

P2 Report

Re-Design of an Air Purifier for Indian Mid-Income Group

DEP702 MDes Project-2

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APPROVAL FORM

This is to certify that the Industrial Design Project entitled "Re-design of an Air purifier for Indian Mid-Income Group" by Amit Kumar is approved for partial fulfillment for the Master of Design degree in Industrial Design.

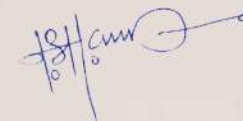
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I also declare that I have adhered to all principles of academic honesty and integrity and have not falsified, misinterpreted or fabricated any idea, data, facts or source in my submission.

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ABSTRACT

This is a College course project in an effort to understand the Design Process that is followed to design any product for general consumers.

The topic selected for the project was the Redesign of an Air Purifier for the Indian mid-income group. The Concise brief can be Quoted as "To Design a range of Air Purifiers for middle-income groups keeping in mind usability, serviceability, portability, ergonomics, aesthetics, interface/navigation, visual semantics as features." The issues targeted were selected based on interviews that were conducted during the project.

Air quality is deteriorating around the globe rapidly, and to mitigate that problem for metropolitan cities an air purifier remains the only solution. As a necessity, that product becomes an integral part of our lives. Following the design principles of Dieter Rams who said "Good design is often invisible" The goal is to make the product with the best possible interaction for the user to make it invisible.

ACKNOWLEDGEMENT

I would like to use this opportunity to give thanks to those who helped me going through this Course project. I would like to extend my respect to all the people who helped me in accomplishing this task.

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I also extend my gratitude towards all my batch-mates, juniors, who have always supported me and inspired me throughout this Project. I also want to offer my appreciation towards IIT Bombay for all the help and facilities they have provided.

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INTRODUCTION

Today, many countries and major cities in the world suffer from severe air pollution. Factories, vehicles, and the use of non-renewable energy pollute the air around cities. This is a major problem in China and India, where more than a billion people live in polluted cities in these countries.

The solution people use to clean indoor air in polluted areas is called an air purifier. This is the device that most people who are affected by poor air quality have in their homes and offices. The function of an air purifier is to create a flow of air through your home, usually by drawing air from a fan in the unit. , clean air comes out.

However, most air purifiers on the market today use so-called HEPA filters, which need to be replaced every few months and consume a lot of energy. This solution is very expensive and is not for everyone as one of the most important factors for customers when purchasing an air purifier is the price. The aesthetic design of the air purifier is also important because it is also part.

1

BACKGROUND

According to the World Health Organization (WHO), 7 million people died in 2012 due to air pollution. Most people fear that dangerous levels of air pollution will only occur in parts of Asia and in large cities. But now big cities in Europe face the same problem. Drastic modifications have been implemented in Madrid and Paris, reducing traffic at times to reduce air pollution. In China, it

INTRODUCTION

is common to install air purifiers in homes to prevent living with polluted air. This is not yet commonplace in Europe, but increased awareness could increase demand for air purifiers. Today, most air purifiers are designed for the Asian and US markets, but design preferences may change as the European market grows.

AIR POLLUTION

Air pollution can shorten lives by almost 10 years in the Indian capital, Delhi, the world's most polluted city, says a report by a US research group.

The study adds that the average Indian life expectancy is shortened by five years at current air quality levels.

India's 1.3 billion people live in areas where the "annual average particulate pollution level" exceeds the WHO safe limit of $5\mu\text{g}/\text{m}^3$, it says.

Bad air kills millions in India every year.

The smog-filled air, which usually covers Indian cities during the winter months, contains dangerously high levels of fine particulate matter called PM2.5 - tiny particles that can clog lungs and cause a host of diseases.

The Air Quality Life Index by the Energy Policy Institute at the University of Chicago (EPIC) notes that some 510 million people who live in northern India - nearly 40% of India's population - are "on track" to lose 7.6 years of their lives on average, given the current pollution levels.

However, reducing pollution levels to WHO standards would mean

Exposed to pollution



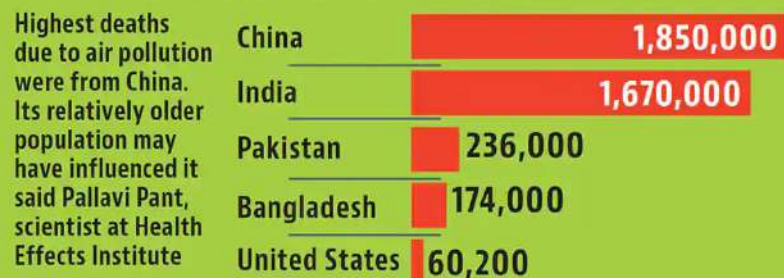
India had the worst annual average concentration of PM2.5 in its air in 2019, according to the State of Global Air 2020 report

1,670,000 Deaths in India in 2019 attributed to air pollution, according to the report

EXPOSURE TO PM2.5 (population-weighted)



DEATHS ATTRIBUTED TO AIR POLLUTION



Highest deaths due to air pollution were from China. Its relatively older population may have influenced it said Pallavi Pant, scientist at Health Effects Institute

fig. 2 Deaths due to Air Pollution(PM2.5 Particulate). ©Hindustan times

that an estimated 240 million people in the northern Indian state of Uttar Pradesh would gain 10 years in life expectancy.

