to drop tests and the like while connected to the composter and what kind of damage is incurred. Placing the lid onto the composter dozens of times to see if any wear or tear takes place.


Lid Concept
6"
1½"
½"
1"
½"
1"
1"
= Handle

Appendix K: Feedback Summary

SueSan Chen-Ford Visit

SueSan came to Ford to test out our composter mockups. They tested one of our group's mock-ups first- the Compostinator. They liked the fact that it was small and portable enough to carry and walk around with. This is because SueSan is used to walking around their home with their current composter in order to spread worm castings to their plants. However, when they saw the removable drawer for the worm castings, they appreciated having a more portable worm-casting distribution system. But, SueSan did have some concerns with the drawer.

At this point in the mock-up design phase, we did not have the stopper that acts as a block between the drawer and the food waste. So, when the drawer was removed, all the food waste would fall to the bottom of the composter. After reworking the design to include a stopper between the drawer and the food waste, SueSan was concerned of food scraps getting caught in the stopper when inserting it back into the composter. To fix this design flaw, in the third mock up design, we included a sharp edge onto the stopper so that it can cut through the food waste.

Another concern of SueSan was fruit flies. The Compostinator mockup did not have any provision to address fruit flies. So, in the third mockup design, we included mesh under the air holes to prevent flies from entering the composter.

The last remark SueSan made was in regard to our filter. Our mock-up, like most of the other mockups, had a filter to separate out the worm castings from the food waste. They said something similar to "the group that finds the right material to separate the castings from the food scraps will probably have the best design." Our group also thinks this is true.

Testing with Dirt

On Tuesday, October 26th, we tested our third mockup design with actual dirt, which could replicate the size, shape, and behavior of the worm castings. We noticed that moist dirt (moist dirt better replicates worm castings than dry dirt) clumps together and builds on top of our filter rather than falling through it. We noticed, like most groups did, that we had to shake the body of our composter in order to make the dirt fall through the filter. Naturally, vigorously shaking the composter to filter out worm castings is burdensome for our client. After thinking about how to better filter out the worm castings rather than shaking the composter, we came up with a solution.

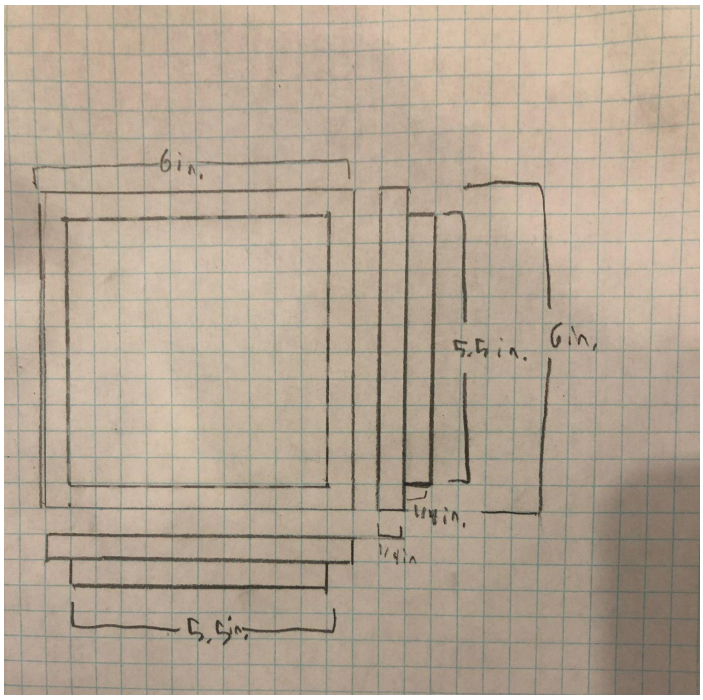
The solution was a long rectangular filter that is disjointed from the drawer (in the first mockup, the filter was connected to the drawer) that would be pulled back and forth perpendicular to the falling of the worm castings. The filter would be longer enough so that when it was being pushed and pulled, a portion of the filter would be in the composter at all times. The motion of the filter moving in the composter causes it to filter out the worm castings from the food. When we tested out our new filter system with dirt, most of the dirt was able to filter through to the drawer.

