Redesign of Insect Killer

Industrial Design Project- 2

Juwin Thomas-156130005
Guide: Prof. R Sandesh

IDC School of Design
Indian Institute of Technology, Bombay
2015-2017

Approval

Industrial Design Project II
“Redesign of insect killer”

By: Juwin Thomas
M. Des Industrial Design 2015-2017

Is approved as a partial fulfillment of requirements of post graduate Degree in Industrial Design at IDC, IIT-Bombay.

External Examiner

Internal Examiner

Project Guide

Chairperson

Declaration

I declare that this written submission represents my own ideas and where other's ideas or words have been used, I have adequately cited and referenced the original sources. I also declare that I have adhered to all the principles of academic honesty and integrity and have not misrepresented or fabricated or falsified any ideas/source/fact in my submission. I understand any violation of the above will be the cause for a disciplinary action by the institute and can also issue penal action from the sources which has been thus not been properly cited or from whom proper permission has not been taken where required.

Juwin Thomas
IDC, IIT Bombay
156130005

Acknowledgment

I take this opportunity to thank the entire faculty at IDC school of design for the inputs that helped me successfully complete this project.

I express my gratitude to my guide- Prof R Sandesh for his consistent support and guidance in this project.
The Feedbacks I received at every stage of the project were immensely helpful and it allowed to look at a wider perspective of the project.

I like to thank Mr.Thomas and Thomson & Thomson industries located at Marol for the opportunity provided to learn things practical and in detail.

Last but not the least i am grateful to my classmates for contributing their valuable insights to this project.

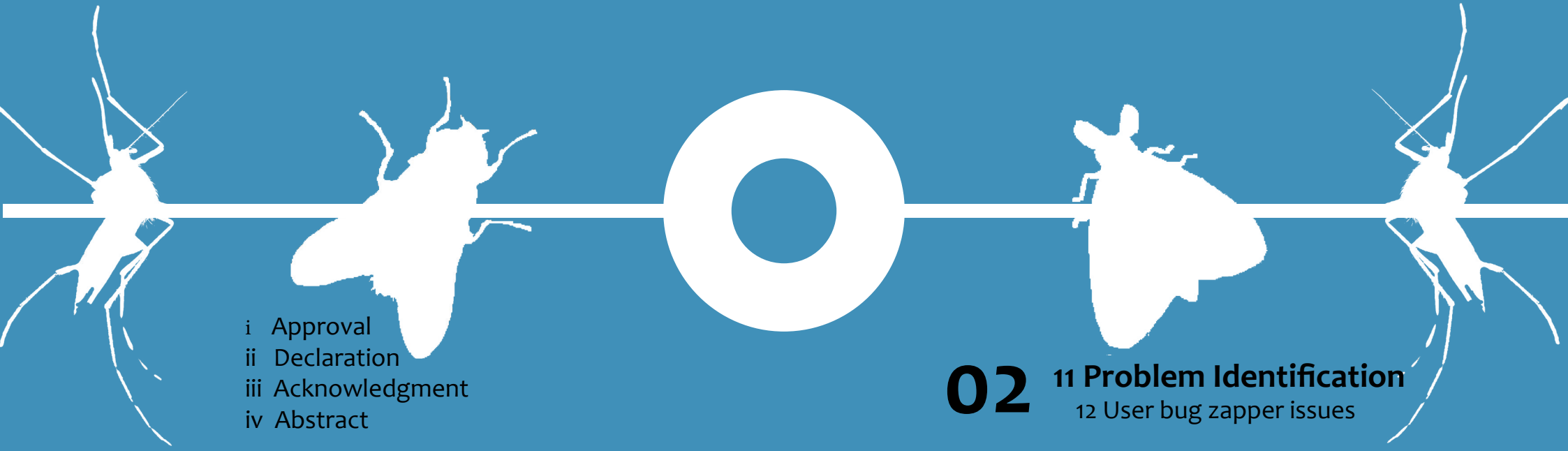
Abstract

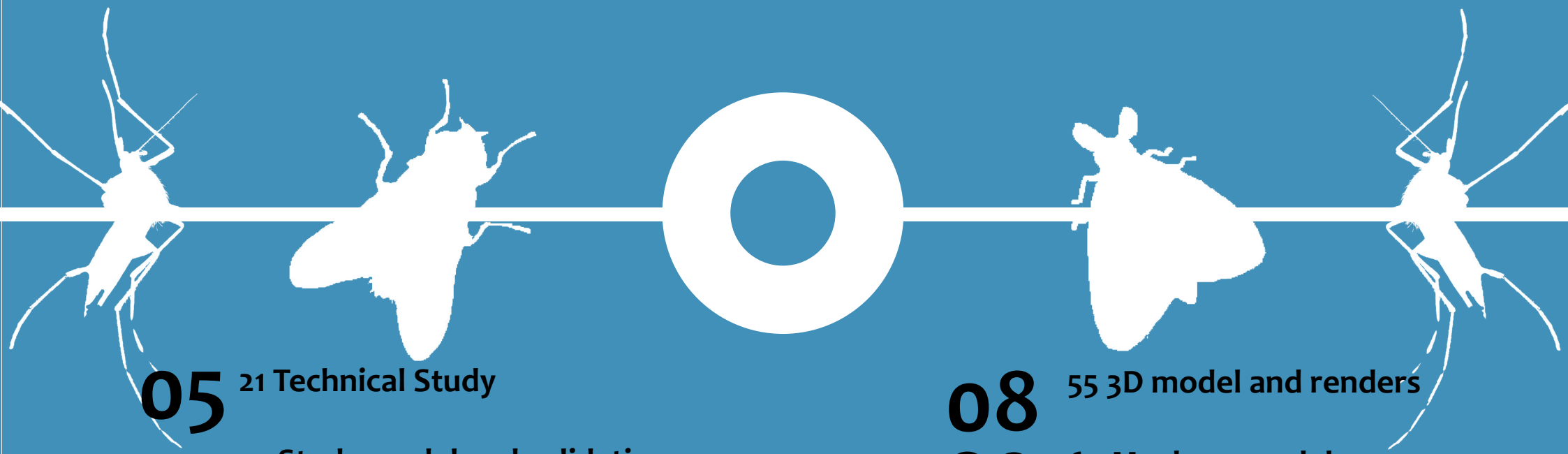
Pest is defined as a destructive insect or other animal that attacks crops, food, livestock and humans.

Insects like house fly, mosquito and moths are often attracted to food , human/animal presence and light. These are the commonly found pests in public areas and if remained unchecked they rapidly spread **diseases** and cause considerable **damage to environment**. It is thus necessary to implement pest control measures to ensure healthy living conditions.

Pest control equipment's and insect traps are getting increasingly popular these days. They play a key role in trapping/killing insects in public and indoor spaces that help minimize pest population of surrounding areas. In this project I have looked into possibilities of redesigning insect killers adopting newer technologies that are safer and effective with reduced health hazards.

Contents





01 Introduction and Research

Methods of pest control

Over the centuries we have developed various methods to destroy pests. Some are Eco friendly while others are not. Some common techniques practiced are as follows

Biological pest control
Since the time of Egyptians cats were used to remove rats from the fields. In biological pest control natural predators are introduced to kill prey.

Poisoned bait
By poisoning the food that attracts the pest which when consumed will kill them

Pesticides
Pesticides are chemicals that kill pests. They are often harmful to other organisms including humans.

Elimination of breeding grounds
Waste water and garbage are breeding grounds for most pests. Once they are eliminated, pest population could be controlled.

Traps
Traps capture pests either live or dead. Traps usually have food or chemical (pheromones) that attract/lure a specific pest. In this way they are selective and enables to capture a particular type of pest.

Repellents
There are natural and chemical repellents that keep away the pest. Most repellents produce an odor that is unpleasant for the pest and discourages pest from entering .

Insects and UV light

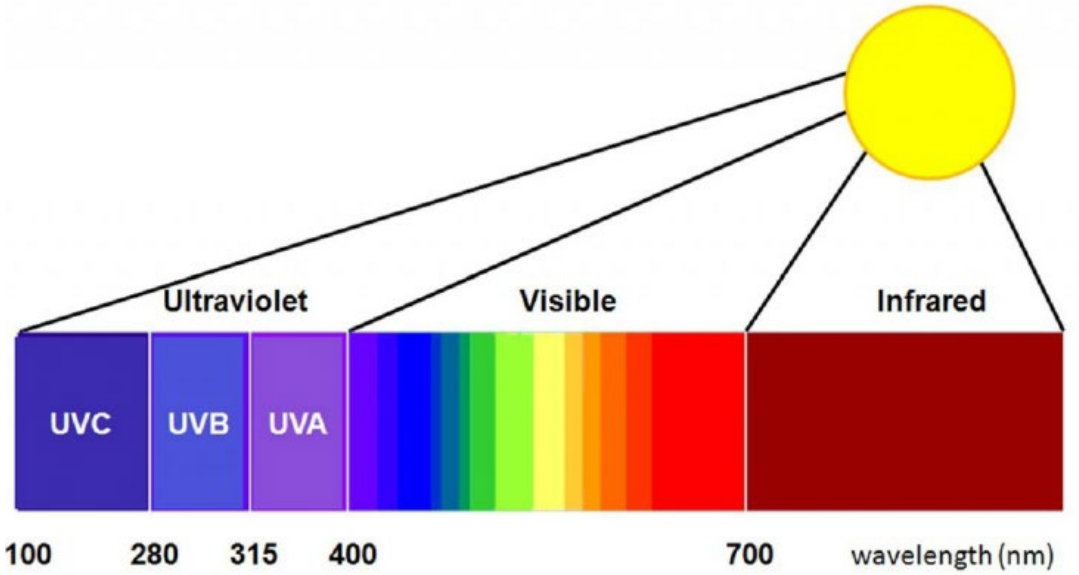
Ultra violet(UV) light has three parts

UV-A : wavelength 315-400nm
UV-B : wavelength 280-315nm
UV-C : wavelength 100-280nm

UV-C
UV-C is known as germicidal irradiation and is used to disinfect food,water and air. UV-C penetrates the outer membrane of bacteria, yeasts, molds and viruses, attacking the DNA which stops them from reproducing. UV-C is harmful if exposed directly

UV-B
UV-B is used for skin tanning purposes

UV-A
UV-A attracts **phototactic insects** (attracted to light) and are most effective between **350-370 nm**. Unlike humans insects can see UV light since they have compound eyes.



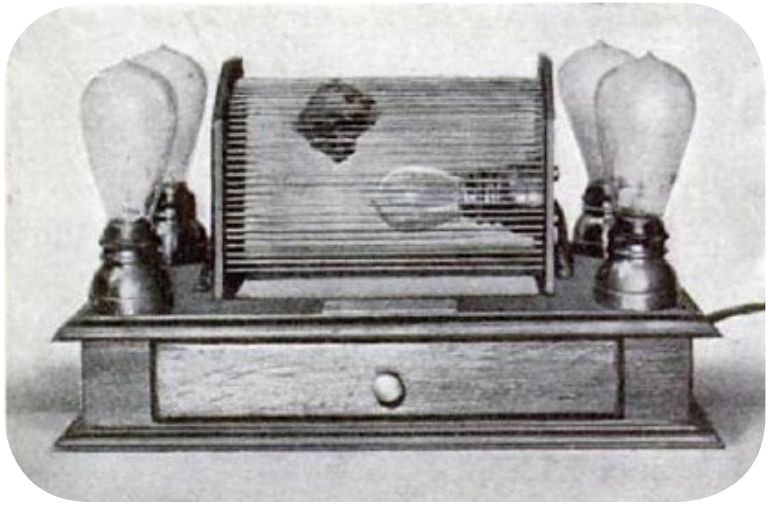
Available at : http://panelop.com/images/fd-1/sunlight-light-spectrum-decorating-ideas-5.jpg

History of bug zappers

The first bug zapper was invented in 1911 by two unnamed men from Denver. It had all the parts including electric grid and electric bulb similar to the modern bug zappers but was conceded to be too expensive for day today usage.

However the technology was patented 1932 by William M. Frost. The patent was filed Jan 14 1928, and the devices were first sold in 1928.

Modern bug zappers are inspired from the model made by Dr. William Brodbeck Herms in 1934, a professor of parasitology at the University of California.



Available at : https://en.wikipedia.org/wiki/Bug_zapper#/media/File:Bug_Zapper_1911.JPG

Current trends in bug zapper

Flowtron Programmable Insect Killer
Pros:
-Aesthetically Pleasing
-Bulb is Simple to Change
-Self-regulating unit is controlled by photocell timer
-Additional Octenol replacement
-1-acre area reach

Cons:
-Metal Frame Can Cause a Minor Shock
-Not so Clog resistant

https://images-na.ssl-images-amazon.com/images/I/715ZROmiT0L._SL1125_.jpg

Aspectek Indoor Insect Killer
Pros:
-Best indoor zapper
-Easy to Use
-Chemical Free
-Simple Design
-6,000 square feet reach

Cons:
-Frame Can Cause a Shock

http://ecx.images-amazon.com/images/I/71L-n3%2B3hGNL._SL1500_.jpg

Flowtron FC-8800 Diplomat
Pros:
-Covers a Large Area (2 acres)
-Can be Used Both Indoors and Outdoors
-Powerful(5,600 volts)
-Up to 2 acres coverage

Cons:
-Extremely Bright Light
-Large Size

https://images-na.ssl-images-amazon.com/images/I/31xFHf-dwoL.jpg

Stinger Cordless Rechargeable Insect Zapper
Pros:
-Cordless
-Easy to Clean Tray
-Indoor/Outdoor Use
-Additional back light that lets unit to be used as lantern

Cons:
-Small Coverage Area
-The lithium ion battery only runs for 3-4hrs
-You can't operate it while plugged in

https://images-na.ssl-images-amazon.com/images/I/41Y5HC3lOsL.jpg

Construction details

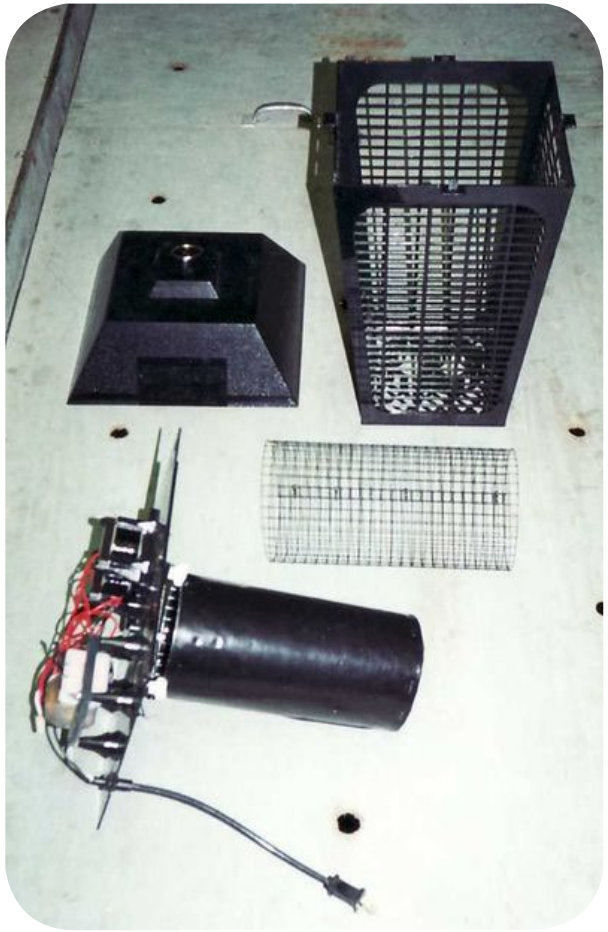
Typical bug zapper have mainly four parts

Housing made of plastic or metal parts

A light source, which is usually fluorescent-type, such as mercury, neon or ultraviolet light

Wire grid(electrified) which kills the insect once in contact

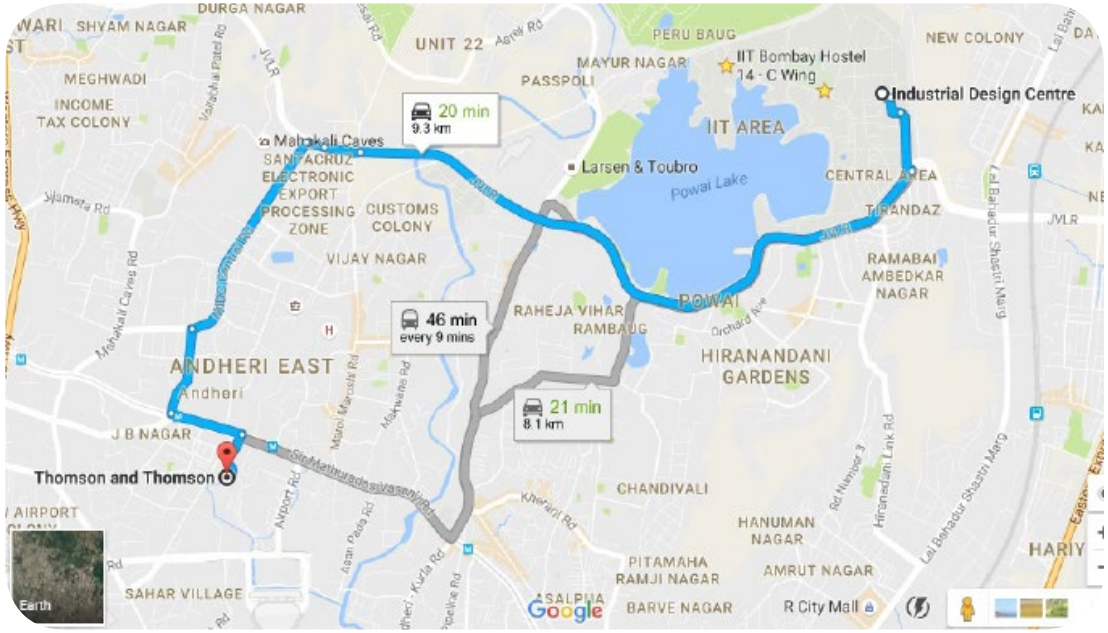
Step up transformer changing the 250-volt, electrical-line voltage to 2000 volts or more



https://cdn.instructables.com/FN6/MB0K/F2FRVDFX/FN6MB0KF2FRVDFX.MEDIUM.jpg

Industry visit

Thomson & Thomson Manufacturer located at Marol, Anderi East,Mumbai have specialized in low cost manufacture of bug zapper,water purifier and air curtain. An industry visit was paid to understand the detail working and configuration of bug zapper. The visit was crucial to better understand the construction and technical details of the product.



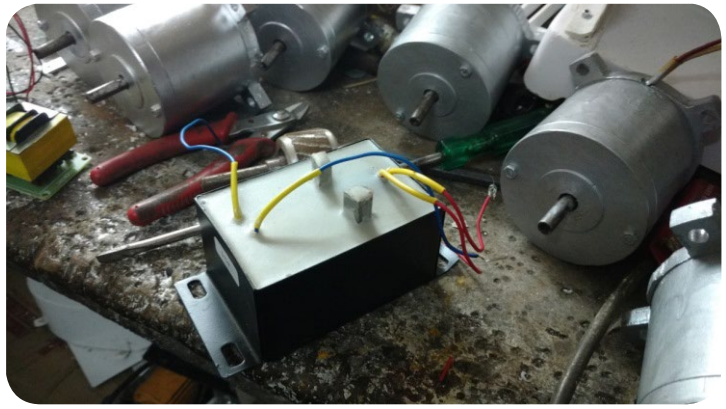
google maps

Observations

In the industry I had an opportunity to learn working of several components and had the privilege for a hands on experience in assembling a unit.

