Easy Indoor Composting

PORTFOLIO AND PROJECT BY:

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Special thanks to our instructor Brian Rickard.

Problem Statement

In the United States each person throws away an average of 277 lbs of food waste per year that could be composted instead (Maldarelli). However, current composting methods are time-consuming and geared for outdoor use.

Problem Justification

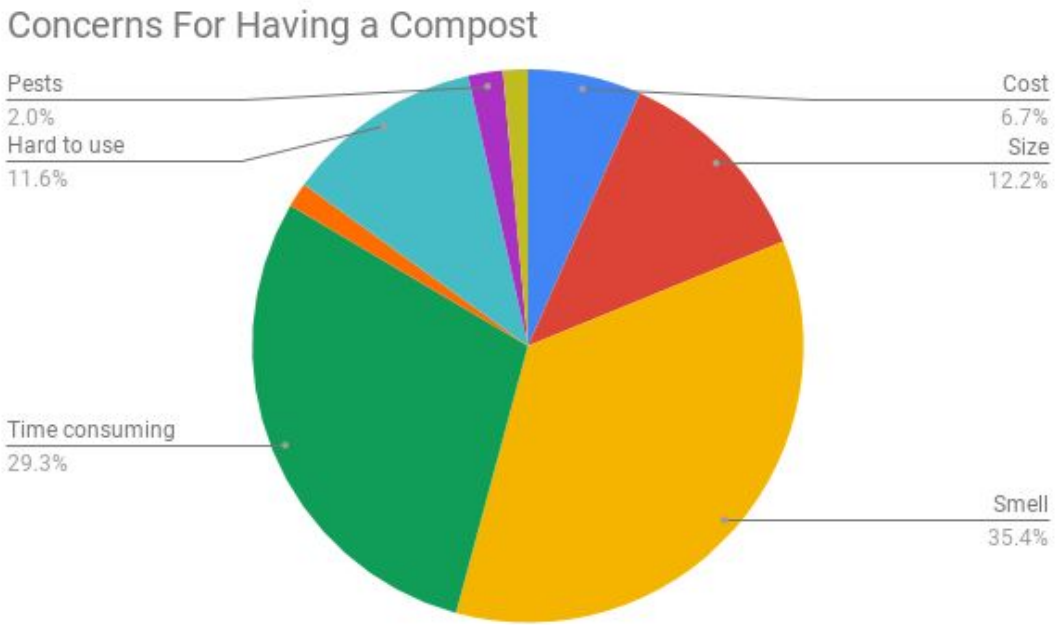
- Environmental
  - 25% of our trash can be composted
  - Compostable items don’t break down in landfill
  - Landfills are the largest source of methane gasses
  - Composting can prevent pollution and clean the soil
  - Recycling or composting saved the emission equivalent of over 38 million passenger cars

Problem Justification

- Economical
  - Cubic yard of compost can replace $160 of fertilizer
  - Compost can improve the quality of soils by improving soil structure, water required for crops, and increase yield
- Legal
  - Mandatory Recycling and Composting Ordinances
  - New York City and LA have pledged to zero waste by 2030

Problem Justification - Market Research

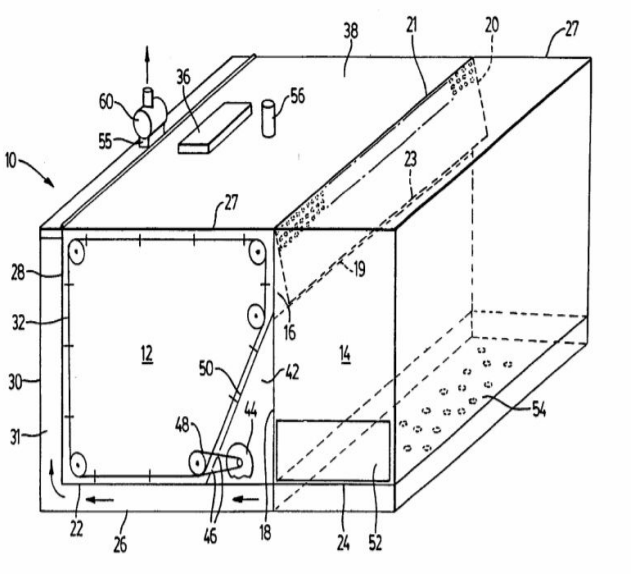
- 237 responses to survey
- 95% of those surveyed are aware of composting
- Only 17% own a compost bin
- The main concerns are smell and time consuming



What have been some of the similar Solutions?