Appendix L: Final Design Concept

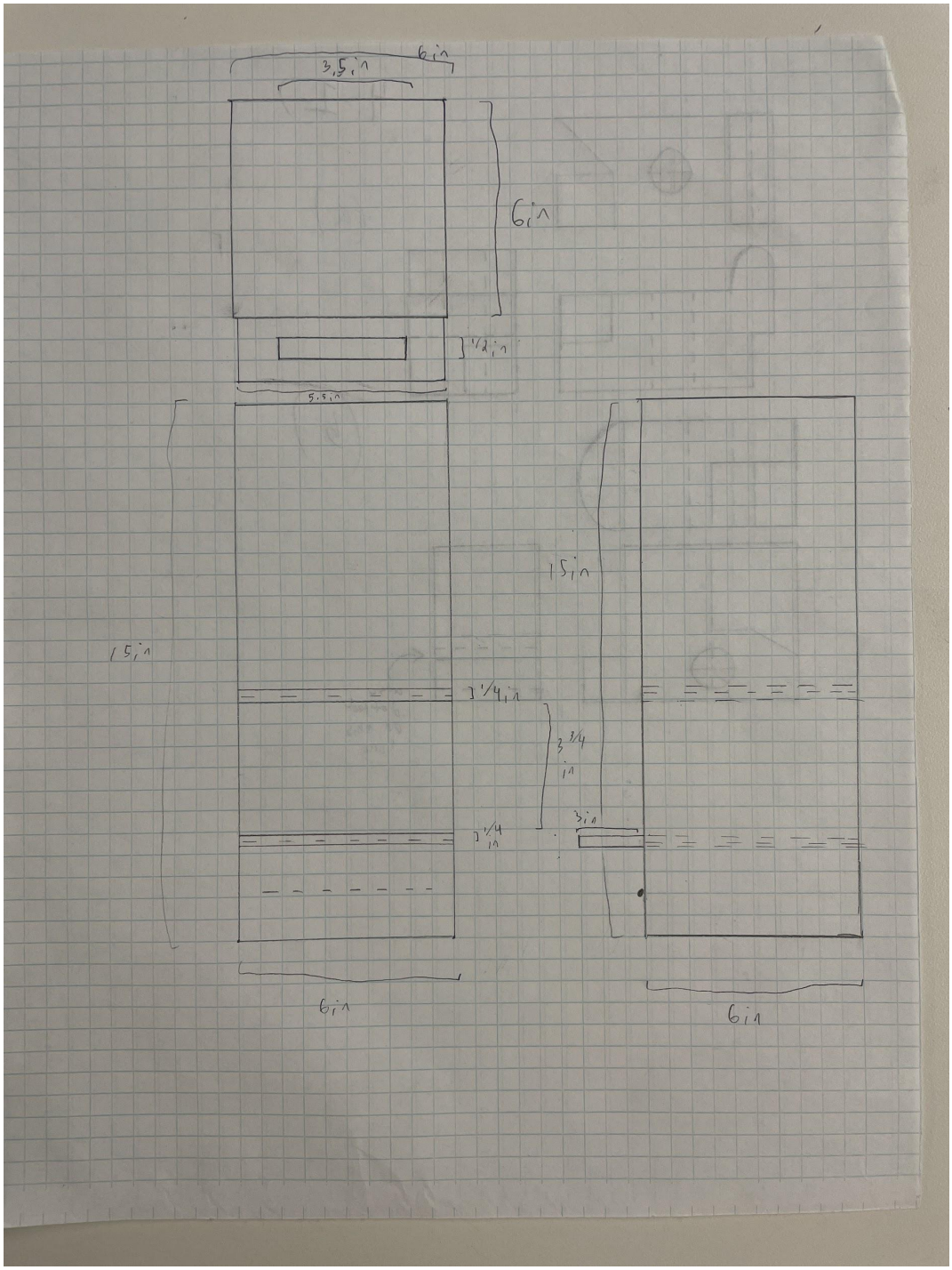