The following observations were made during the visit

Labeling and fixing

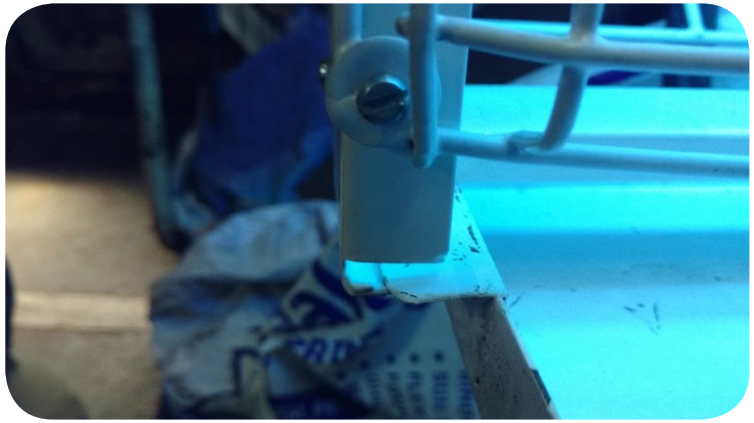


Transformer used is locally manufactured and steps up 240v to 1800v

Teflon strips helps in keeping conducting rods equi-distant and they are resistant to high current/spark. A gap of 6-5mm has to be maintained between

Starters for UV tubes, fuse

The manufacturer sells a unit for about 3000 Rs/. The construction is robust with mild steel sheets and rods. This also makes the unit heavy. The industry also supplies spare parts like step up transformer and UV tube.



Screw for removing outer grid and collecting tray detail

Final product assembled

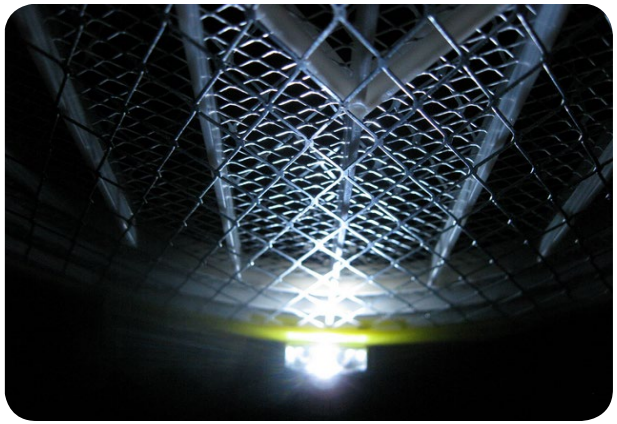
02 Problem identification

User-Bug zapper issues

Noise

Electrocution of bugs lead to spark and creates noise every-time while device is performing. This is also an indicator that the device is working effectively.

While a majority of user finds it pleasant to “hear” the device working others find it annoying after a certain period.

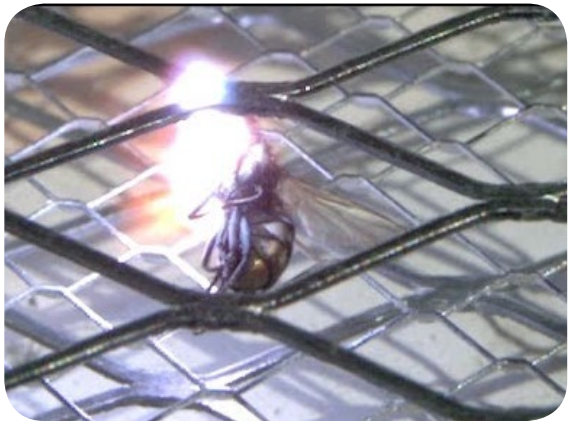


http://www.suspendease.com/i/THE%20INSECT%20ZAPP/IMG_3381.JPG

Burning Smell and live virus- Hygiene issues

Electrocuted insects are blasted into a fine mist that contains miniscule insect parts, as well as some surviving bacteria and viruses.

This mist can be spread up to 7 Feet from the device, contaminating the air surrounding the zapper with potentially dangerous organisms commonly carried by flies.



https://i.ytimg.com/vi/oUJLgKkmllA/hqdefault.jpg

Cleaning and maintenance

Hygiene is extremely important for indoor bug zappers. Hence regular maintenance is a must for bug zappers.

Clogged up insects will also reduce performance and efficiency of the product.

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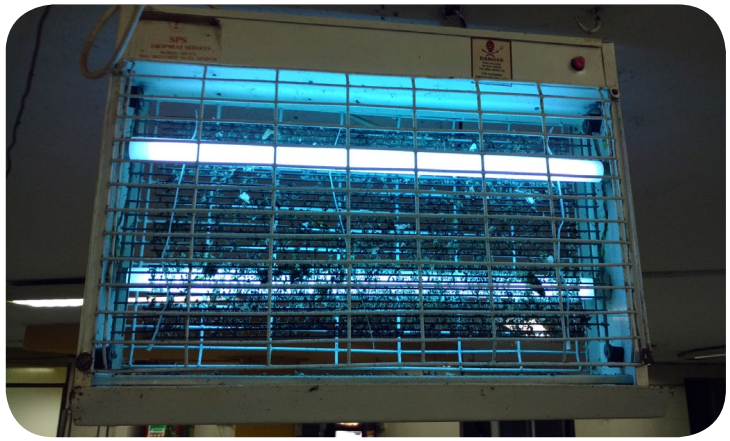

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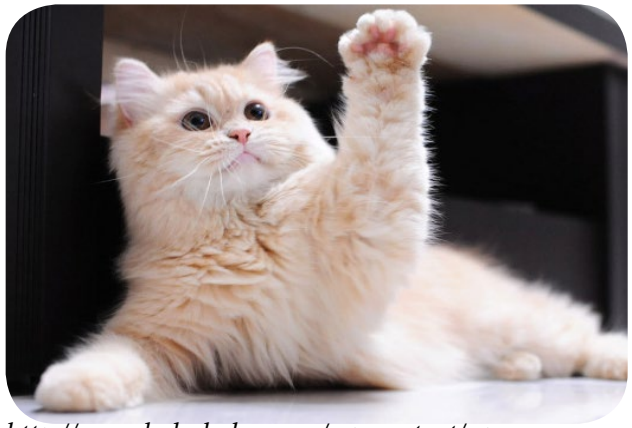


http://www.lodoshaber.com/wp-content/uploads/2015/01/cak-bir-beslik-kedi-866-x-600.jpg

Fails to trap mosquitoes but may attract and kill harmless insects

Bug zappers generally use ultraviolet light to attract insects. However, the most troublesome insect we all target, the mosquito, is not attracted to ultraviolet light.

Children and safety

Children are always curious to explore. If kept in reach they may attempt to insert hands into the zapper grill and can lead to a nasty shock. Pets like cats may also attempt reaching inside the zapper

03 Repositioning

Repositioning Bug Zapper

Repositioning bug zapper is an important factor I wanted to bring though this project. This may be defined through a new set of semantics and design approach. The approach will require detail analysis of the following factors

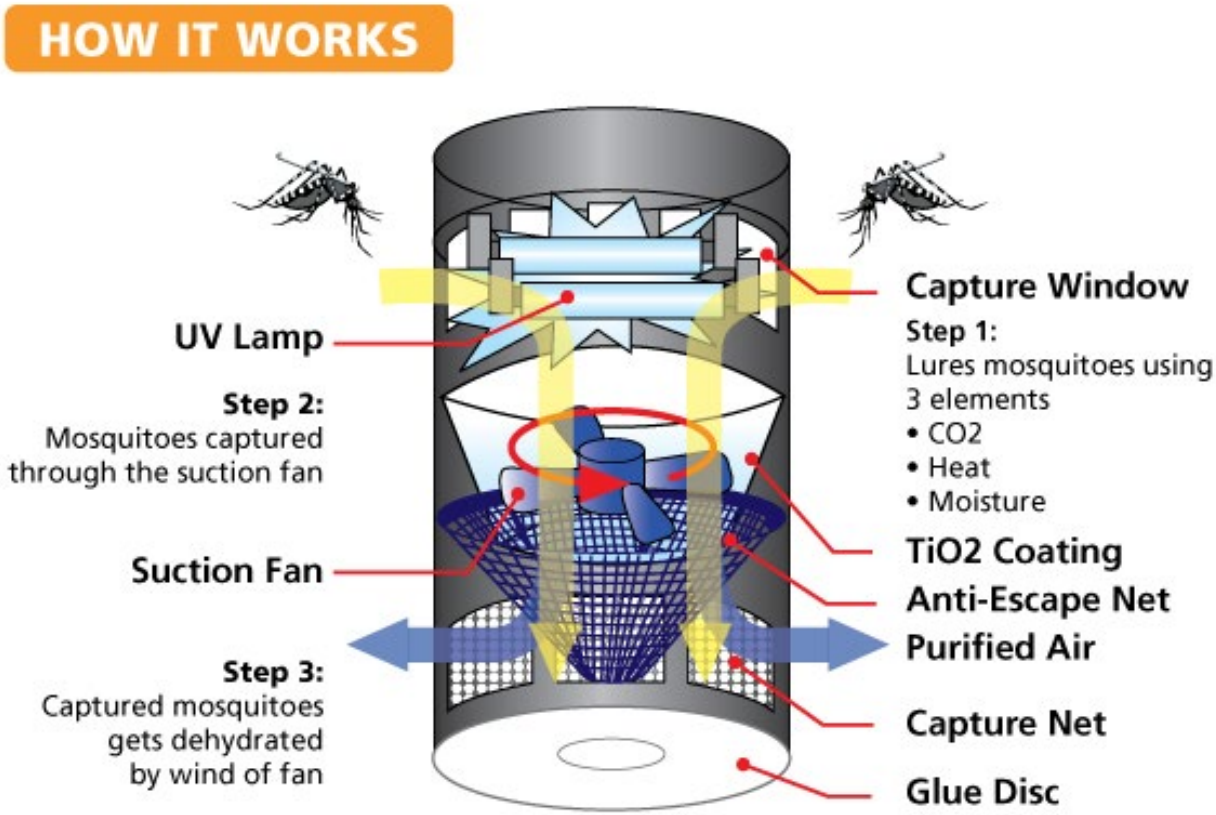
Adopting latest technology
Aesthetics and feel
Multi-utility
Added value

Latest technology-Without Zapping!

The current problems and possible health hazards associated with bug zappers have lead researchers to look for new technologies to capture and kill insects without causing harm to people.

Modern mosquito traps have suction fan instead of electrified rods. In order to attract mosquito, in addition to UV light **Photocatalysis** of TiO2 is utilized. In this process TiO2 acts as a catalyst where a Titanium Dioxide (TiO2) coating inside the unit combines with UV light to produce Carbon Dioxide (CO2). This process is aided by any carbon matter left behind on the inner surfaces from bugs as they've been drawn into the unit by the fan.

This process also results in the production of hydrogen radicals that offers a level of air purification.



https://www.duro.com.sg/uploads/brandDetails/1434171390BlackHole-How%20it%20works.png

Added value

Brainstorming led to several possible ideas that could be added/inc-operated on a bug zapper depending on location and place of use.

-CCTV camera inbuilt /mount while placed on a height

-May have provision to play game,music

-Integrated smoke alarm unit

-LED display that counts kill ,shows Time and reminds of cleaning

http://www.mantratec.com/IR-cameras/Night-vision-cameras-2.jpg

http://hcsurveyors.co.uk/wp-content/uploads/2015/11/smoke-alarm.jpg

https://sc02.alicdn.com/kf/HT-B1Yr0SKXXXXXbLXFXXq6xXFXXXn/Playstation-TV-game-console.jpg

http://watch.brando.com/prod_img/zoom/WCLOC006800_01_L.jpg

04 Design brief

Design brief

To design a smart insect killer by critically incorporating value addition that promotes more user interaction with the product. To adopt new technologies that prevents zapping related health hazards and increase safety standards that allows easy handling, maintenance and cleaning.

The project also aimed to bring in a new sense of aesthetics and design language that relates user to the product and establish a connection.

05 Technical Study

Components

https://www.solidrop.net/photo-14/20-pieces-40x40x10mm-dc-cooling-fan-cooler-5v-40mm-4010s-4cm-with-usb-connector.jpg

12v DC cooling fan:
Cooling fan comes in various sizes and are widely available. They have relatively silent operation(as low as 10-20 dBa) and consumes less power

http://4.imimg.com/data4/RX/CK/MY-24836144/off-grade-titanium-dioxide-powder-250x250.jpg

A coating of TiO2 is powder coated on metal surface directly below UV light

http://w1.sayato.com/6466/images/UV%20LED%20BULB.JPG

UV light is available as UV LED light ,UV CFL bulbs/ Black light and UV tube light

http://wonderopolis.org/wp-content/uploads//2015/04/1453_2.jpg

06 Study model & validation

A study model was purchased in order to proper understand their working. The model claimed to catch mosquitoes by the attraction created due to Co2 produced by photocatalysis of TiO2.

The unit is manufactured by a dealer in Coimbatore and is one of the few leading makers of mosquito trappers with this technology in India.

Construction and build quality was average and i personally felt that the inlet where mosquitoes fly was too small.

Octenol (1-Octen-3-ol) is also called **mushroom alcohol** is chemical that has proven attractive to mosquitoes. It is also contained in human breath and sweat.

I also purchased an Octenol lure made by a US based manufacturer.

Mosquito trap unit

Suction fan and inside controls

Octenol lure

Validation

The study model was kept at various places in campus where mosquito is infested. Validation of proposed technology was crucial to make sure that the technology is reliable.

The model had an option to use battery. This was helpful because it allowed to place the product in several places away from a plug point which otherwise would be impossible.

I selected places where me myself had experienced troubles because of mosquito bites.

Brewberries cafe is a crowded place in the campus where several students spent hours enjoying coffee, celebrating birthday parties etc. This place is often infested by tiny mosquitoes.

The other location chosen was the Amul milk shop outlet located outside hostel 14.

Observations

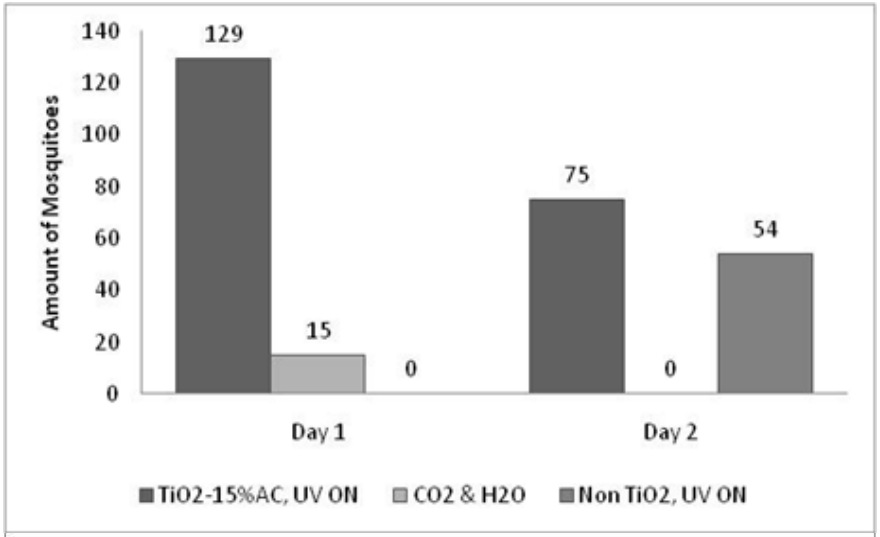
Place of trial	Hours	Volume of catch	Type of insect
Amul milk shop (H-14)	7pm-9pm	2	1 mosquito, 1 fly
Brew Berries	12am-3am	3	2 mosquito, 1 fly
Brew Berries (with octenol* patch)	6pm-12am	5	3 mosquito, 2 fly

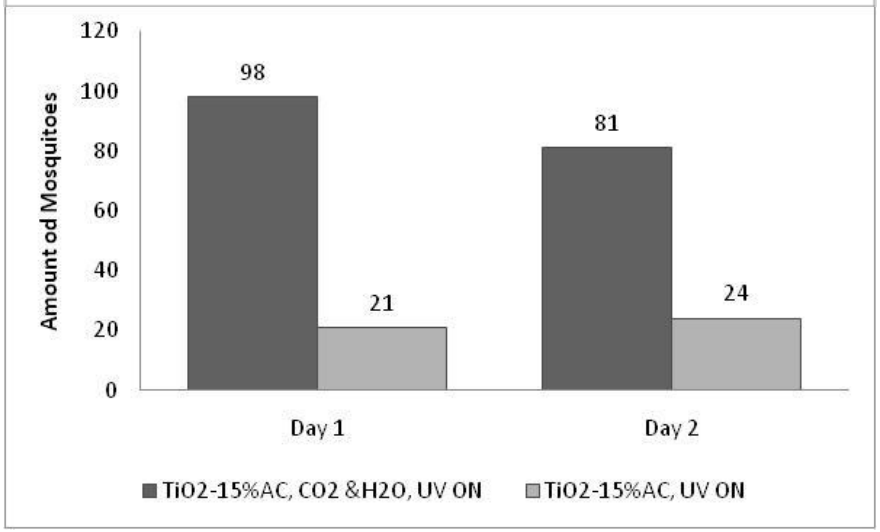
The overall catch rate of the equipment is observed not up to the mark as promised by the manufacturer. Catch rate was found to be little high while trap is set with octenol. The conclusion is that either there is no sufficient Co2 produced through photocataylis due to poor/absent coating of Tio2 or the LED lights doesn't emit wavelength in the required nanometer range to create attraction.

However, there is enough papers and journals published sating that the technology is valid and working. There are two patents issued under this technology.