DIY's

Patents



Outdoor Use

All indoor only make a soil additive

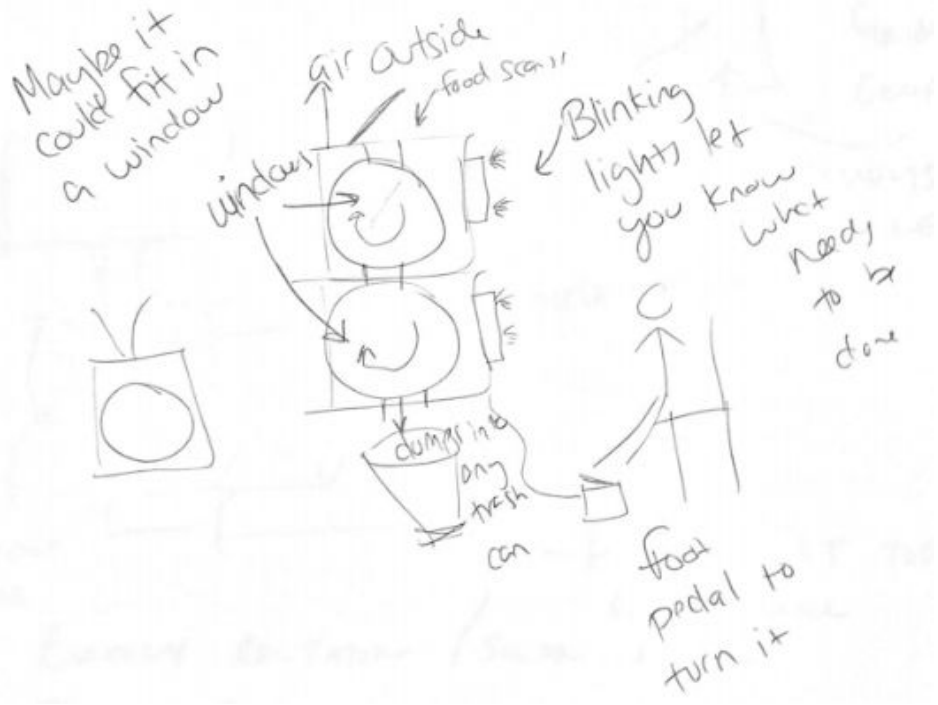
The Primary Stakeholders

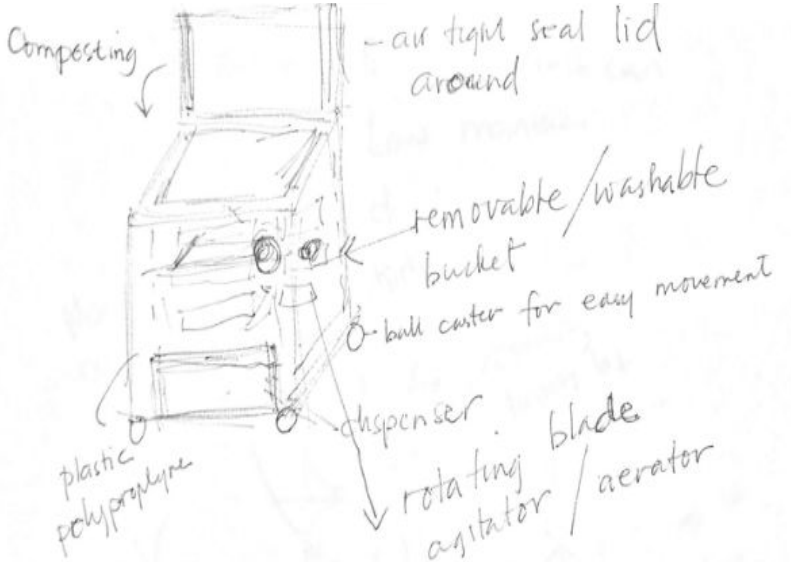
- People who want to compost with low space
- Gardeners
- Waste management
- Municipalities