Final Design Concept

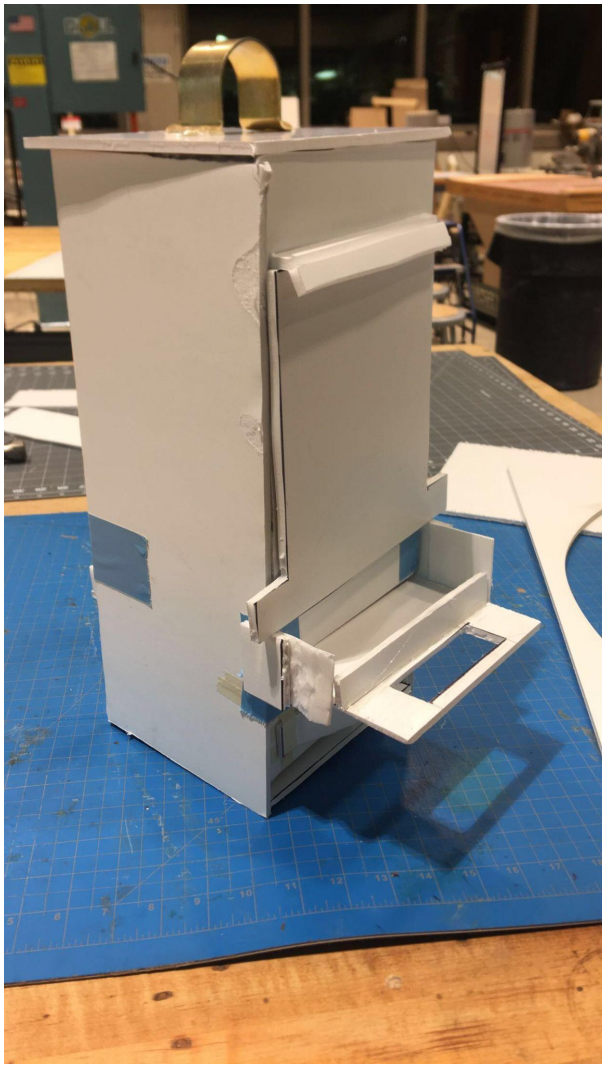
1) Drawings/Pictures

Lid:

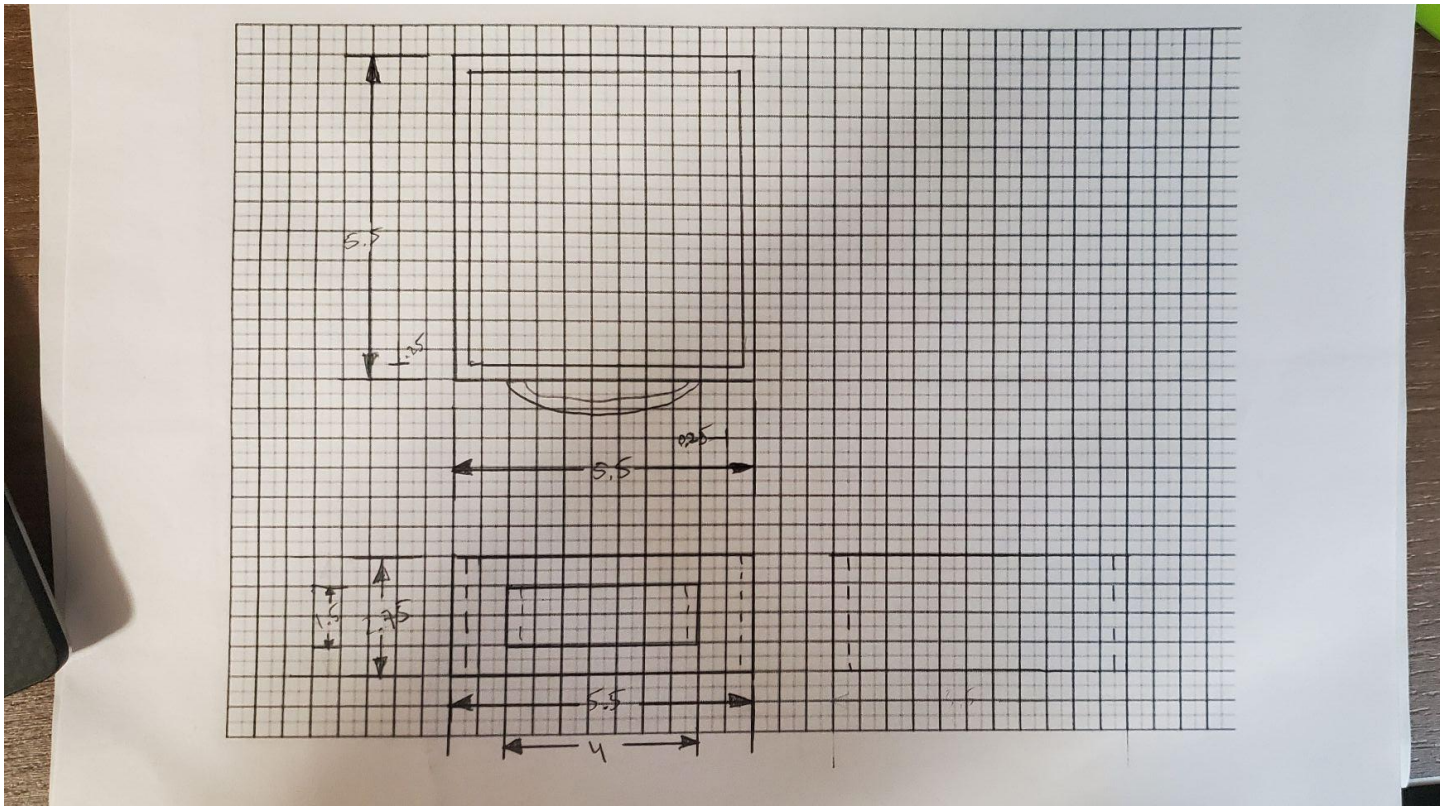


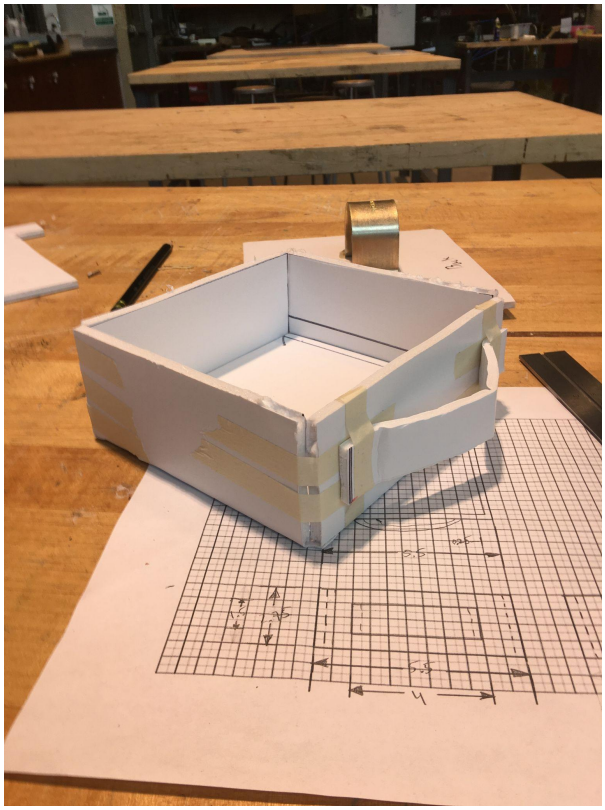
Body:


6 in
3,5 in
6 in
1/2 in
5,5 in
15 in
1 1/4 in
3 3/4 in
1 1/4 in
15 in
3 in
6 in
6 in

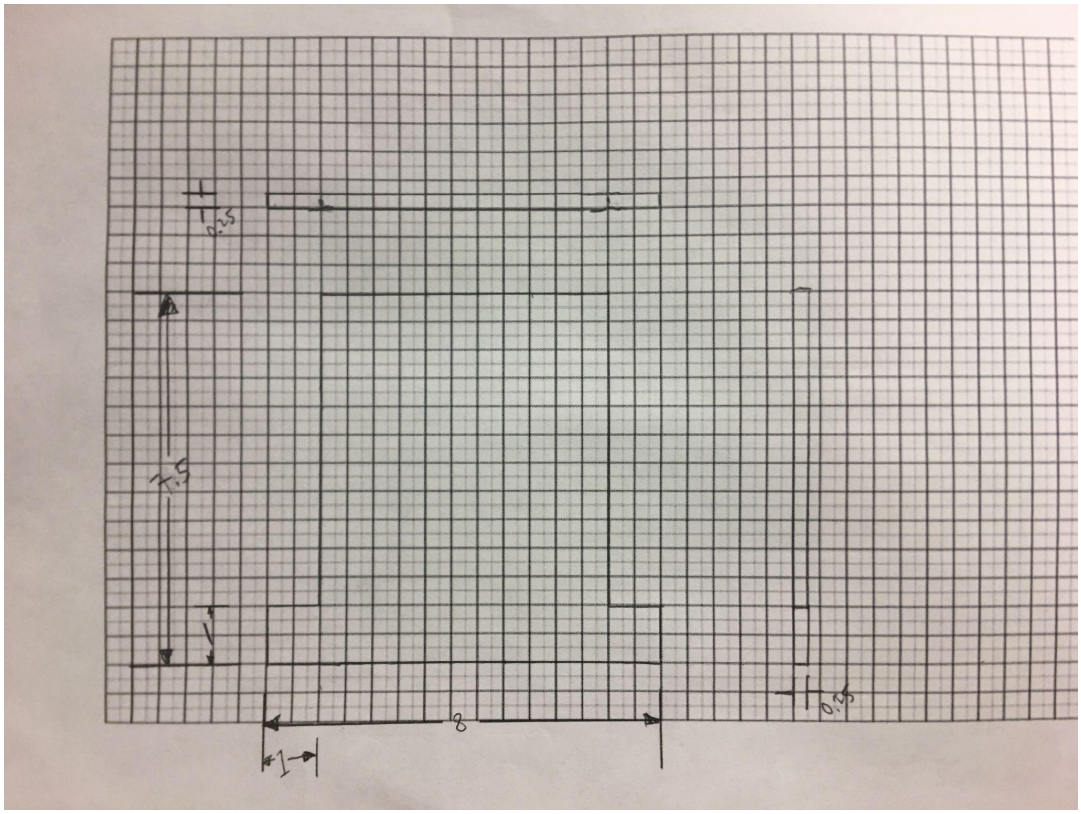


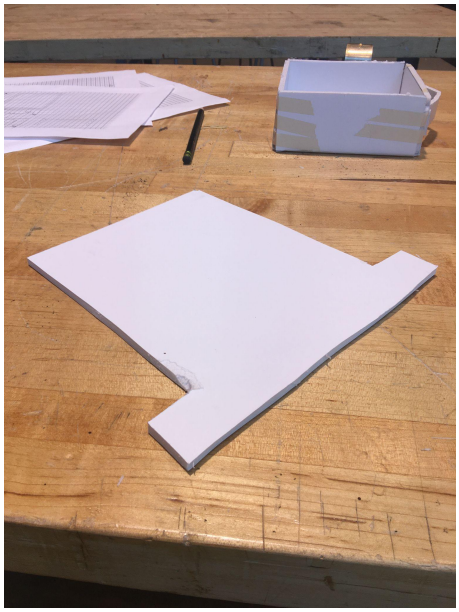
Drawer:



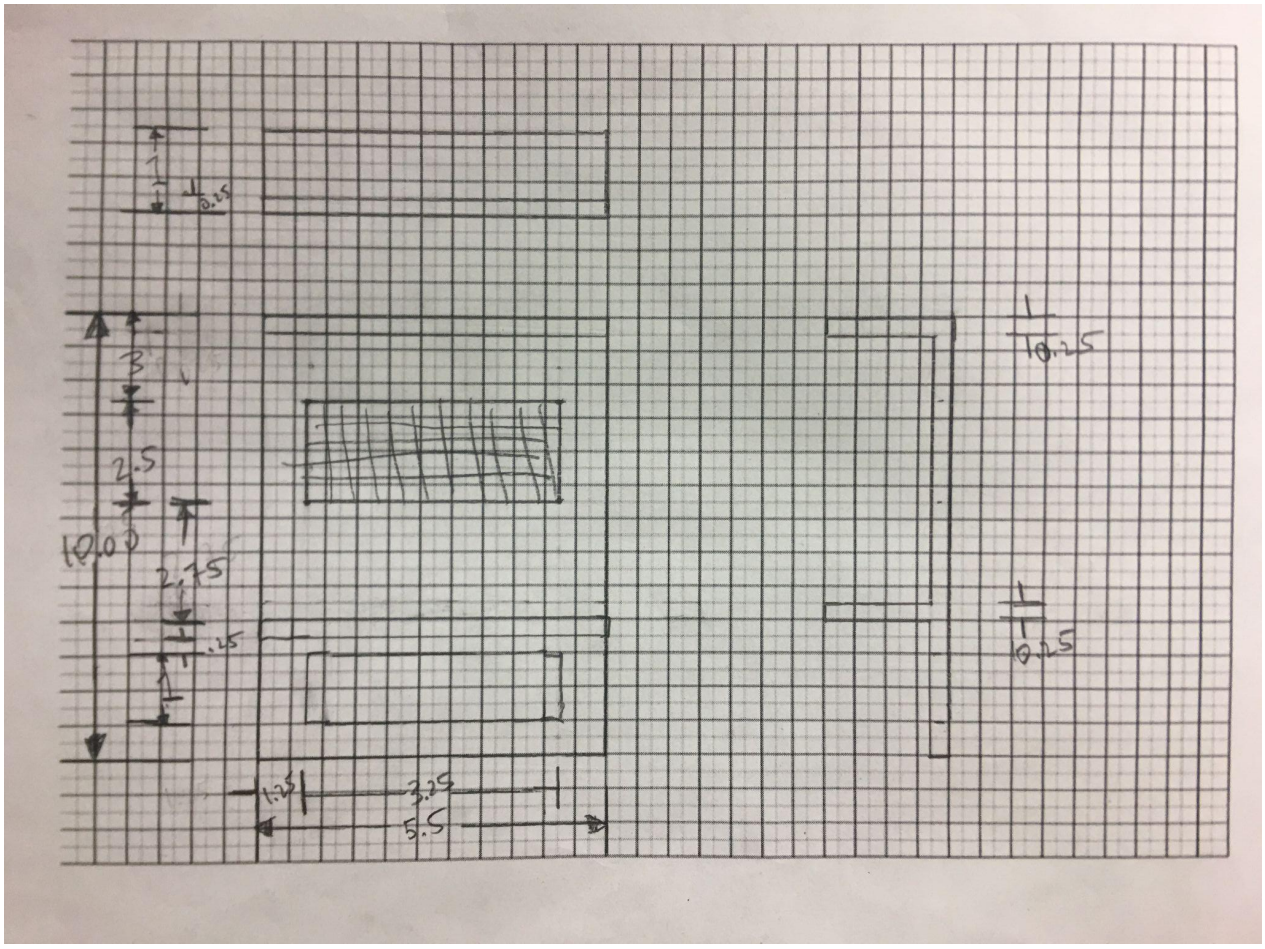


Slider:





Sifter:



2) Description of Design

Our composter design is a tall rectangular box shape with the opening at the very top. It features a sliding filter that moves back and forth inside the composter about 3-4 inches. That sliding filter is right above the sliding drawer, which holds all of the filtered castings and can be removed for easy transportation of said castings. Above the sliding filter is a plate that blocks the whole lower half of the composter. This is used right at the very beginning of the composting process to let dirt and worms get in without having to replace the dirt and worms constantly. After the original casting buildup has started, you can take that plate right after.

We will build the composter by first cutting out the front facing slits and panels, so we don't need to do that after the composter is built. Then we can get a snug fit on the drawer and sliding filter, before assembling the walls of the composter. The last thing to do is fit the lid to the top of the composter. With the composter built, we can move on to the other components. We build the drawer, cut out the sliding stopper, and make the entire sliding filter except the stopping bar on one side. We then place the filter in the composter, and attach the last stopping bar for that side.

3) Materials List

Item	Description	Qty	Source	Part#	Unit Cost$	Total Cost$
Acrylic Sheet	White Acrylic Sheet, 24”x36”,¼” thick	1	McMaster Carr	8505K758	66.42	66.42
Mosquito Netting	Coghlan’s Mosquito Netting, 72”x48”, .03” thick	1	Amazon	B000KBLD0K	3.99	3.99
Stainless Steel Woven Wire	TIMESETL 304 Stainless Steel Woven Wire 5 Mesh - 12"X24" (30cmX60 cm) - Metal Security Guard Garden Screen Cabinets Mesh	1	Amazon	0607860847785	14.99	14.99
Cork	U Brands Square Cork Bulletin Board, 14 x 14	1	Amazon	463U00-04	7.99	7.99

	Inches, Frameless, Natural, Push Pins Included					

Sifty

an elegant composting solution

Problem

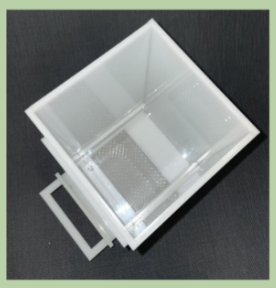
Designing a composter that filters worm castings, prevents flies, and prevent odors

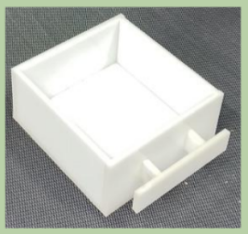
Solution

A tall, rectangular, frame that allows castings to be sifted out using the sliding filter and removed easily using the drawer

Sifter

- User slides back and forth
- Separates castings from food scraps and worms



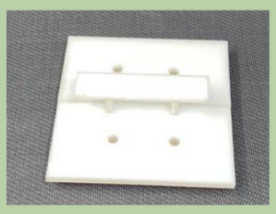


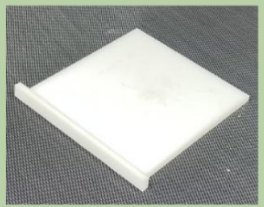
Drawer

- Easy extraction of castings
- Portability

Lid

- Odor-absorbing cork
- Holes w/mesh for aeration and fly prevention





Stopper

- Stops undesired filtering
- Allows casting buildup

DTC |Fall 20201|Section 5|Team 3 | Siby Suriyan | Blake Thompson | Yanni Wilcox

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