A Project Report On **Project II**

"Designing an aerobic human powered food composter for everyday use in residential spaces for or a middle-class family up to 4 members to give ready to use compost as the end product."

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Design Methodology

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-what is the topic about giving a short introduction about the product.

- **justification of topic**

-through a small research giving and justifying why i have taken the topic.

Research

- **Primary Research**

Collecting information by site visit and from the user experience

- **secondary research**

Collecting information from desktop from different research paper and sources.

- **User study**

this can be done by directly interacting with the user or from desktop research

- **Market study**

Look for similar kind of product available in the market.

Design Brief

- **Define design brief**

what to achive in our design project that need to be brief out.

- **possible design direction**

search for various design direction and its process

- **scope of project**

look for what are the scope available in the project

- **Limitation**

Ideation conceptualisation

- **Initial Ideas scribble**

At the beginning i will create multiple ideas and start scribbling

- **Form evoluation**

once ideas are ready rething on the form of the design

- **3 concepts**

Generate 3 concepts and going in 3 different direction

- **Mockup making**
- **prototyping making**
- **User Testing**

final Design

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prototyping testing will lead to select the design direction

- **concept evaluations**

evaluation can be done by achving the point of design brief

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- **select a final design**
- **3d visualisation**
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- **Prototyping testing 2**
- **Rating the product**
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1. Introduction

1.1 What is home composting???

- Home composting is the process of using household waste to make compost at home.
- Composting is the biological decomposition of organic waste by recycling food and other organic materials into compost.
- Home composting can be practiced within households for various environmental advantages, such as increasing soil fertility
- reduce landfill and methane contribution, and
- limit food waste.

1.2 What is a home composter???

- During composting, microorganisms eat the organic (carbon containing) waste and break it down into its simplest parts.
- This produces a fibre-rich, carbon-containing humus with inorganic nutrients like nitrogen, phosphorus and potassium.
- The microorganisms break the material down through aerobic respiration
- Composting is worth it for those who want to create their own nutrient-rich soil amendments for a yard, garden, or flower bed. Turning yard debris and kitchen waste into compost is an excellent way to save money, make use of otherwise discarded material, and prevent unneeded landfill waste.

Figure 1 - Compost life cycle

1.3 Why????

Composing the waste created in own homes leads to less carbon footprint thus serving as a sustainable option.

Reduces the Waste Stream
Composting is a great way to recycle the organic waste we generate at home.
Food scraps and garden waste combined make up more than 28 percent of what we throw away.
Not only is food waste a significant burden on the environment, but processing it is costly.eg if left untreated in landfills, it creates the gas methane
Composting at home allows us to divert some of that waste from landfills and turn it into something practical for our yards.

Reduces Personal Food Waste
Consumers are responsible for a staggering amount of wasted food.
Composting from personal level reduces the waste going to such landfills
However, even if we do everything possible to decrease food waste, there will still be food scraps that cannot be consumed (e.g., a banana peel).
Composting is a great way to recycle those discards instead of tossing them in the trash.

Figure 2 - Personal food waste and landfills

Cuts Methane Emissions From Landfills

- When compostable waste goes to a landfill, it gets **buried** under massive amounts of other trash, **cutting off a regular supply of oxygen** for the decomposers.
- The waste then ends up undergoing **anaerobic decomposition**, being broken down by organisms that can live without free-flowing oxygen.
- During anaerobic decomposition, **biogas** is created as a by-product.
- This biogas is roughly **50 percent methane and 50 percent carbon dioxide**, both of which are potent greenhouse gases, with methane being 28 to 36 times more effective than CO_2 at trapping heat in the atmosphere over a century.
- Because our solid waste infrastructure was designed around landfilling, only about 6 percent of food waste gets composted.

Improves Soil Health and Lessens Erosion

- Compost is an essential tool for **improving large-scale agricultural systems.**
- Compost contains three primary nutrients needed by garden crops: **nitrogen, phosphorus, and potassium.**
- It also includes traces of other essential elements like **calcium, magnesium, iron, and zinc.**
- Instead of relying on synthetic fertilizers that contain harmful chemicals, composting offers an **organic alternative**.
- Research has shown the capability of compost to increase soil's **water retention capacity, productivity, and resiliency.**

Conserves Water

- Research has shown the **water-retaining capacities** of soil increase with the addition of organic matter.
- In fact, each **1 percent increase in soil organic matter helps soil hold 20,000 gallons more water per acre.**
- By using compost to foster healthy soil, farmers do not have to use as much water and can still have higher yields compared with farming with degraded soil.

Figure 3 - Healthy soil, Conserve Water

1.4 Different types of composting

- There are three kinds: **aerobic, anaerobic, and vermicomposting.**
- Each has its pros and cons.
- Households, farms, restaurants, schools, offices and places of business produce compostable materials.
- For example, food scraps, grass clippings, leaves, animal manure, and coffee grounds are all compostable.
- Composting is useful for making inexpensive fertilizer for lawns, gardens and farms.

Aerobic Composting
In aerobic composting, air is introduced to help break down materials quickly. The compost needs to be turned every few days. Add scraps, then turn the handle or spin the composter to keep it aerated. You will probably want to add plenty of green matter that contains lots of nitrogen, such as grass clippings. As the bacteria break down the high-nitrogen-content scraps, the temperature of the compost will get higher. This speeds the process. Also, moisture may need to be added from a hose or watering can. The odors from aerobic composting will be bad if you don't keep it moist and forget to turn it frequently. Also, you need to leave lots of air space in the composter. E.g. backyard composting

Anaerobic Composting
anaerobic is the opposite of aerobic. Anaerobic composting takes almost no effort at all. Just chuck scraps into a compost pile or composter. Takes several years to compost Anaerobic composting stinks to high level. Without oxygen, some pretty nasty bacteria take over. This is what happens in a landfill, and it's not healthy. Landfills produce so much methane, they can actually have explosions! Methane is a greenhouse gas that is bad for the environment.

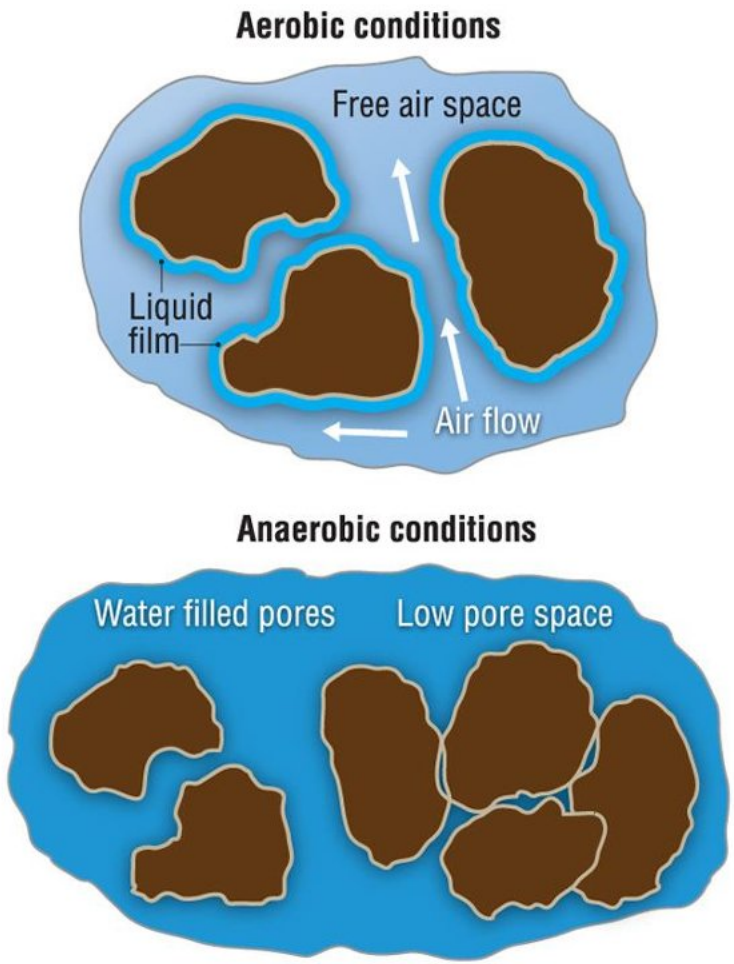


Figure 4 - Aerobic and Anaerobic Composting

Vermicomposting

Vermicomposting uses worms, oxygen and moisture to safely break down organic material with little odors. Red worms are favorites for this type of composting. Vermicomposting is preferable to the other two methods, for these reasons:Very little odor, No need to "turn" frequently, Can be done indoors or outdoors, Easy to harvest the fertilizer, especially with a tray-based, composterTakes minutes a week

1.5 Composters available in the market

1. **OXO Good Grips Easy Clean Compost Bin**

- Made from plastic
- perfect size for countertop use
- easy-to-use lid that stays open when needed.
- easy it is to use.
- It has a unique design that keeps the bags tucked inside for a neat look
- The bin reduces odor with the soft-seal design that promotes oxygen flow, but that does not mean this is completely odorless
-

2. The Squirm Firm Worm Factory 360 Worm Composting Bin

- Low maintenance
- Odor free
- The worms will grow in size and quantity and consume several pounds of waste each week.
- The first tray takes about 3 months to become fully composted by the worms, and then each tray takes about a month moving forward.
- The kit includes mineral rock dust that adds nutrients to the finished compost, four stacking trays, a thermometer, a hand rake and scraper, a worm ladder, a base with spigot, and a comprehensive instruction manual.
- Managing the Worm Factory is low maintenance and takes less than 15 minutes a week.

Figure 5 - Market study

3. FCMP outdoor dual chamber tumbling composter

- **Sleek and sturdy** design
- Easy to use
- Quickly and effectively breaks down food
- Doesn't attract bugs
- The position of this composter in the yard affects how it works: It needs to be **situated in full sun.**
- In hot, sunny conditions, depending on the combination of ingredients, your compost can be ready in as few as two weeks, according to the brand.

Product Name	Dual Chamber Tumbling Composter
Product Brand	FCMP Outdoor
Price	$99.95
Weight	30 lbs.
Product Dimensions	36 x 31 x 28 in.
Color	Black
Model Number	IM4000
Color	Black
Material	BPA-free UV-inhibited recycled polypropylene
Capacity	37 gallons

4. Fence Cedar Wood Composter

- Nice looking
- Easy setup
- Good airflow
- Takes up a lot of space
- Pricey
- It designed for outdoor use, with a wide-open bin that makes turning the soil easy.
- The cedar wood gives it an elegant appearance that looks nice in your backyard.
- This compost bin is easy to maintain.
- The kit comes with four posts, 28 boards, and 48 spacers, which give you one bin once assembled.

5. Daily Dump

- Daily Dump provides a commercial compost 'pit' that one can have at your home.
- All the leftovers and other organic waste can be dumped into these pits.
- Within a few months this becomes manure and can be used for garden or just sell it off to a needy farmer maybe
- Compost can be made in as little as six to eight weeks, or, more usually, it can take a year or more.
- In general, the more effort you put in, the quicker you will get compost.
- When the ingredients you have put in your container have turned into a dark brown, earthy smelling material, the composting process is complete.

Figure 6 - Market study

1.5 What can and can't you put in a composter?

- You can put all kinds of food scraps into a composter, such as apple cores, banana peels, vegetable skins, coffee grounds, eggshells, and bread. However, animal products, such as meat, dairy, and bones, generally aren't recommended for composting because they can harbor pathogens and attract pests
- You also can add grass clippings, leaves, wood shavings, hay, animal manure, and other yard waste, as well as paper towels, cardboard, and shredded newspaper. Things you generally shouldn't put in a composter include oils, pet waste, diseased plants, charcoal, and ash.

Figure 7 - what can be added

1.6 How to reduce the smell of compost

- The best way to reduce the smell of your compost is to use a bin that has adequate ventilation or a drip tray on the bottom, as too much moisture can be a culprit. Also, fluffing up the bin with lighter, dryer materials, such as leaves, can help keep odors under control. Additionally, avoid putting meat, dairy, and eggs into your composter.

1.7 How often should you clean your composter?

- Outdoor composters don't have to be cleaned very often—once or twice a year is plenty. It's more important to regularly remove the decomposed matter. With an indoor compost bin, wash it out regularly to keep odors under control and prevent bacteria growth. You can purchase compostable liners, which are just like garbage bags, except they decompose with the rest of your scraps

Figure 8 - what cannot be added

2.Literature Study

2.1 Daily dump by Poonam Bir Kasturi

- Daily Dump's focus is to create easy engaging solutions for conscious city living.
- Daily Dump targets organic waste right at its source – the household – before it is mixed with other waste creating a toxic mess.
- What Daily Dump has done over these years is that it has set up a decentralized waste management approach by not letting the government be the only body responsible in managing the country's waste.
- By making people responsible for managing their waste in their own backyard via composting it has helped divert some amount of waste from the landfills
- Daily Dump offers a product range of over 50 aesthetically designed terracotta composters that support various family sizes and volumes of kitchen waste generated.
- The products are manufactured by potters who are otherwise seeing a decline in the demand for their craft and hence their incomes.
- The products are accompanied by colorful, illustrative step-by-step guides that educate the customer on composting.
- To ensure compliance and prevent dropouts, the Daily Dump team contacts customers once a month to check on their progress and help with queries.

Figure 9 - Daily Dump - Kambha range

2.2 Berkeley method of hot composting

Locate your compost heap in an area protected from too much sun or heavy rain, to prevent the compost from drying out or becoming water-logged and slowing down the composting process.

- use 1/3 green nitrogen-containing materials that break down quickly (moist lawn/grass clippings, fruit and vegetable scraps, animal manure and green foliage) and 2/3 brown carbon-containing materials that break down slowly (sawdust, cardboard, dried leaves, straw, branches and other woody or fibrous things).
- Pile alternating thin layers of greens and browns on top of each other until your heap is about one meter square.
- Wet the compost heap down very well so it is dripping water out of the bottom and is saturated.
- Leave it for the next four days (no turning).
- Turn compost every second day for 14 days
- Use a garden fork or long-handled pitchfork. When turning compost, move the outside of the pile to a spot next to it, and keep moving material from the outside to the new pile. When you're done, all the material that was inside will be outside and vice versa.
- The compost heap should reach its maximum temperature on days six to eight. Stick a thermometer into the middle of the heap to confirm it's between 50 and 65 degrees Celsius.
- When earthworms move into the compost, you know it is finished and ready, because it's cooled down and full of nutrients!

Figure 10 - Berkeley method of hot composting

2.3 Biological process

Techniques for effective aerobic composting

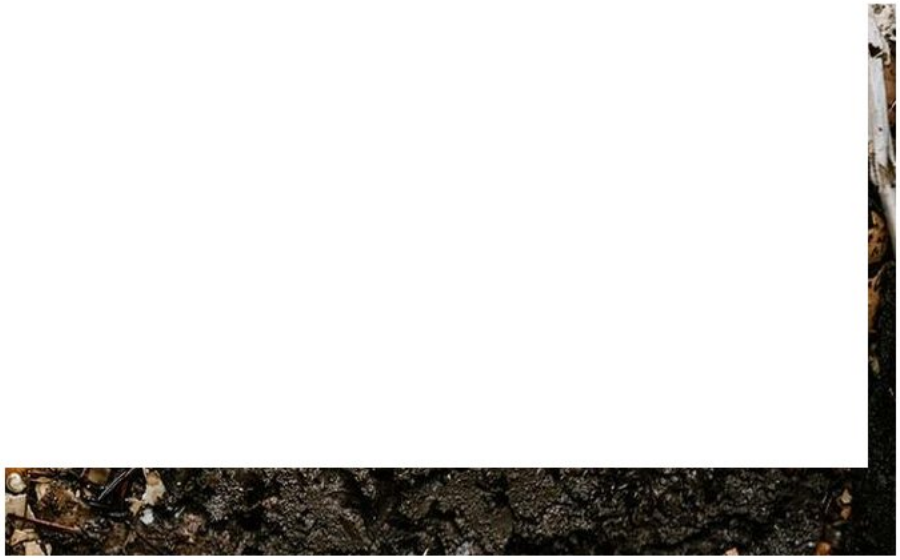
Improved aeration
In order to obtain the end product of uniform quality, the whole of the pile should receive a sufficient amount of Oxygen so that aerobic micro-organisms flourish uniformly.

Pile size and porosity of the material
- The size of the pile is of great significance.
- Where the pile or wind-row is too large, anaerobic zones occur near its centre, which slows the process in these zones.
- On the other hand, piles or wind-rows that are too small lose heat quickly and may not achieve a temperature high enough to evaporate moisture and kill pathogens and weed seeds.
- While more porous materials allow bigger piles, heavy weights should not be put on top and materials should be kept as loose as possible. Climate is also a factor.
- With a view to minimizing heat loss, larger piles are suitable for cold weather.
- However, in a warmer climate, the same piles may overheat and in some extreme cases (75 °C and above) catch fire.

Ventilation
- Provision of ventilation complements efforts to optimize pile size.
- Ventilation methods are varied.
- The simplest method is to punch holes in the pile at several points.
- Aeration is improved by supplying more air to the base of the pile where Oxygen deficiency occurs most often.

Turning
- Once the pile is formed and decomposition starts, the only technique for improving aeration is turning.

Supplemental nutrition
- The techniques mentioned above often need to be complemented by the provision of nutrients.
- One of the most common practices is to add inorganic fertilizers, particularly Nitrogen, in order to modify a high C:N ratio.
- Similarly, P is sometimes applied as the C:P ratio of the material mix is also considered important (the ratio should be between 75:1 and 150:1).
- When micro-organisms are inoculated, they require sugar and amino acids in order to boost their initial activities; molasses is often added for this purpose.



2.4 Power driven process

- Easy to use
- Odorless
- Convenient
- Once the composter is full, hit the power button, and it goes through a **drying, grinding, and cooling** process that cuts down food waste by up to 90 percent. You can leave it alone for a few hours until it completes the cycle.
- This composter comes at a higher price
- it's mess-free
- does it all indoors—truly adopting a "set it and forget it" functionality.
- The main downside is replacements for the **filters**, which last **about four months**.

Figure 11 - Electronic Composter

3.Case Study

3.1 Case Study 1

IITB Biogas plant – Anaerobic Treatment

- Biogas production (typically an anaerobic process) is a **multistep process** in which originally **complex organic** (liquid or solid) wastes are progressively transformed into **low molecular weight products** by different bacteria strains

Figure 12 - IITB Biogas plat

- The process starts with **collection of everyday food waste** from each of the hostels in drums.
- They are segregated as **dry food waste and wet food waste.**
- Dry waste goes to the **goshalas** everyday and wet waste goes to the **biogas plant.**
- On an average, **1000 to 2000 kg** of food waste is collected **every day**
- There are 2 biogas plants that works alternatively
- The waste collected in drums from each of the hostels are then collected everyday morning and taken for treatment.
- Following are the steps carried out in the biogas plant to convert the wet food waste into biogas:

SHREDDING

- The food waste is shredded into small particles using this machine. Its crushed into smaller pieces and slurrified to prepare it for the anaerobic digestion process.

Figure 13 - food collector, drum, shredder

HYDROLYSIS TANK

- Large organic molecules such as proteins, carbohydrates and lipids are allowed to break down into simpler units with the help of certain enzymes.
- Here in this step the fermentation of organic products takes place and yield many products like organic acids, alcohols, amino acids, CO2 which can be used in the next level

MIXING TANK

- Waste from the hydrolysis tank is then fed to the mixing tank were its thoroughly mixed.

DIGESTER

- The mixed matter then goes to the digester which has a capacity of 2000kg. Digester is made of steel.
- To optimize the flow of substrate, large digesters have a longish channel form.
- Large digesters are agitated by slow rotating paddles.
- The gas gets collected inside the digester, then goes to a flexible cover called gas holder.
- Gasholder is made of a flexible material.
- It acts like a balloon and gets filled with the gas during digestion.

STORAGE VESSEL

- The biogas produced is stored in the storage vessel from where it's distributed via pipes to 4 hostels.
- This process produces a mixture of gases – **primarily methane, some carbon dioxide and tiny portions of other gases such as hydrogen sulfide**.
- The leftover slurry is then taken as manure.

Figure 14 - Hydrolysis tank

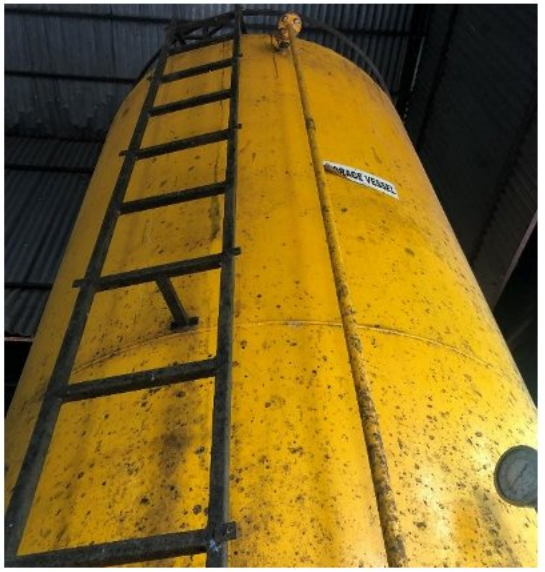


Figure 15 - Mixing tank, digester, storage tank

3.2 Case Study 2

Daily Dump – Aerobic Treatment

- Daily Dump's focus is to create **engaging solutions for conscious city living.**
- It does this by making people aware of the big picture in fresh and simple ways and by making it easy and fulfilling for everyone to tackle large issues like waste in a city.

Figure 16 - Daily Dump

Figure 17 - range of kambhas by daily dump

STACK
Composter for flats and homes with very less space

STACK
Composter for flats and homes with very less space

HOW IT WORKS

- Add dry leaves to pot c to absorb extra water coming from above pots
- Add newspaper and remix power to the first pot A
- Add the food waste
- Cover it with remix powder
- Continue the process until the pot A gets filled
- After which add microbe and place the pot in the middle and bring B up and repeat the process
- When B is filled remove the contents in A to C and keep A on top to repeat the process.
- When a is filled check c if its ready. It would take approximately 6 weeks if not ready transfer content of c o another pot and transfer b to c

Figure 18 - working of daily dump**HOW IT WORKS**

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Figure 19 - working of daily dump

Figure 20 - how remix powder works

3.3 Case study 3

Electric Composters

- Food scraps are placed in a bucket, the unit is closed and turned on. An automated cycle dries the material and "grinds" it.

Figure 21 - Electronic Composter

- At the end of the process, you have something that is dry but still kind of resembles the food you put in. Some items turn into brown powder while others stay quite chunky and fibrous.
- There is a bit of odor, but it is not unpleasant.
- Some units have charcoal filters that reduce the odor while it is exhausting the water vapor.
- The buckets are quite small. Most of them have 2-liter capacity (0.5 gal)
- kitchen waste, mostly orange rinds, banana peels, apple cores, some potato peelings and a couple of eggshells fills the bin in 2-3 days.

Most of the electronic composters have 3 different modes of composting

- **Eco Express mode**
- **Moderate Mode**
- **Grow mode**

Grow mode

- Soil that can be used for garden
- Low heat to preserve the micro-organisms and bacteria's
- 16 to 18 hrs.
- Can be added 1 part to 10 part soil

Moderate

- 5 to 8 hours
- All food and plastic
- Cannot be used for gardening

Eco express mode

- 3 to 5 hours only
- Cannot be used for gardening
- Should go to trash

Electric Composters – do they compost

- they "don't compost".
- They reduce the volume of food waste and reduces the quantity of landfill.
- end product showed a total nitrogen level of 2.9% and a nitrate level of 0.005%.
- During composting, organic forms of nitrogen are converted to inorganic forms of nitrogen, mainly nitrate.
- These numbers confirm that composting has not yet started
- It is just dehydrated food waste byproduct rather than calling it a fertilizer
- Once to take out this by product and put it in soil, there are chances that it stinks while the plat is watered

Electric Composters – do they grind

- Many of the products claim to "grind" the food as it's heated.
- The blades in the unit are not sharp nor is the space between the blades and the fixed bar, small enough to grind food.
- They rotate once per minute and this can be called agitation or mixing.
- **The material is not finely ground and contains a lot of larger pieces**

Figure 23 - Byproduct of electronic composter

What can you do with food scraps?

- You can compost them yourself and that is probably the best option.
- This can be either an outdoor compost system, vermicomposting, or even aerobic composting.
- Another option is to send it to a municipal composting facility. This is also a good option especially if you don't have a garden.
- sending it to landfill (ie throw it in the regular garbage) is the worst option because organic matter in landfill can't decompose aerobically, and therefore produces methane gas, which is 25 times worse than CO2 for global warming.
- This is only eco-friendly if you don't send the food waste to landfill because reducing its volume by drying does not reduce the amount of methane it produces in landfill.
- therefore, it is a good option to add a composter within the same product so that people living in urban areas or apartments with less outdoor space and soil needn't search for a place to compost the waste.

Is an electronic composter eco-friendly?

- It is expensive to buy.
- It takes up way too much room on a countertop.
- Making it, running it and disposing of it at the end of its life are not very eco-friendly.
- What are you going to do with the dehydrated food waste?
- If it is sent to landfill you have accomplished nothing for the environment. In fact, you have made it worse.
- If you add it to the garden, compost bin, or send it for municipal composting – you could have done that without an electronic composter.