-International patent: PCT/kr/01-00427 (2000)
-Korea domestic patent: No.43847 (2001)

In a research paper published by International Journal of Engineering, students from University of Indonesia Kampus, Baru have made comparative graphs showing erole of photocatalysis in mosquito attraction compared to non TiO2 coated trappers. They also observed that water vapor and slightly warm temperatures further increase attraction of mosquitoes





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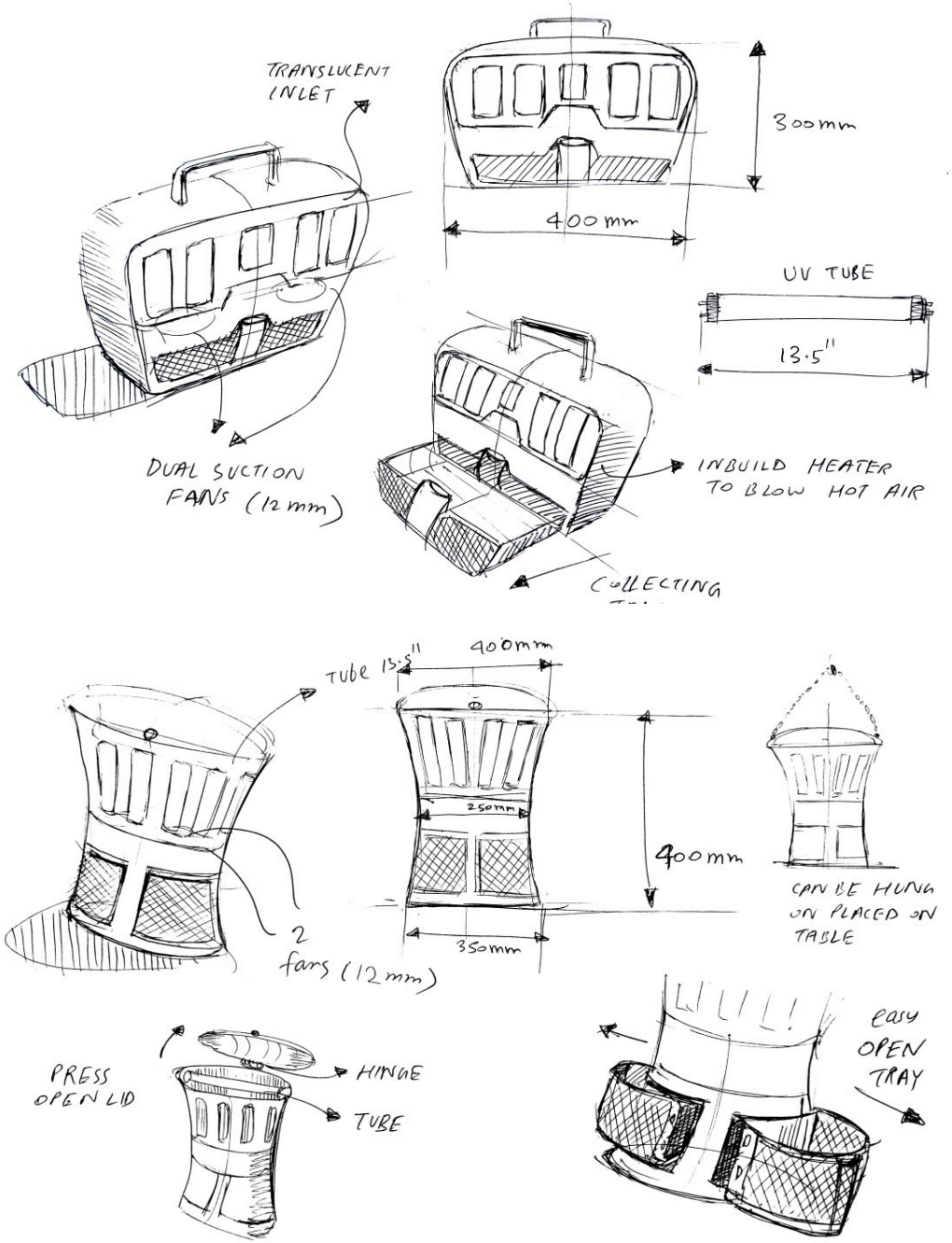
Research Paper

SPC

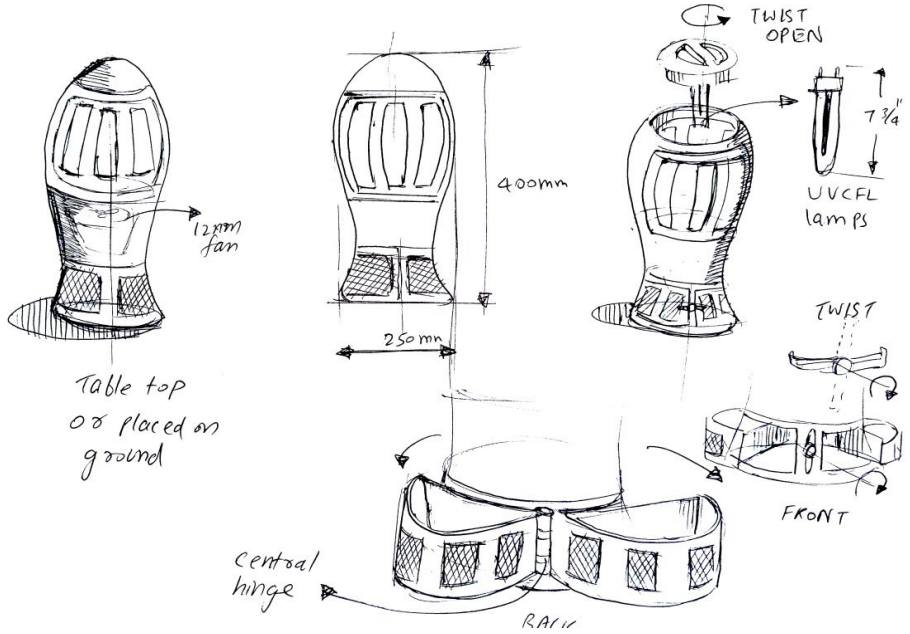
Published under Chemical Engineering Department, Engineering Faculty, University of Indonesia Kampus Baru

07 Ideation sketches



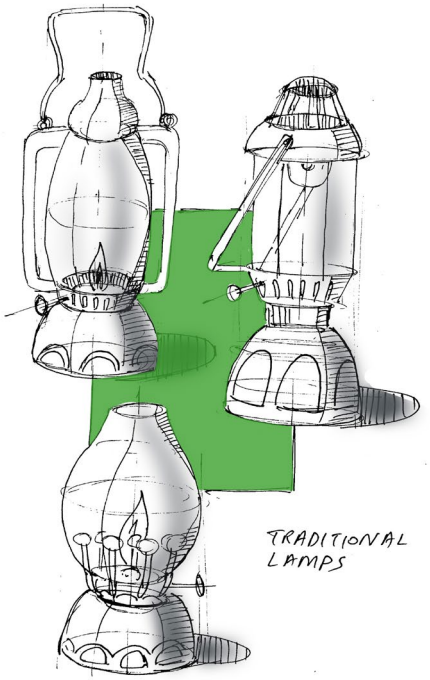
Initial sketches were made to explore a new form language for the product. The attempt was to create a form that invokes new emotion in the viewer distinct from the usual perception of a regular bug zapper.

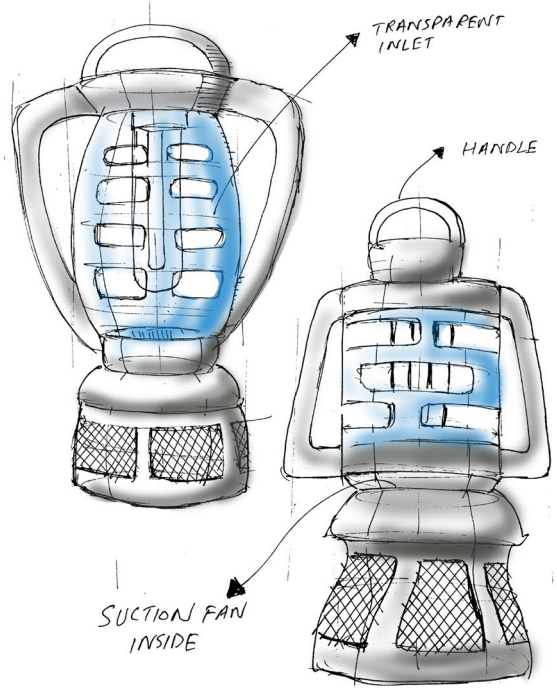
I also explored possibilities of easy collecting tray removal, opening and servicing etc. While keeping portability and ease of use in mind.

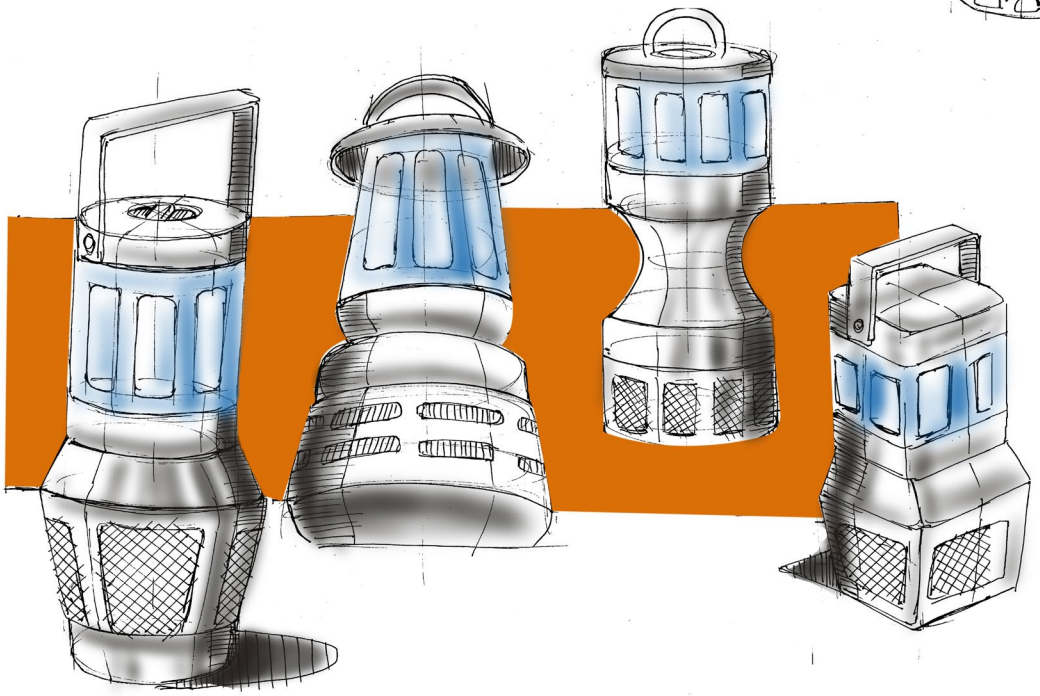


Ideation sketches -Domestic domain

To give the product a familiar face, form inspirations were taken from various day- today products.

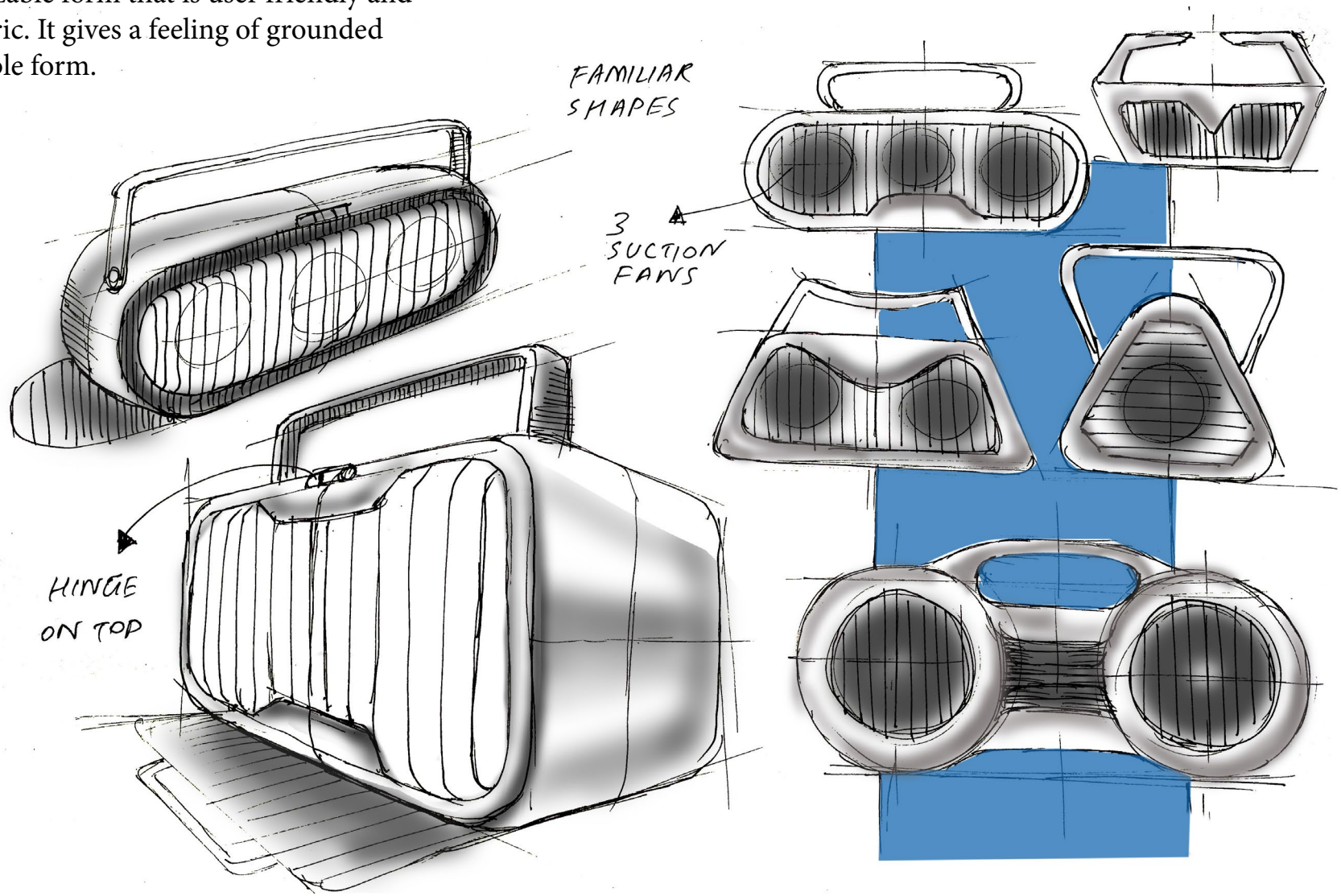




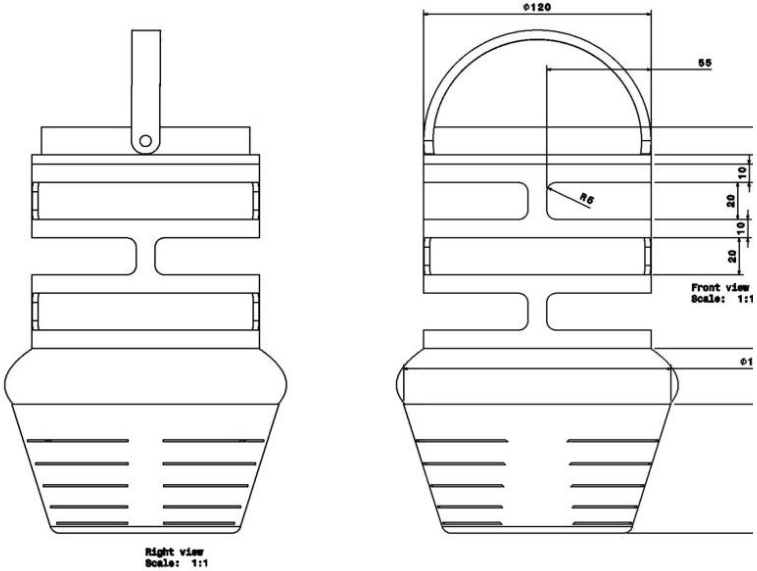


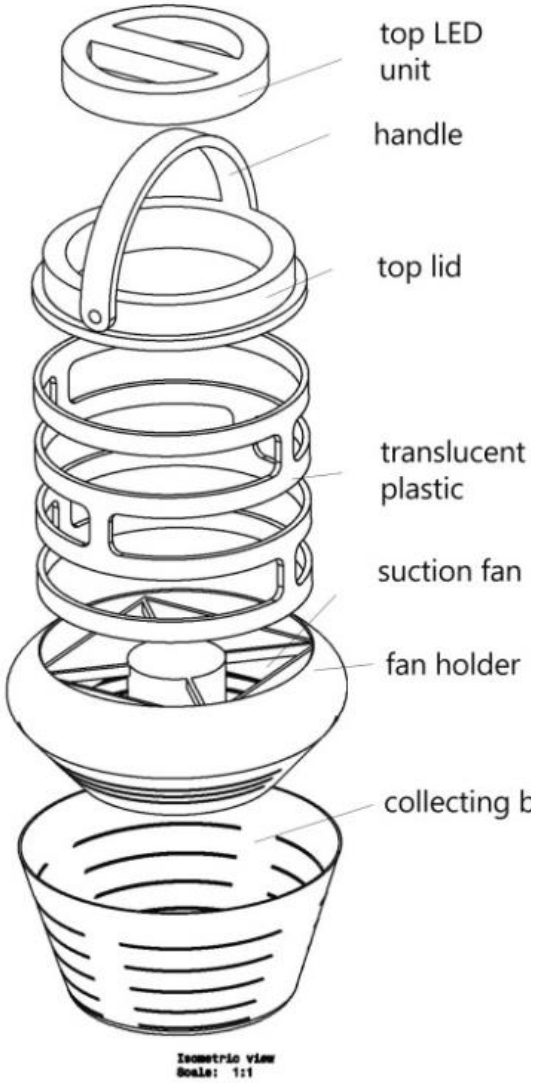
The design was inspired from lanterns as traditional lanterns are handy. The form is flexible to adapt to any indoor or outdoor situation and is easily portable.

Radio is one of the most easily recognizable form that is user friendly and geometric. It gives a feeling of grounded and stable form.



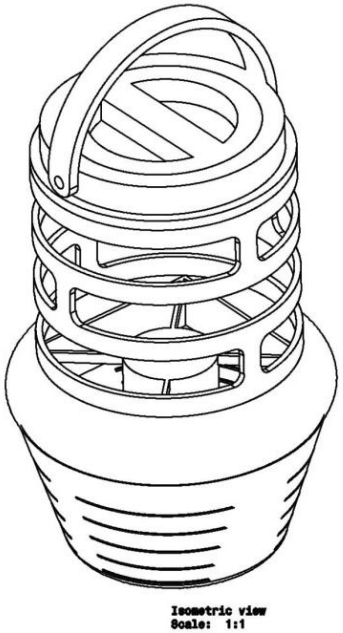
Dimensional drawings-concept 1



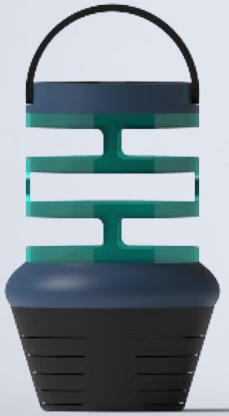


Materials used
Casing and outer cover-ABS
Inlet- translucent acrylic

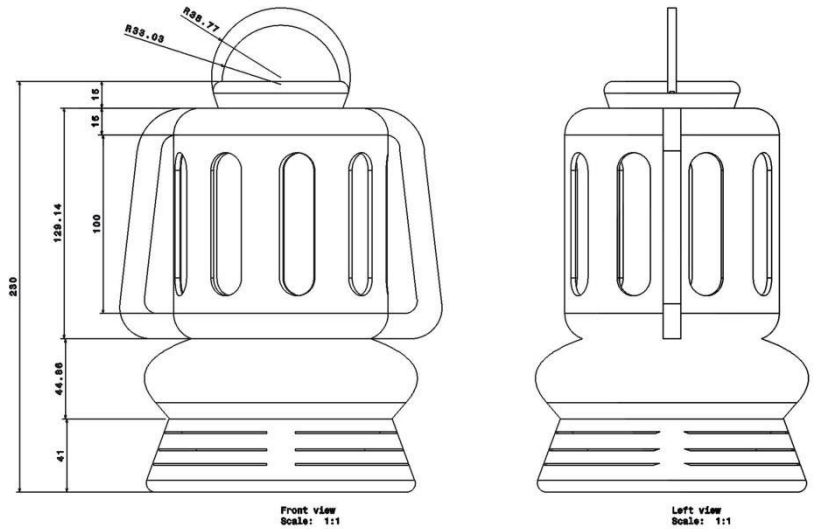
Process
injection molded
snap fit joineries

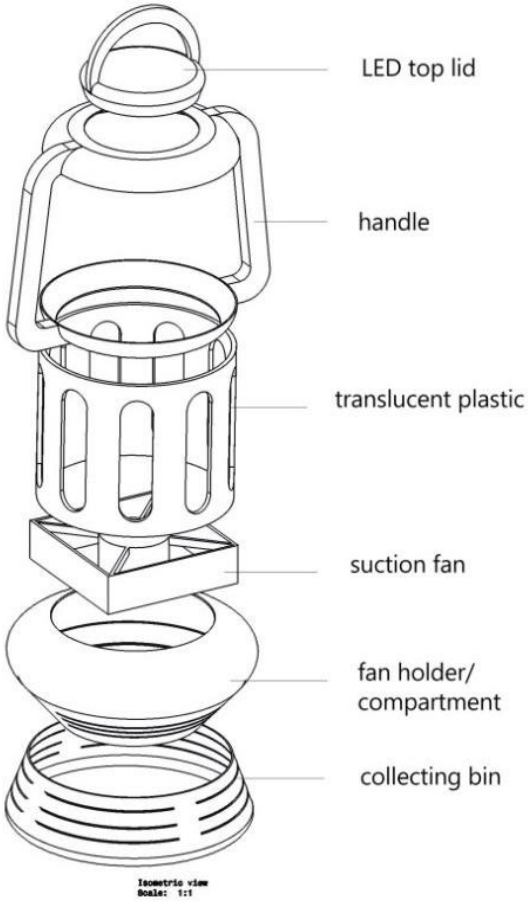


The design consists of a foldable handle on top that merges completely with the top profile in folded position. A suction fan is kept at the middle and the collecting tray is connected to the main body by a twist lock. The top Led unit may also be accessed by twist opening the cap at the top.