Preliminary Design Requirements

1. Odor free
2. Small in size
3. Compost
4. Low touch time (<10/week)
5. Easy to use (loading and unloading)
6. Durable
7. Uninterrupted flow of compost
8. Non electric

Design Concepts - Brainstorming





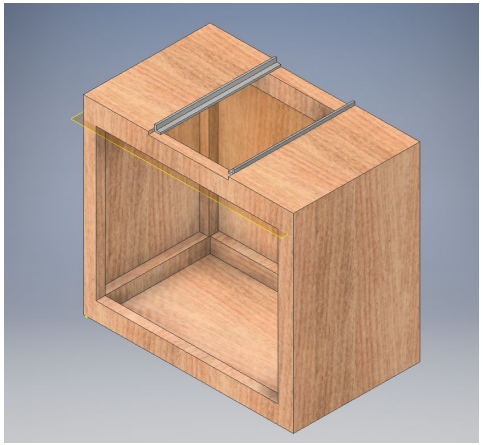
Design Concepts - Comparison

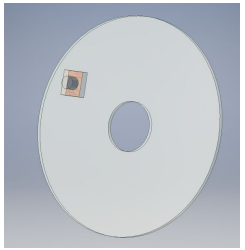
- Chose four best concepts from brainstorming to develop further.
- Compared each of these in similar solution matrix, weighting each requirement by level of importance.
- Solutions Developed
  - Ashley - Double Barrel Window System
  - Heath - Garbage Disposal Attachment
  - Allison - Dual Bin System
  - Marlon - Moveable Compost
- In the end we decided to combine the best features of these into one design.

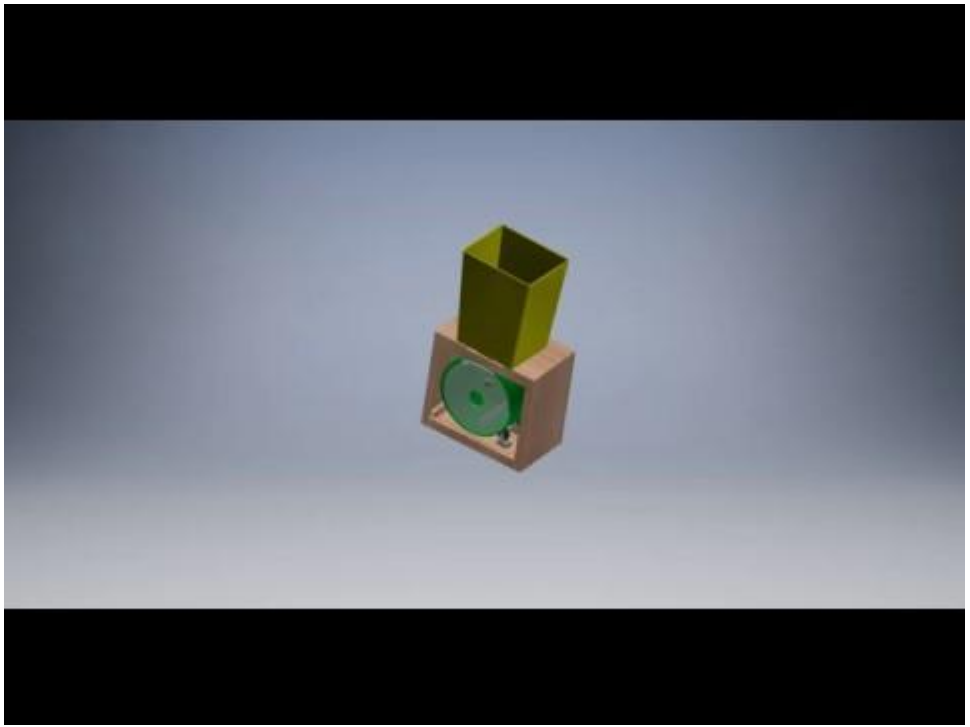
		Scoring		Weighting	
		Meets Requirements	2	Required	300%
		Partially Meets Requirements/ Yes	1	Desired	200%
		Does Not Meet Requirements/ No	0	Optional	100%