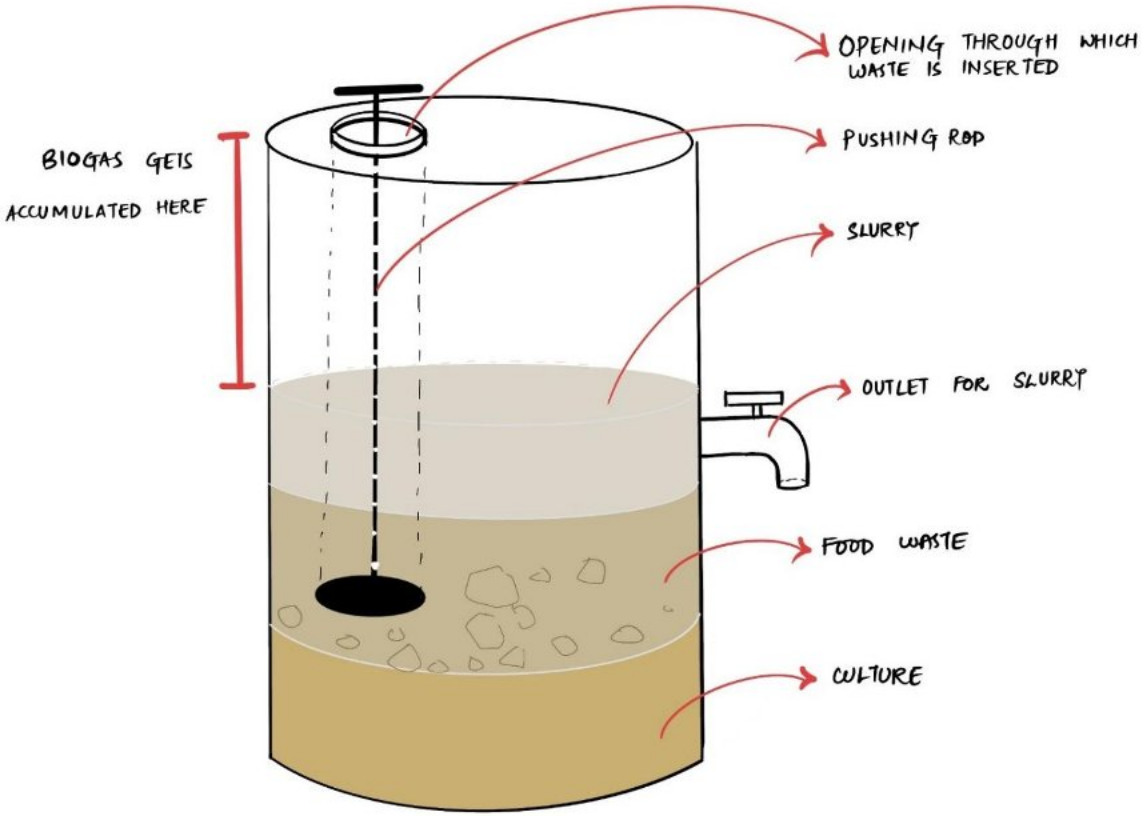
Figure 24 - Vayu Mitra biogas plant

3.4 Case study 4

Vayu mitra
Home biogas plant – anaerobic treatment

- Biogas production (typically an anaerobic process) is a multistep process in which originally complex organic (liquid or solid) wastes are progressively transformed into low molecular weight products by different bacteria strains

- The process starts with collection of everyday food waste
- The food is collected in 2 separate cans, one for the waste that should no be added to the plant which includes fishbones, citric waste like lemon peel, orange peel etc and one with rest of the food waste which includes the raw food waste as well as leftover food
- The first can of waste is taken for aerobic composting process
- Second goes to the biogas plant tank every day
- The tank has a got a capacity of 2kg
- The food waste added should a maintain a ph level 7
- Food waste is inserted through this opening
- A rod with flat circular base is used to push the waste deep into the drum
- The drum has got already filled culture in it which eases the fermentation process
- As the process starts, the slurry rises up and gas gets accumulated above the slurry
- There is an outlet provided at the middle of the tank through which the slurry can be taken out every day and added as a natural fertilizer to plants
- Every day an average of 2 litres of slurry is collected.
- The gas formed in the upper half of the drum is then transferred to the gas holder which is made of a flexible material through a pipe
- A t junction is provided at the middle of the pipe to expel gas coming due to overpressure
- The gas holder expands once its filled with the biogas
- The amount of gas generated is more during summer due to heat
- The gas is then taken through pipes to the stove area.
- it fulfills 20 to 30 percent of the per day needs in the household for 6 members
- An extra outlet is also provided which can be opened occasionally to expel the water accumulated along with the biogas which will be in a very less quantity
- The product doesn't require much maintenance
- Jus opening the lid and removing undigested food once in a year is the only maintenance that once must do


OPENING THROUGH WHICH WASTE IS INSERTED
PUSHING ROD
BIOGAS GETS ACCUMULATED HERE
SLURRY
OUTLET FOR SLURRY
FOOD WASTE
CULTURE

BIOLOGICAL PROCESS aerobic	BIOLOGICAL PROCESS anaerobic	POWER DRIVEN PROCESS aerobic
Indoors • Collecting food waste • Adding remex powder, paper etc to absorb moisture • Turning frequently to increase oxygen • Same step repeated until bin gets filled • Adding microbes and keeping it for composting • 1 to 2 months to completely decompose outdoors • Collecting food waste • Adding remex powder, paper, sawdust etc to absorb moisture. • Frequent turning • Same step repeated until bin gets filled • Adding microbes and keeping it for composting • Heat of sun fasten the process to an extend • 14 to 30 days to completely decompose	• Collecting food waste • Shredding • Hydrolysis • Mixing • Digestion • Collection of biogas Or • Just chuck scraps into a compost pile or composter. • Takes several years to compost without any human effort • Without oxygen, some pretty nasty bacteria take over. • This is what happens in a landfill • Landfills produce so much methane, they can actually have explosions! • Methane is a greenhouse gas that is bad for the environment.	Indoors • Collecting food waste • Power on once thee bin in full • Drying the waste • Grinding the waste • Cooling • Takes 1 to 4 hours • Mixed with soil and kept for 2 days • Compost ready

BIOLOGICAL PROCESS - aerobic	BIOLOGICAL PROCESS - anaerobic	POWER DRIVEN PROCESS - aerobic
Needs ventilation and oxygen	Generates free gas	Easy to use
Speed up under sun		Odourless
Cheap and economical		Less time consuming for dehydrating – max 4 hrs
Frequent turning and layering, slow process, fragile	Costly as it should be well equipped	pricey
size of the pile matters	Creates unpleasant odours	Draws lot of electricity , runs for more than 20 hours for the process to complete. Even then compost is not the end product. Quick process doesn't give a product that can go into the soil.
Addition of supplemental nutrition	Requires a lot of space	Replacement of filter in every 4 months
Time consuming - 1 to 2 months, no one has time or energy to dedicate to the process	Human effort is high	Dehydrated food waste need to be made into compost again, bad quality compost/ not compost
Requires lot of manual effort and messy	Not all the waste can be added	Should not add bones, shells, too much sugar
Price range – 1000 to 7000	Initial setting cost – 15000 approx.	Price range – 20000 above

Volume specification

Volume of 1 chamber is as follows

- 1 gallon = 3.79 kg
- the amount of food waste per capita/week is about 1.6 kg

7 days – 1.6 kg
1 day for 1 person – 0.22 kg
1 day for 4 people - .88kg (approx. 1 kg)

Sl no	Name of composter	Volume of composter	Waste of how many days for a family of 4
1	**OXO Good Grips Easy Clean Compost Bin** 	1.75 gallons (6.6 kg) **Dimensions:** 7.75 x 7.3 x 7.6 inches	7 days
2	**FCMP outdoor dual chamber tumbling composter** (outdoor) 	37 gallons (140 kg)	140

Sl no	Name of composter	Volume of composter	Waste of how many days for a family of 4
3	I ·Gallon Stationary Composter 	1.2 gallons (4.5 kg)	5
4	**Vitamix Food Cycler FC-50** 	0.5 gallons (1.8 kg)	2
5	**Simple Human 4-Liter Compost Caddy** 	1 gallon (3.8 kg) **Dimensions:** 5.7 x 9.6 x 8.5 inches 15 25 20	4
6	**RSI 65 Gal. 2-Stage Composter Tumbler (outdoor)** 	65 gallons (245 kg)	245

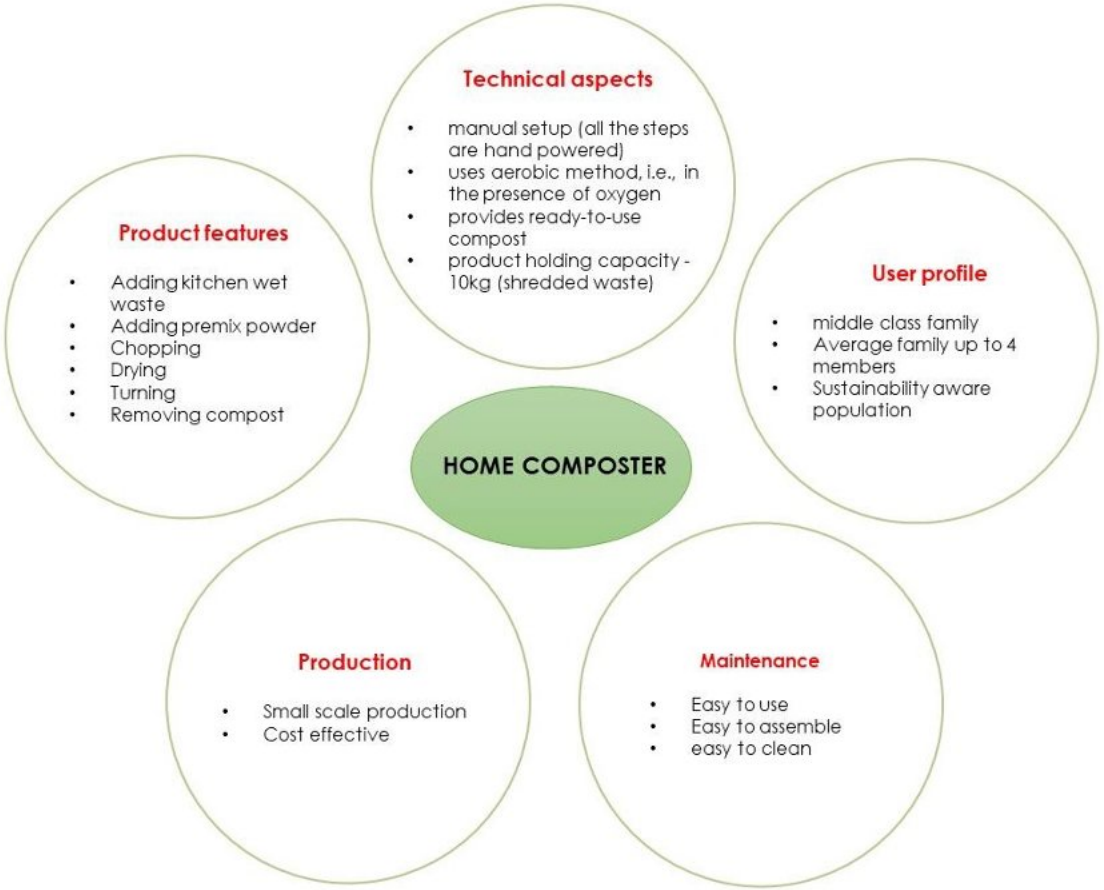
4. Design Brief

- To design an aerobic human powered food composter for everyday use in residential spaces that is
- Cost effective
- For a middle-class family (up to 4 members)
- To give ready to use compost
- Operated manually
- For balcony spaces or near windows exposed to sunlight
- Price can be positioned between the conventional aerobic composters and electronic composters

- To design an aerobic human powered food composter for

Requirements...

- Should **reduce the manual effort** involved in the conventional aerobic composting process
- Should **speed up** the process by providing ample heat and oxygen
- Material that increases the heat inside can be used
- Turning mechanisms to **increase oxygen** content
- Should be **compact t**o fit in less space
- Should produce **compost** at the end of the process
- Should be **odourless**
- Should be an **economical** option
- Low cost manufacturing process



5. Story Board

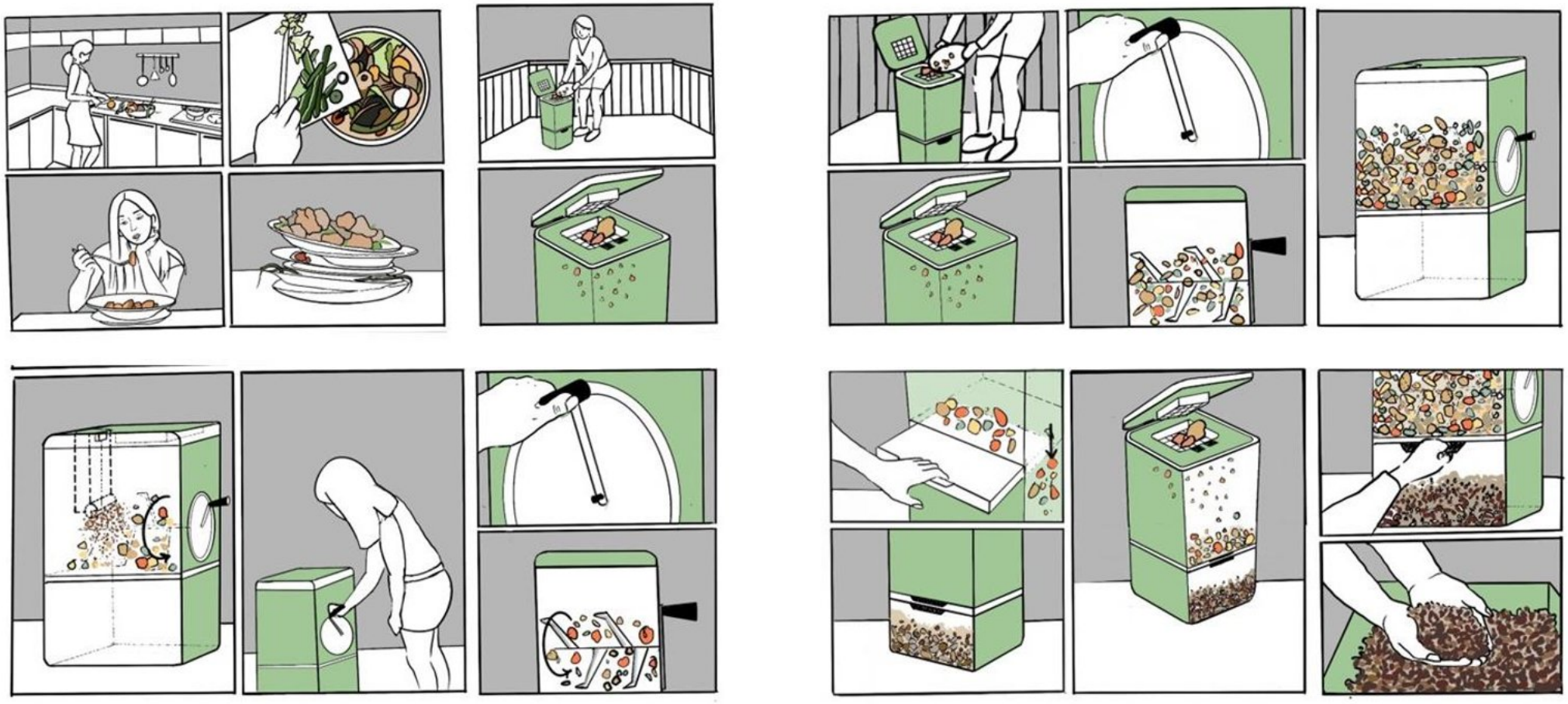
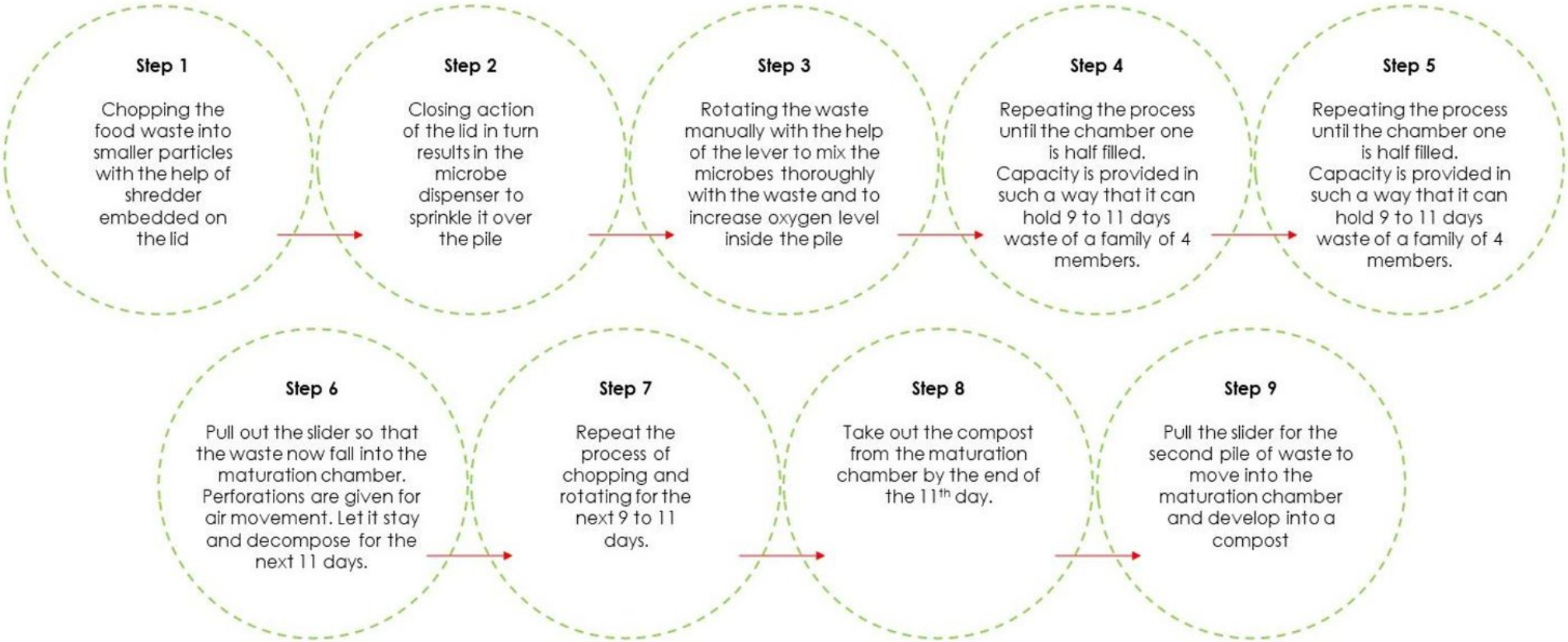
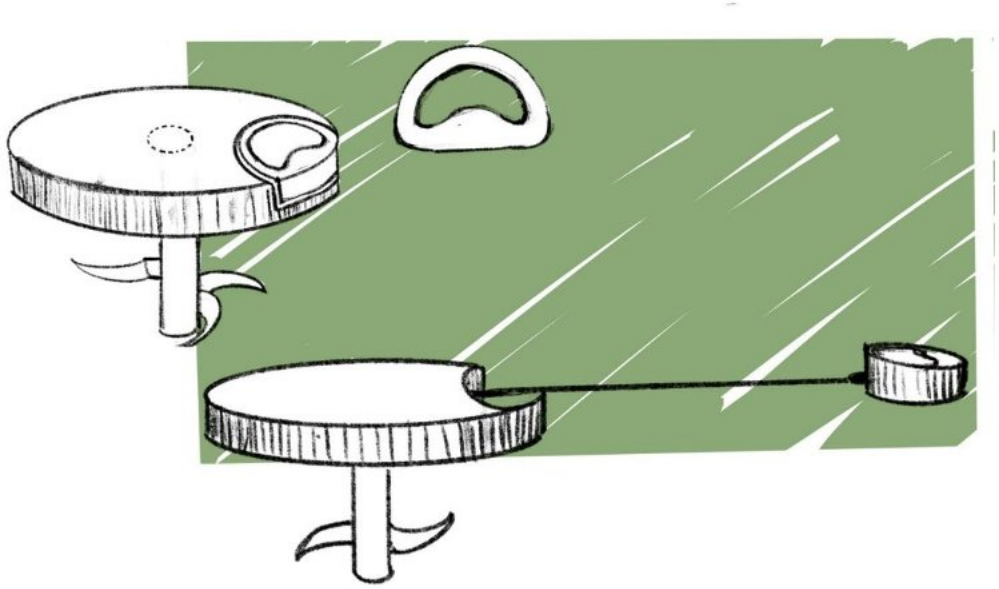


Figure 25 - storyboard

6. Task Analysis



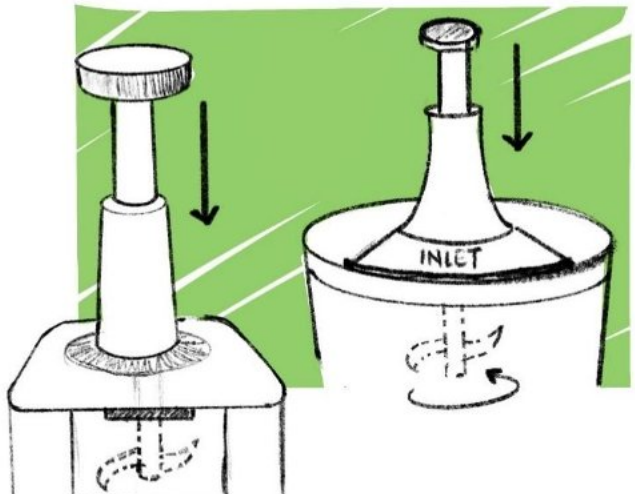
7. Design Direction



The composter can have 2 racks (one where the initial dehydration and mixing takes place and second, a maturation chamber where the compost is prepared) within it.

7.1 Chopper

- Can be attached with the composter lid
- wet waste is shredded into small particles to speed up composting.
- The smaller, the better is the rule for compost ingredients
- The chopping is done by hand power



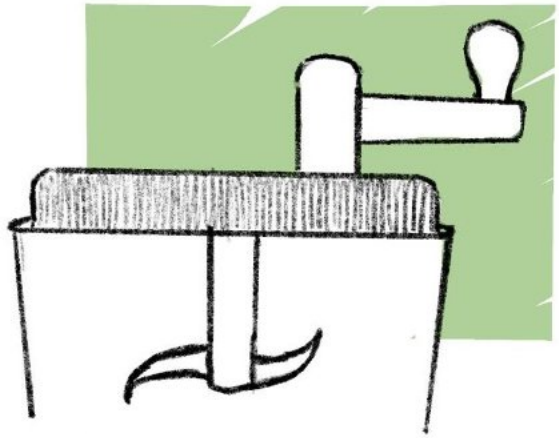
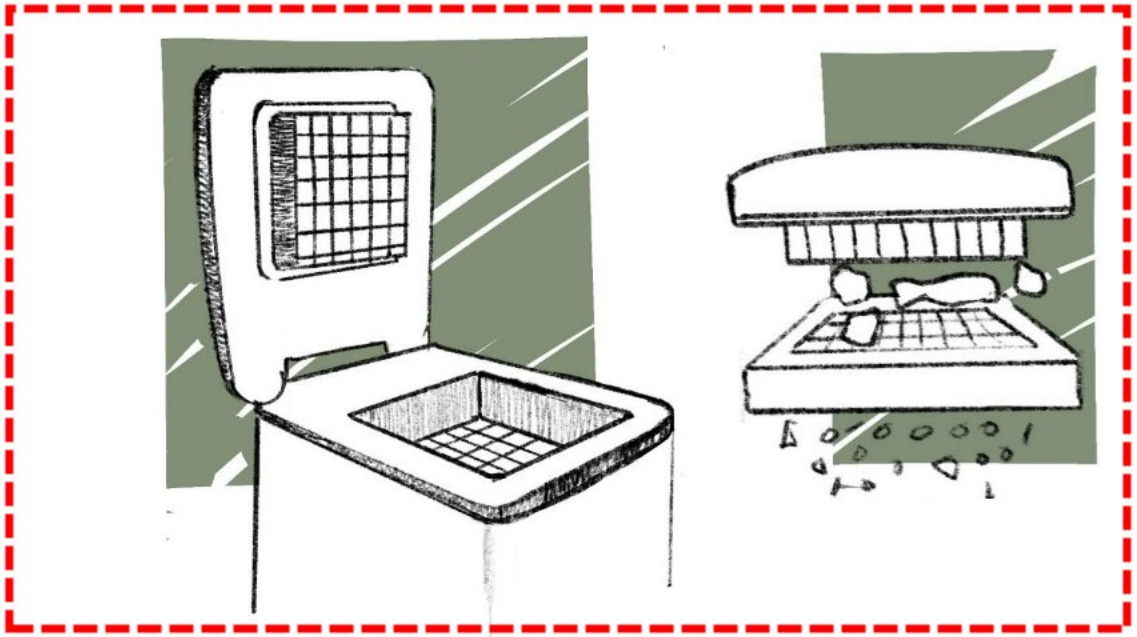
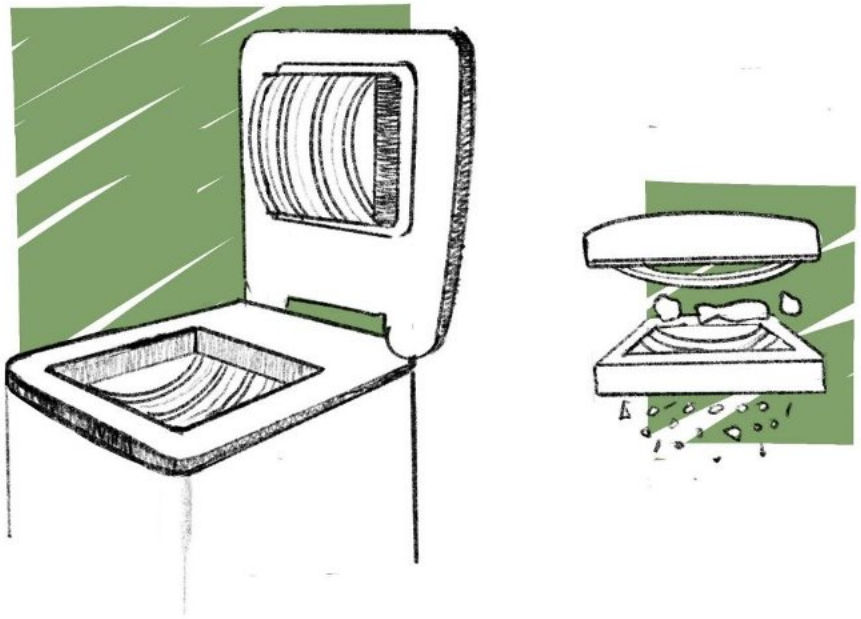


Figure 26 - ideations for chopper



- Chopper blades are attached within the lid
- The user needn't put an extra effort to chop the waste
- It gets chopped while the lid is closed



7.2 Dispenser

- A dispenser is attached close to the lid so that when the lid it closed it allows the remix powder as well as microbes to automatically fall into the composter which increases the speed of composting.
- Adding a space within the lid and providing manual rotating mechanism

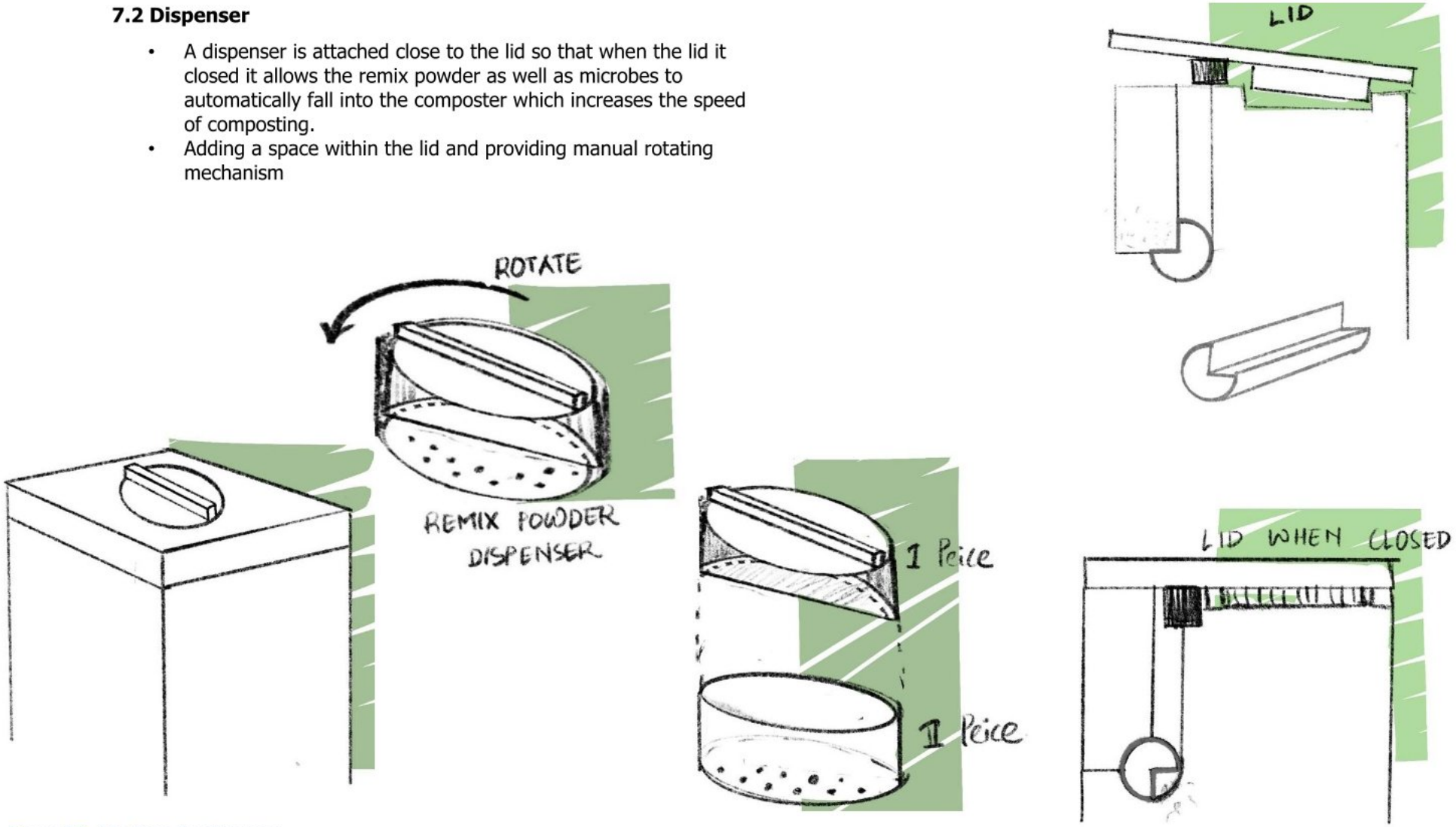


Figure 27 - ideations for dispenser

7.3 Perforations

- Reduces odor by increasing air flow
- To ensure that methane is properly and regularly emitted out
- Upper chamber needs more perforations to initiate the composting process while turning with microbes
- Lower chamber or maturation chamber is also provided with holes but less number to allow circulation.