Dimensional drawings-concept 2





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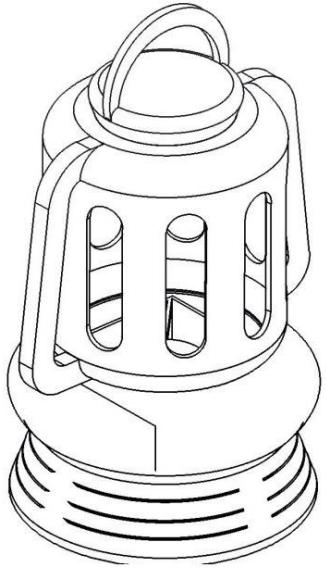
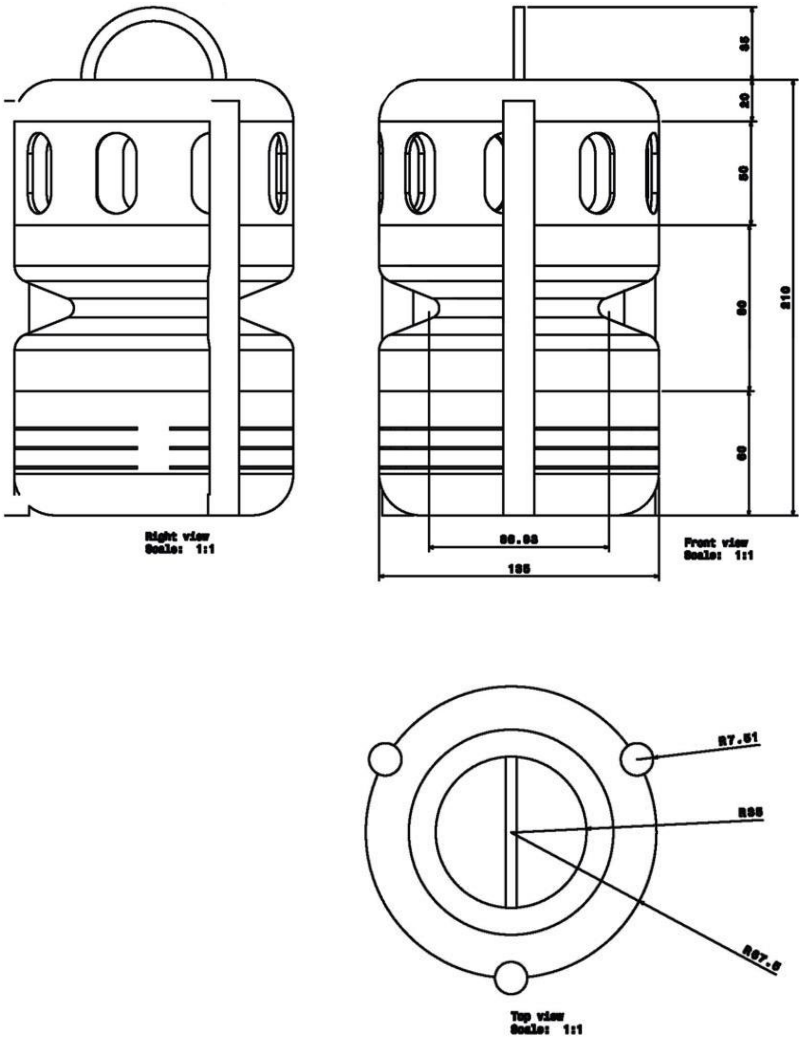
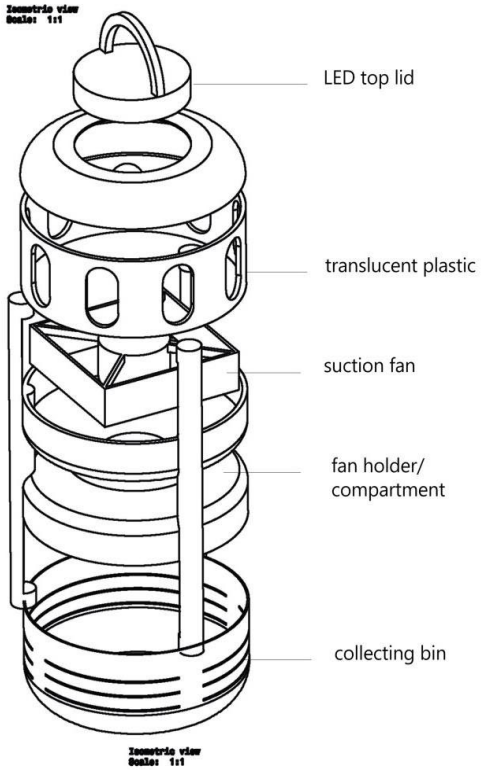


This design directly connects user to traditional kerosene lamps. A suction fan is kept at the middle and the collecting tray is connected to the main body by a twist lock.

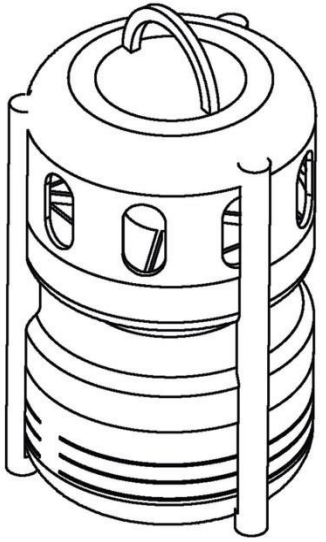
Dimensional drawings-concept 3





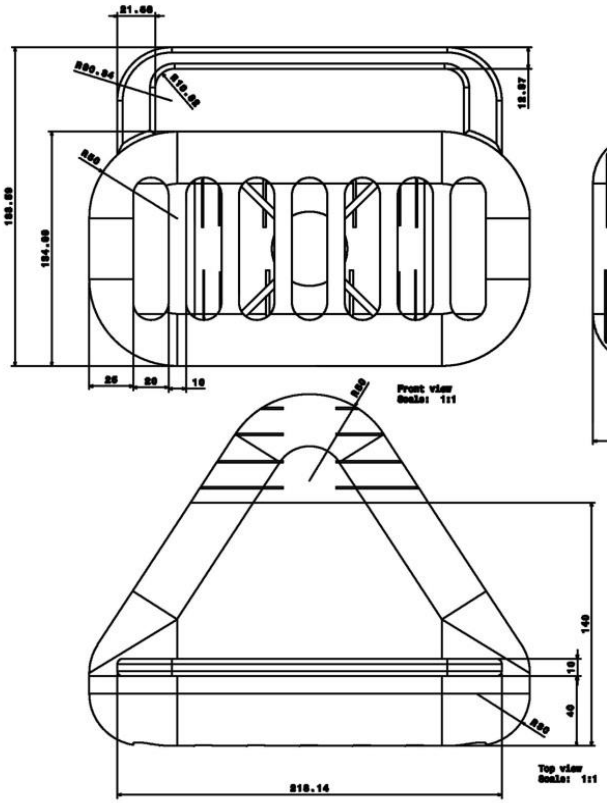
Materials used
Casing and outer cover-ABS
Inlet- translucent acrylic

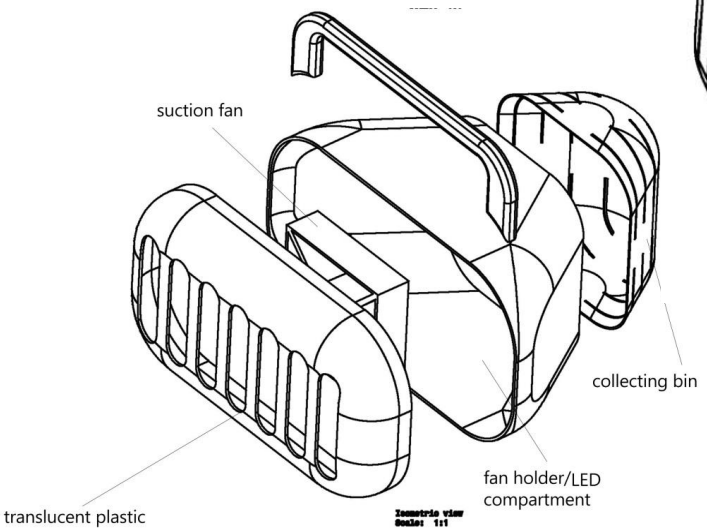
Process
injection molded
snap fit joineries

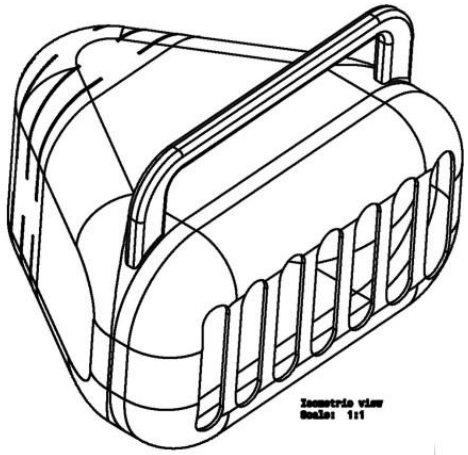


This design was inspired from a sand clock. A suction fan is kept at the middle and the curved central portion directs airflow faster with less chances of insect escaping. Collecting tray is connected to the main body by a twist lock.

Dimensional drawings-concept 4

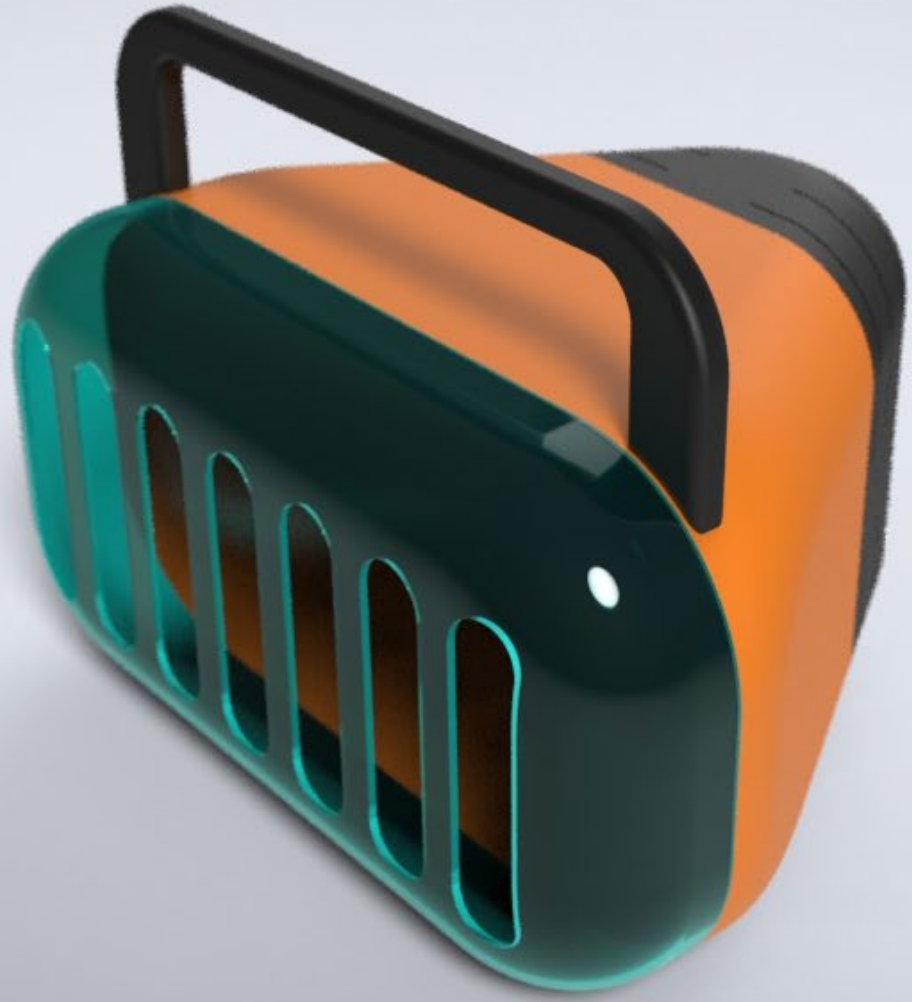






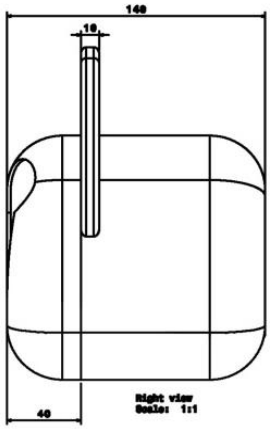
Materials used
Casing and outer cover-ABS
Inlet- translucent acrylic

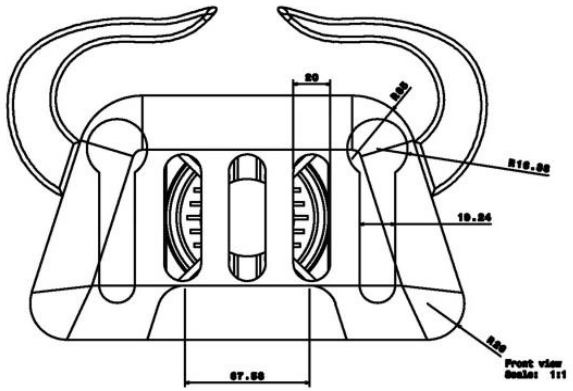
Process
injection molded
snap fit joineries

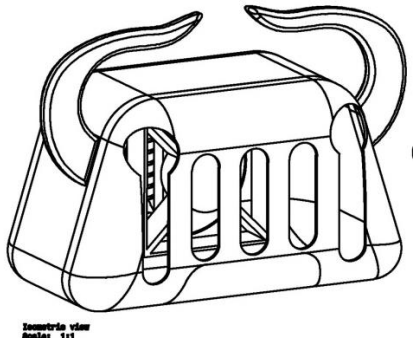


Inspired from a radio, the suction fan is kept at a horizontal axis which makes the product more grounded.

Dimensional drawings-concept 5

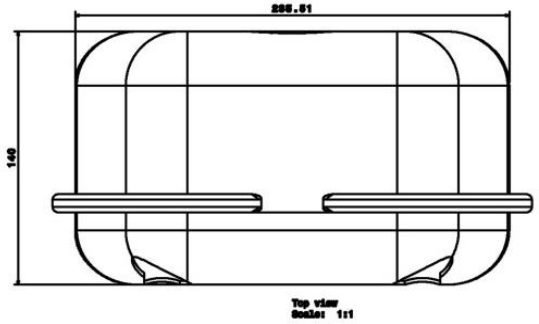


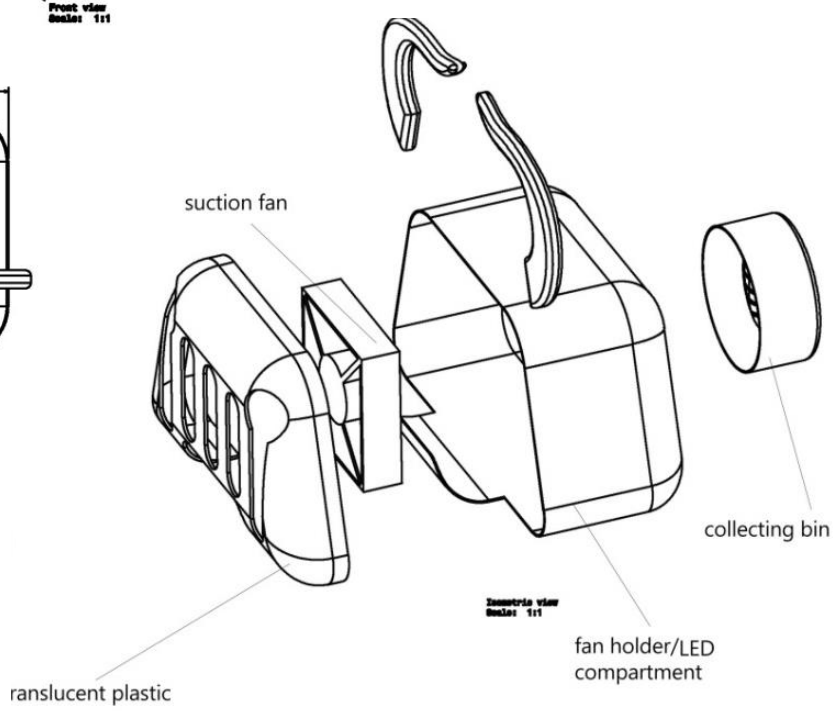




Materials used
Casing and outer cover-ABS
Inlet- translucent acrylic

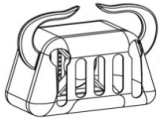
Process
injection molded
snap fit joineries





Kid friendly design with a unique touch to the handle. The suction fan is kept at a horizontal axis which makes the product more grounded.