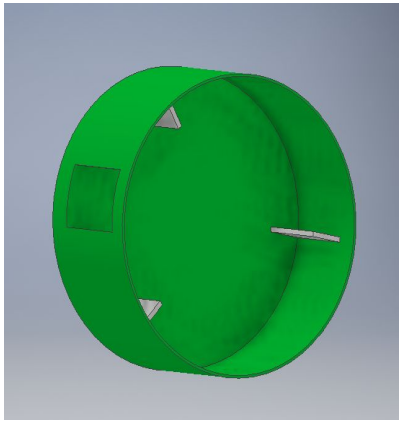
Requirement	Level of Importance	Ashley		Heath		Allison		Marlon	
		Score	Total	Score	Total	Score	Total	Score	Total
No Smell	9	2	18	2	18	2	18	2	18
Small Size	8	2	16	2	16	2	16	2	16
Composts	7	2	14	2	14	2	14	2	14
Low Touch Time	6	1	6	1	6	1	6	1	6
Intuitive	5	1	5	0	0	2	10	2	10
Ease of Disposal	4	2	8	1	4	2	8	1	4
Durable	3	2	6	2	6	2	6	2	6
Uninterrupted Input	2	2	4	2	4	2	4	1	2
No Electricity	1	1	1	1	1	0	0	2	2
			78		69		82		78

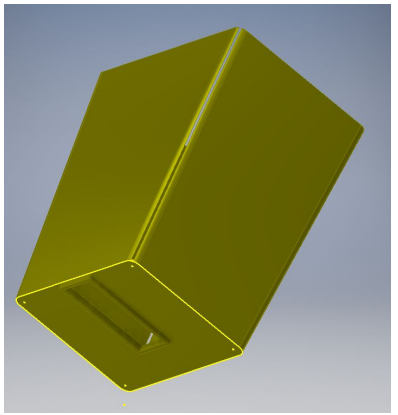
Design Concepts - Technical Drawings







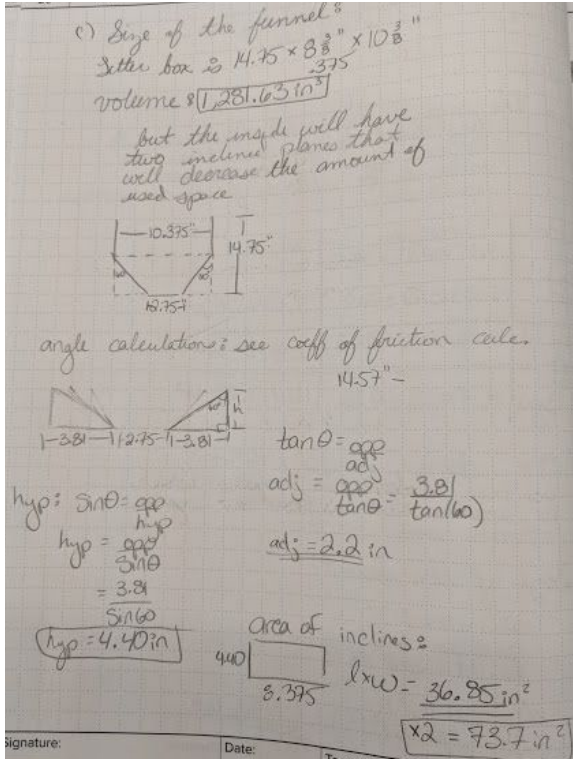




Application of STEM Principles

The following principles were mathematically considered while developing the design:

- Volume for overall size
- Friction and angle calculations for sliding
- Mechanical advantage of the handle for spinning
- Biochemistry of composting for proper ratios and temperature of reaction.