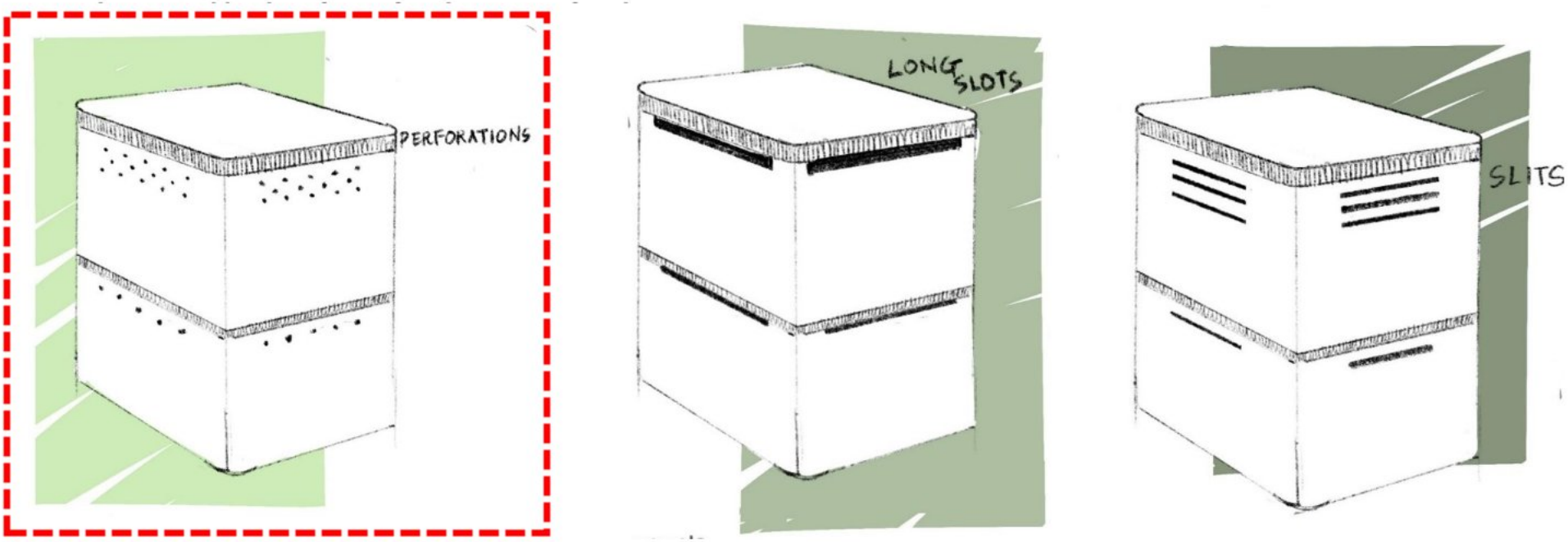
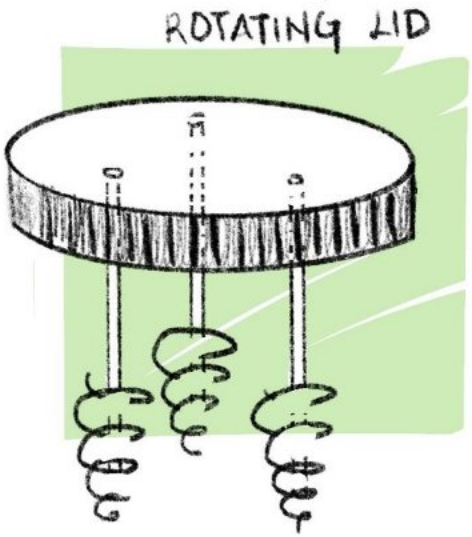
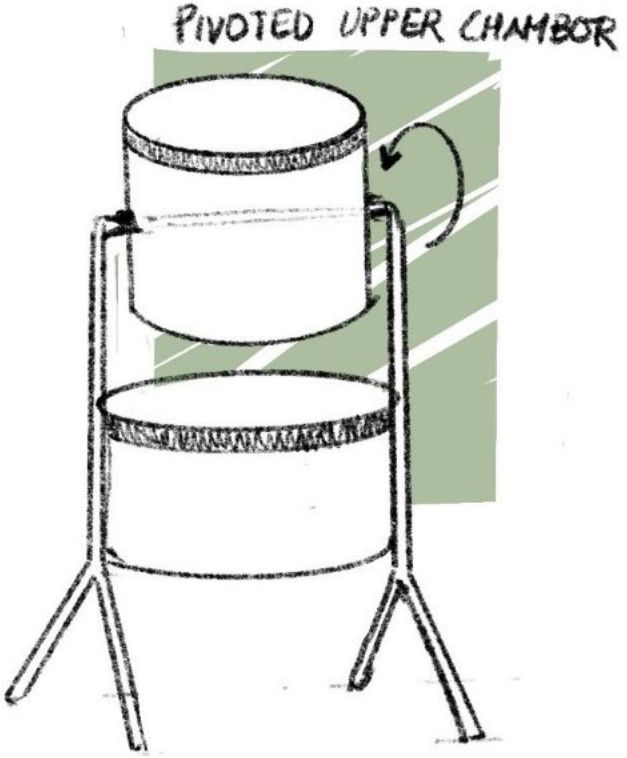


Figure 29 - ideations for perforations

7.4 Lever or any rotating mechanism

- Thus helps in constantly rotating the waste thus increasing the oxygen level inside and speeding up the process





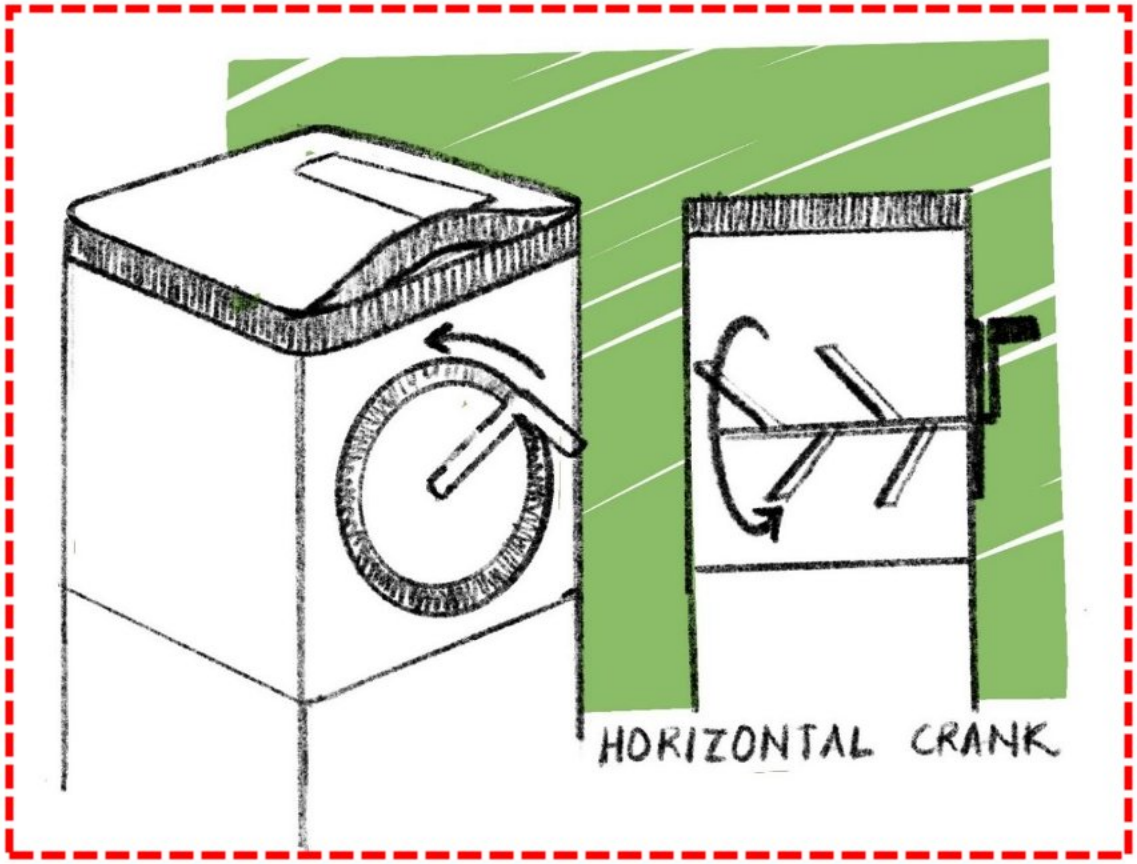


Figure 31 - ideations for crank mechanism

- Best option for uniform mixing of the microbes
- Helps in speeding up the process
- Need to be turned once in every day for 7 to 10 days
- Provided on one of the side face of the composter for easy usage

- Figure 30 - ideations for crank mechanismBest option for uniform mixing of the microbes
- Helps in speeding up the process
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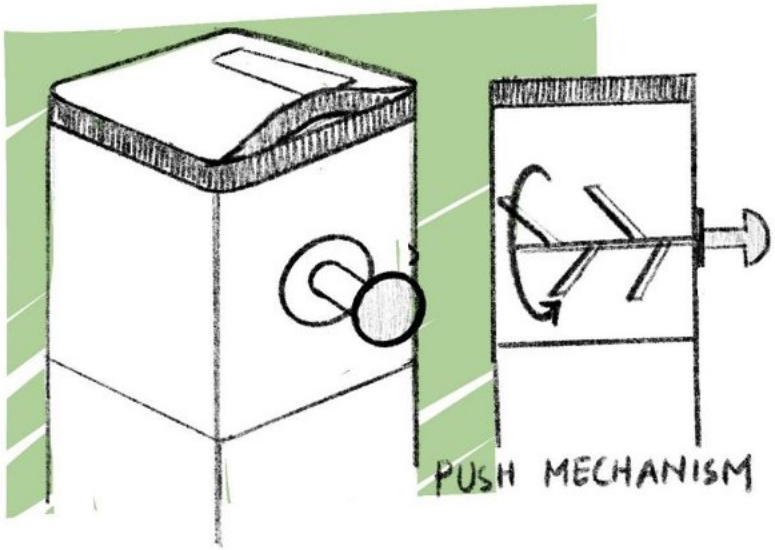
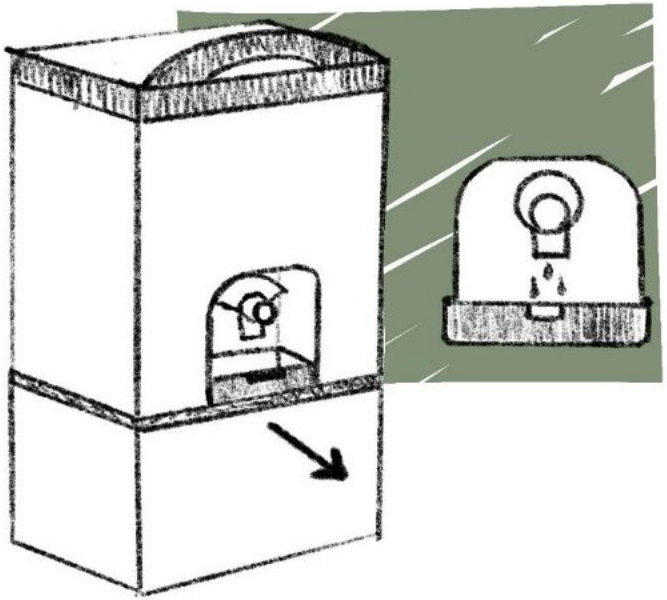


7.5 Drainpipe

- An outlet can be provided from the first chamber to remove excess water from the kitchen waste if needed
- To remove smell of compost
- To provide nutrient rich water to the garden

7.6 Slider – manual

- A slider can separate the rack 1 with rack 2 of the composter
- By manually sliding, the compost falls to rack 2 from which it can be taken out



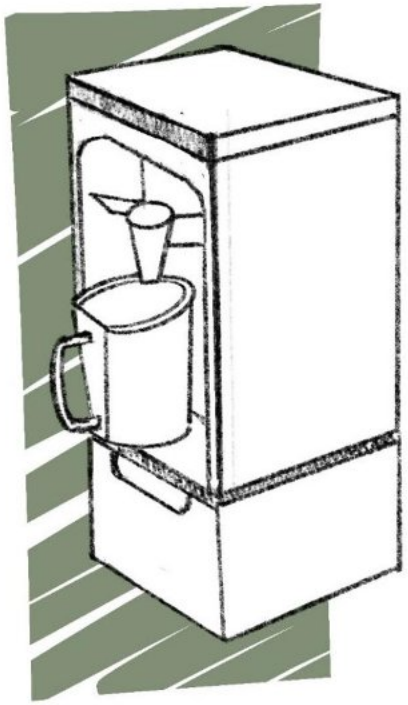


Figure 32 - ideations for drainpipe

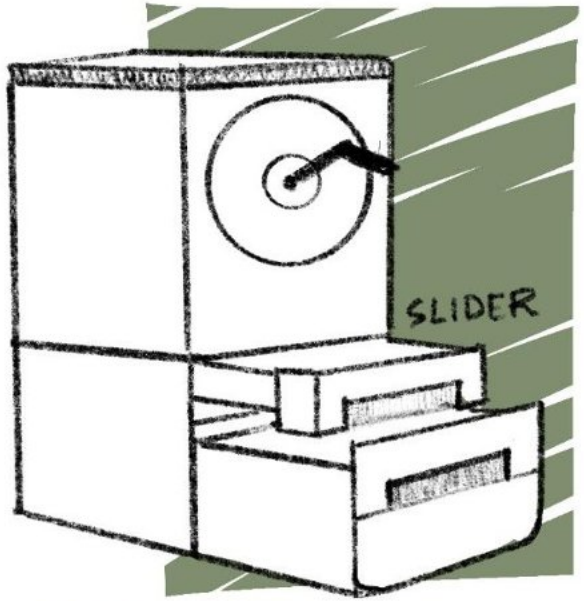


Figure 33 - ideation for slider

7.7 Maturation chamber

- Once the chamber one is filled and thoroughly mixed with microbes it can be sent to the maturation chamber to develop completely into a nutrient rich compost.

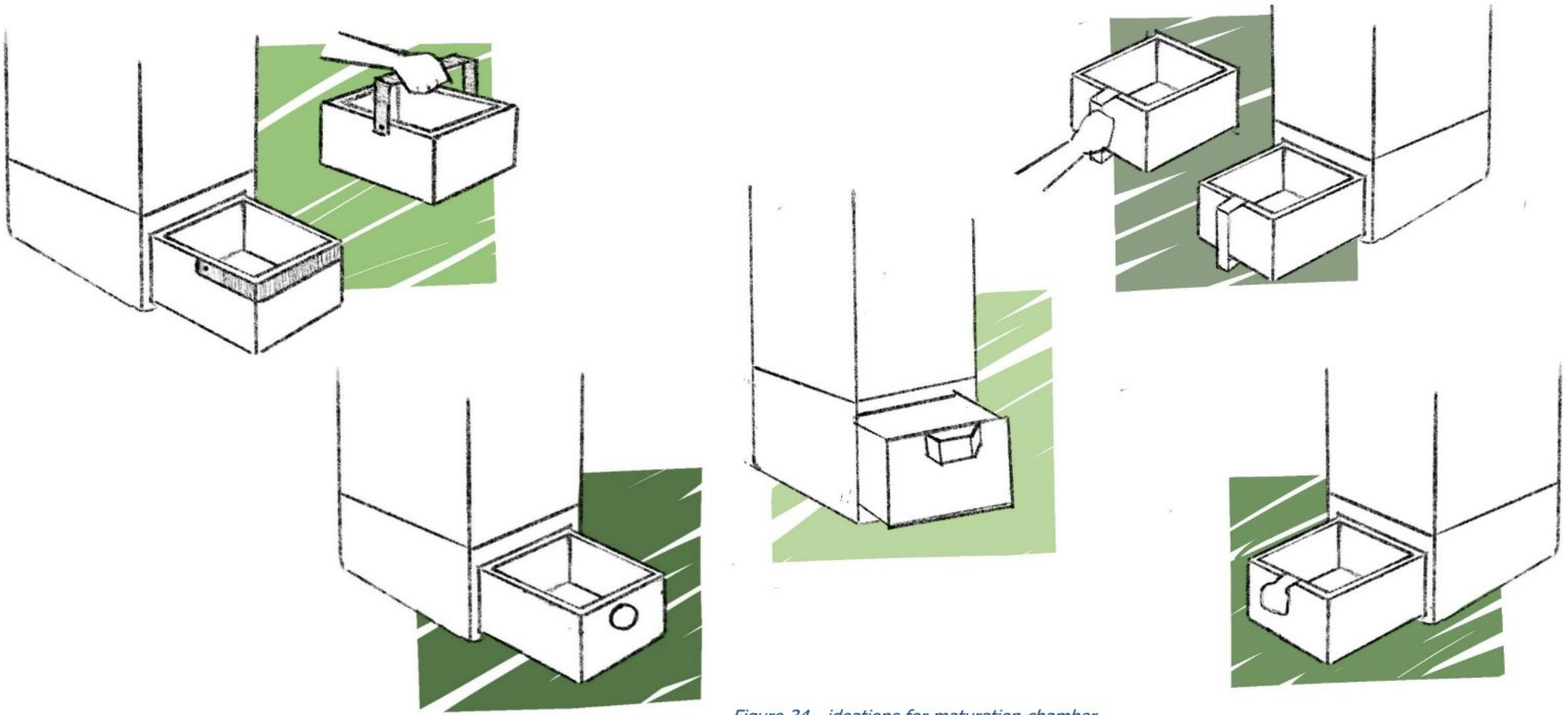


Figure 34 - ideations for maturation chamber

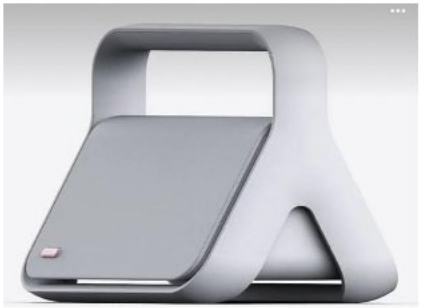
Heat produced from the compost

- Electric composters heats the scraps to a temperature of about 135 to 160 degree Fahrenheit (57 to 70 degree Celsius) which kills pathogens and weed seeds and reduces the moisture content of food which in turn will speed up the process of dehydrating
- end product from these composters when tested showed a total nitrogen level of 2.9% and a nitrate level of 0.005%.
- During composting, organic forms of nitrogen are converted to inorganic forms of nitrogen, mainly nitrate.
- These numbers confirm that composting has not yet started
- To activate compost micro-organisms to their fullest potential, temperatures must remain between 90 and 140 degrees F. (32-60 C.).
- Heat will also destroy seeds and potential weeds.
- Compost managers strive to keep the compost below about 65°C because hotter temperatures cause the beneficial microbes to die off.
- If the pile gets too hot, turning or aerating will help to dissipate the heat.
- If the pile is built correctly, it will heat up within 24 to 36 hours to the ideal temperature of 32-60 C(weed seeds and disease pathogens die at these temperatures) and will maintain its temperature for several days to a week or longer.
- Combine green nitrogen-rich materials, such as grass clipping and plant trimmings, with brown carbon-rich materials, such as dead leaves and sawdust, Use a compost thermometer to monitor the temperature.
- If temperatures rise above 160F°, the compost will become anaerobic, which means the temperature will kill the beneficial microbes that make high-quality compost.
- putting it in the sun will fasten the composting process.
- Sun helps increase the temperature, so the bacteria and fungi work faster
- Thus an extra heating mechanism is not required in the initial step as compost itself will produce heat

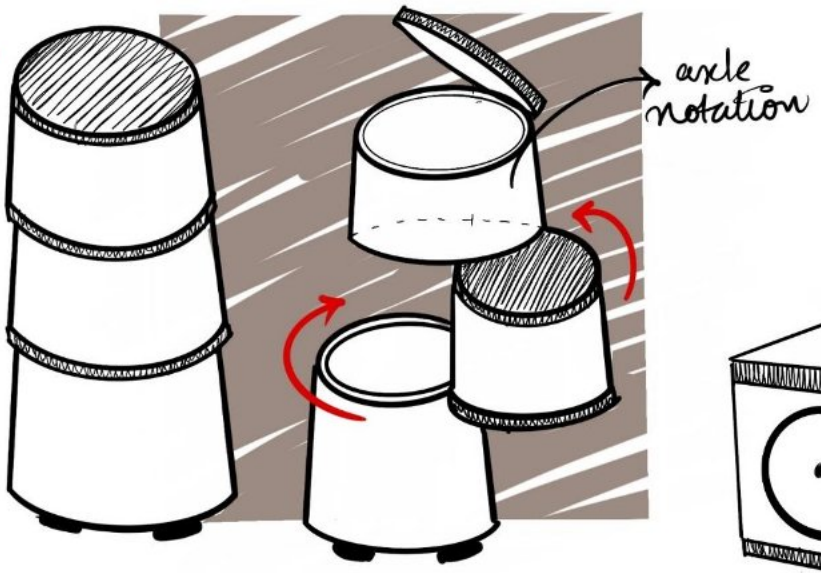
Figure 36 - proper layering of a compost

8. Mood board

- Simple
- Clean
- Minimalist



9. Initial ideas and form sketching



All the ideations have more than 2 compartments that are connected by a middle axle.

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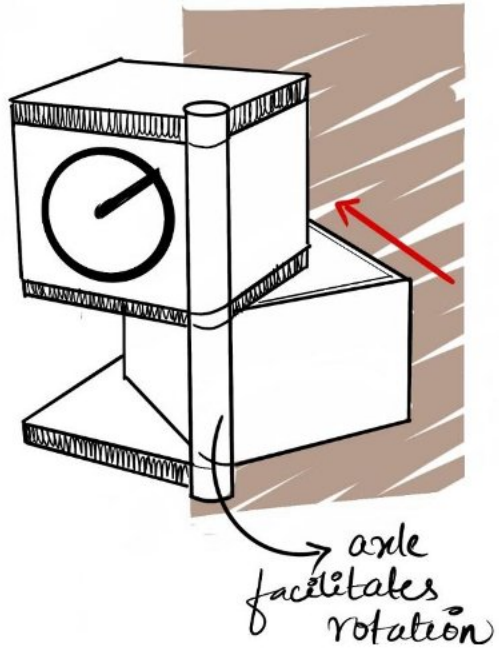
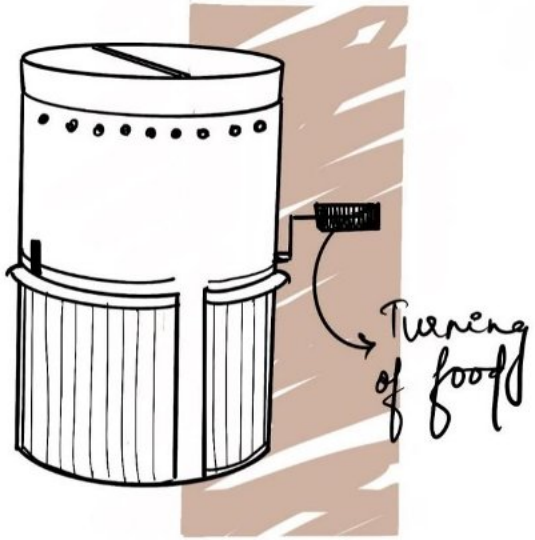
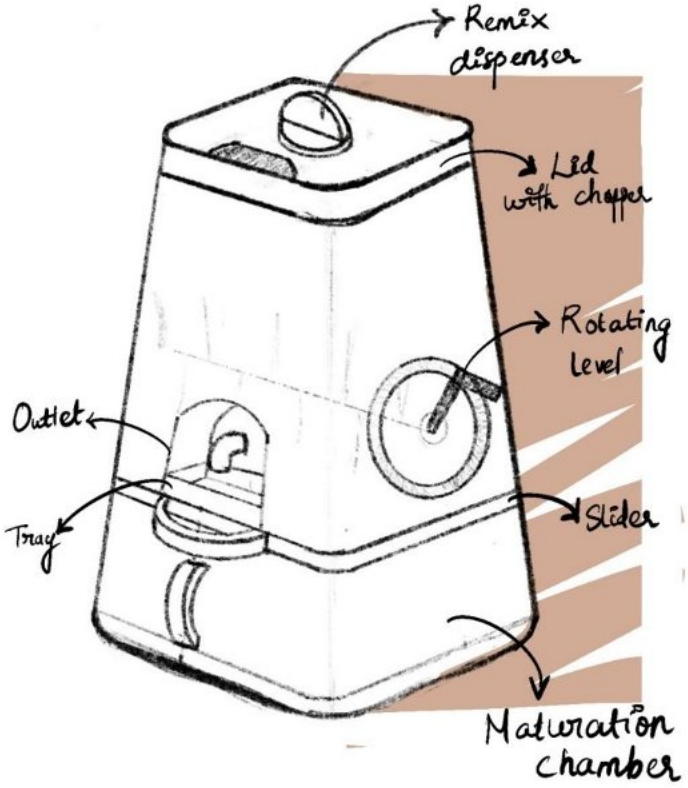
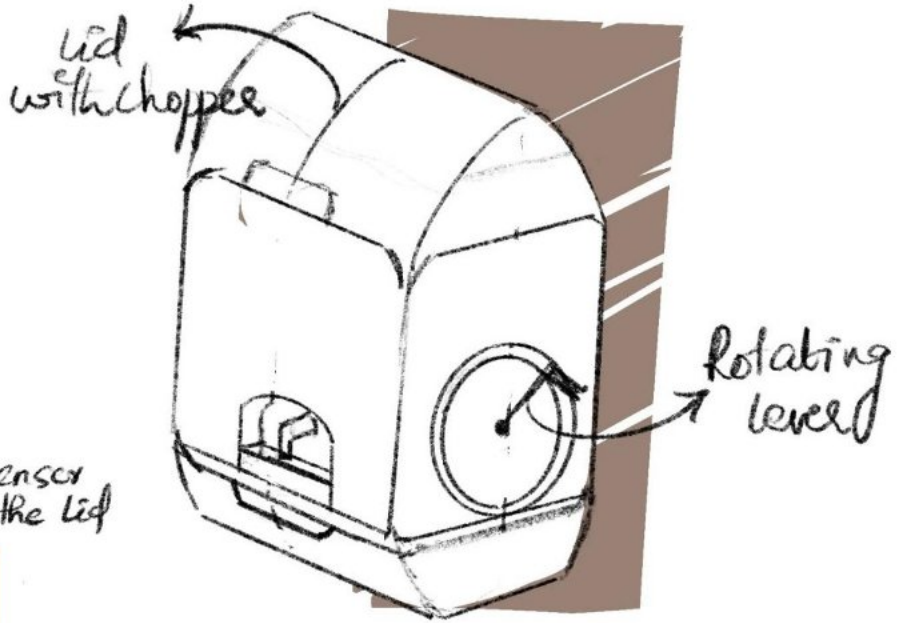
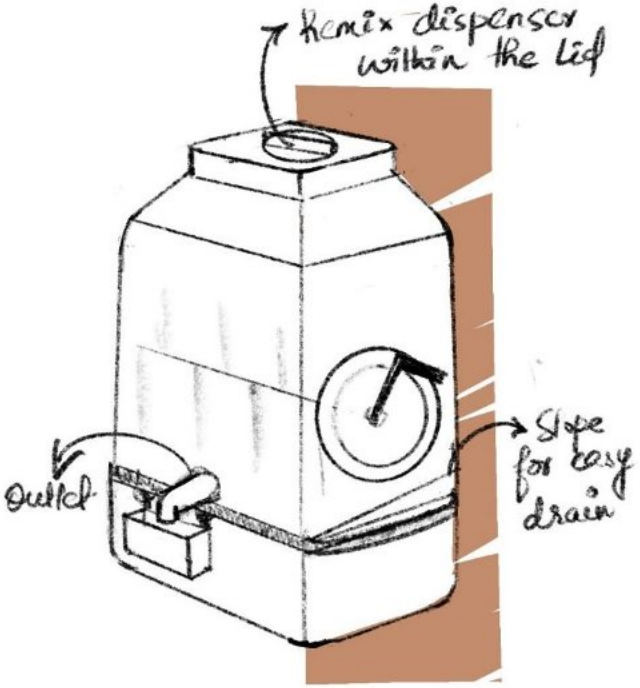
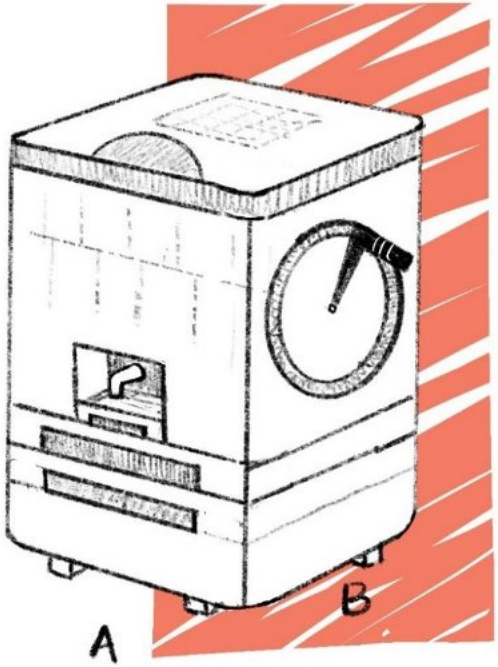