Comparison -domestic scenario concepts

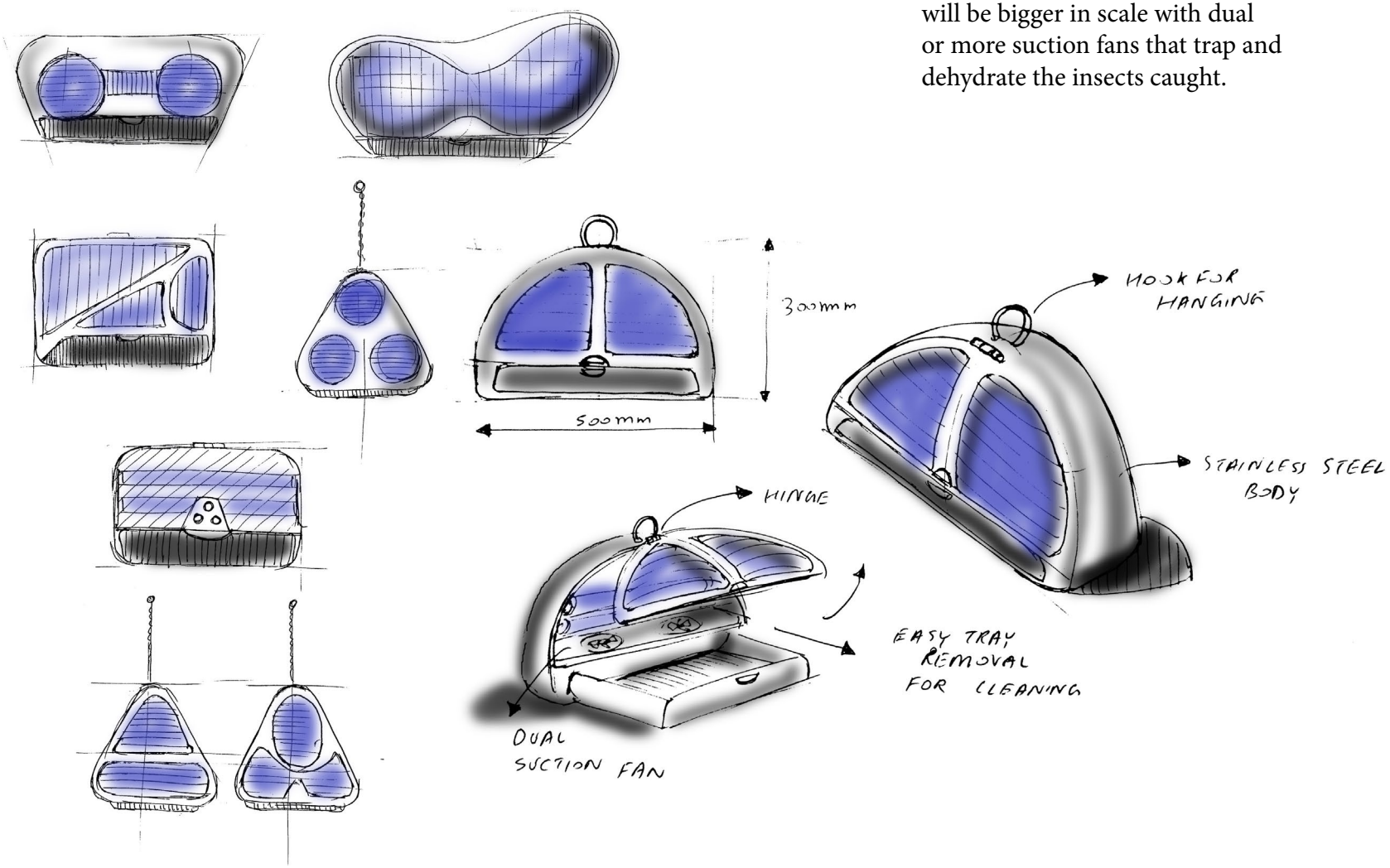
Design Proposal	Location of use	Dimension (mm)	Range	Power supply	Technology	Octenol tray
	Indoor/Hung/ Table top	H-220 Dia-150	360 degree	240v AC	UV+Suction fan+- TiO2	Yes
	Indoor/Hung/ Table top	H-230 Dia-150	360 degree	240v AC	UV+Suction fan+- TiO2	Yes
	Indoor/Hung/ Table top	H-210 Dia-135	360 degree	240v AC	UV+Suction fan+- TiO2	Yes
	Indoor/ Table top	H-185 L-250	180 degree	240v AC	UV+Suction fan+- TiO2	No
	Indoor/ Table top	H-185 L-250 B-150	180 degree	240v AC	UV+Suction fan+- TiO2	No

Critical Thinking

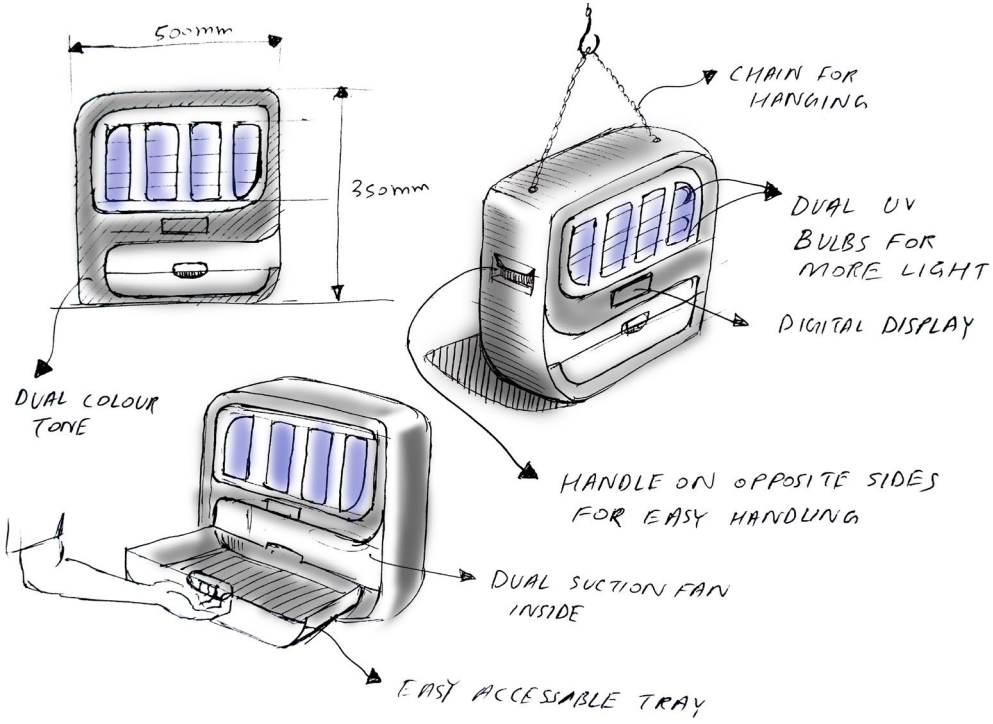
As the initial ideation was not explored with any specific constraints or context, it was suggested to look at certain refinement of concepts with in the context.

This lead to further exploration into the project for a public domain product that addressed segments needs like wall mounted, grounded, hanging etc. by giving a family nature to the products.

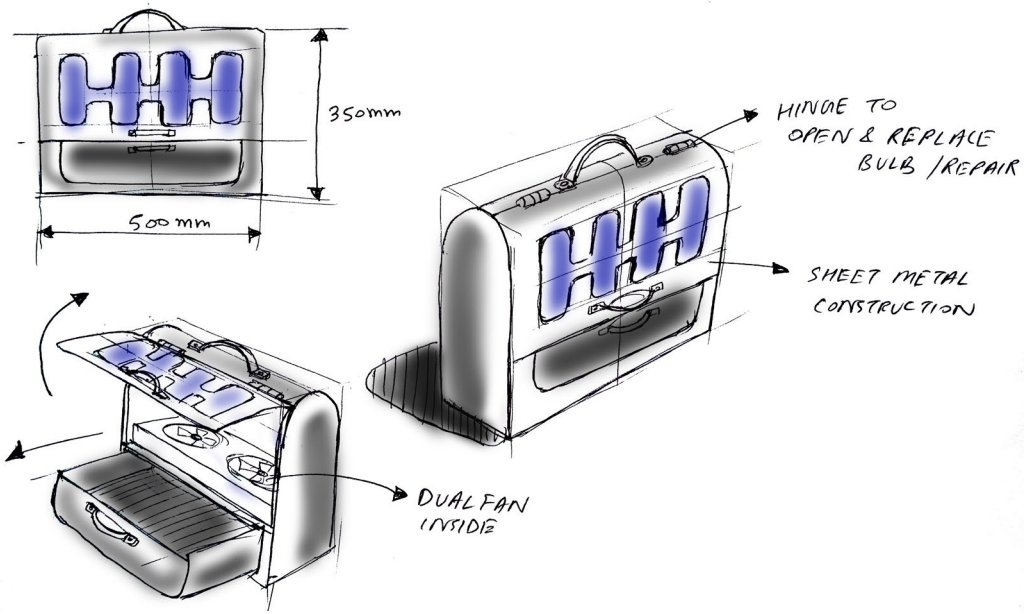
Ideation sketches-public domain



Products placed in public domain will be bigger in scale with dual or more suction fans that trap and dehydrate the insects caught.

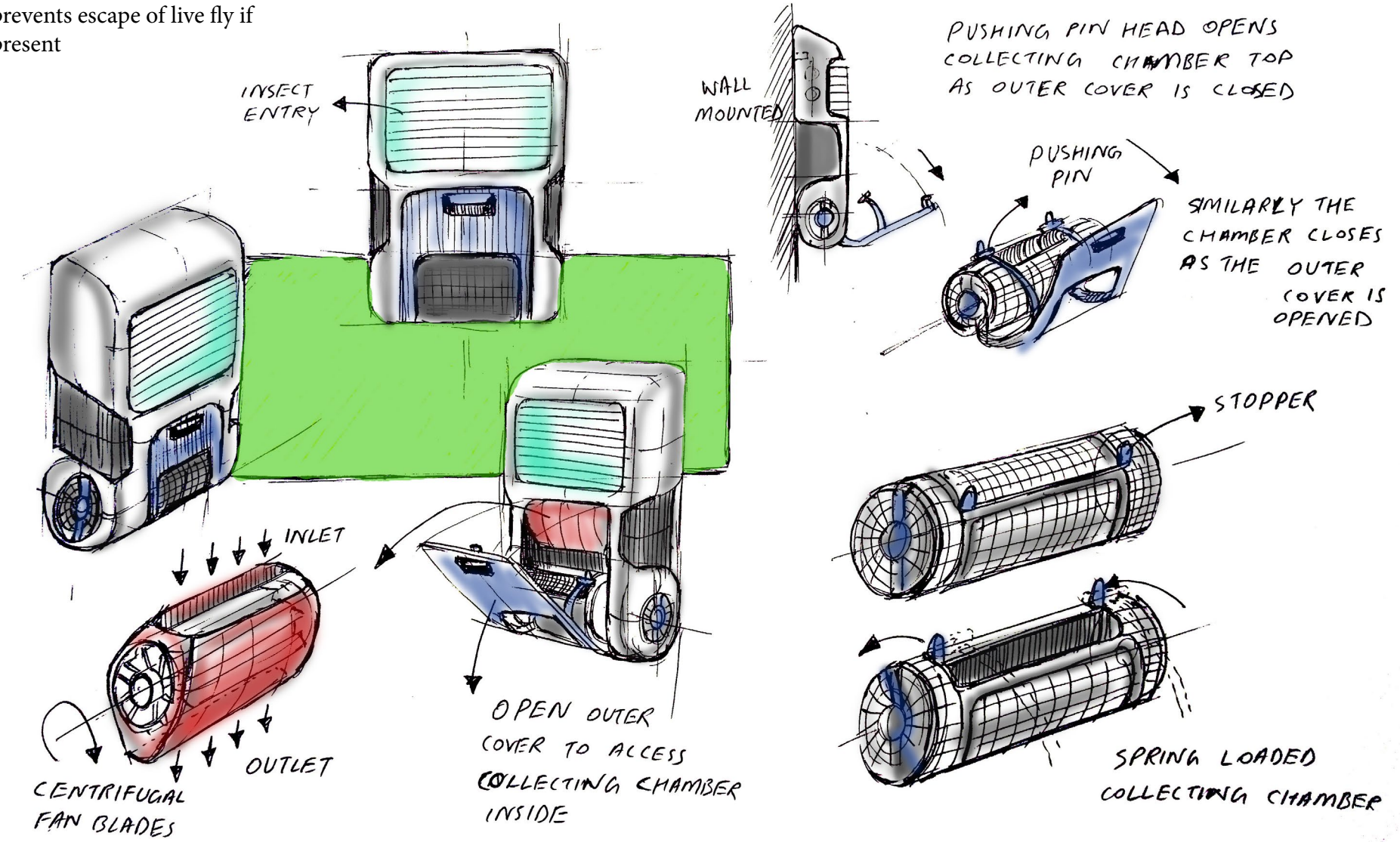


Hanging and grounded

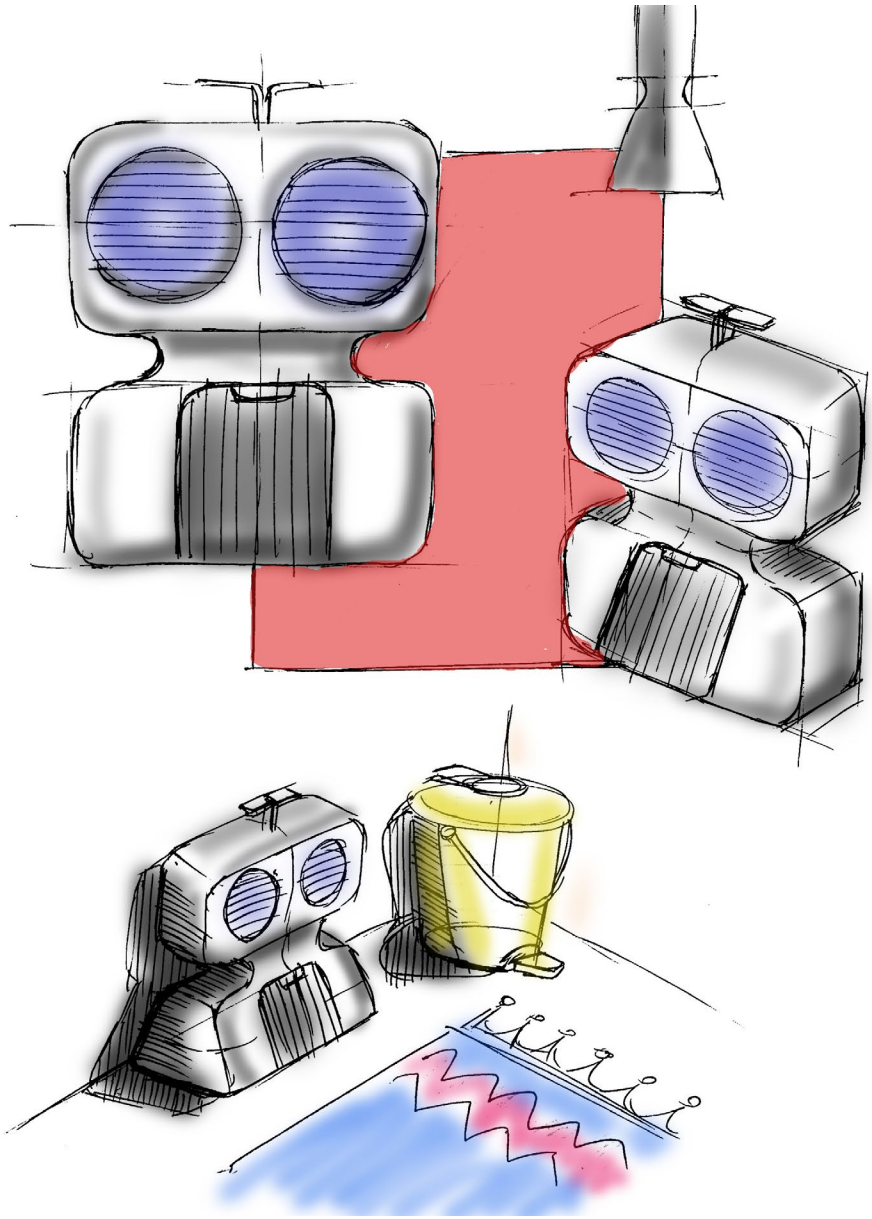


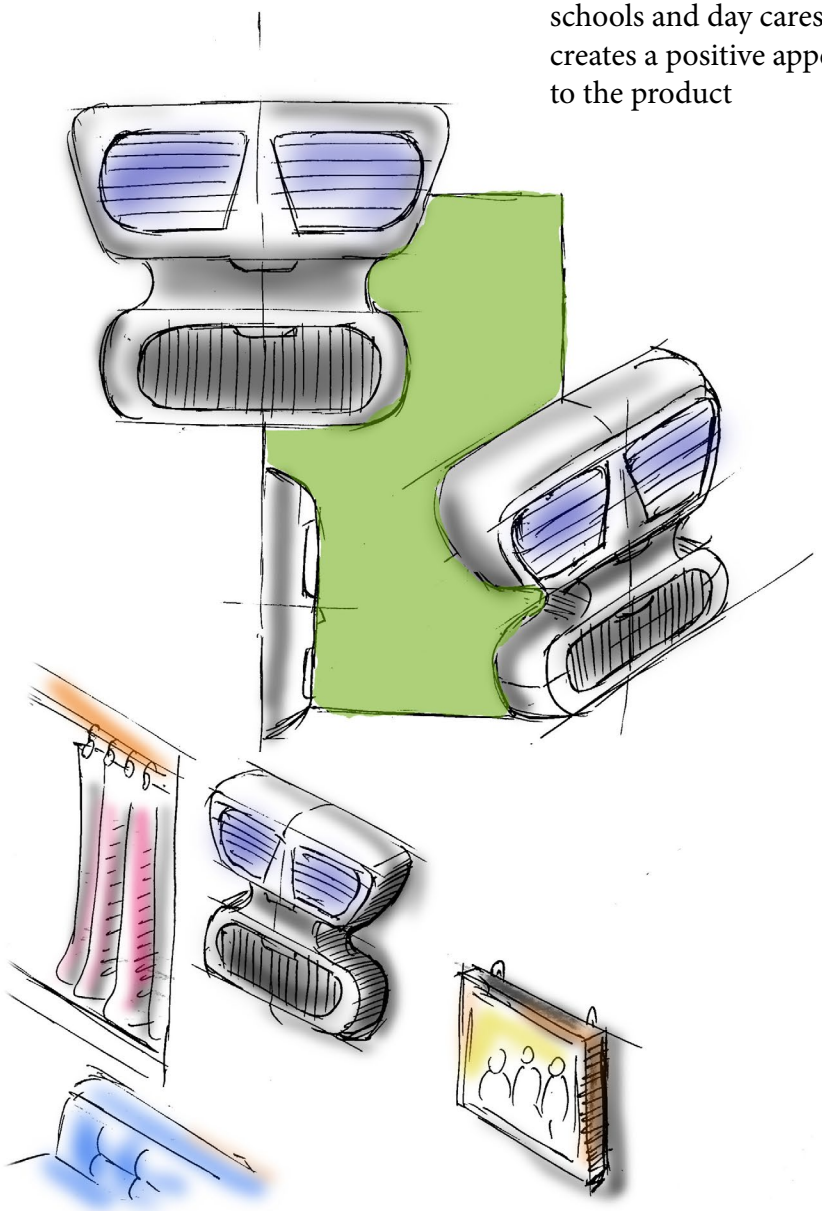
Grounded

Spring loaded collecting bin that automatically close once outer cover is opened prevents escape of live fly if present