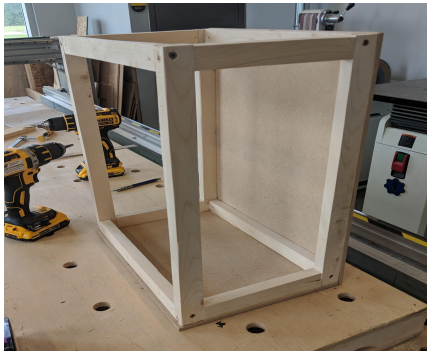


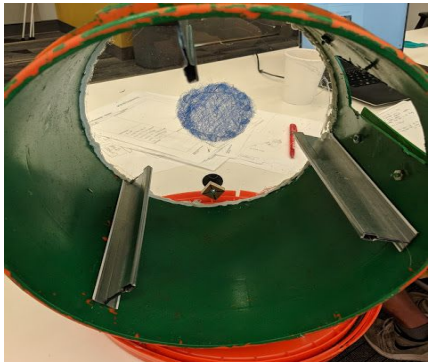
Design Viability

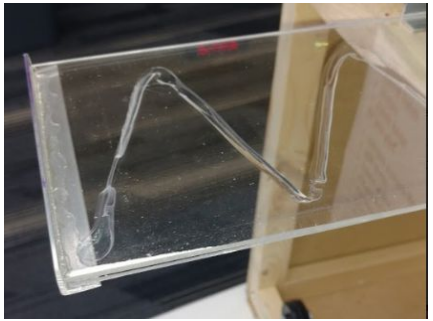
The design is viable for the following reasons:

- Solves problem of indoor composting is too difficult currently
- It can be easily manufactured
- The design is simple
- The solution is very environmentally friendly
- Supports new laws in some cities that require food scraps to be composted

Prototype Construction







Testing of Design Requirements

Passed

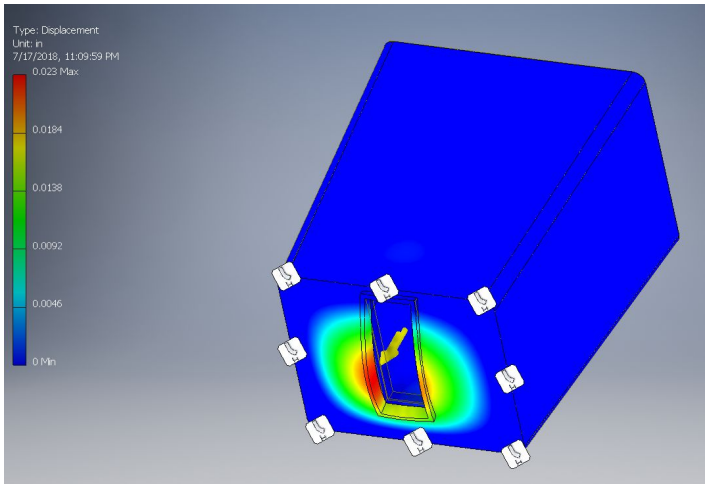
- Low touch time
- Easy to use
- Compost easily removed
- Durable
- Uninterrupted Input
- No Electricity

Failed

- Small Footprint

Could Not Be Tested

- Smell
- Compostability



External Evaluation

Met with three expert stakeholders

- Jessica - Designs Compost Facilities for Waste Management Companies
- Travis - Owns a Local Food Waste Collection Business in Wichita
- Rebecca - Master Gardener at Kansas State Horticulture Extension Office