Remix dispenser
Lid with chopper
Rotating level
Outlet
Tray
Slider
Maturation chamber


Lid with chopper
Rotating lever


Remix dispenser within the lid
Outlet
Slope for easy drain



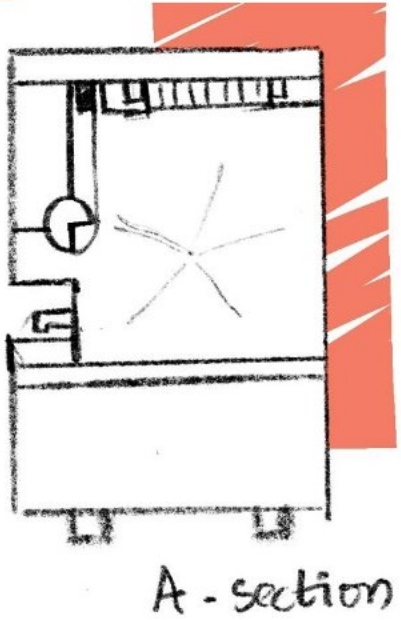
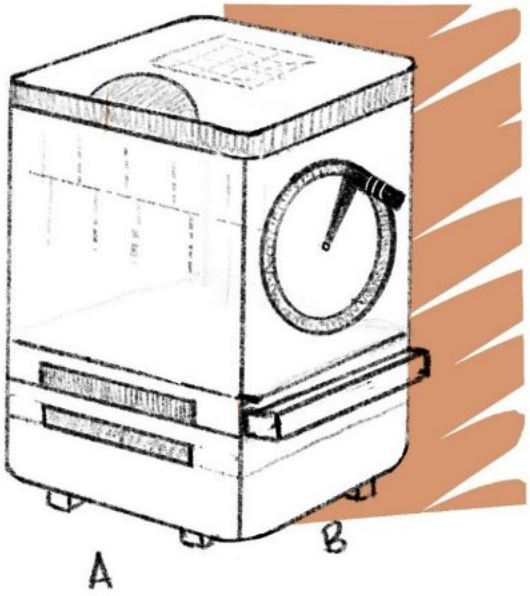
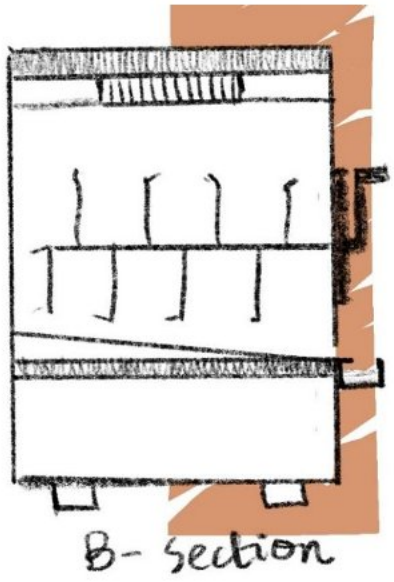


Figure 37 - initial ideations





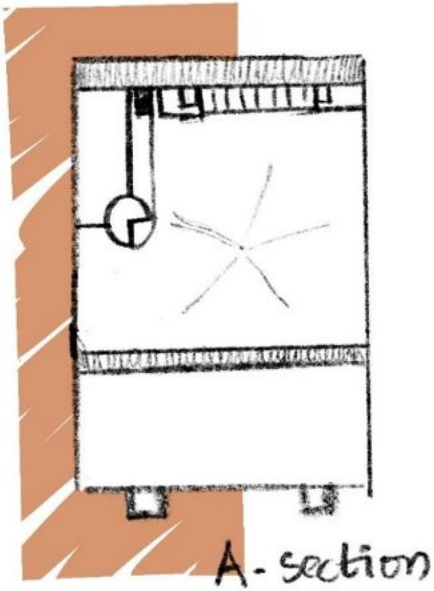
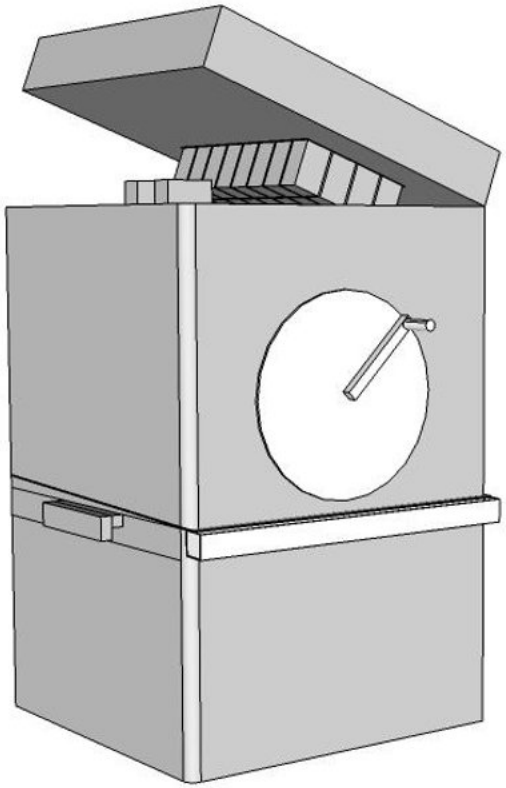
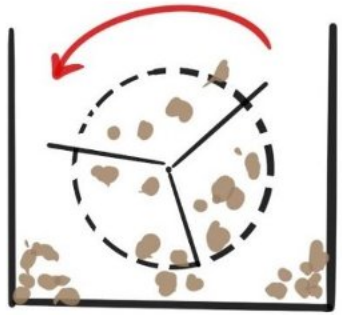
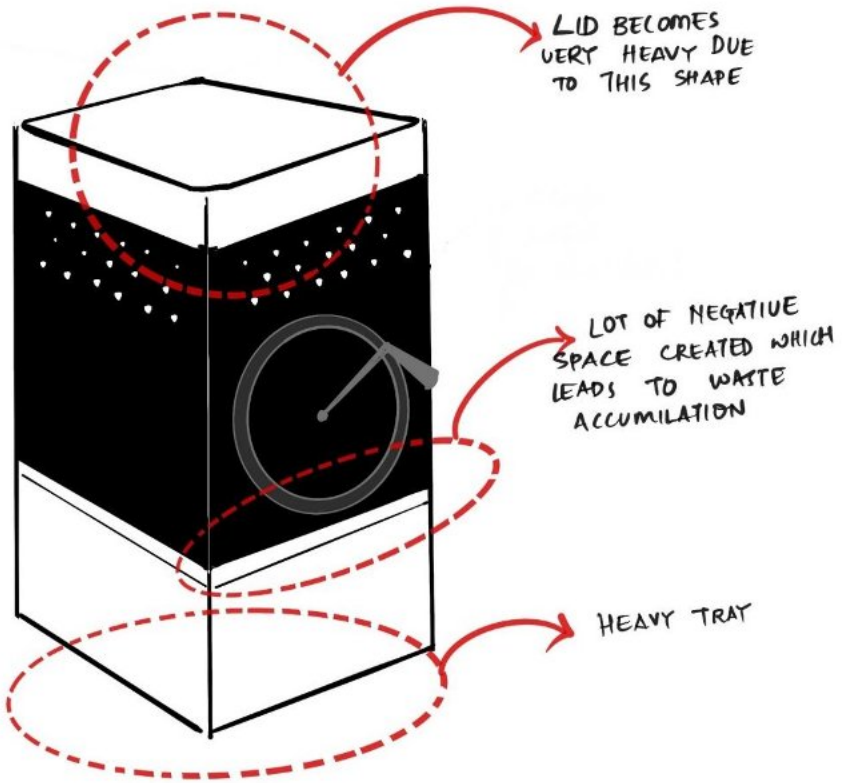


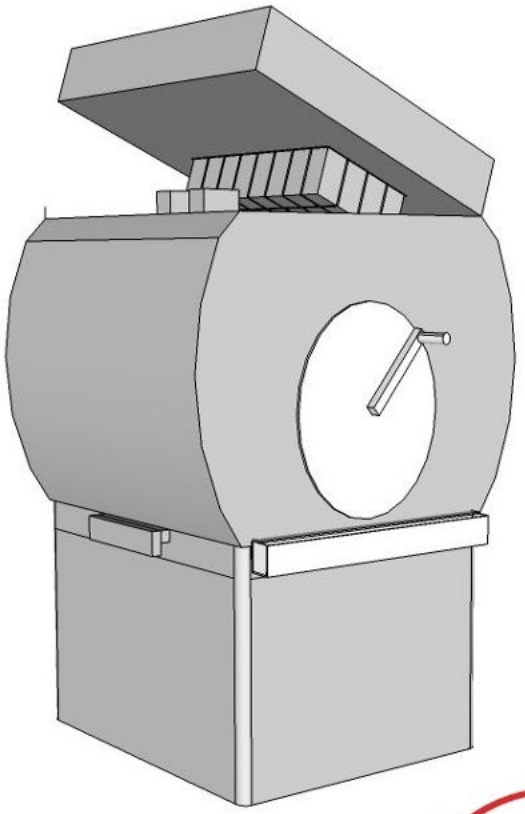
Figure 38 - initial ideations

Form Exploration

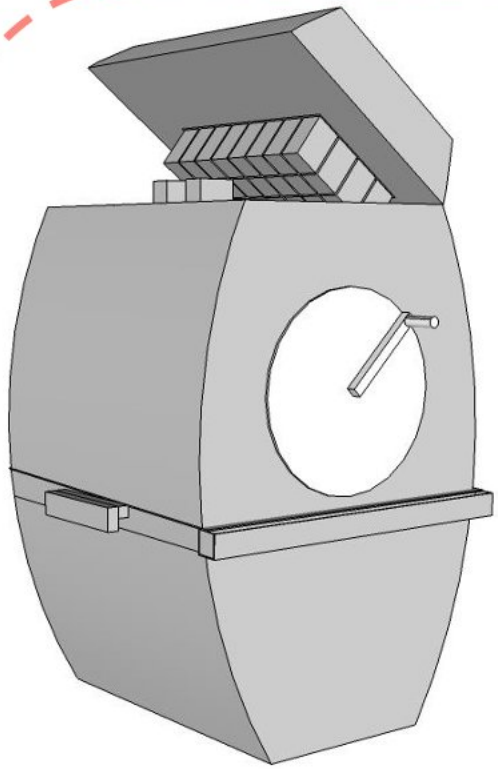




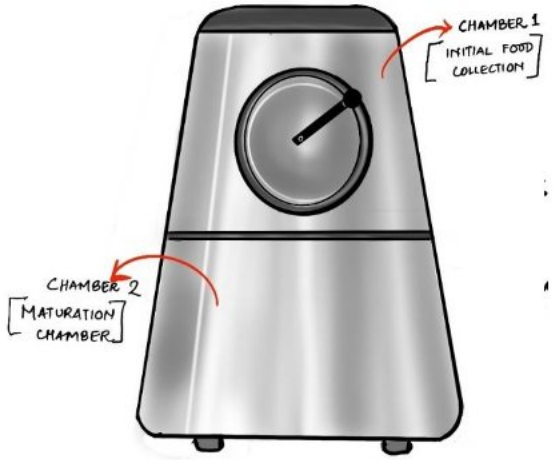


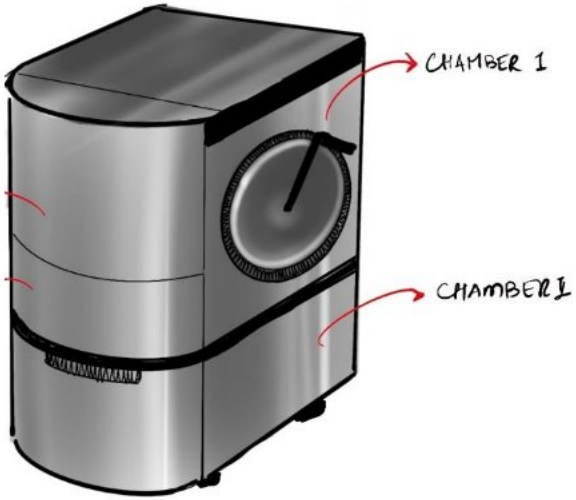


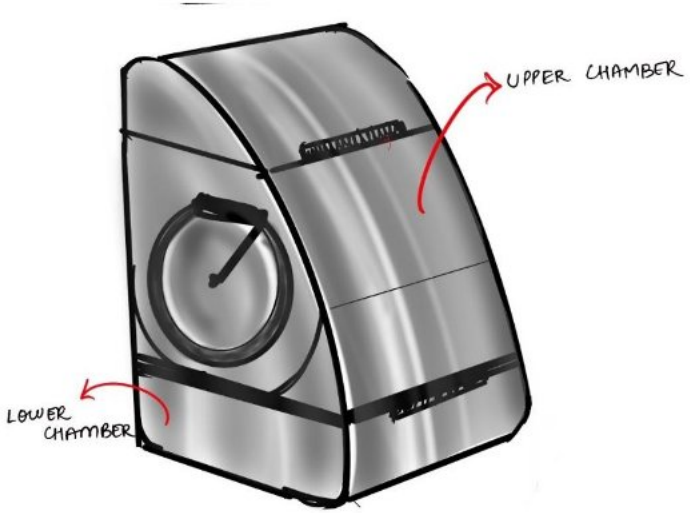
CONCEPT 1

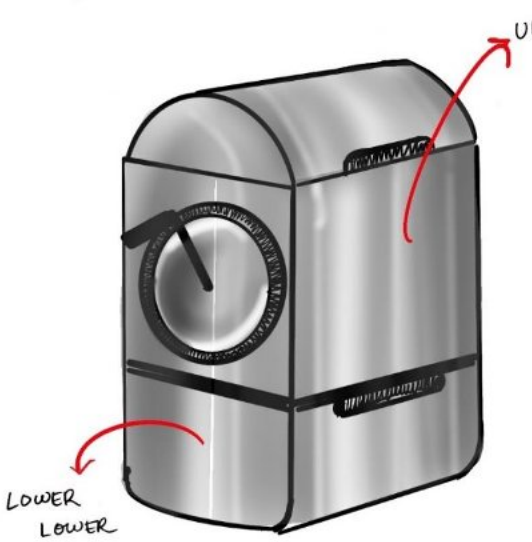


CONCEPT 2









CONCEPT 3

10. Concept- A

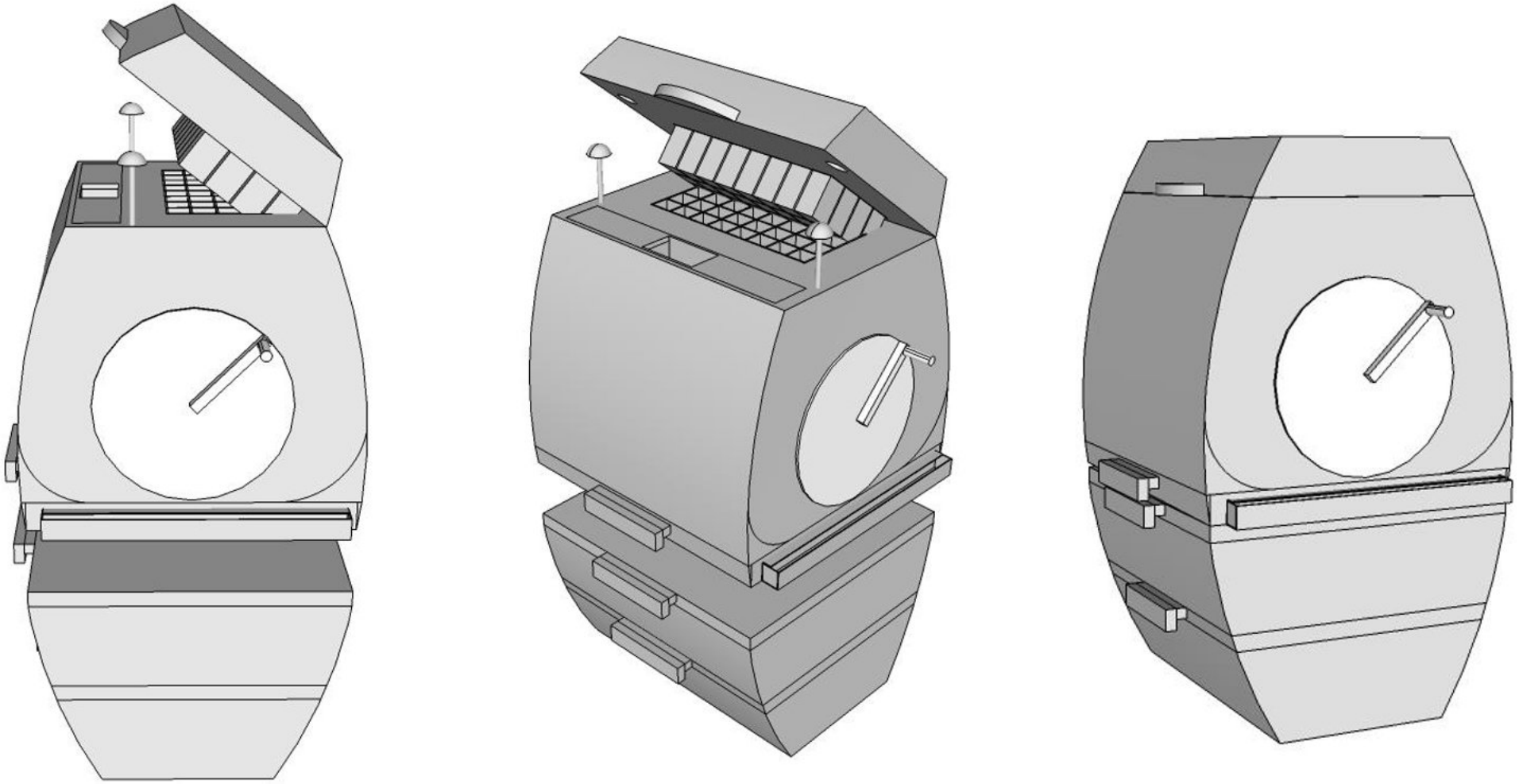
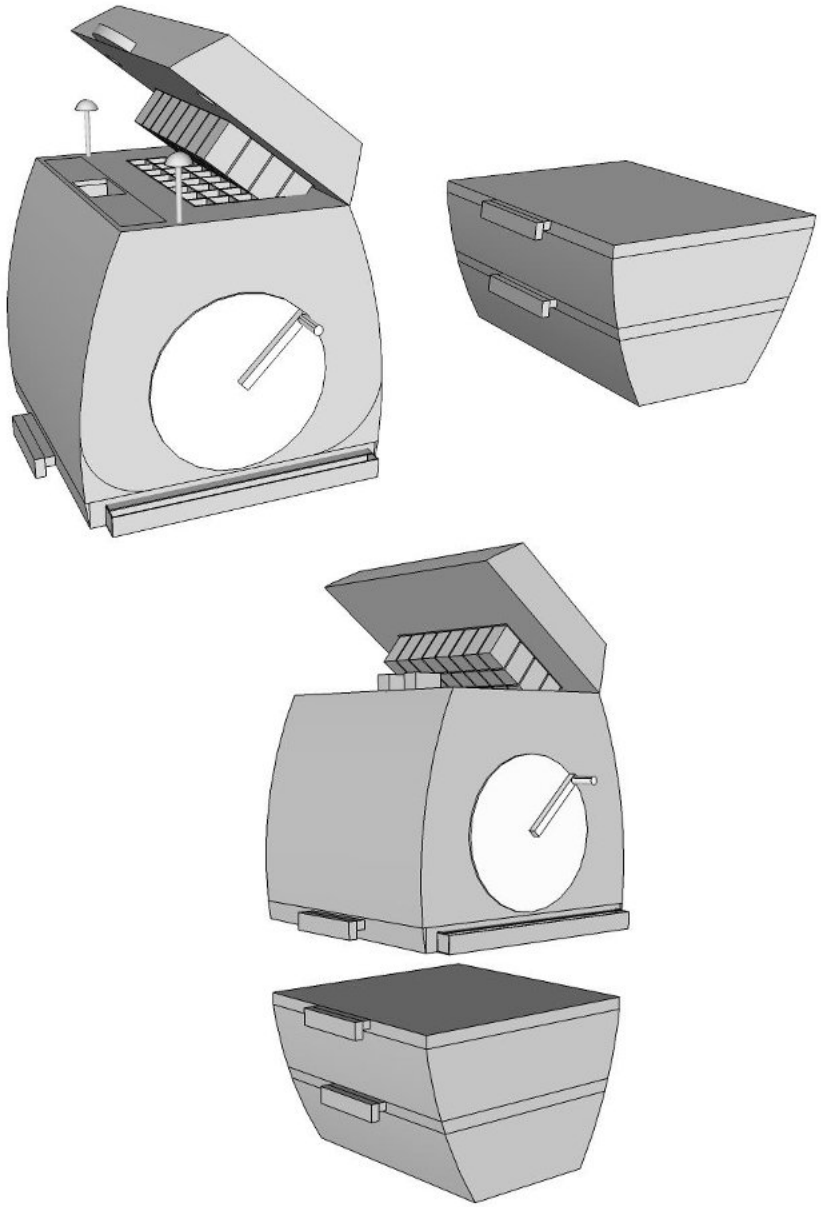


Figure 40 - concept 1

- This design based on the concept of modularity which increases the usability aspect too.
- One can use it as two separate chambers if the balcony or the work area is not nearby the kitchen.
- Chamber 1 has the following components
- Lid with chopper
- Microbe dispenser
- Rotatable lever connected to a fan
- Carbon filters to reduce the unpleasant smell coming from the chamber 1
- Perforations To ensure that methane is properly and regularly emitted out
- This module can be placed on the kitchen counter itself so that
- Reduces the effort to move to somewhere else to put the waste
- Reduces the effort of bending and rotating the lever each time one put the waste into it
- It gets heated up by itself up to a temperature of 50 to 60 degree Celsius, therefore doesn't require an extra heating element.
- When filled the module can be taken and kept over the second module and the slider can be removed so that waste now moves to the chamber 2
- Chamber 1 can now start collecting the waste of next 10 days
- The process can be repeated
- There is a 3rd chamber also so that the compost can be sent to it in cases where it needn't be used at that point of time. It can be stored till whenever needed
- The second module or chamber 3 and 2 can be made from metal as metal is found to conduct heat when kept under sunlight
- At this stage, an extra heat can be provided because the pile do not produce as much heat as produced initially and also to speed up the process