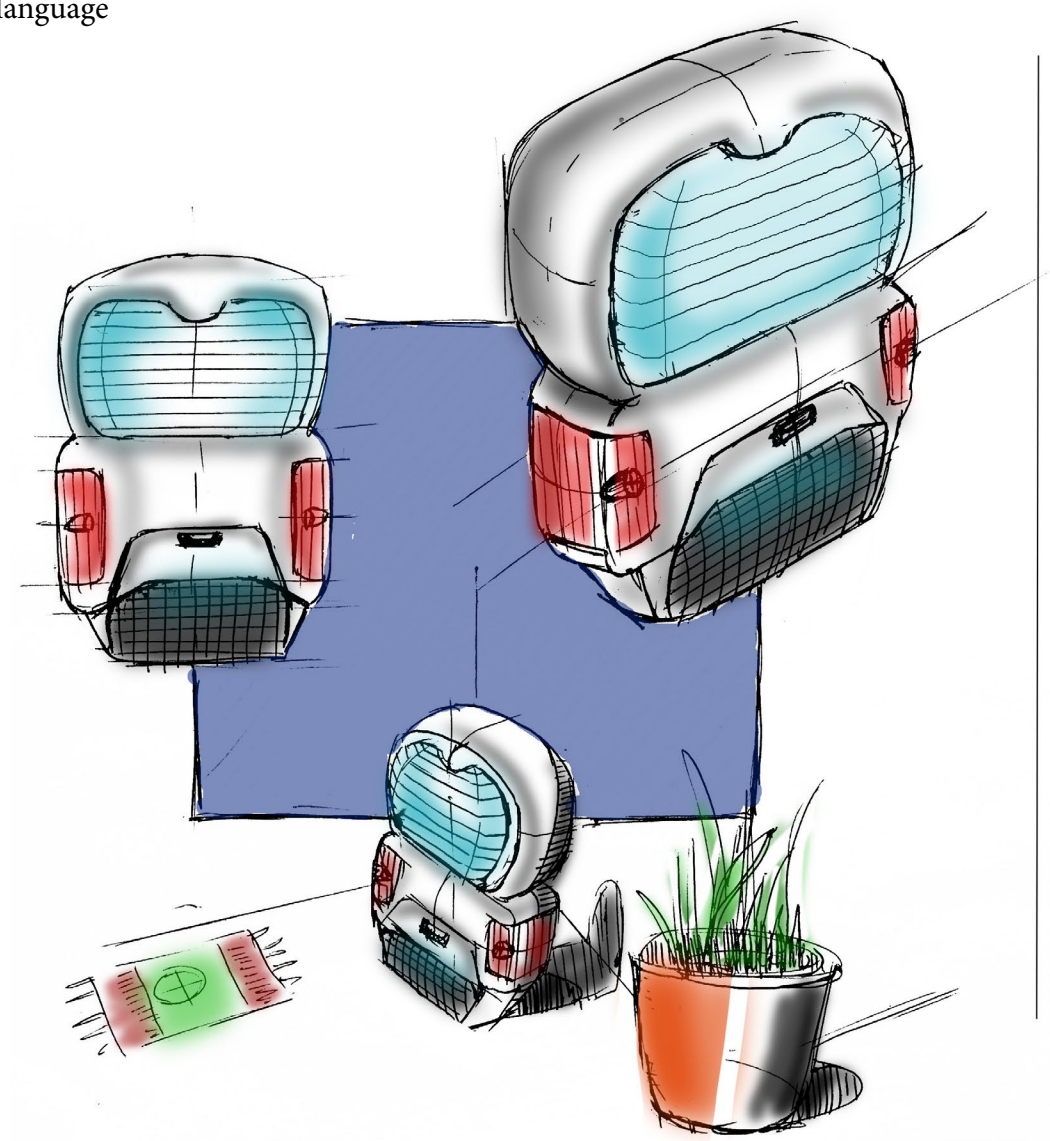


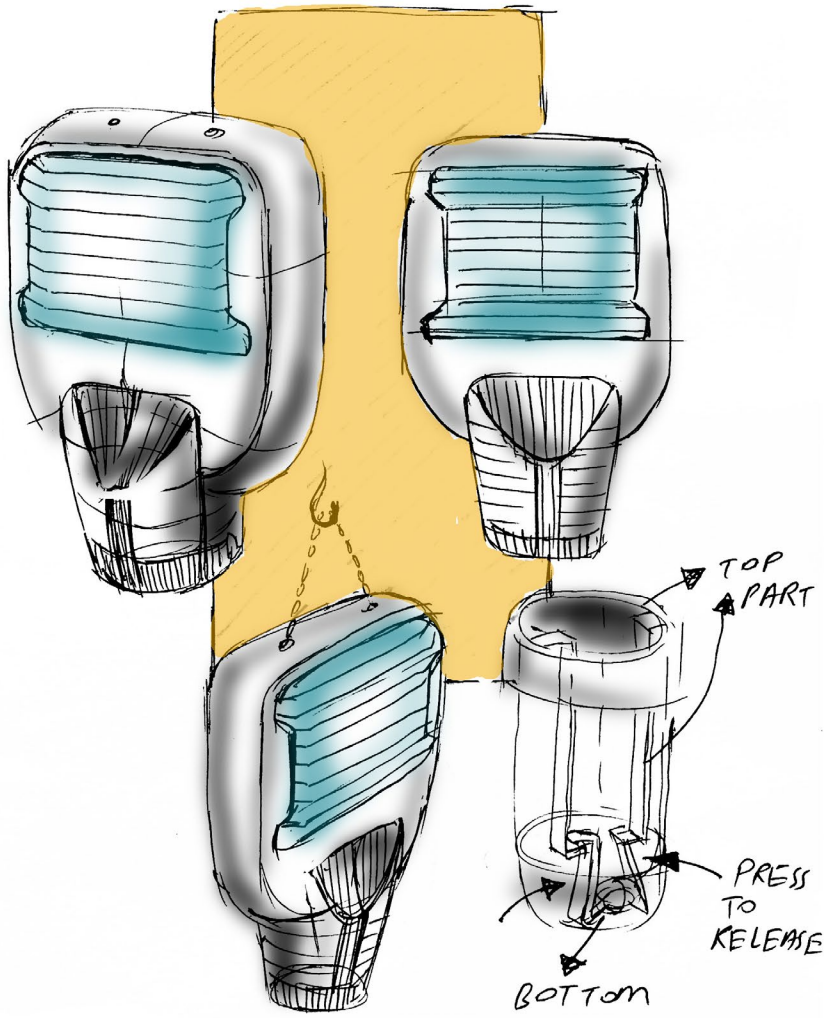
Child friendly designs may be deployed in nursery schools and day cares that creates a positive appearance to the product

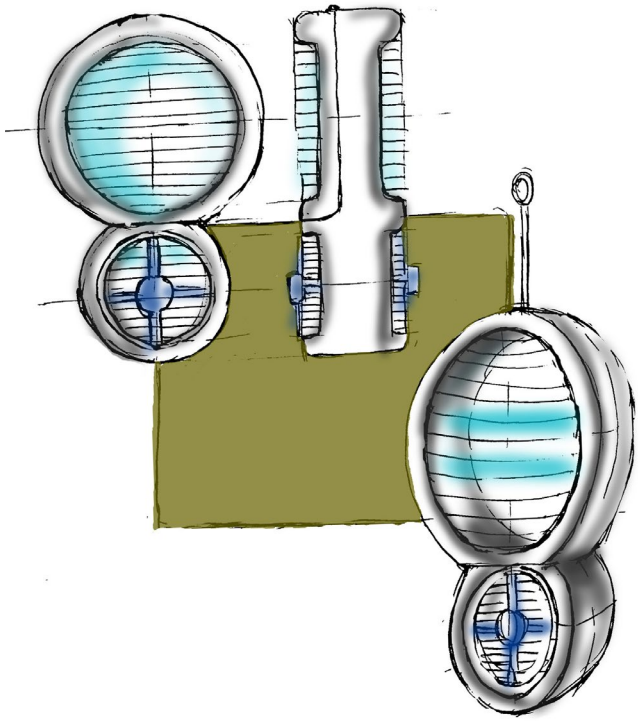


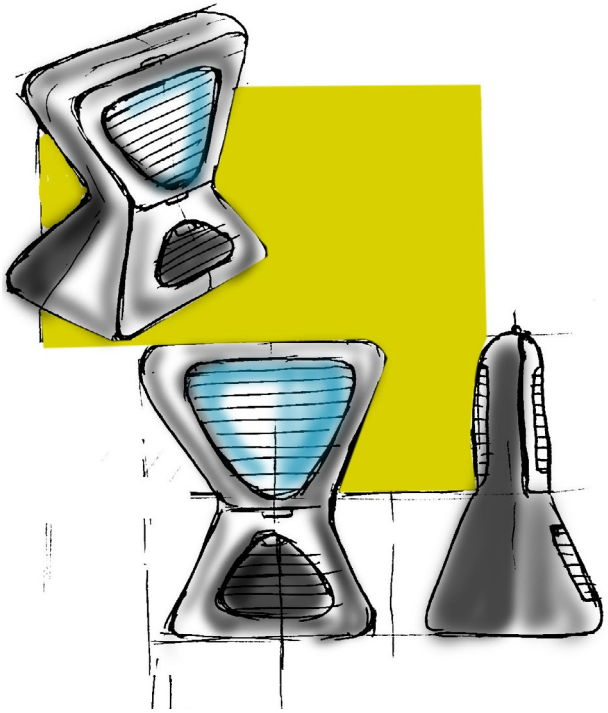


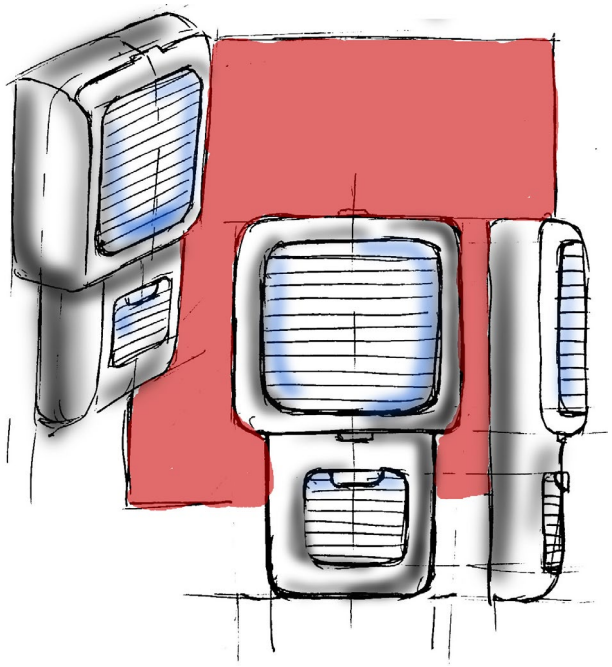
Semantics of public domain products were studied to arrive at a certain design language



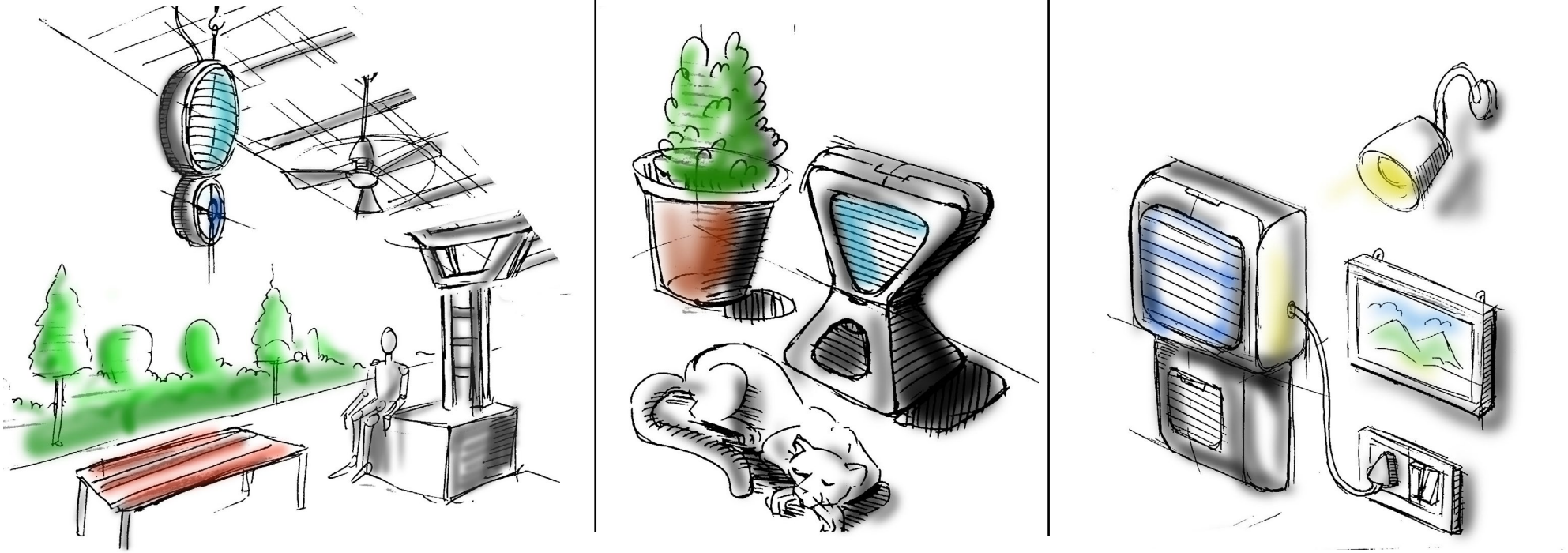








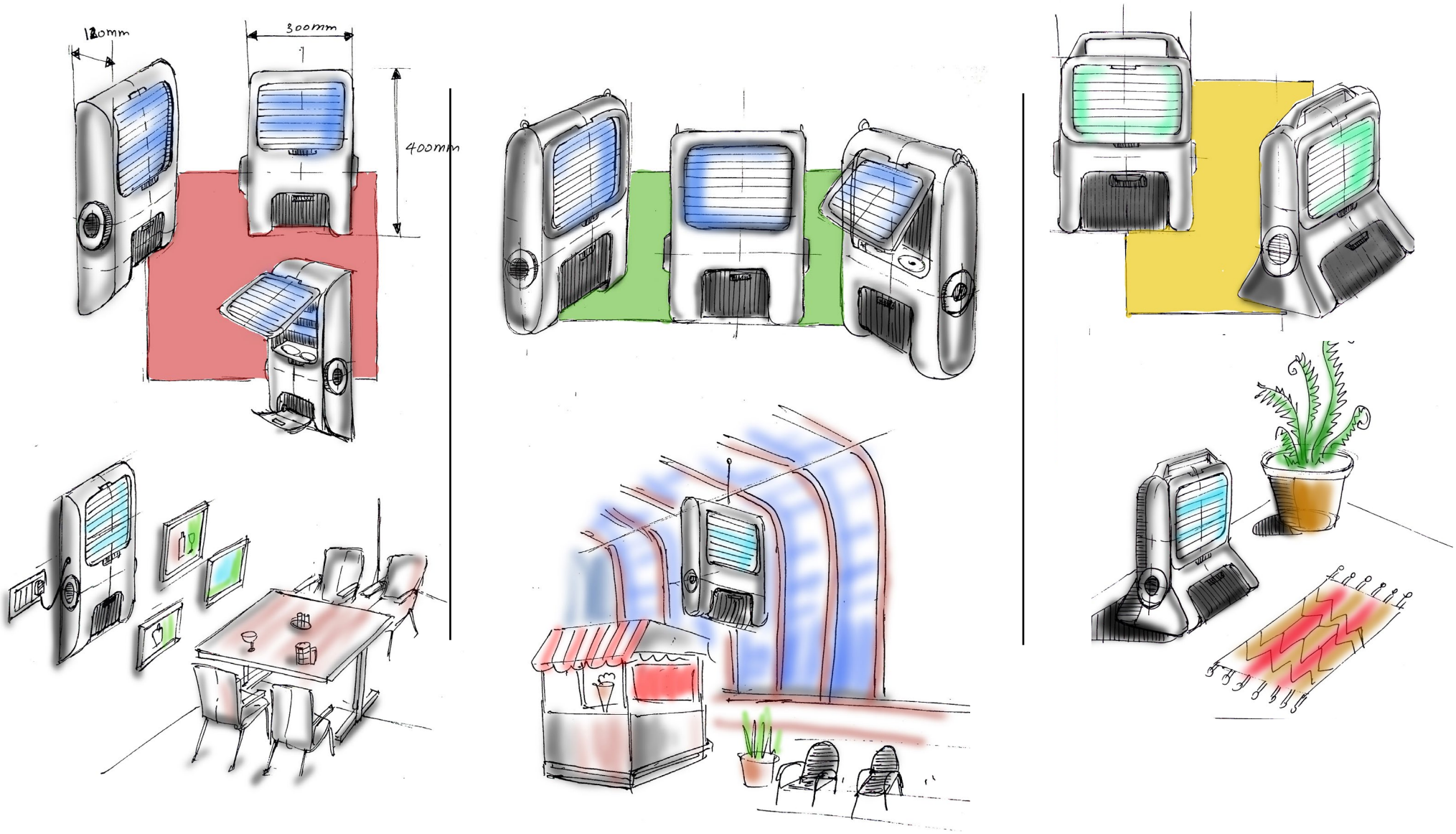
An exploration to see how combining geometric shapes in different proportions brings out unique look and feel