Feedback

- Too small
- Hard to add brown materials
- Bottom bin should be water tight or have a tray
- Top bin should be air tight and much smaller than bottom bin

Reflection and Recommendations

- Determine if Composting in Small Volume is Possible
  - Insulate bottom bin
  - Using ideal mixture and conditions, let scraps sit
  - Using a temperature probe determine if compost reached
  - Vary conditions to determine limits
- Improve Prototype
  - Shorten & improve top bin
  - Make watertight
  - Improve air flow & flap functionality,
  - Ensure smell free
- Compare to Vermicomposting (worms)

Thanks and Questions

Special thanks to our classmates for all their feedback, WSU for their wonderful facilities especially Nathan and the Innovation Hub, Jason for fulfilling all our needs like supplies (and Diet Pepsis), our expert stakeholders for all their feedback. And to our amazing instructor Brian, we learned so much from you and you kept us going through all obstacles.

Questions?

Citations

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Reference Slides!!!!

Testing of Design Requirements By Importance

1. **Design Requirement:** The unit should have little to no smell at all times.
   No Results Gathered: Would need compost to sit for weeks.

2. **Design Requirement:** The unit needs to have a smaller footprint than a 13 gallon trash can, which measures 15 x 13 x 25 inches and is about 5100 cubic inches.
   Results: Same footprint, larger volume.

Height	Depth	Width	Volume	Percentage of average trash can
38” (lid open) 30.5” (lid closed)	13”	15”	Lid Open = 7410 in^3 Lid Closed = 5947.5 in^3	145% 117%

Testing of Design Requirements By Importance

3. **Design Requirement:** The solution should break down organic materials to a soil replacement.
   No Results Gathered: In order to test compostability you would need at least 2 weeks.

4. **Design Requirement:** The user should spend less than 10 minutes per week.
   Results: 3 people performed all necessary functions. On average it would take a minute per week.

Action	Time 1	Time 2	Time 3	Average
Sorting Material into compost bin.	4 seconds	5 seconds	3 seconds	4 seconds
Turning bucket 3 times	10 seconds	8 seconds	10 seconds	9.3 seconds
Moving material from top to bottom	8 seconds	9.5 seconds	9 seconds	8.8 seconds
Dumping materials	18 seconds	11 seconds	14 seconds	14.3 seconds

Testing of Design Requirements By Importance

5. **Design Requirement:** The solution should break down organic materials to a soil replacement.
   Results: All users thought it was either very easy or easy to use so it passes the test.

	Difficulty of Adding Food	Difficulty of Turning Bin	Comments
Response 1 (no name, teacher)	2 - Easy	2 - Easy	Not accepting meat is inconvenient
Response 2 (no name)	1 - Very Easy	1 - Very Easy	Needs separation of foods capabilities
Response 3 (Josh PLTW teacher)	1 - Very Easy	1 - Very Easy	
Response 4 (Alex PLTW teacher)	1 - Very Easy	1 - Very Easy	Very cool design
Response 5 (Thomson, student)	2 - Easy	1 - Very Easy	Convenient, could be used for most gardening purposes

Testing of Design Requirements By Importance

6. **Design Requirement:** The compost will be able to be easily repurposed.
   Results: At one-third full bin weighs 5.8 lbs, emptying the container would qualify as sedentary work since it is under 10 lbs according to North Dakota state agency Workforce Safety & Insurance. If completely filled it would weight 12.2 lbs, emptying the container would qualify as light work since it is under 20 lbs.

   The second test would verify the ease of removing all compost from the bin. 3 participants emptied the bin, below are their responses:

Justifications

This problem has a variety of justifications, the main ones are:

- Environmental
- Economic
- Health & Safety
- Technical and Legal
- Market Research

- 25% of our trash is material that can be composted
- Compostable items don’t break down here

- Composting can prevent pollution and clean the soil
- Compost in gardens produce higher yields with less water and fertilizer