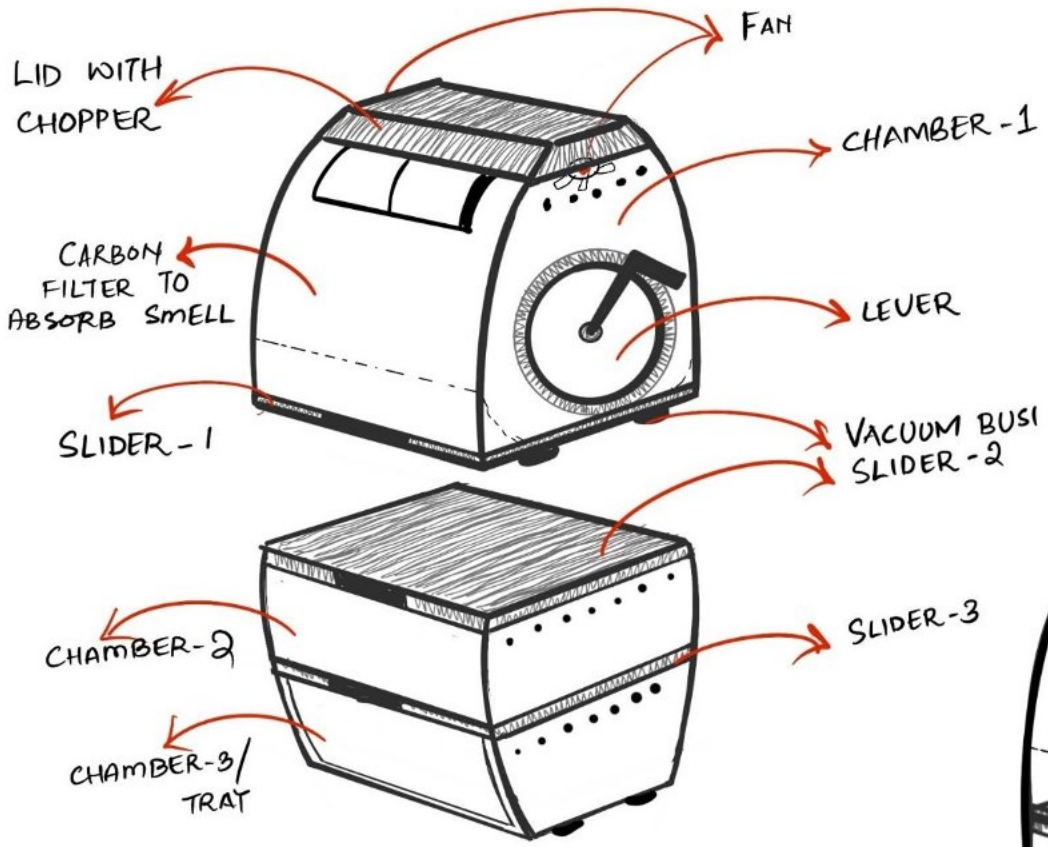
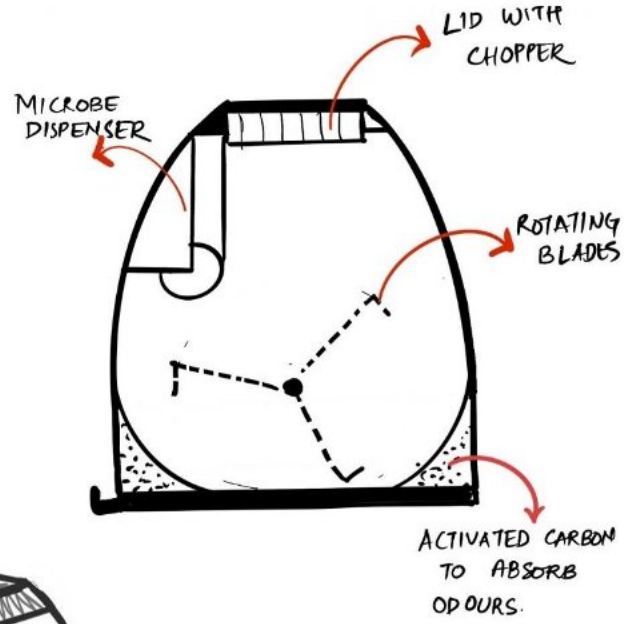
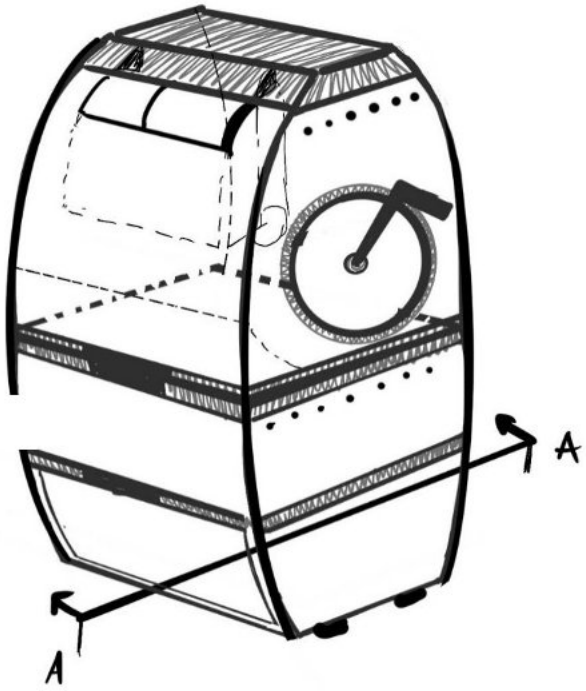


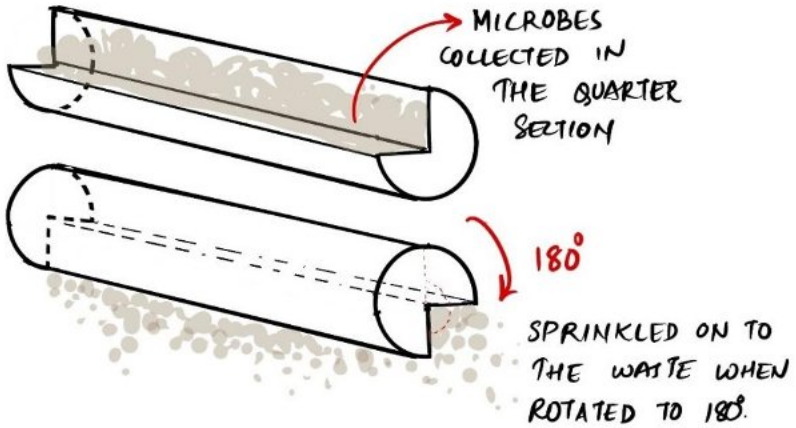
Figure 41 - details of concept 1





10. 1 Microbe dispenser mechanism

- The microbe dispenser is provided with a volume half of the volume of the waste that can be accommodated inside the composter
- On the bottom innermost corner of the dispenser, a cylinder is fitted in such a way that quarter section of it is open.
- This section takes up the microbe powder from the composter and sprinkles it to the food waste when the lid is closed.
- The cylinder is attached to rotatable gears that allows rotational motion when the lid comes in contact with the rod connecting the lid
- A spring is also equipped in the midway of the rod to store energy that makes the rod go back to its original position when the lid is open
- This is when the microbes gets filled in the circular section.
- This process continues each time one opens the compost to add food waste into it



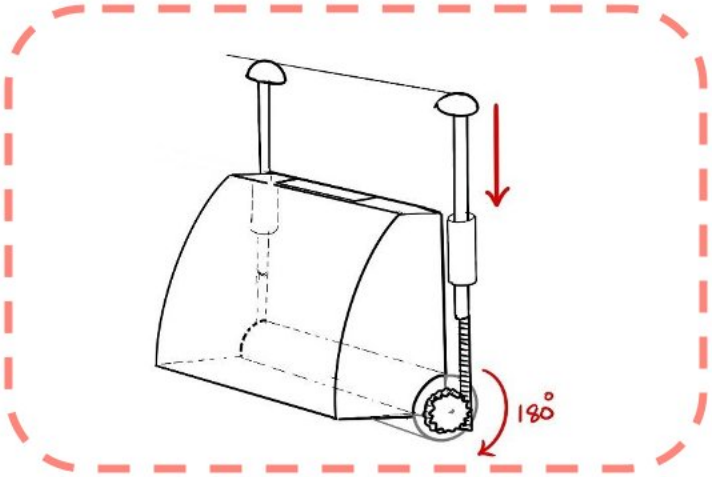
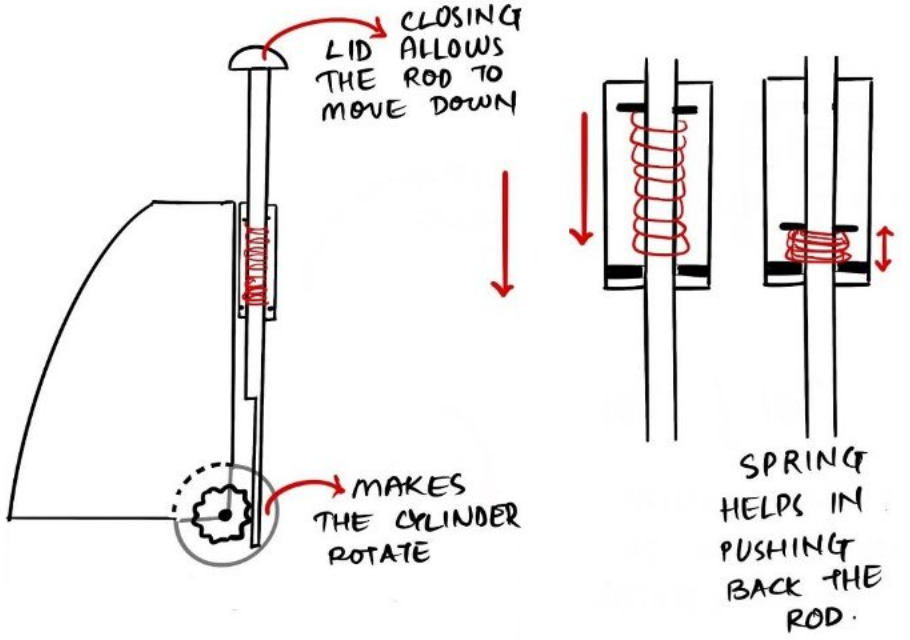
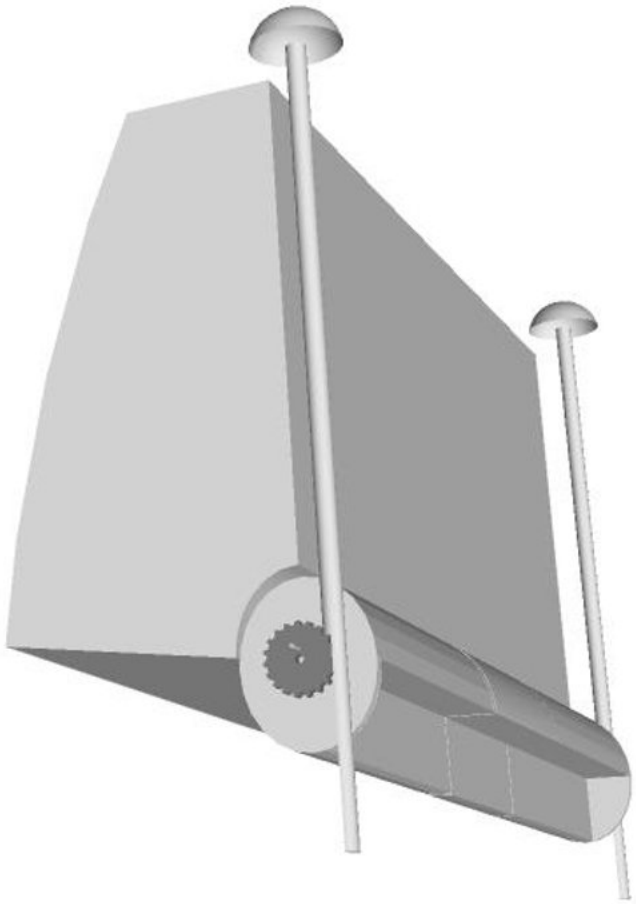
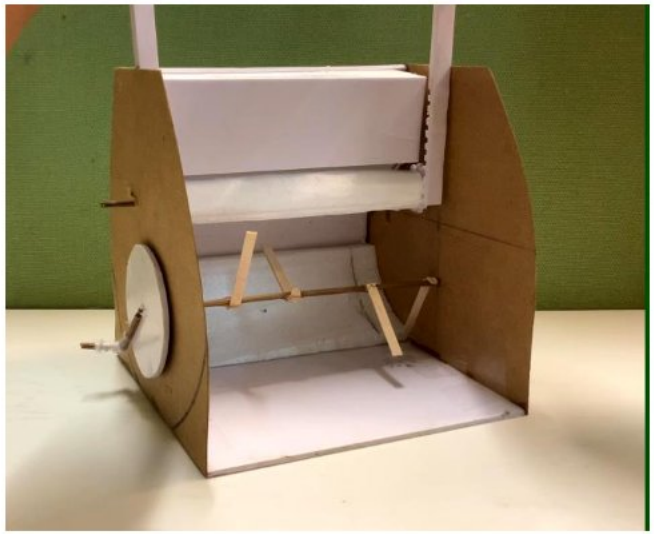
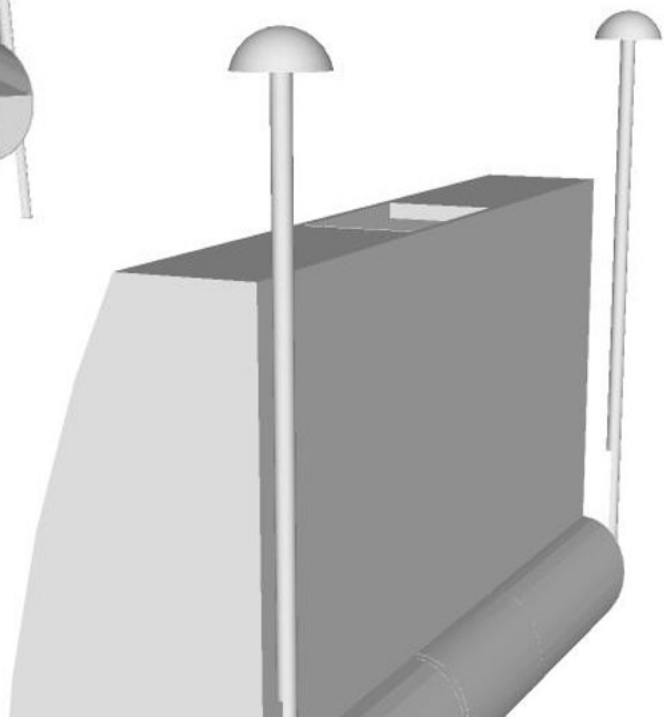


Figure 42 - dispenser mechanism







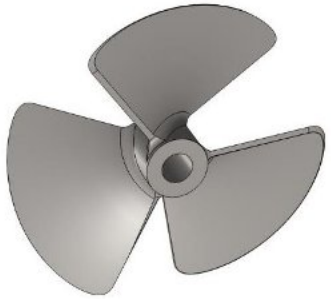


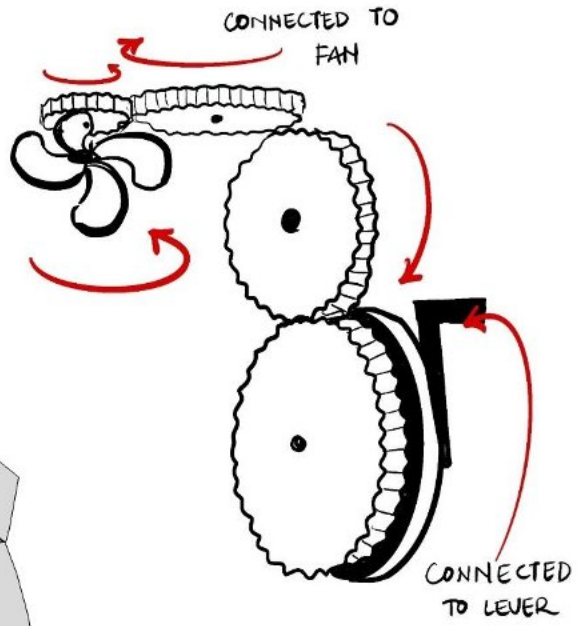
10.2 lever connected to fan to dehydrate the waste

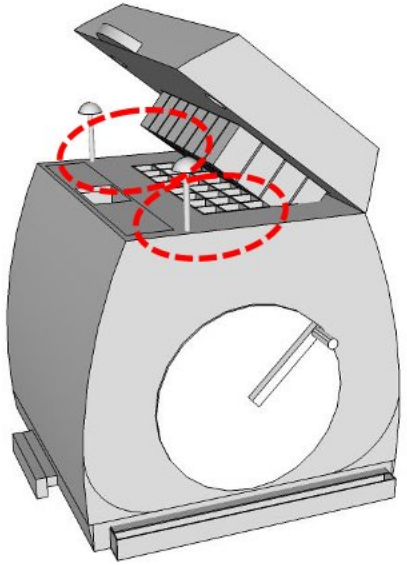
- This can work with the help of escapement mechanism.
- The escapement is driven by force from a coiled spring that is wound up due to the rotational action of the lever.
- The biggest gear and the gear that's directly connected to the lever is connected to the torsion spring as well
- More you twist the spring, the tighter it becomes, and more energy will be stored inside it.
- This mechanical energy is then slowly released when the torsion spring unwinds which makes the fan spin.
- This results in the fan to spin more even if the lever is turned very little.
- Gear train is the set of gears small and big that facilitates the movement
- The vertical rotation is converted to horizontal rotation by placing the gears perpendicular to each other at a point
- Fan with a curved blade design, the backward curved fan is one of the most efficient fan options available. It's able to move high volumes of air at high static pressures

Providing a fan helps in

- Increasing the oxygen content inside the composter
- Reduce odor by expelling air
- Reducing the moisture content inside the composter







Lever connected to fan

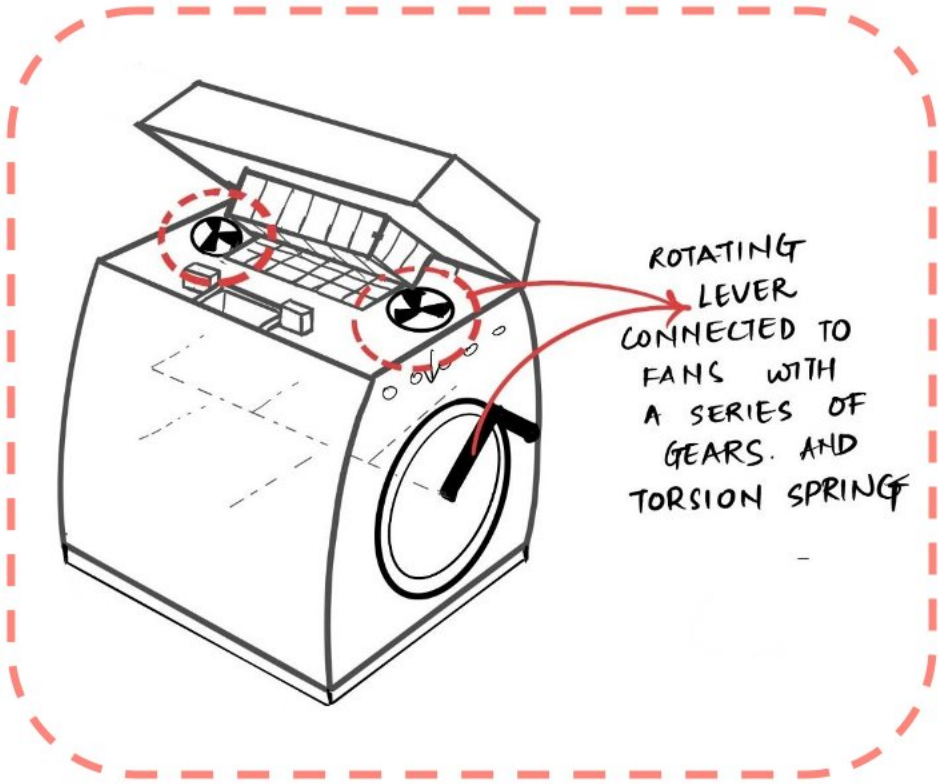
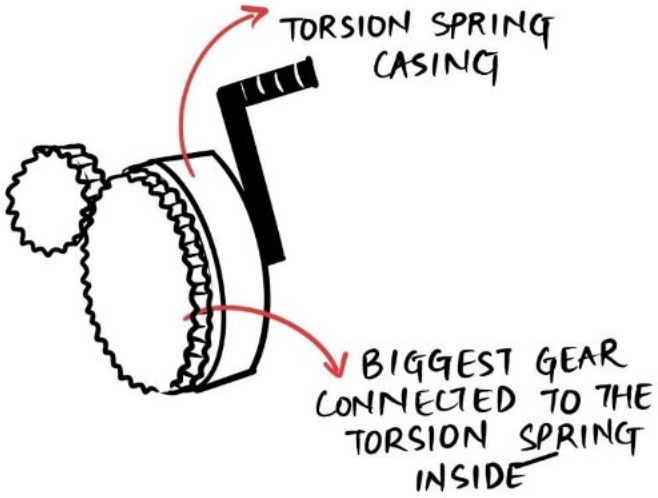
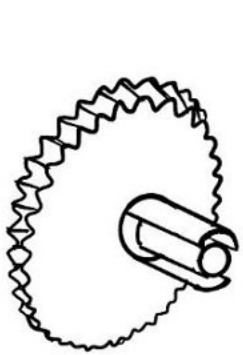


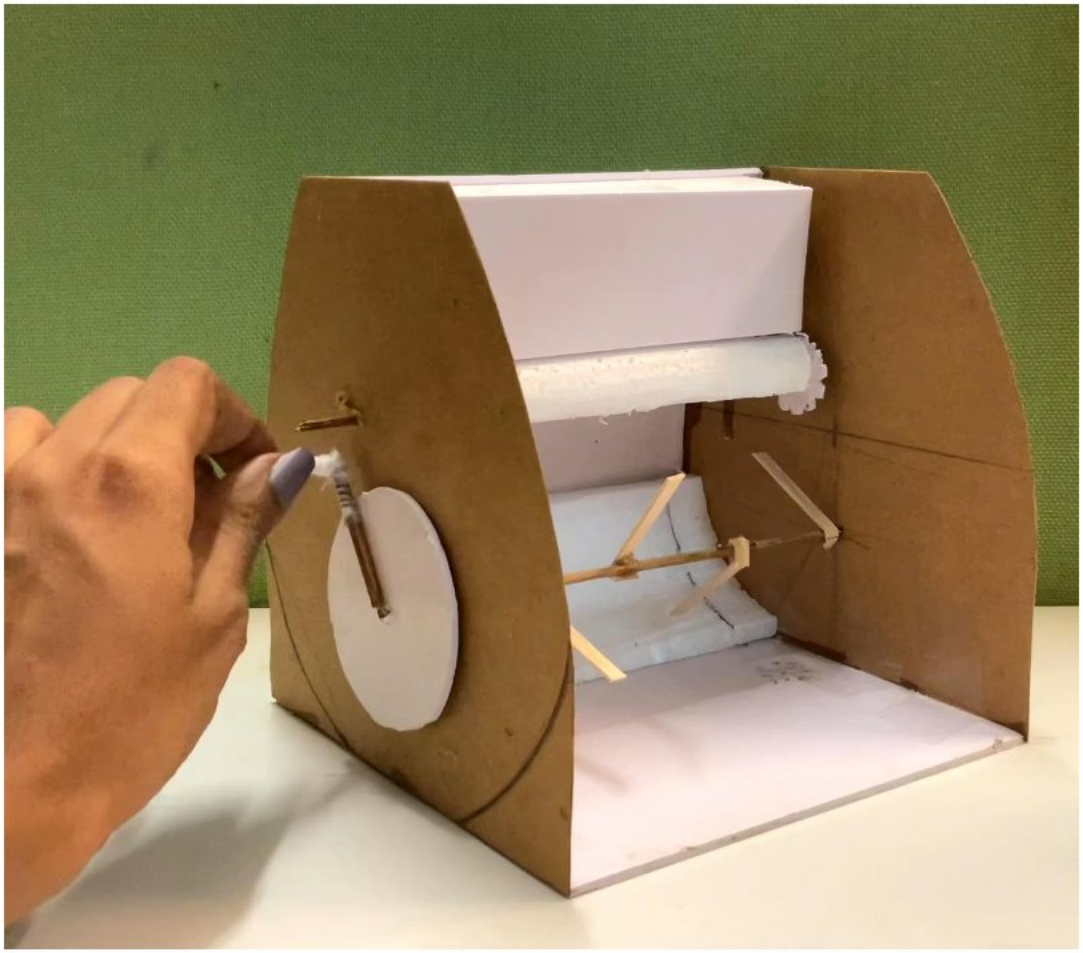
Figure 44 - fan mechanism of concept 1





Projection on the biggest gear to hold the torsion spring and twist when the spring is rotated

Twisting of torsion spring with the help of the gear



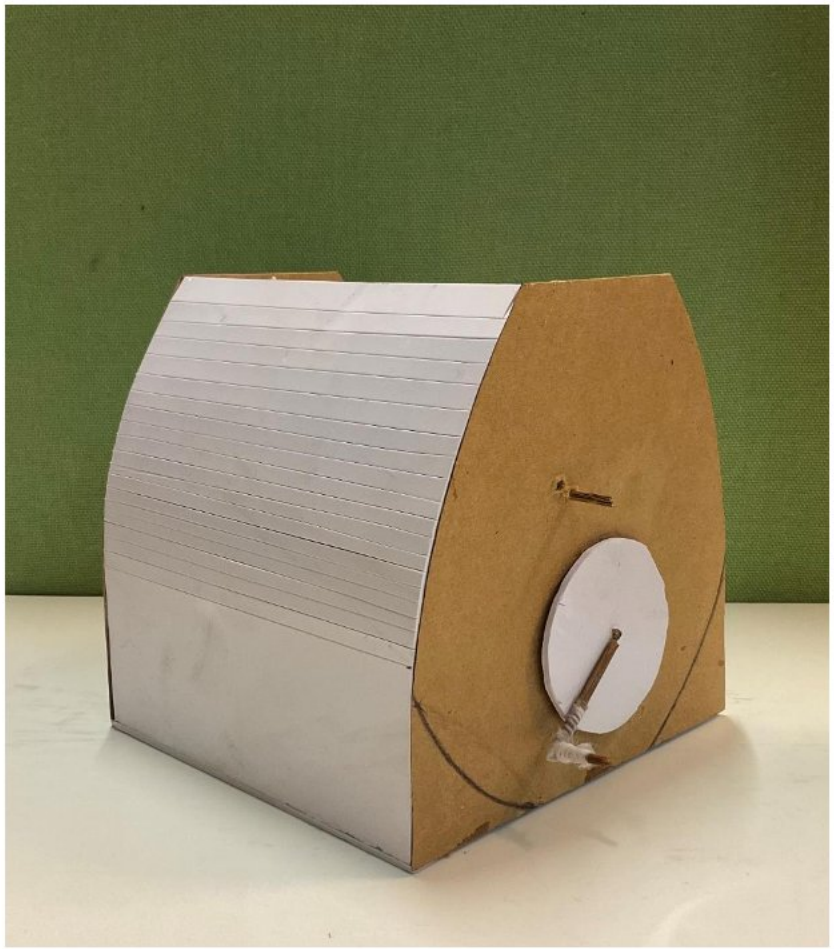


Figure 45 - mock up model of concept 1

10.3 Carbon Filter

- **Aactivated carbon,** also called activated charcoal, carbon can **help trap odors**
- **Carbon filters trap odors through a process called adsorption**, which occurs when molecules attach to the outside of a surface, rather than being soaked into it.
- The more porous the activated carbon, the better, as this will increase the amount of surface space available for contaminants to latch onto when air passes through the filter.
- Activated carbon is an effective solution to reduce odors
- It should be replaced every **3 to 6 months** depending on the usage.
- This can then be added to soil in a ratio of 1:6

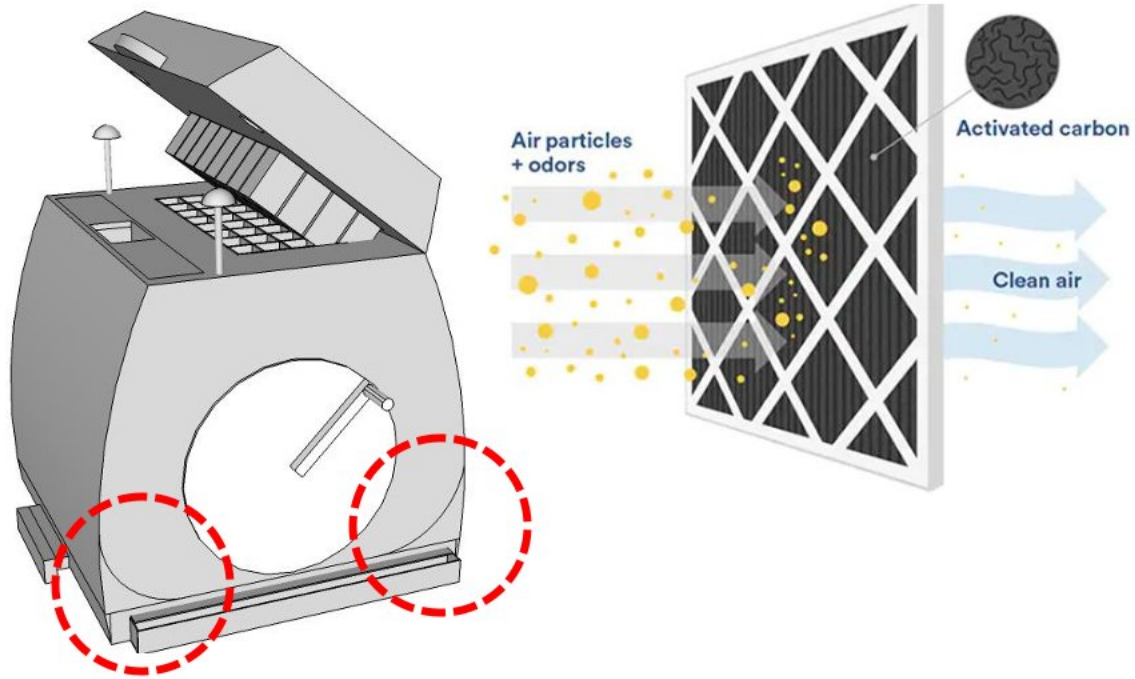
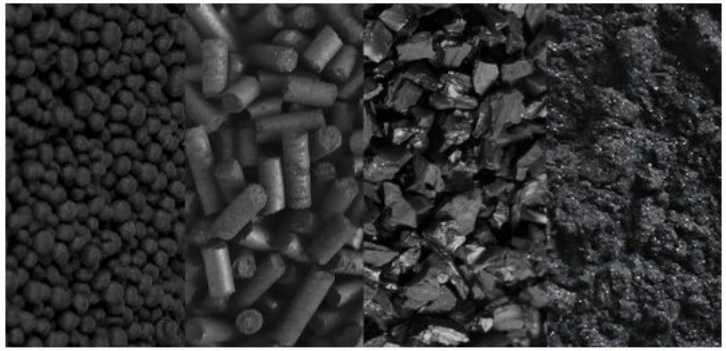
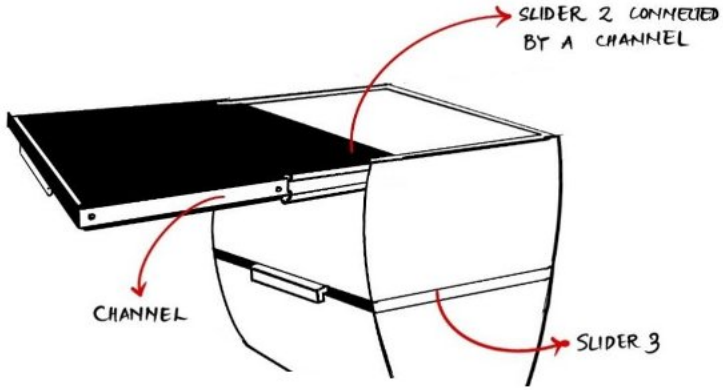


Figure 47 - positioning of carbon filter



10.4 Slider

- There are 3 sliders provided in this composter.
- Slider1 – Kept as the base for chamber 1
- Slider2 – Kept as the lid for slider 2
- Slider3 – Kept as a mid partition for the chamber 2
- All sliders are connected with channels for easy opening and closing.