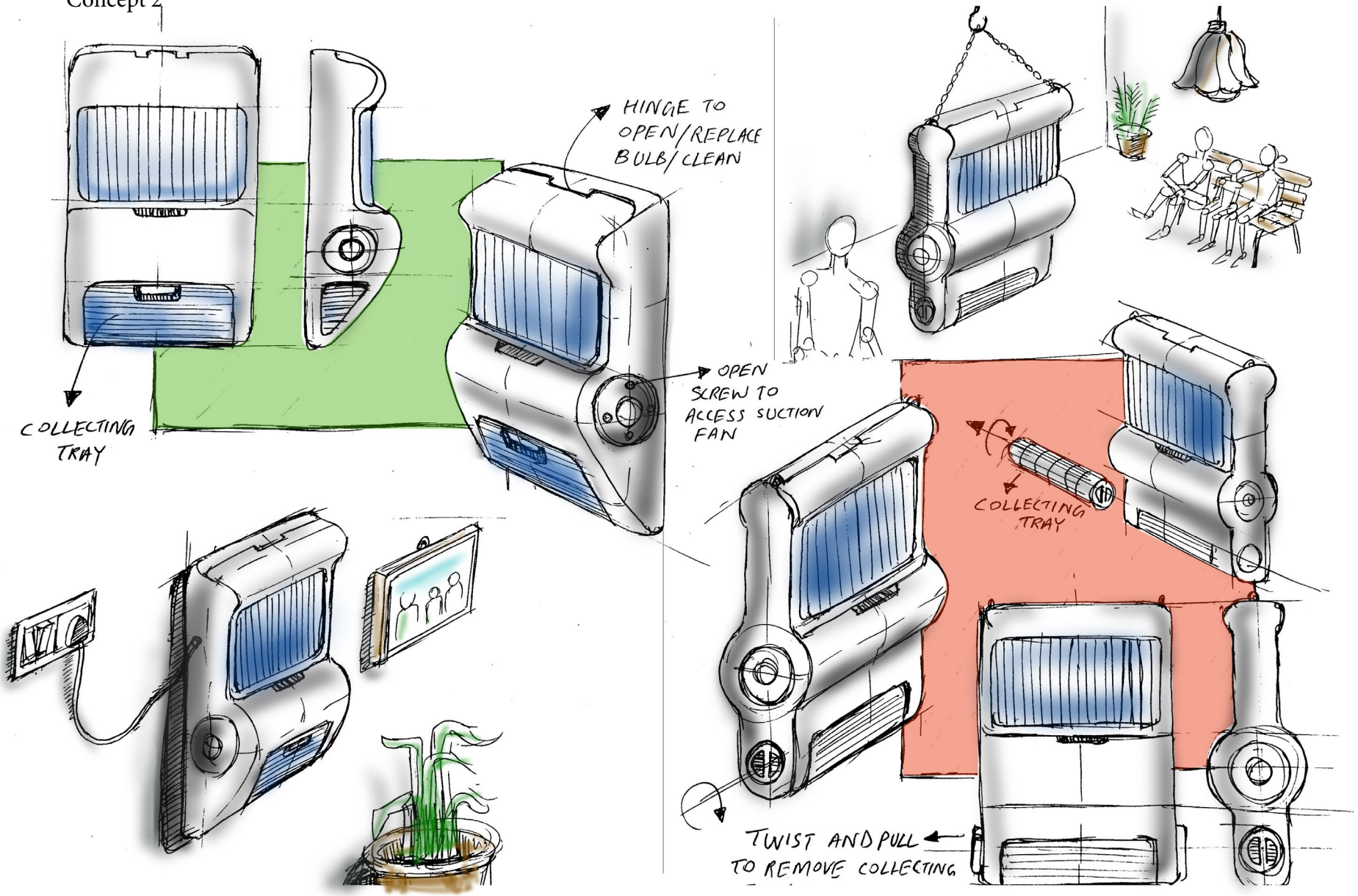
Render with scenario of usage

Refined sketches-Public domain

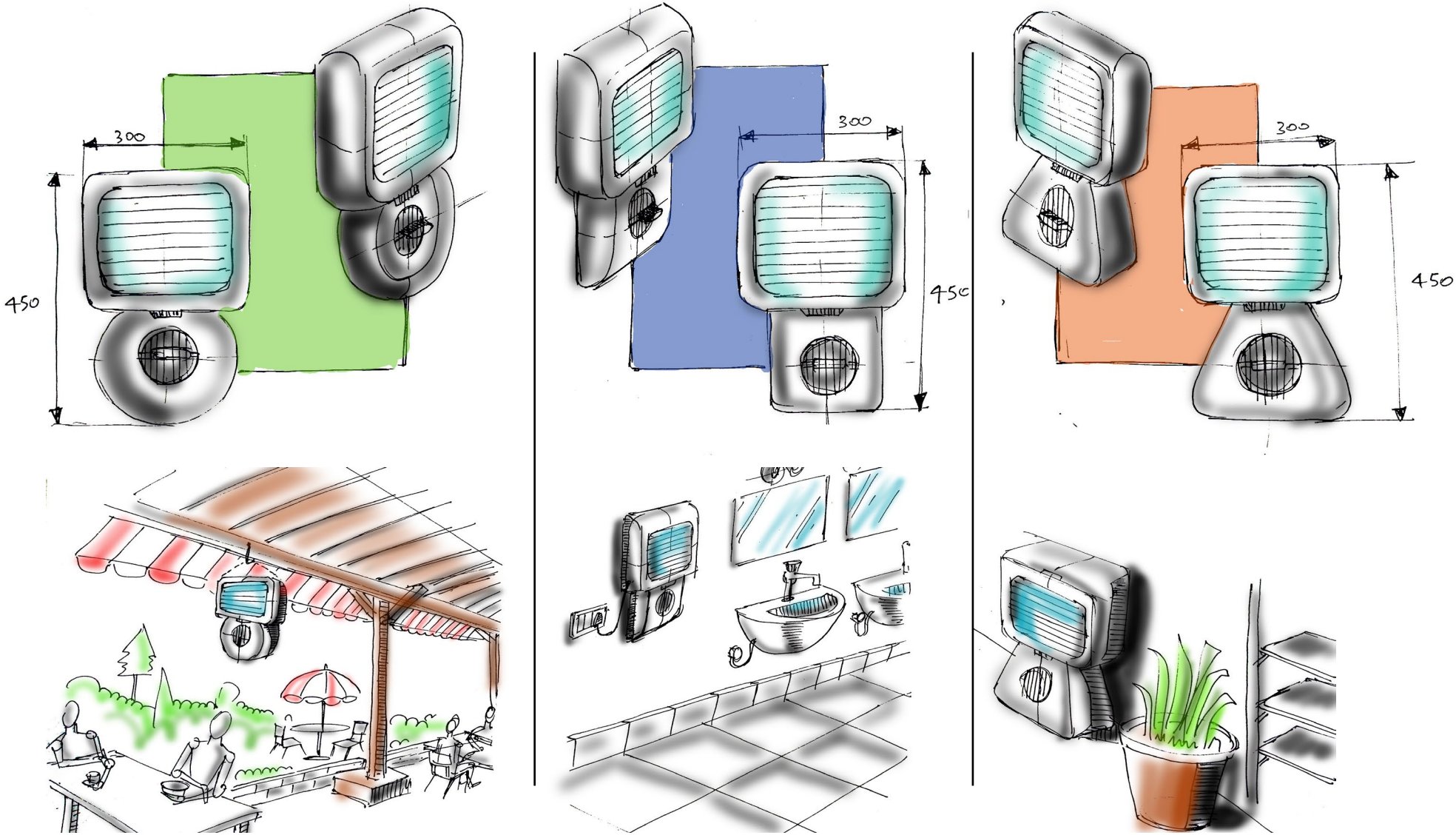
Concept 1



Concept 2


HINGE TO OPEN/REPLACE BULB/CLEAN
COLLECTING TRAY
OPEN SCREW TO ACCESS SUCTION FAN
COLLECTING TRAY
TWIST AND PULL TO REMOVE COLLECTING

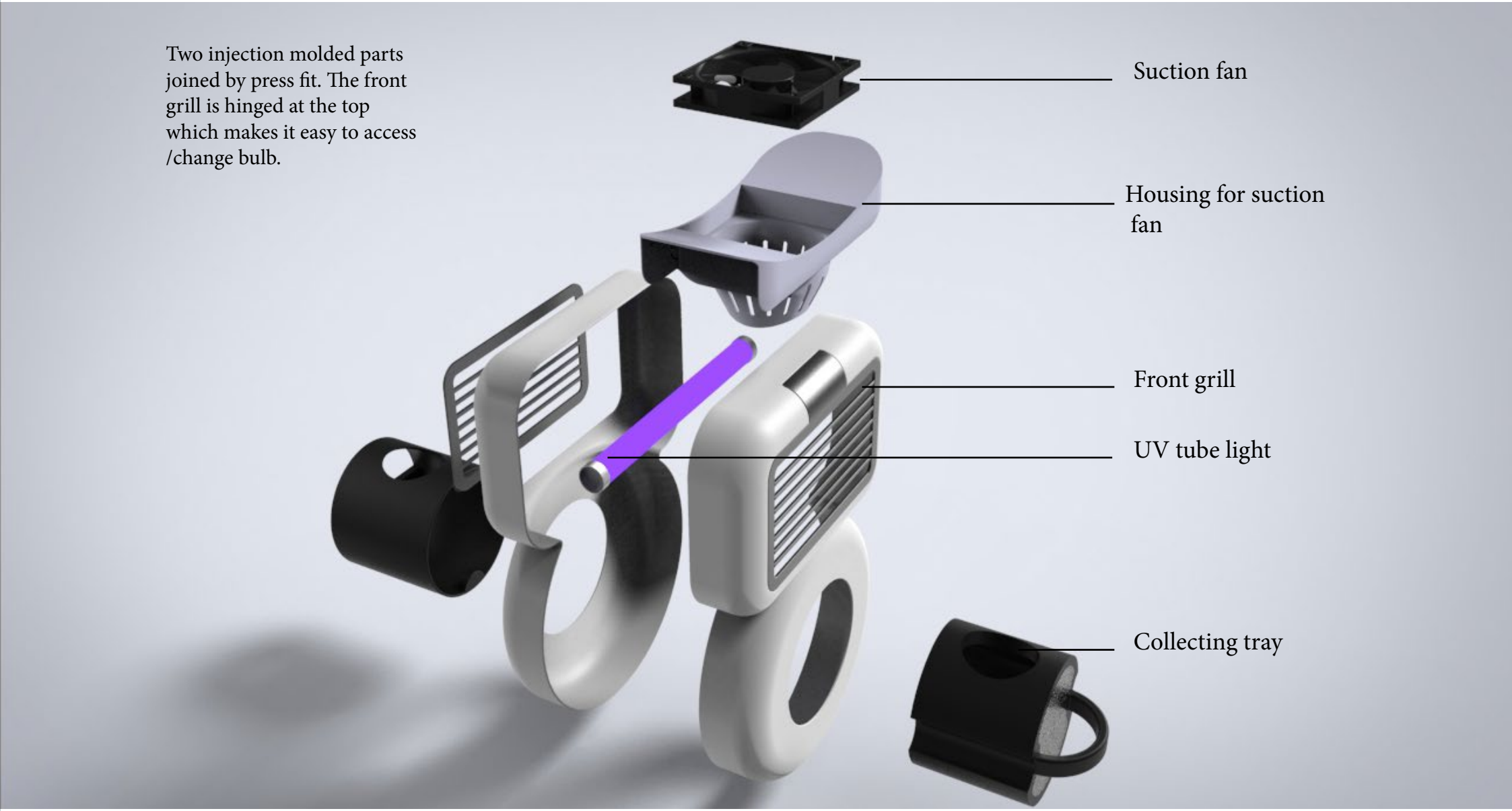
Concept 3



08 3D model and renders

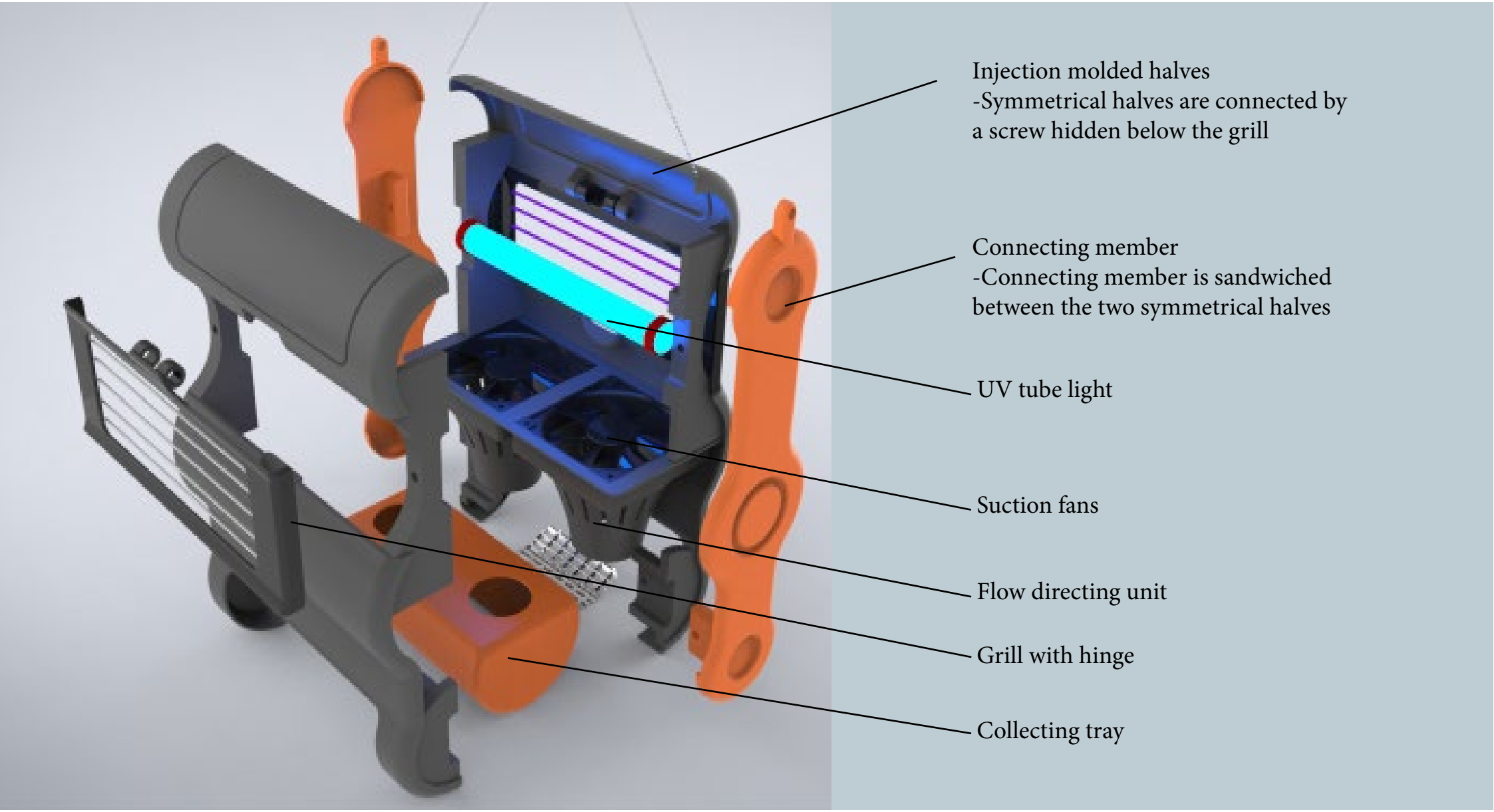
Part list -set 1

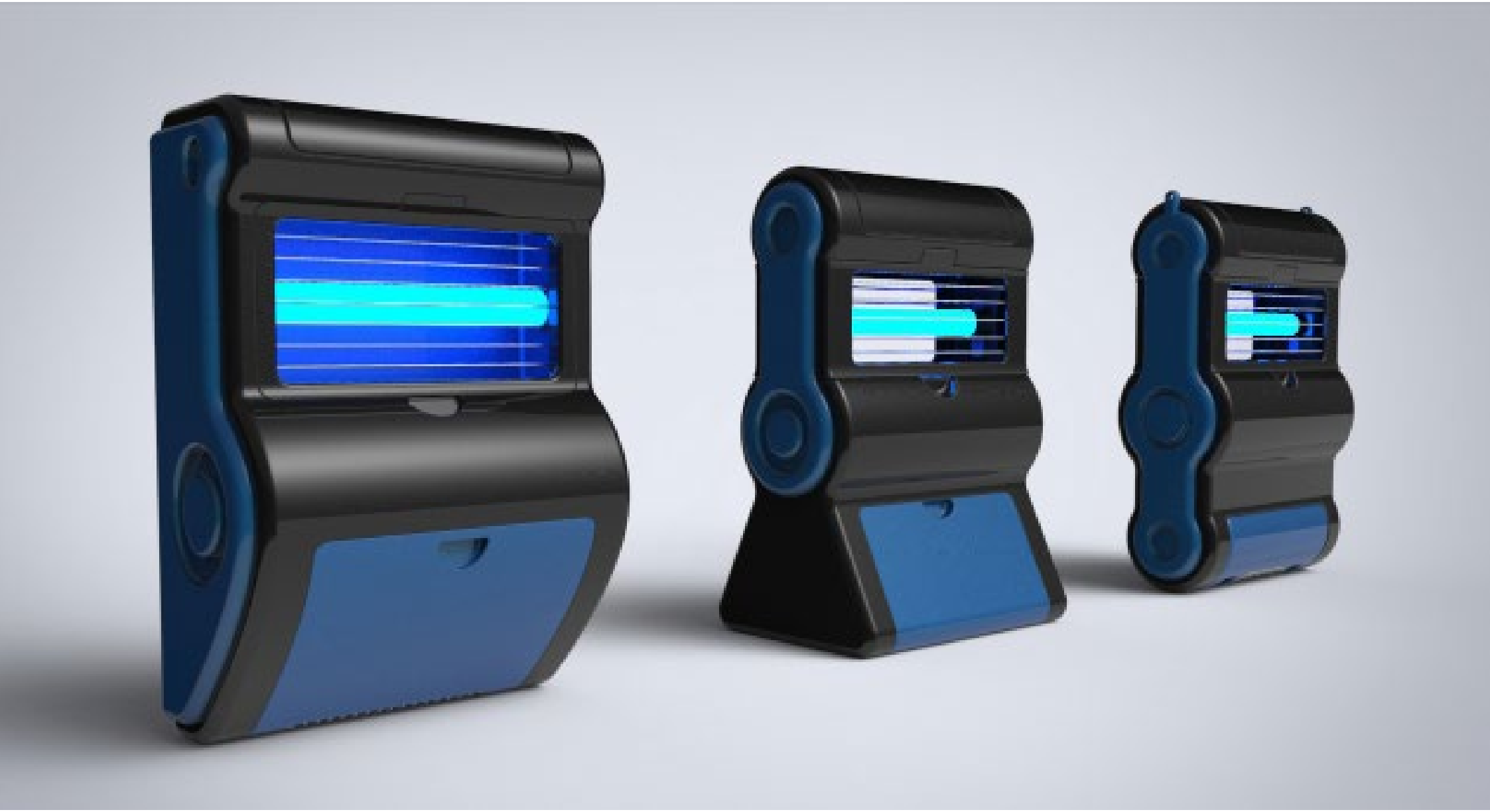
Two injection molded parts joined by press fit. The front grill is hinged at the top which makes it easy to access /change bulb.

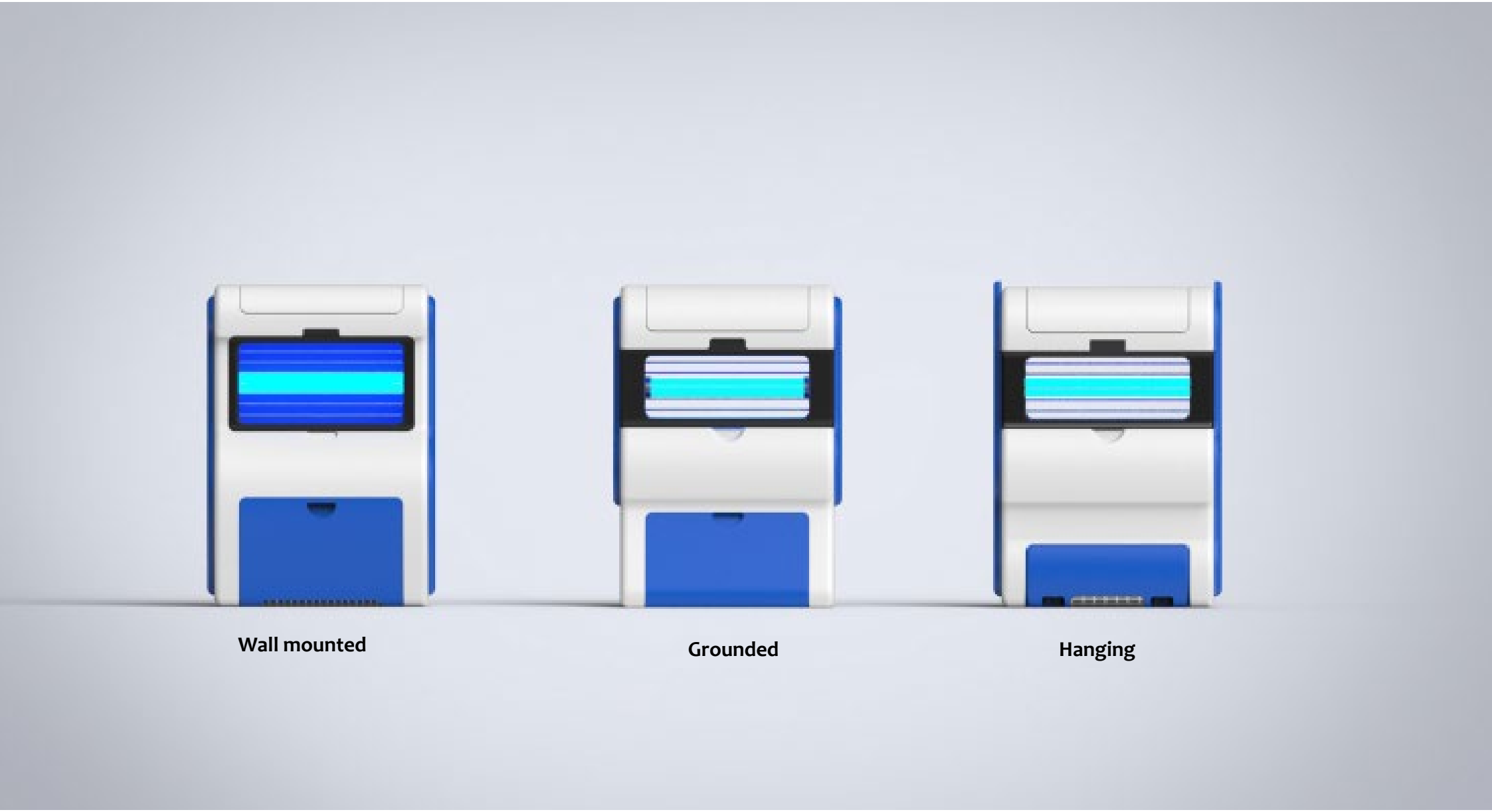



Hanging
Grounded
Wall mount

Part list -Set 2






Wall mounted
Grounded
Hanging

Models were made to stand distinct and the design speak of functionality by itself