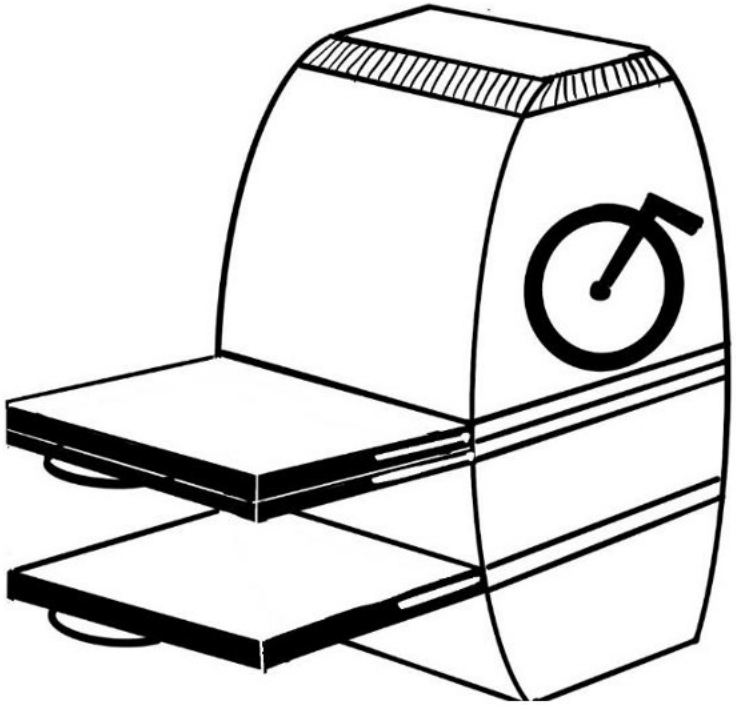
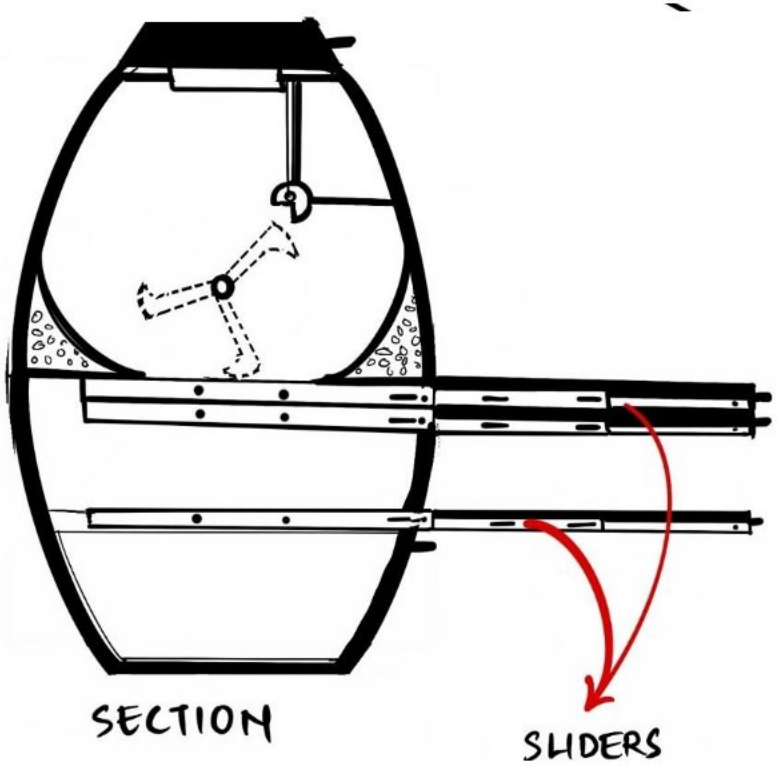


Figure 49 - slider detail



10.5 Material used

Body - metal (Steel)
Handles, chopper, slider - Polypropylene
Manufacturing process
metal sheet forming (roll forming), bending and spot welding
Injection Moulding
Body - metal (Stainless Steel)
It is a small scale production that comes under MSME (The Ministry of Micro, Small and Medium Enterprises is the ministry in the Government of India. It is the apex executive body for the formulation and administration of rules, regulations and laws relating to micro, small and medium enterprises in India)

- Stainless steel is heavier and stronger than aluminum.
- Aluminum is a more costly than stainless steel if you look at price based on weight.
- Stainless steel is highly corrosion resistant and does not easily rust.

Roll Forming
Roll forming is a continuous process which converts sheet metal into an engineered shape mainly larger radius bends using consecutive sets of mated rolls, each of which makes only incremental changes in the form.
Bending
Bending is the process of curving a steel member to a specified radius and arc length. Bending is commonly used to describe the process for a tighter radius bend, whereas rolling is used to describe a larger radius bend.
Spot welding
Spot welding can be used almost universally for different types of metal materials. Specifically, low carbon steel or mild steel is often spot welded
Finally, it is powder coated
Powder coating is a technique mainly used to apply decorative and protective finishes through a process that electrostatically charges the powder consisting of a mixture of finely milled resin and pigment, spraying it, and then fusing it into a smooth coating in a curing oven.

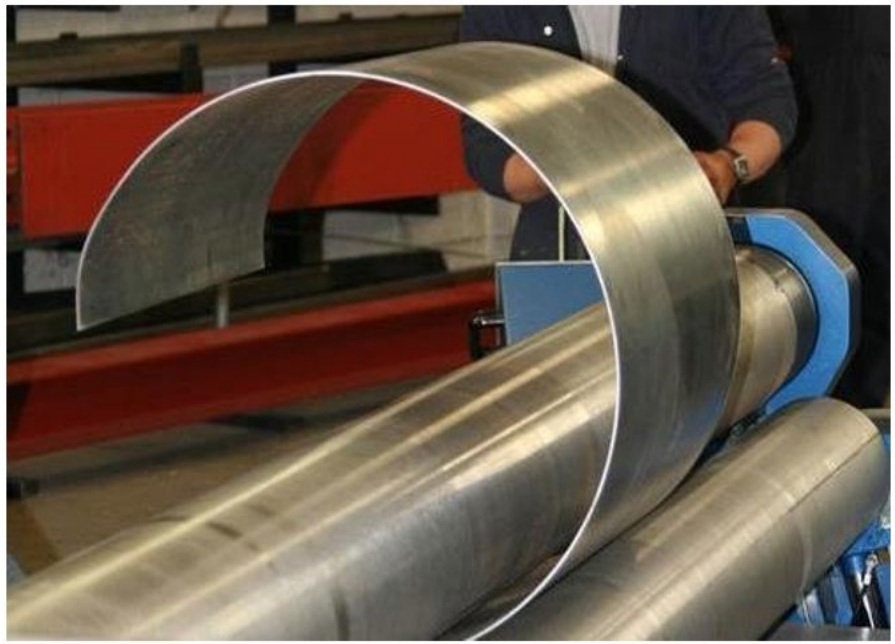


Figure 51 - stainless steel roll forming, ss product

Body - metal (Steel)
Handles, chopper, slider - Polypropylene

Manufacturing process

Steel - metal sheet forming (roll forming), bending and spot welding
Polypropylene - Injection Moulding
Handles, chopper, slider – Polypropylene

- It is a relatively **inexpensive material.**
- It, so it won't break down easily
- It's resistant to cracking and stress, even when flexed, **doesn't react with water, detergents, acids, or bases** so it's used in lots of hinges
- It's quite **durable, so it withstands daily wear and tear**.

Injection moulding

Since plastic products created using **injection moulding are generally smaller and more intricate** than those created by rotomoulding, there is naturally a higher investment of time and labor involved in creating them, which can ultimately increase **the cost.**

Thus only few parts are made out of poly propylene

Figure 52 - polypropylene products

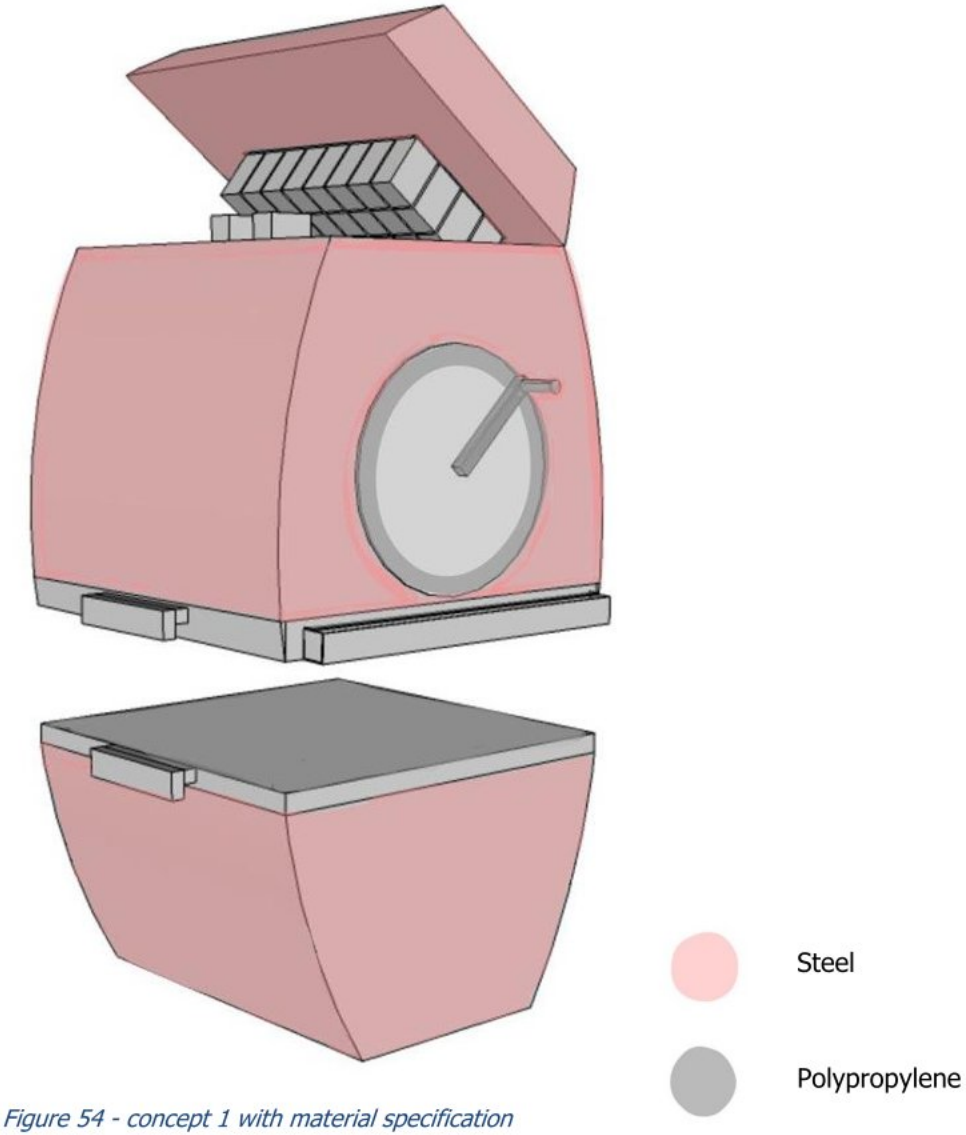


Figure 54 - concept 1 with material specification

Materials used for each parts

- Body – Stainless steel
- Chopper protrusion – PP
- Blades – SS
- Dispenser – PP
- Gears – Nylon - it is used as a gear material in order to reduce the noise of a metal gear train or to reduce vibration, smooh movement, less heavy
- Rotating lever – PP
- Rotating blades – SS
- Channel – SS
- Slider plate – PP

Bill of Materials

- Stainless steel - 316 LSS – 210 rs per kg - 50 to 200 cm width, 100 to 600 cm length
- PP pellets – 50 to 90 rs per kg
- Nylon 66 – 200 rs per kg
- Rotating lever – PP
- Rotating blades – SS
- Channel – SS
- Slider plate – PP

10.6 Volume and dimension

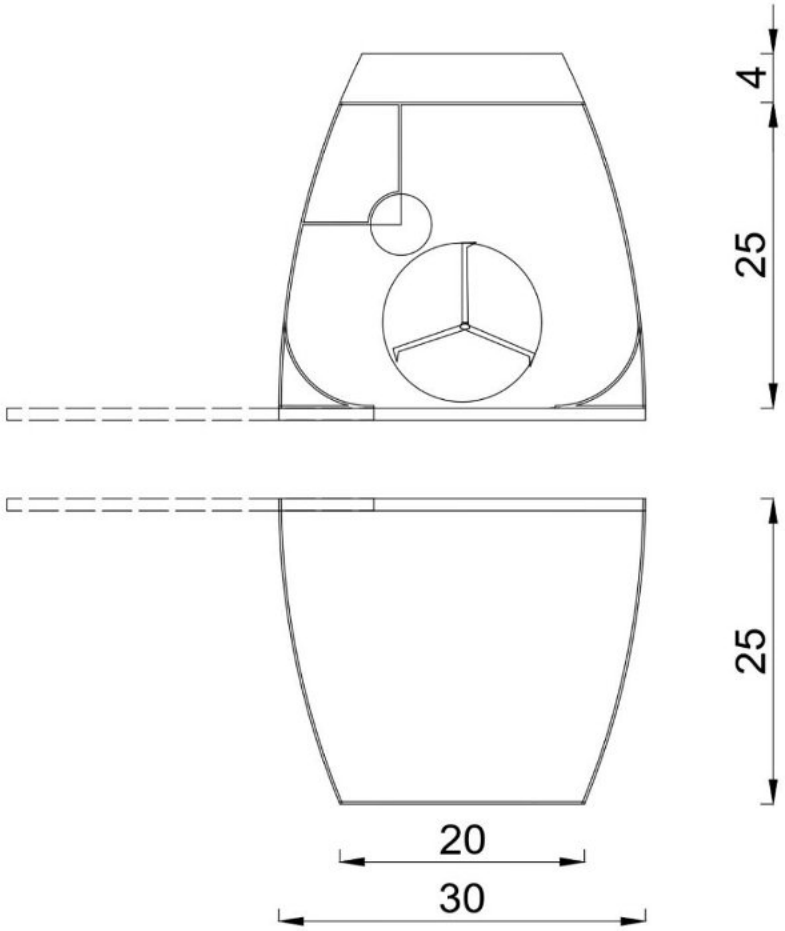
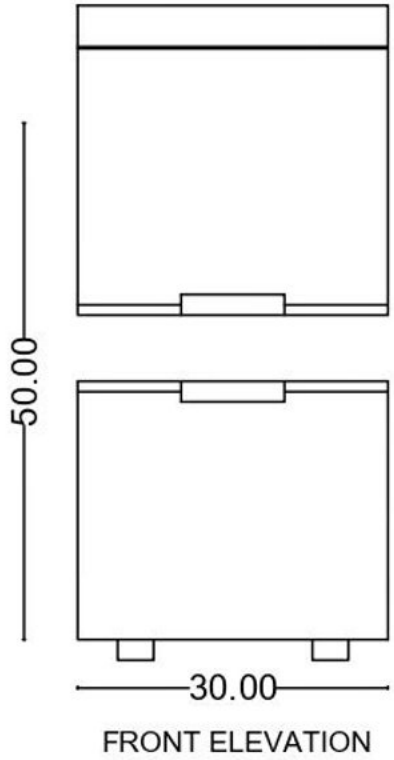
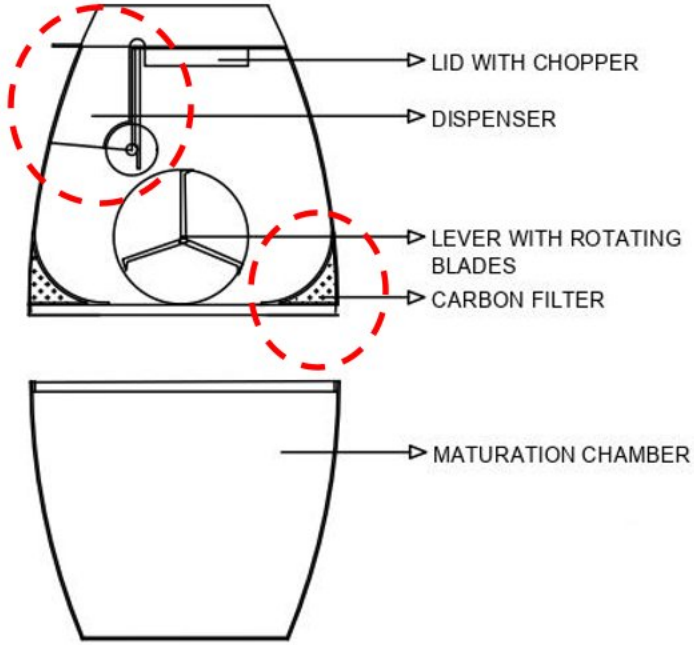


Figure 55 - dimension drawing

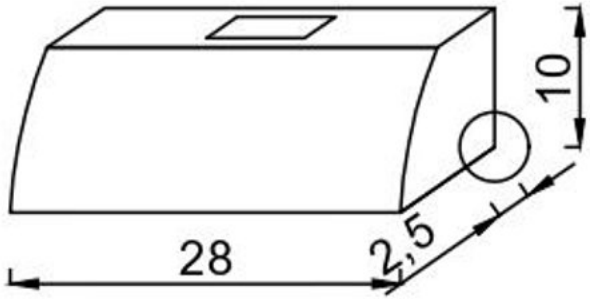
- **Volume of the chamber 1 = 25x30x30 = 22500cm cube**
- This space can accommodate **22.5kg of waste**
- For oxygen to easily pass through the chamber and speed up the process, only **half** the chamber is filled
- Thus it can accommodate **11 kg** of food waste
- 11kg is the approximate food waste produces by a family of **4 members in 10 to 11 days.**
- For 11 kg of waste **5.5kg** (5500cm cube) must be the quantity of **remix powder** that is to be added
- One day it requires 0.5 kg of remix, if its spread in 4 turns, then each turn should give 0.125 kg of remix.
- Volume of remix chamber = 1820 cm cube 28x10x6.5, ie 1.8 kg
- Thus volume of the cylinder = 3.14x2.5.x2.5x28= 549 cm cube/4 = 137 cm cube or 0.137 kg
- After every 11 days the waste is sent to the maturation chamber
- The final compost will have a volume just the **half o**f the initial food waste
- Volume of chamber 2 = volume of waste + volume of remix powder = 11kg + 5.5 kg = 16.5 kg
- 25x28x28 = 19600 cm cube = **19.6 kg**



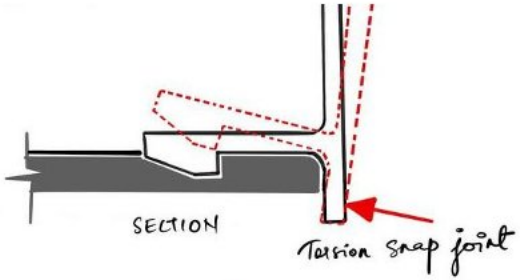
FRONT ELEVATION

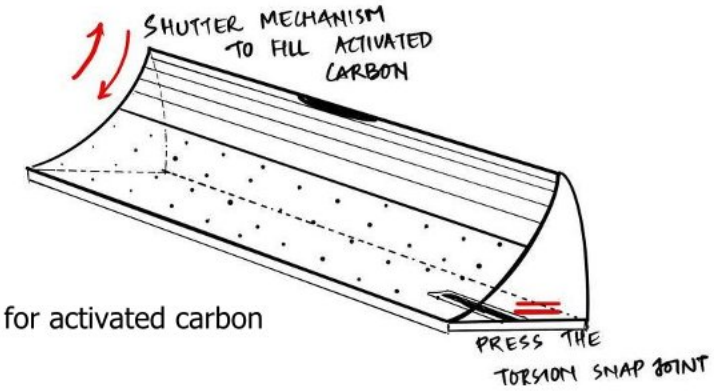


SECTION

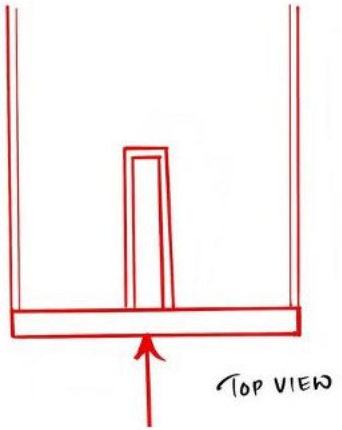


Microbe powder dispenser





Torsion snap joint for activated carbon



10.7 Mock up exploration

Figure 58 - mockup model of concept

11. Concept- B

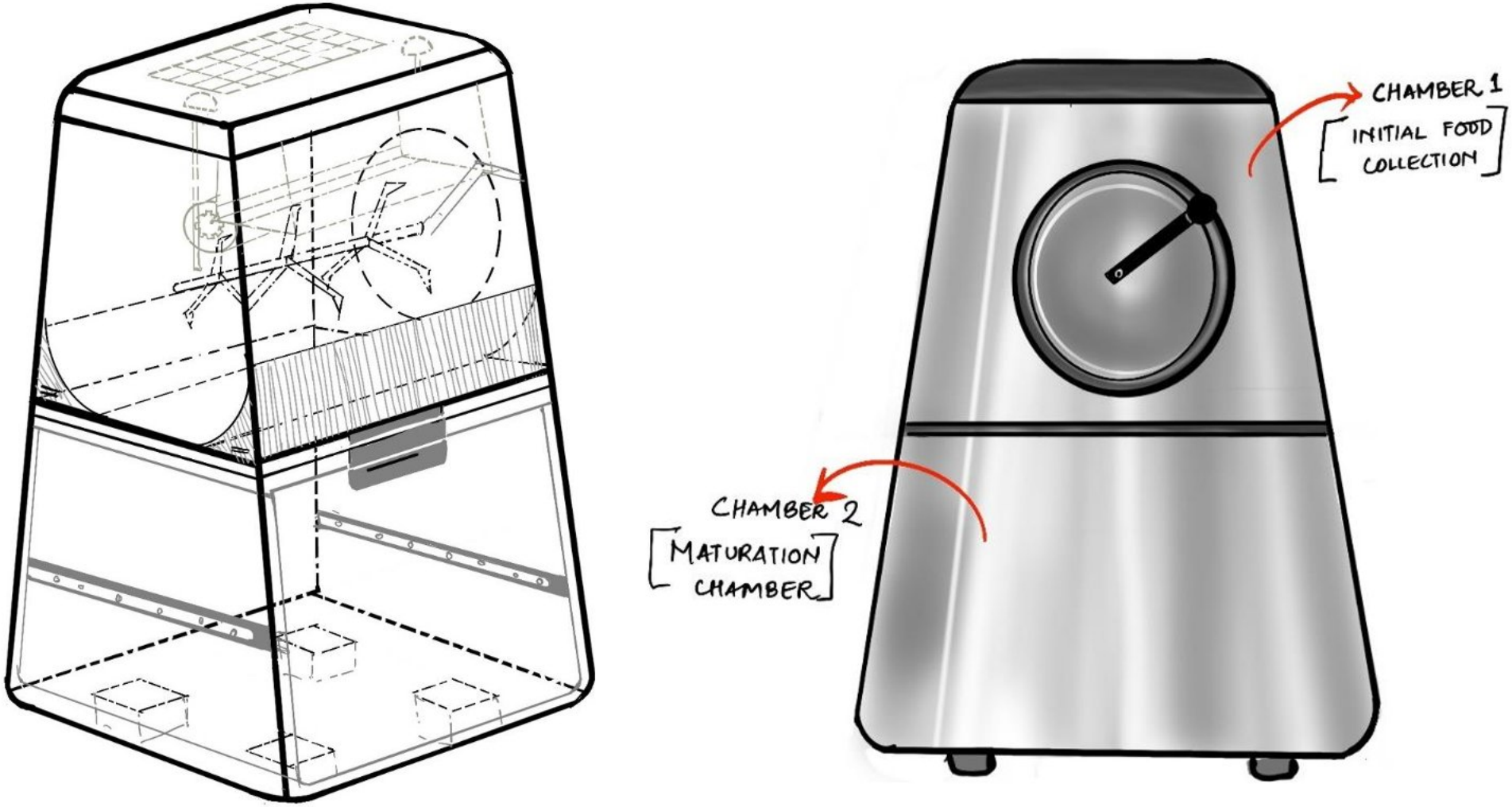


Figure 59 - concept b

- The form of this concept was made in such a way that it can be easily fabricated
- It can be roll formed, bent and welded.

11.1 Dimension Drawings

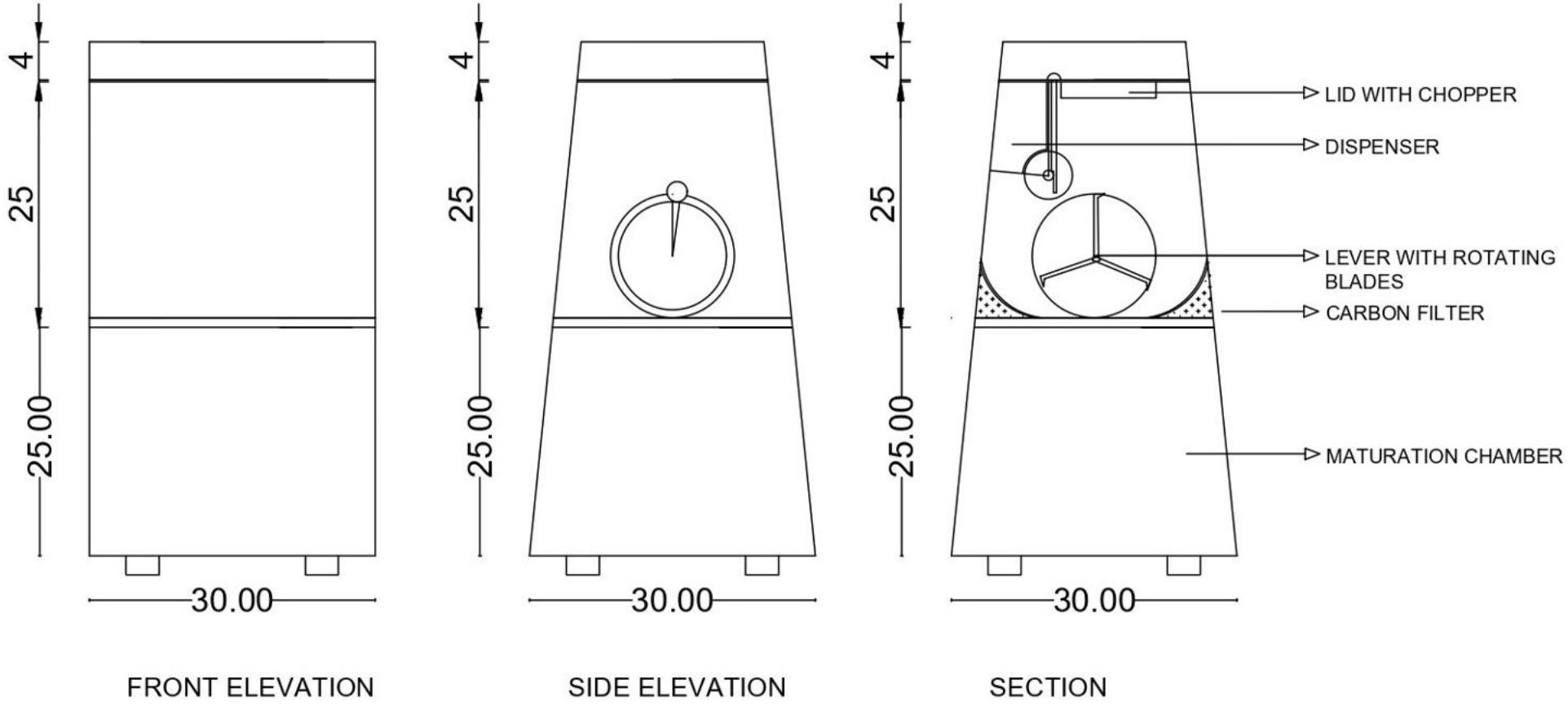


Figure 60 - concept B dimension drawing

11.2 3D visualization

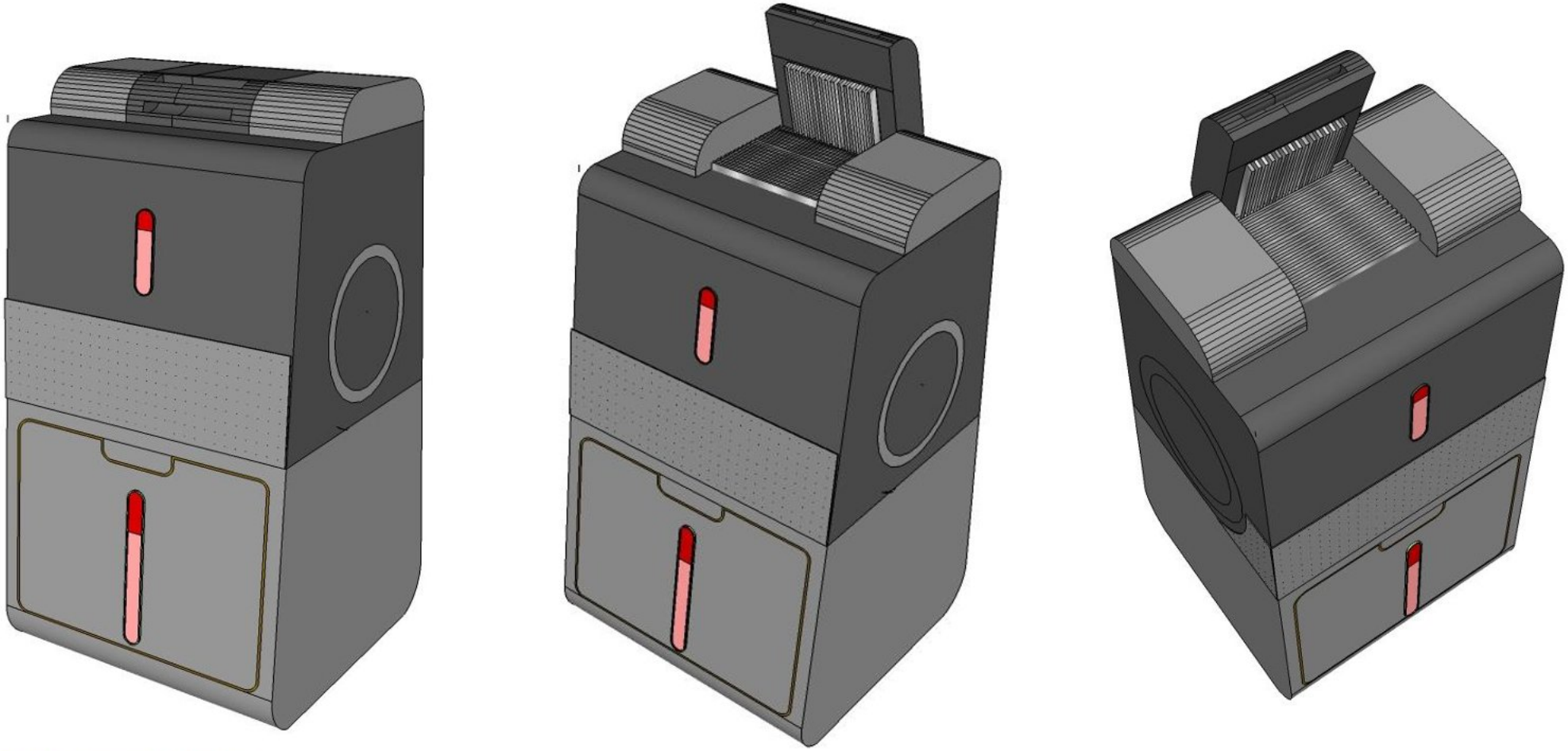
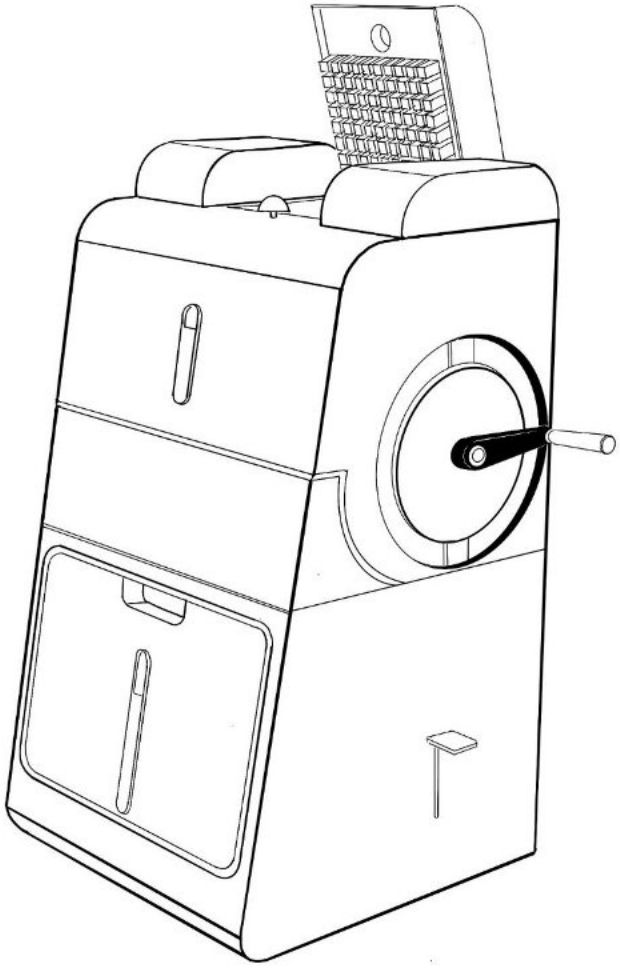


Figure 63 - concept B 3d model

11.3 Prototype

Figure 64 - concept B form model

12. Concept C



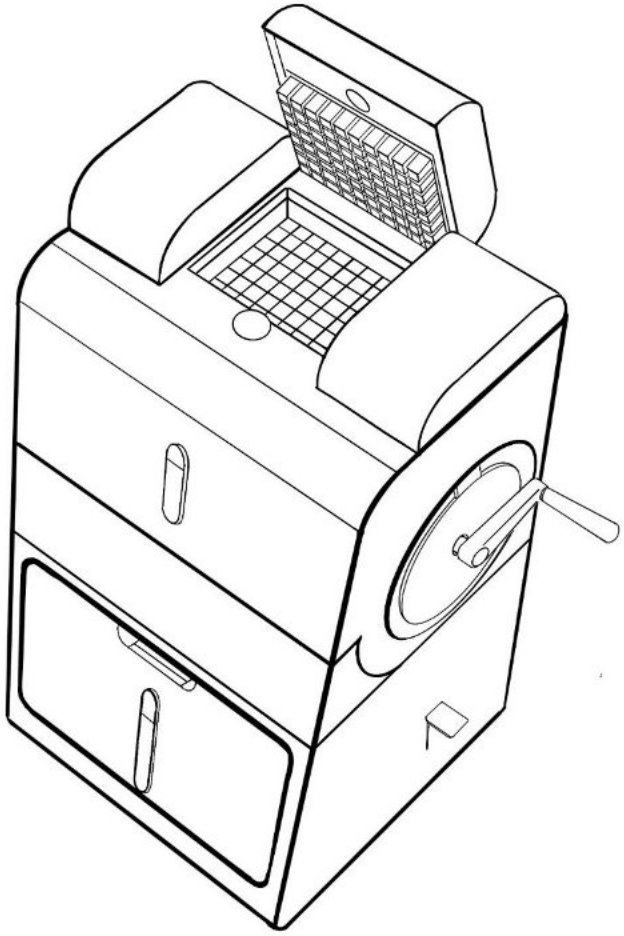


Figure 65 - concept C initial sketches

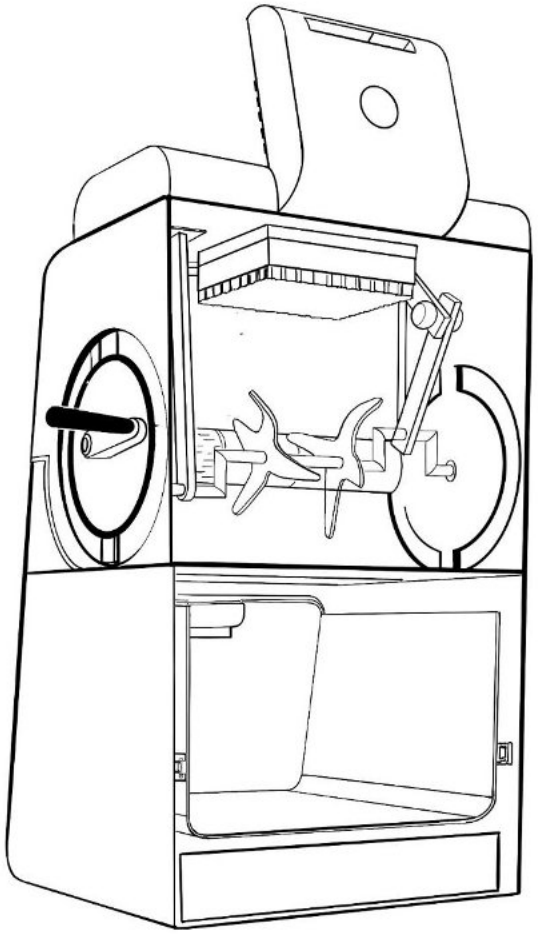
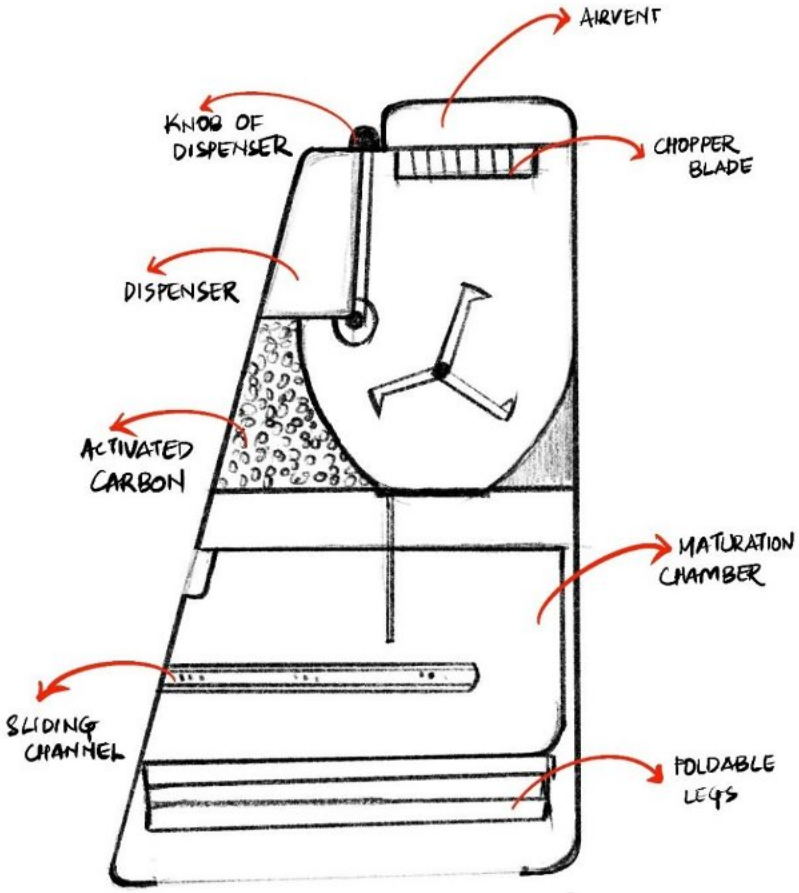
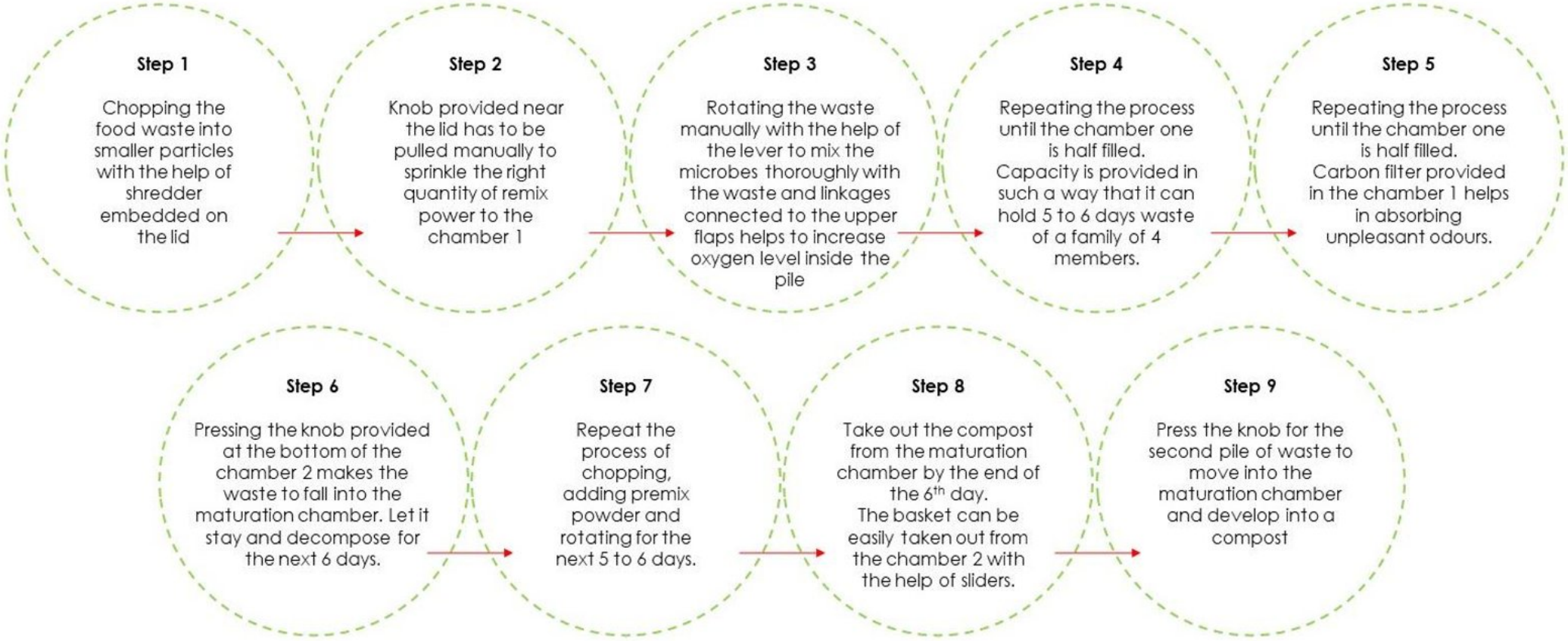
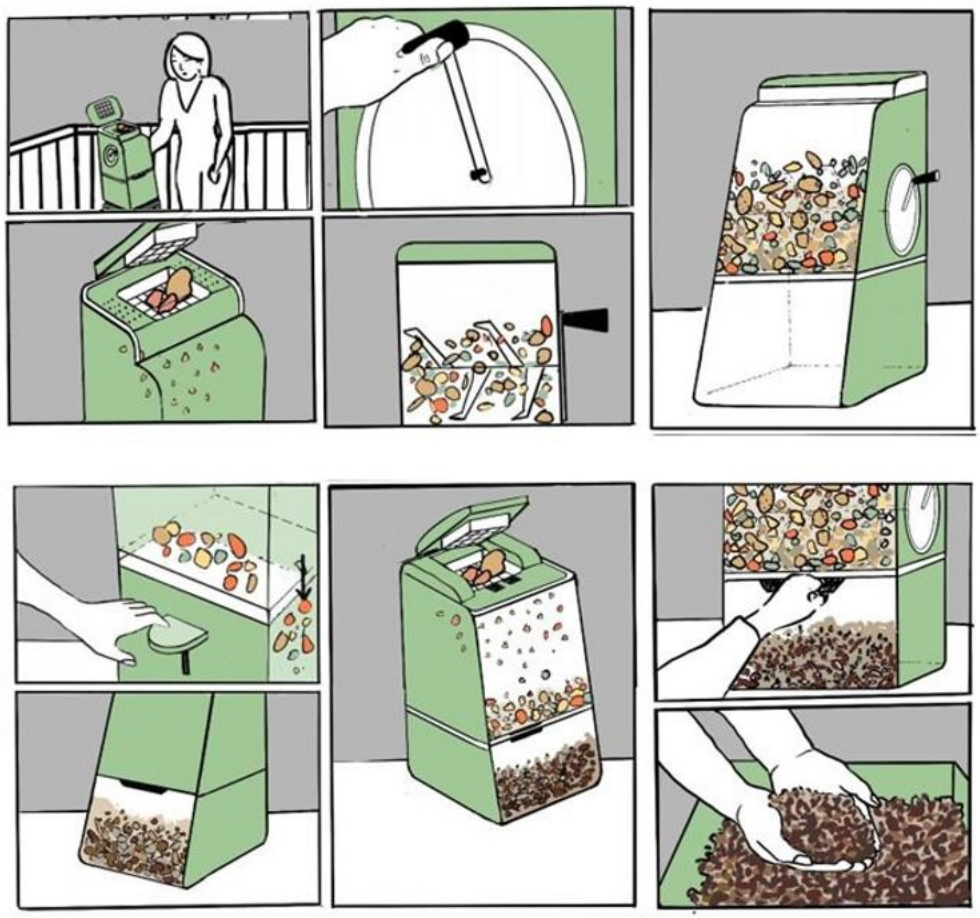