Collecting tray is not directly viewed considering users do not like to see dead insects directly

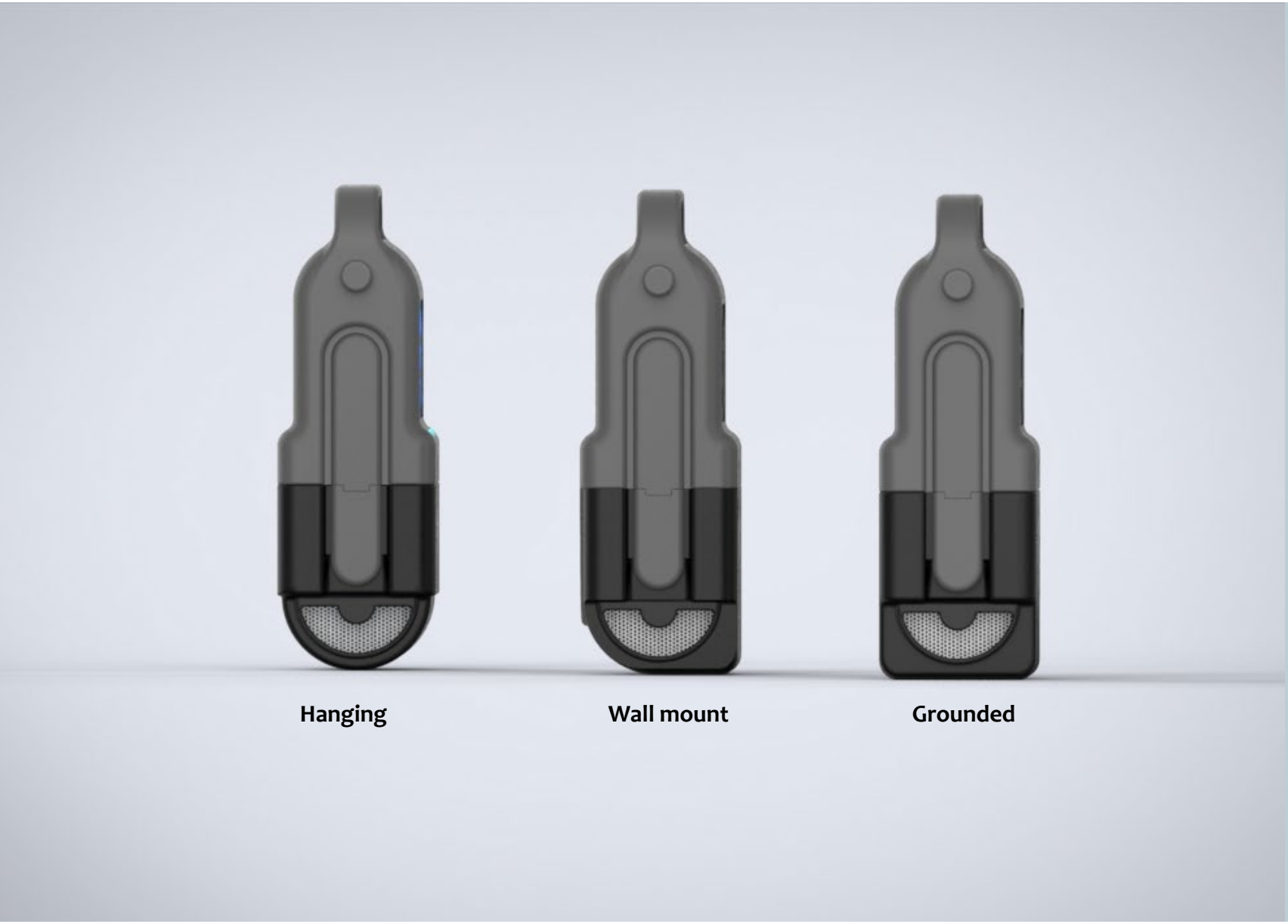
Design elements were made to invoke a sense of family nature with in the products

Part list -set 3

Hanging

Wall mount

Grounded



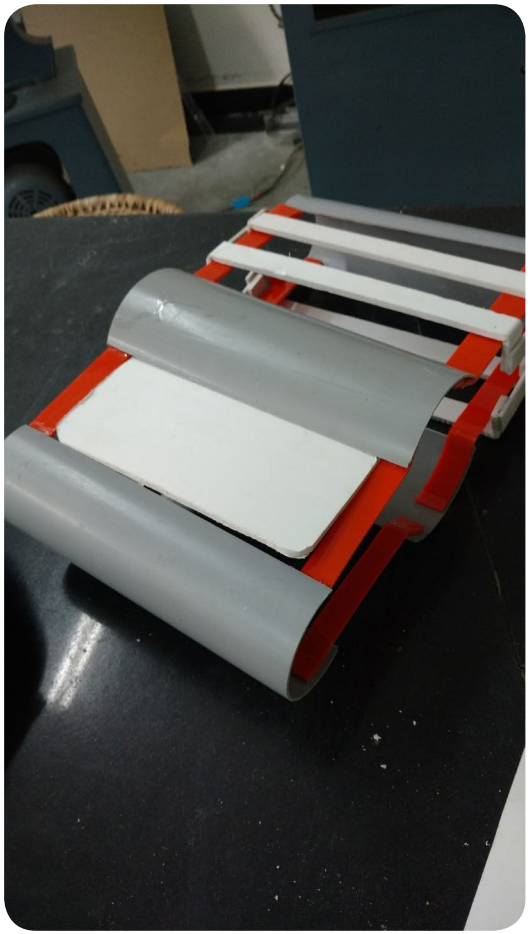
Grills are made of translucent acrylic which effectively disperse light.

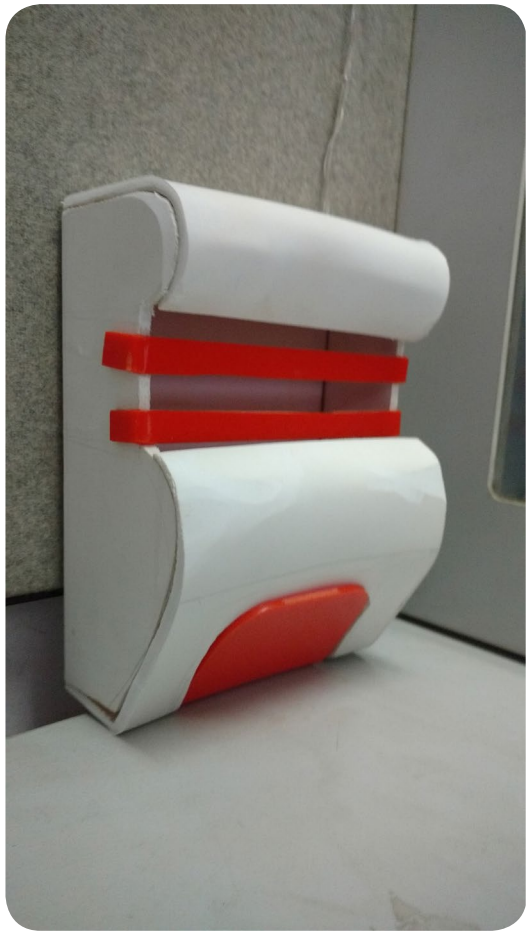
The top module has electronic components that can be switched to different base module catering to the scenario of use.

With a slight adjustment in the handle, the unit may be hung directly from a hang point without the need of chain


Colour Schemes

09 Mock up models





Mock-ups were made out of foam board, acrylic, styrene and PVC.

The mock-up models helped in getting an idea of size and placement of internal components. Task analysis was conducted with the help of these models which aided in better solving user interaction part of the product.

The making process involved bending of styrene using heat gun as well as cutting and sticking using chloroform and fevikwik.

Task analysis was conducted on a 1:1 scale model with similar construction and details as developed in 3D.

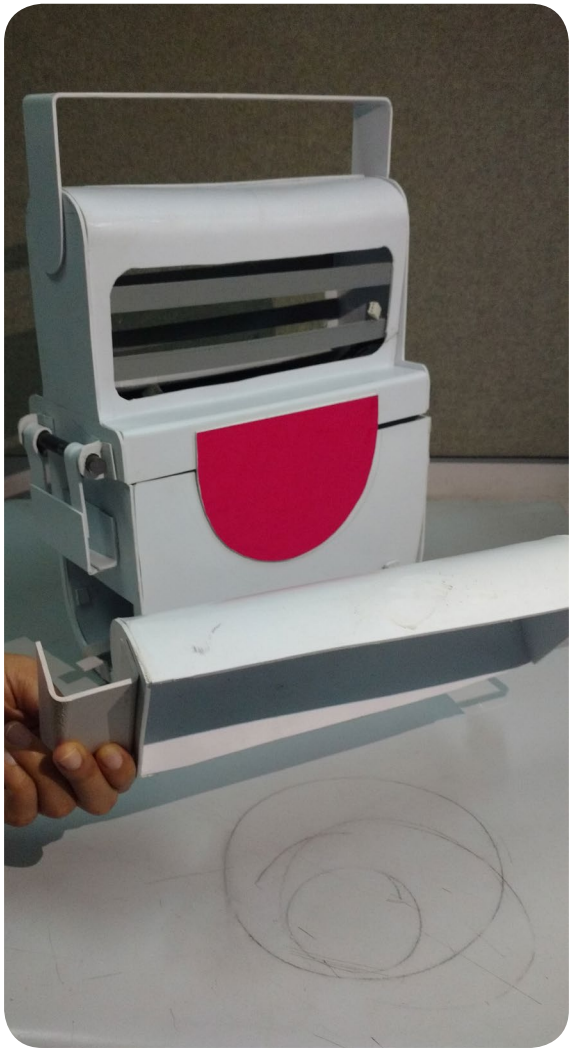
Task analysis

Cleaning

-Step 1
Slide collection tray to release

-Step 2
dumping dead insects and cleaning/ washing of tray

-Step 3
fitting tray back into product



Maintenance

-Step 1
Release the hinge (both sides)

-Step 2
Lift the top half to separate

-Step 3
clean suction fans using a blower.
Replace if necessary

Observations

Once the task analysis was completed with the mock-up model, it was easier to find real time issues faced by th user.

The following are the observations noted from user testing

-Instead of having separate base modules for different scenarios, it is better to have add on parts that transform functionality. This makes sense in a manufacturing point of view as well considering cost constraints.

-Handle may also be foldable/detachable.
The mock-up model had a fixed handle which is may not go appropriate while the unit is hanged or mounted on wall.

-Colors may be more subtle/less loud to merge with surroundings. Based on the colour combinations of the renders made, most user preferred subtle colour combinations.

-Difficulty in identifying front and back
The mock-up built was symmetrical and also identical. This create a confusion among users regarding which way to place.

10 Final Design

Final design is highly optimized version of set 3. Various factors were considered like integrating all possible scenarios. The product may be used as tabletop, grounded, wall hung as well as suspended

Final design

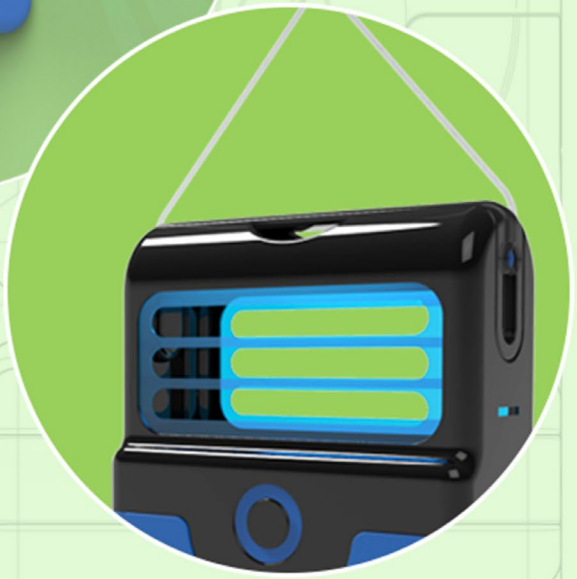
Handle is directly integrated into the unit with sliding mechanism through groves. Both top and bottom module is injection molded and the base module sits flat on ground. The top and bottom halves are joined together by four screws. Grills are made of translucent acrylic which effectively disperse light.

Power consumption

LED
current- 20mA (total 9 LED)
Voltage-3.2-3.4v
connection- 3 in series of 3 parallel circuit

Fan
Current- .2A
Voltage-12v

Total power=11.98W



Attrap can be hung, mount on a wall or simply kept on the ground

Trays are accessible from both sides

Choose your style

Attrap

Available in 3 colors

Attrap

Making

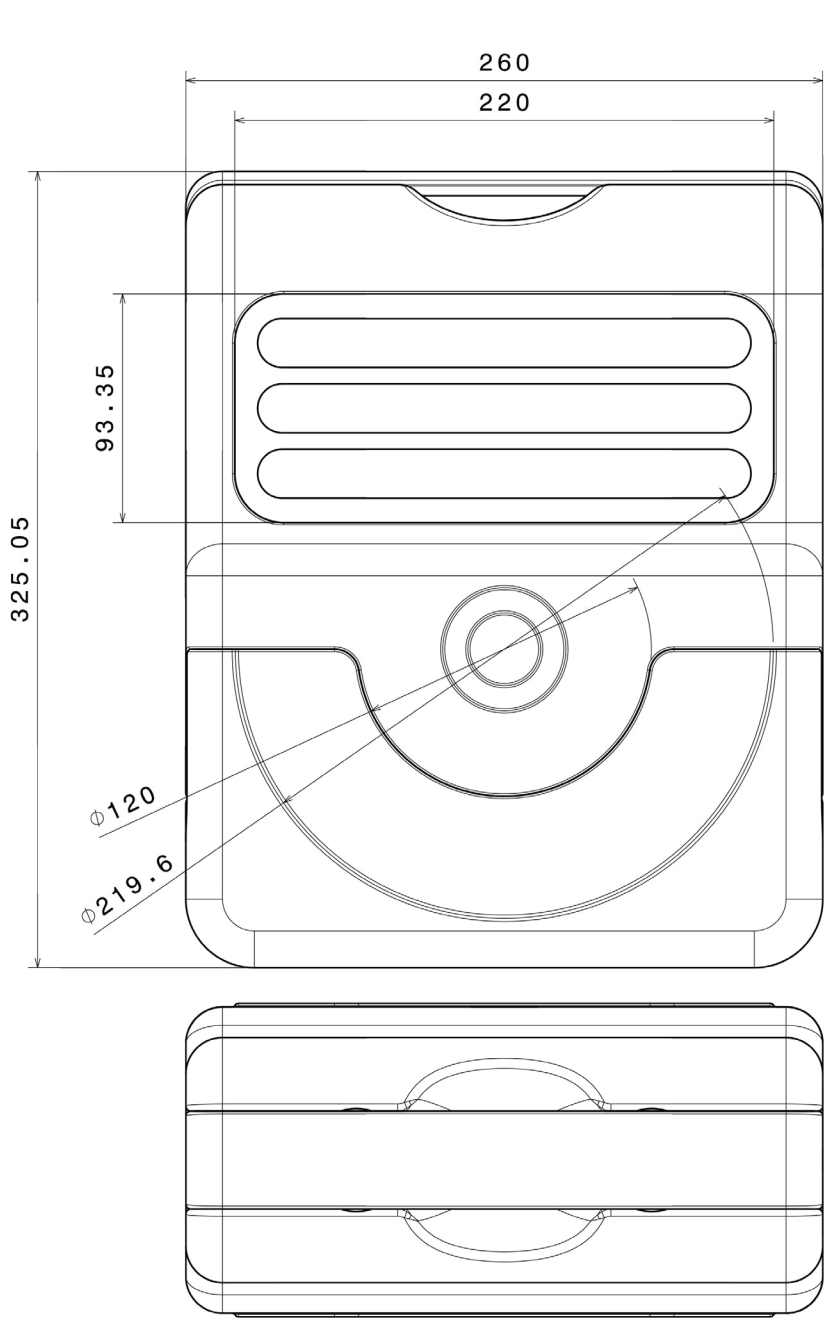
A working prototype was made by vacuum forming of styrene sheet. The asembly was then painted and connections were given

DAY OR NIGHT

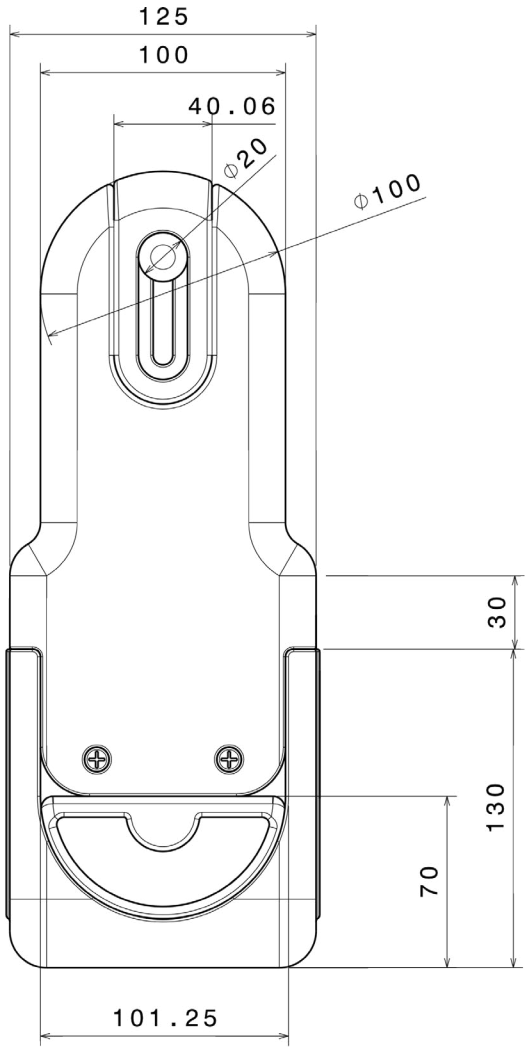
YOU GOT NOTHING TO WORRY AS LONG AS THEY ARE BELOW THIS LINE

Attrap

Mechanical drawing



Top view
Scale: 1:2



Left view
Scale: 1:2

Take aways

The project has lot scope in the market and has the potential of attracting a wide range of customers. Since the product has dual benefits of attracting mosquitoes as well as house flies, attrap will set new benchmarks in keeping pests and insect borne diseases in control.

Further stages of the project include proper testing and validation of technology by setting standards. Multiple versions of the product may also be developed for various scenarios by keeping environment in mind. For example modular systems may be made that can be add on or fixed to a small are of wall or table side that merges with the workspace environment.

References

https://en.wikipedia.org/wiki/Bug_zapper
https://en.wikipedia.org/wiki/1-Octen-3-ol
https://en.wikipedia.org/wiki/Pest_(organism)
http://www.bestproducts.com/appliances/small/g1032/electric-bug-zappers/
http://www.sciencepubco.com/index.php/ijet/article/view/1478