Figure 66 - concept C initial sketches

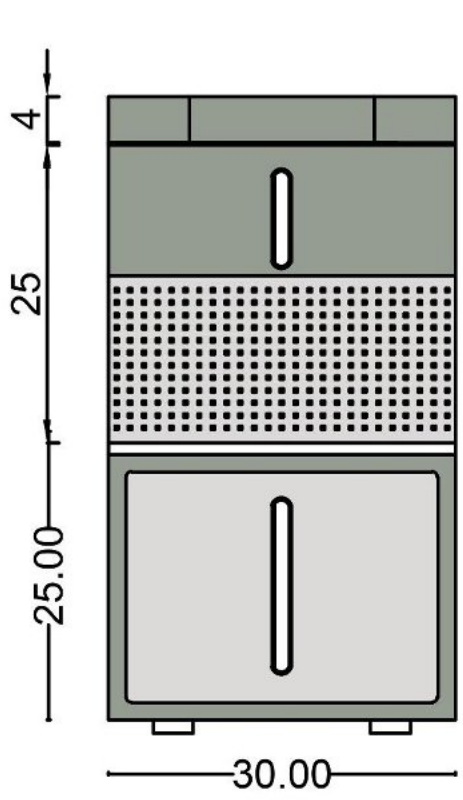


12.1 Task Analysis

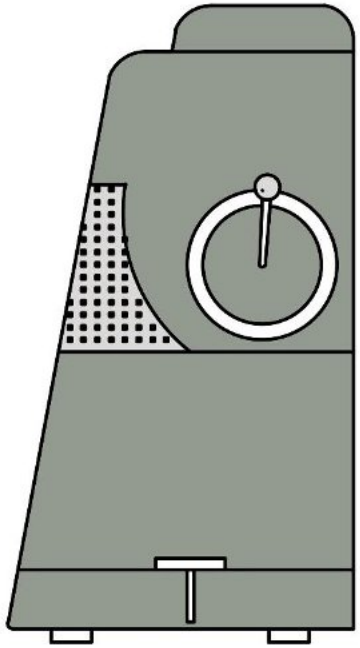




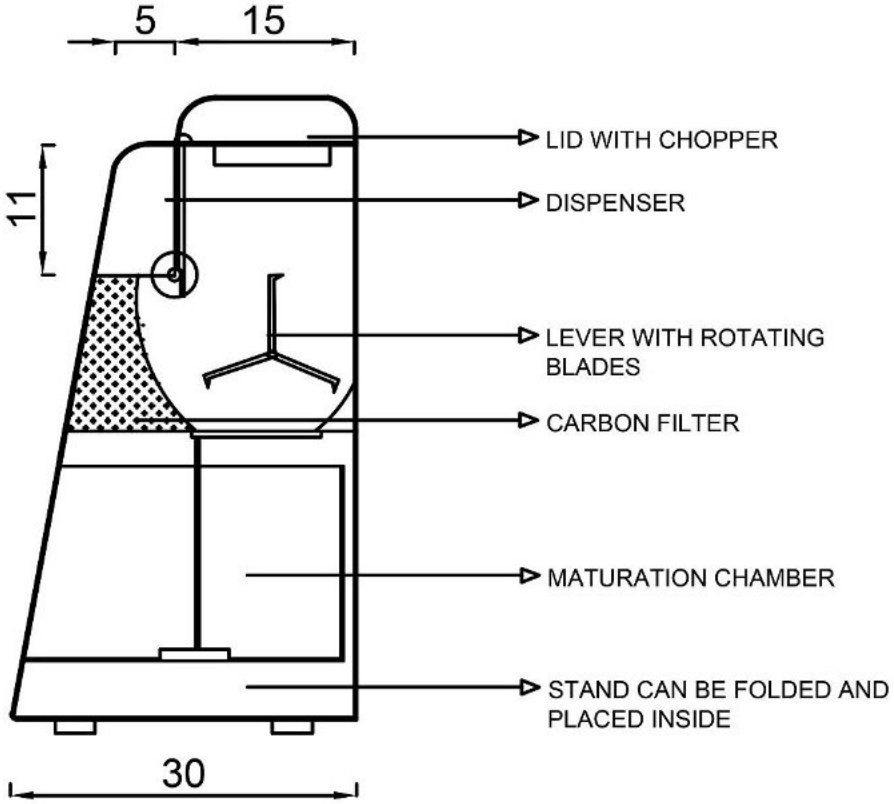
12.2 Dimension Drawing



FRONT ELEVATION



SIDE ELEVATION



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12.3 3D visualization

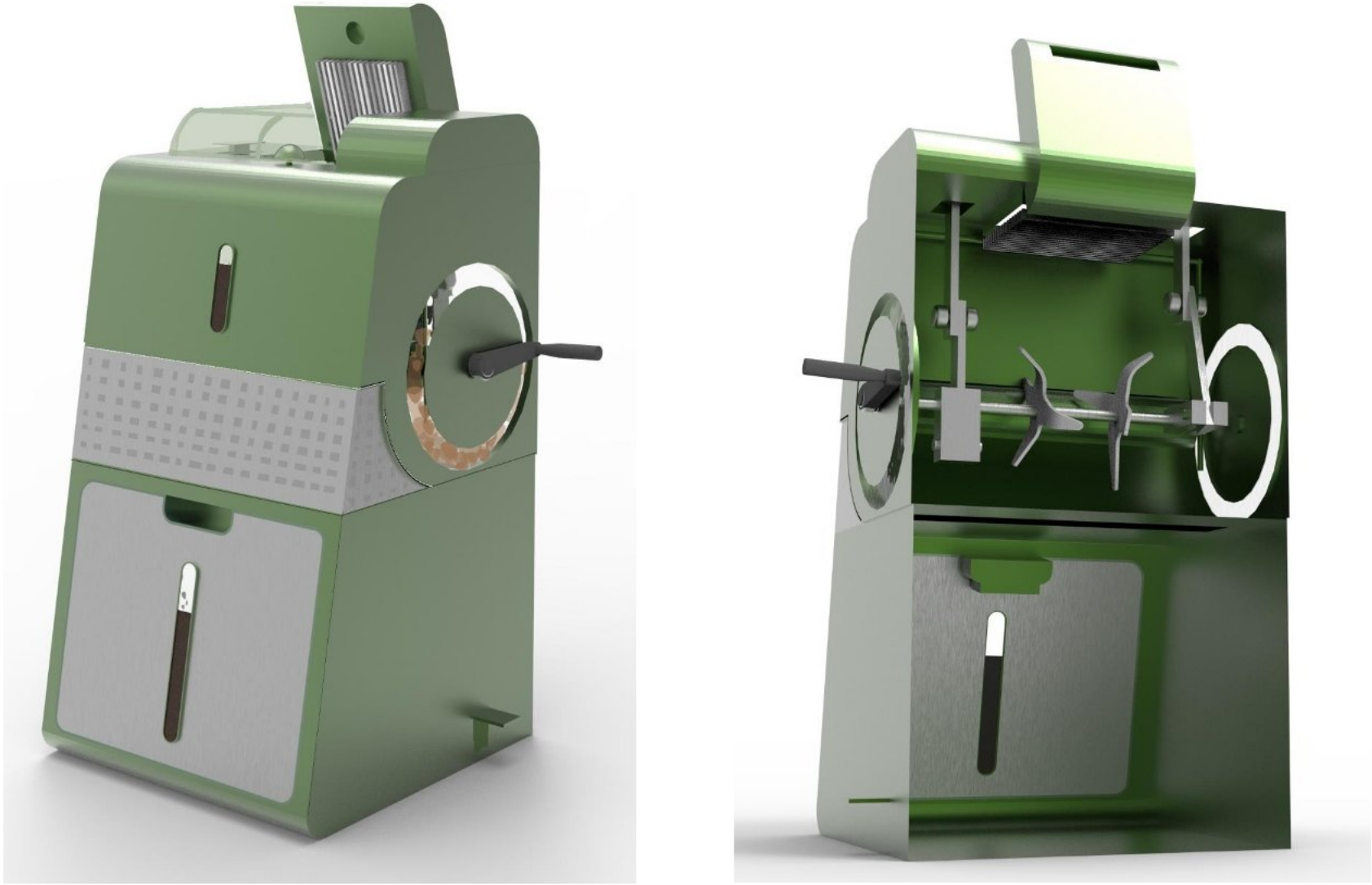
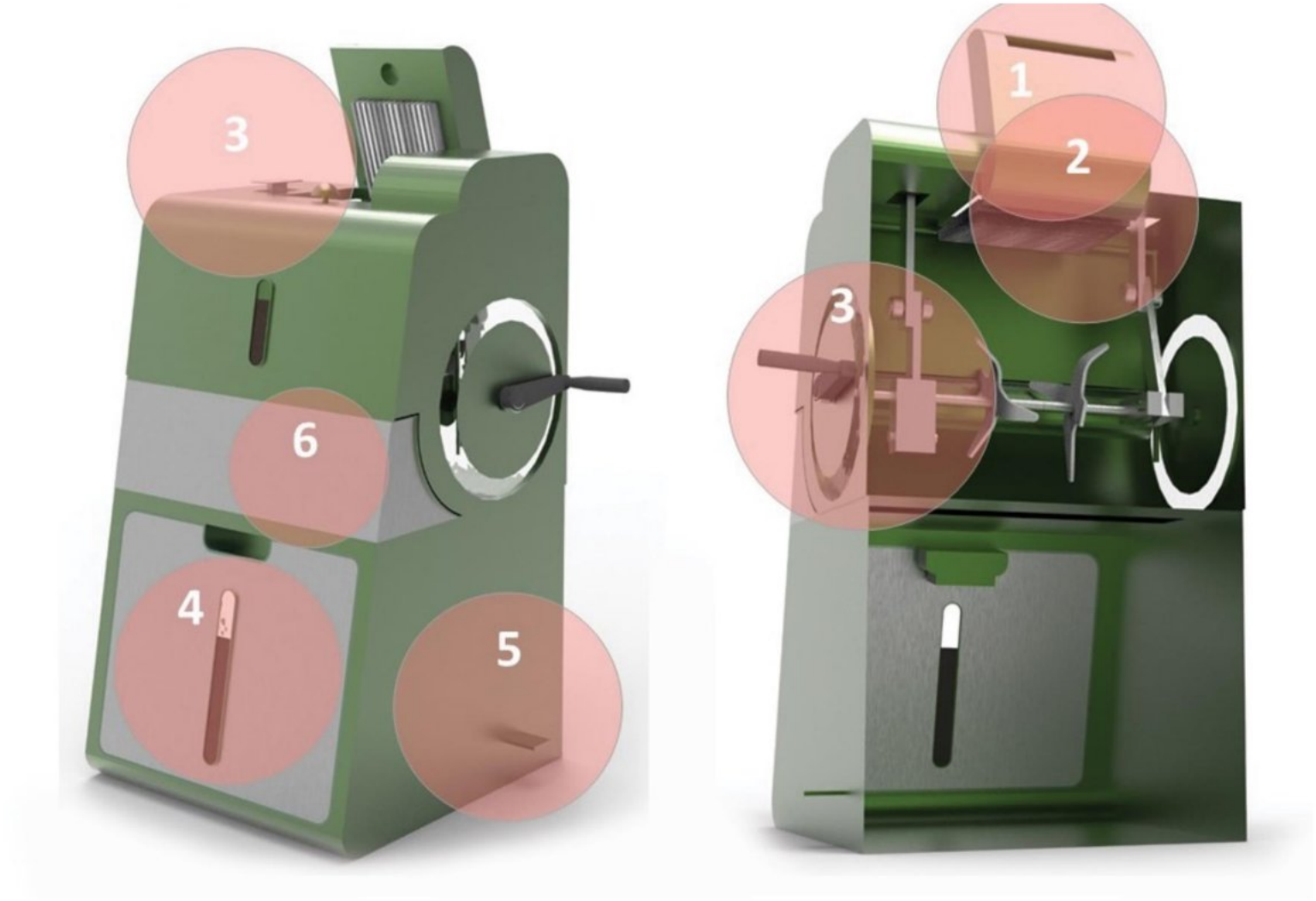


Figure 67 - concept C 3d model

12.4 Product Details



Detail 1
CHOPPER MECHANISM

- Chopper attached within the lid that allows to breakdown food into smaller particles without an extra effort
- The smaller, the better is the rule for compost ingredients

Figure 69 - concept C detail 1

Detail 4
SEETHROUGH SLIT

- Slit 1 – to view the level of microbe powder
- Slit 2 – To view the chamber. Provided the handle
- Slit 3 – To view the contents of maturation chamber.

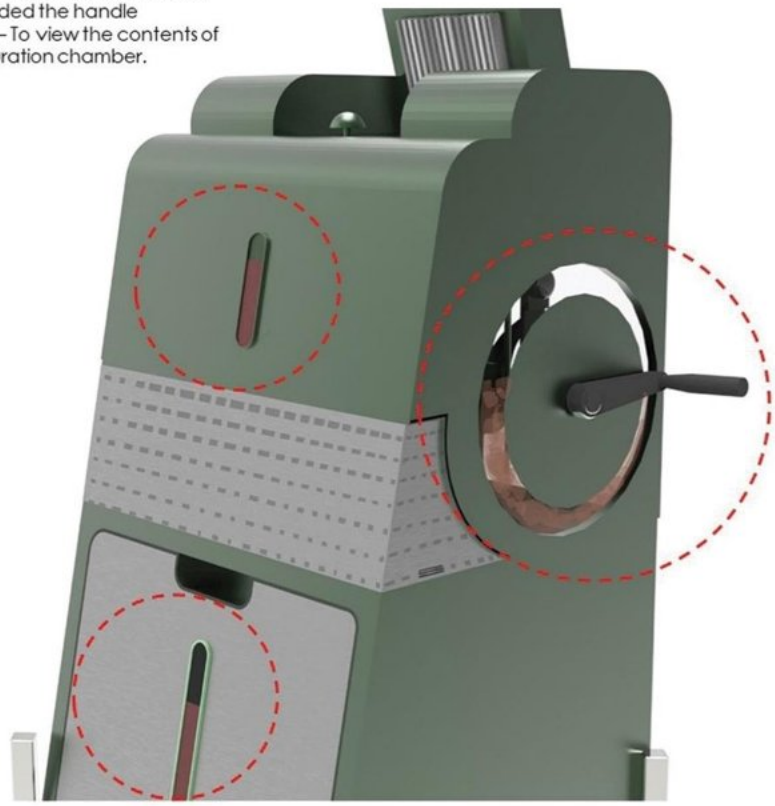


Figure 68 - concept C detail 4

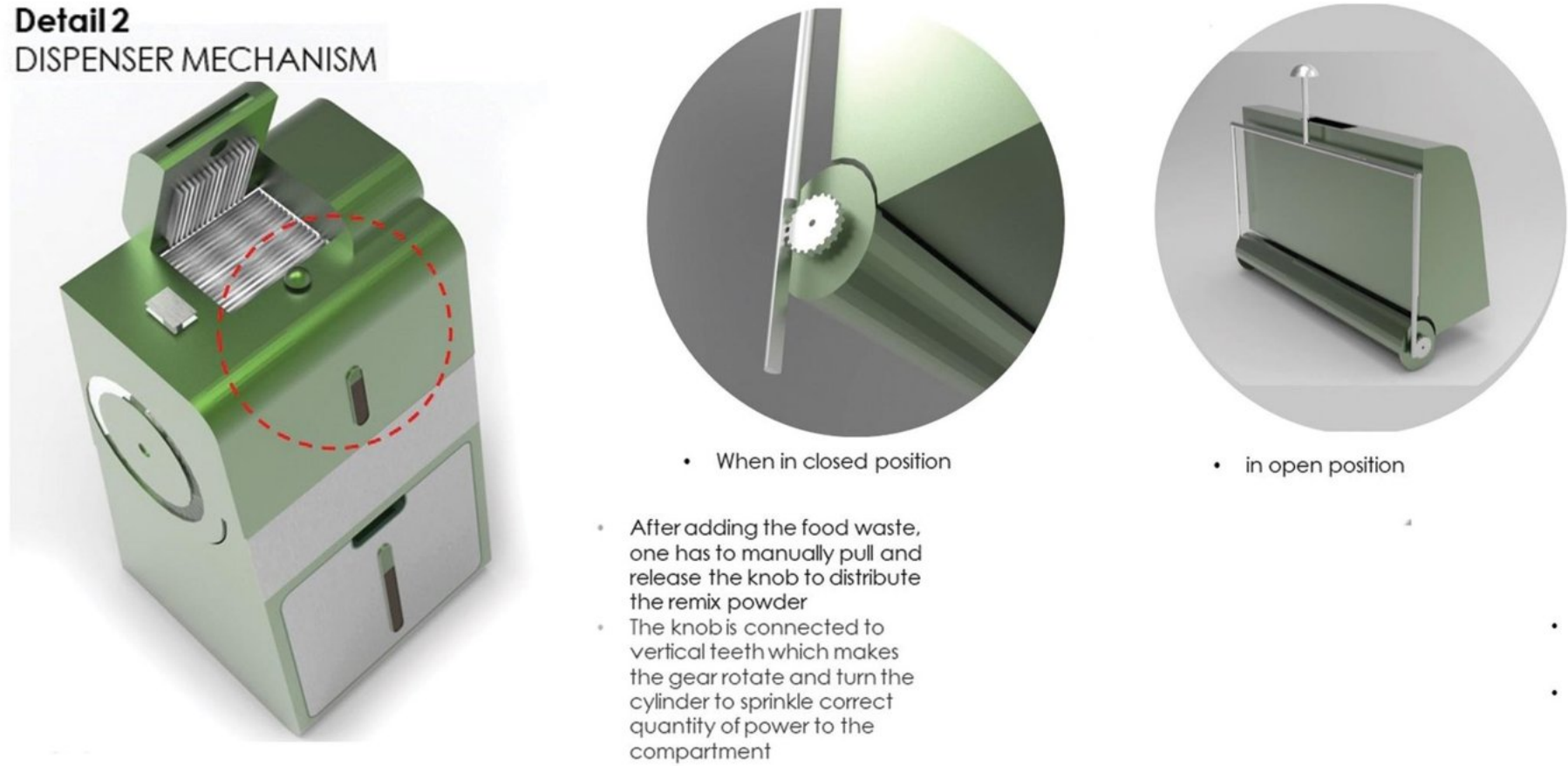


Figure 70 - concept c detail 2

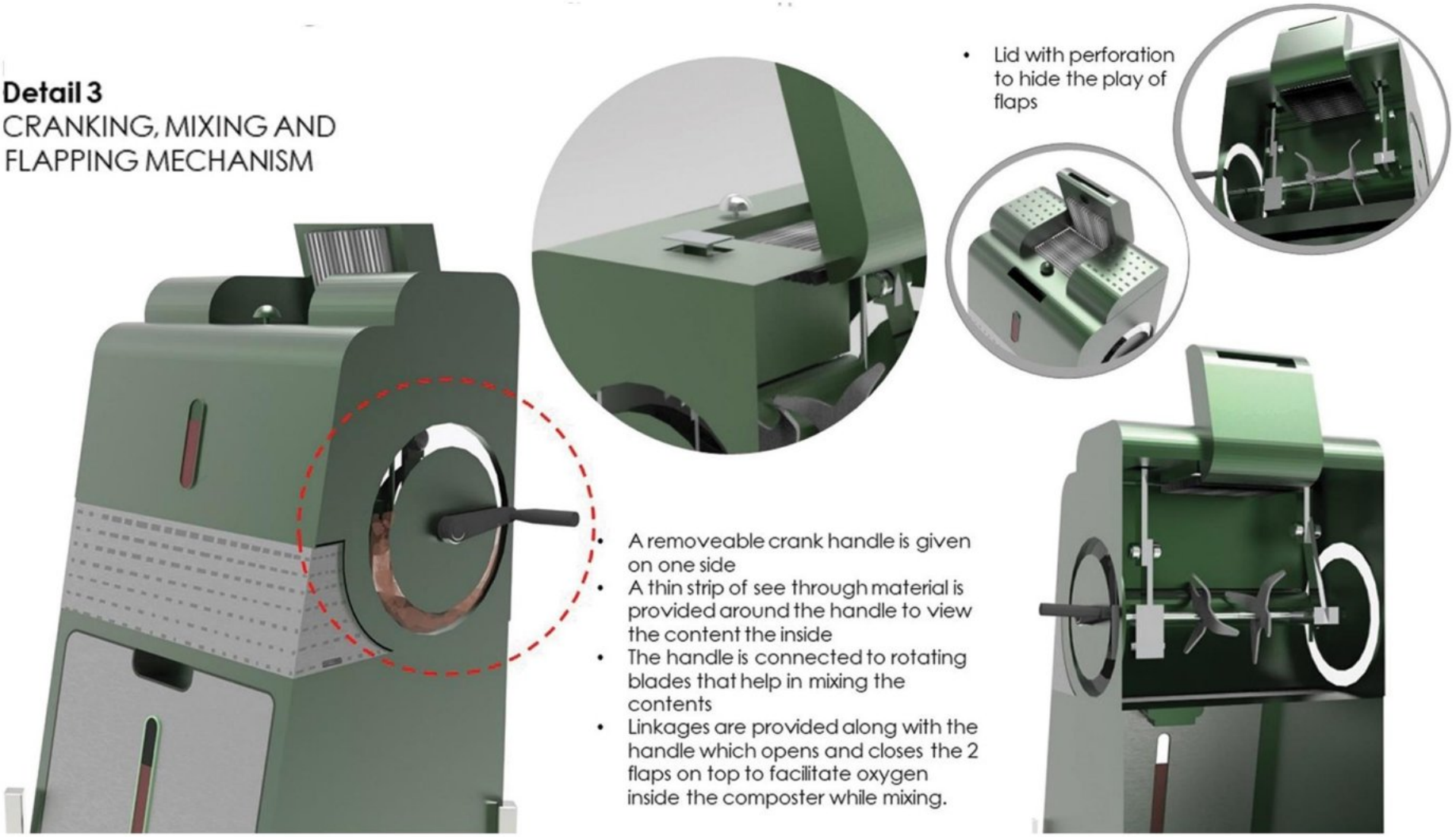
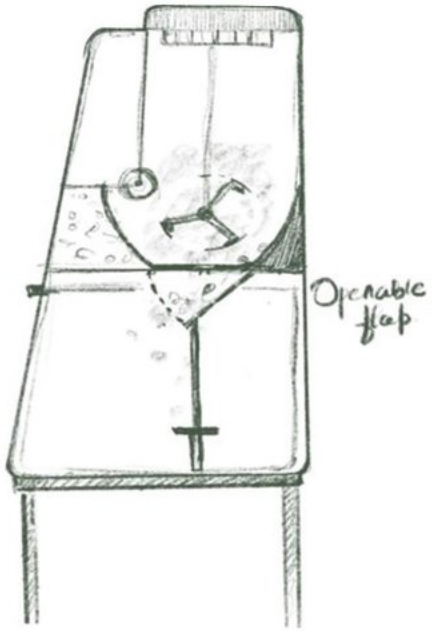


Figure 71 - concept c detail 3

Detail 5
TRASH CAN MECHANISM

When the chamber on is full, just pressing the knob will open up the flap.
The contents are thus transferred from the chamber 1 to chamber 2

- After adding the food waste, one has to manually pull and release the knob to distribute the remix powder
- The knob is connected to vertical teeth which makes the gear rotate and turn the cylinder to sprinkle correct quantity of power to the compartment



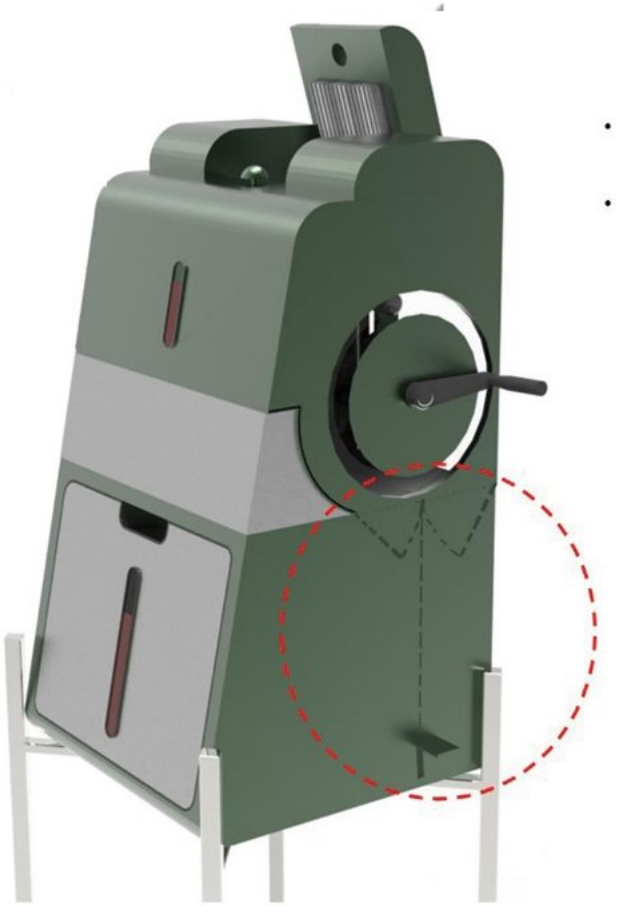


Figure 72 - concept c detail 5

12.5 Volume Specifications

- Volume of the chamber 1 = 25x15x30 = 11250cm cube
- This space can accommodate 11kg of waste
- Thus it can accommodate 5.5 kg of food waste
- 5.5 kg is the approximate food waste produces by a family of 4 members in 5 to 6 days.
- For 5 kg of waste, 2.5 kg (2500cm cube) must be the quantity of remix powder that is to be added
- Volume of remix chamber = 1980 cm cube, ie 1.9 kg
- One day it requires 0.5 kg of remix, if its spread in 4 turns, then each turn should give 0.125 kg of remix.
- Thus volume of the cylinder = 3.14x2.5.x2.5x28= 549 cm cube/4 = 137 cm cube or 0.137 kg
- After every 5 days the waste is sent to the maturation chamber
- Volume of final compost = half the volume of the food waste
- Volume of food chamber 2 = volume of waste + volume of remix powder = 5.5 kg + 2.5 kg = 8 kg

25x16x30 = 12000 cm cube = 12 kg

Figure 74 - colour variations

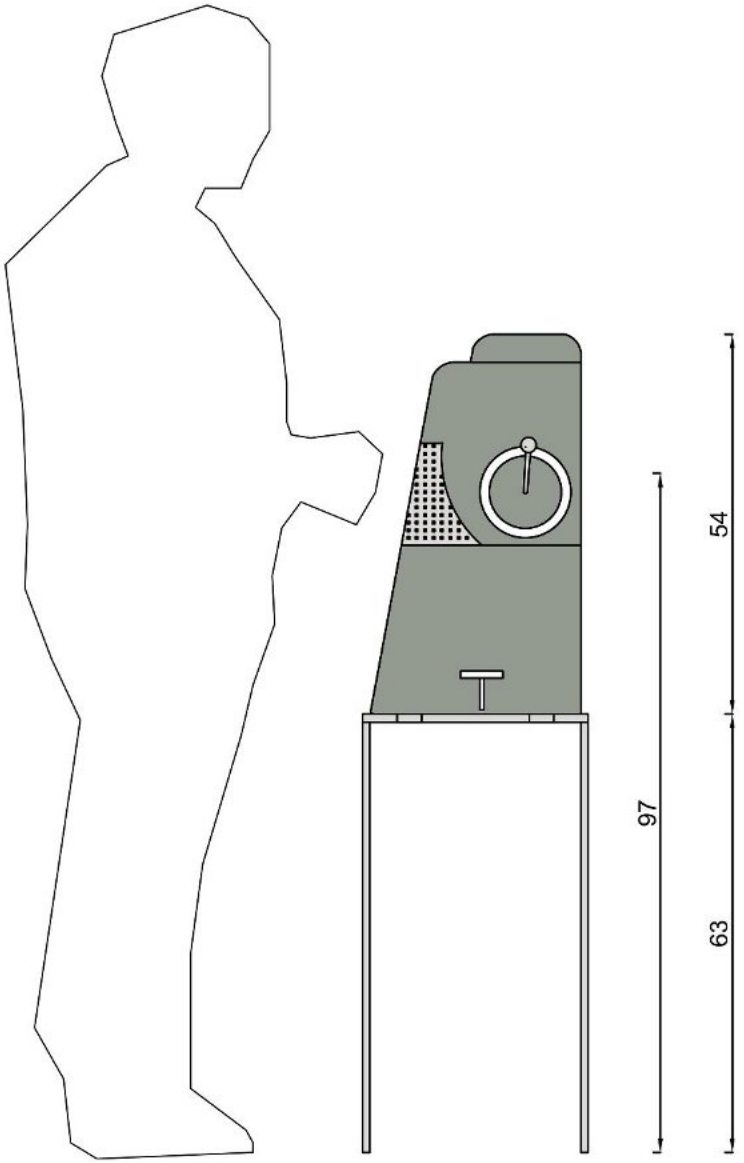


Figure 73 - concept c ratio with human scale

12.6 Color Variations

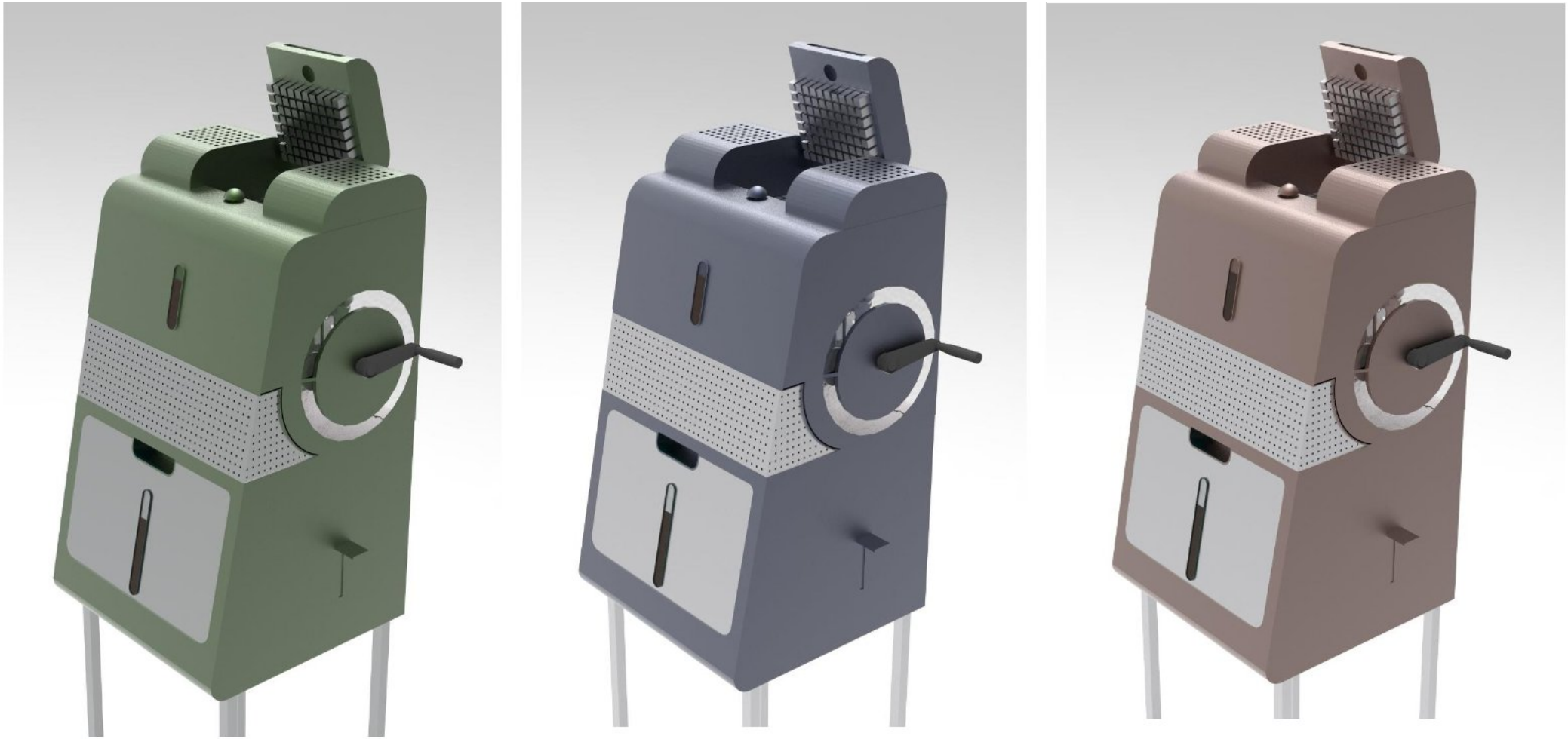


Figure 75 - colour variations

12.7 Materials and Manufacturing Process

- Body, microbe dispenser - metal (Stainless Steel - 2mm thick)
- Stainless steel is heavier and stronger than aluminum, less costly, highly corrosion resistant.
- Metal fabrication -Roll Forming, Bending, Spot welding, powder coated.

- Handles, chopper, - Polypropylene, nylon (already available components)
- It is a relatively inexpensive material, It's resistant to cracking and stress, even when flexed, doesn't react with water, detergents, acids, or bases, it withstands daily wear and tear.
- These parts are Injection molded and already available in the market.

Figure 76 - Raw materials

12.8 Mockup model

Figure 77 - mockup model of concept C

12.9 Final model

Form model
1:3 scale



Rig model Process







Rig model
1:1 scale

Product Roleplay – user interaction with prototype


Adding the food waste through the chopper


Pulling the dispenser knob


Pulling the dispenser knob


Closing the lid


Cranking and mixing the contents


Moving the contents to chamber 2 after 6 days


Keeping it for maturation


Taking the compost out

11. Conclusion:

The main objective of the project was to design an aerobic human powered food composter for everyday use in residential spaces that is for a middle-class family (up to 4 members), to give ready to use compost which is operated manually for balcony spaces. It was challenging to do detailed research on the various types of composting process and positioning my manual composter between the conventional composter and the electronic composter already available in the market. Various mechanisms are provided in the composter that are not power driven but manually working which reduces the effort of the composting process in a more sustainable manner.

12. Reference

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