EPIC says that since 2013, about 44% of the global pollution has come from India - currently the second most polluted country in the world.

The report says that more than 63% Indians live in areas that exceed the country's own air quality standard - which says that $40\mu\text{g}/\text{m}^3$ is safe. But in 2019, India's average particulate matter concentration was $70.3\mu\text{g}/\text{m}^3$ - the highest in the world.

EPIC says that particulate pollution is the "greatest threat to human life" in India in terms of life expectancy and since 1998, this particulate pollution has increased by 61.4%. This makes it more lethal than smoking which reduces life expectancy by about 2.5 years.

The increase in air pollution over the past two decades in India has been primarily due to industrialisation, economic development and the skyrocketing use of fossil fuel. The number of vehicles on the country's roads has increased about four-fold, the report says. It acknowledges government efforts to fight air pollution - the National Clean Air Programme (NCAP) aims to reduce harmful particulate matter by 20 to 30%.

In the Global Burden of Disease 2010 (GBD) study, 'outdoor air' pollution is among the top 10 risks worldwide and the top six risks in the developing countries of Asia. Air pollution has greater impact on developing countries such as India, as 1.4 million people lost their life due to air pollution; US\$ 505 billion towards welfare losses; and US\$ 55.4 billion towards lost labour.

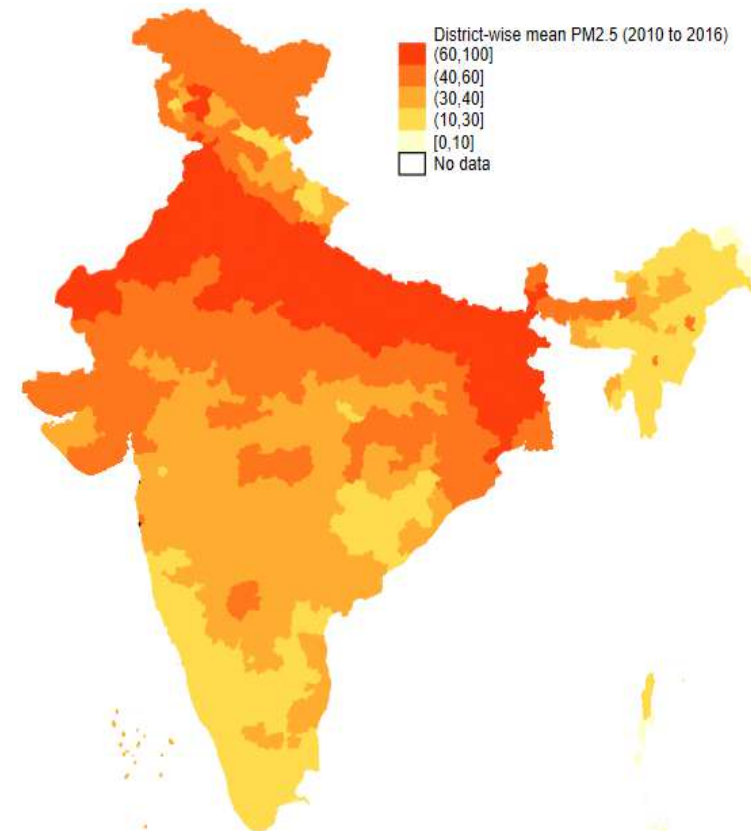


fig. 3 AQI India 2010-2016. ©IdeasforIndia

INTRODUCTION

Approximately

20-30%

Indians
suffer from Rhinitis
Allergies

Leading to

15%

Developing
permanent
Asthama

5

RHINITIS ALLERGIES

Rhinitis is a reaction that happens in the eyes, nose, and throat when allergens in the air trigger histamine to be released in the body. Some of the most common causes of rhinitis are pollen, dust mites, mold, cockroach waste, animal dander, fumes and odors, hormonal changes, and smoke.

Allergic rhinitis is an inflammatory disorder of the nasal mucosa induced by the allergen exposure triggering IgE-mediated inflammation. Clinically, it is characterized by four major symptoms—rhinorrhea, sneezing, nasal itching, and nasal congestion. It can also be associated with co-morbid conditions as Asthma, Atopic Dermatitis & Nasal polyps. Around 20–30 % of the Indian population suffers from allergic rhinitis and that 15 % develop asthma. The diagnosis & treatment of allergic rhinitis should follow ARIA (Allergic Rhinitis and its Impact on Asthma) guidelines while of asthma should follow the GINA (Global Initiative for Asthma) guidelines. The treatment of allergic rhinitis should combine allergen avoidance (whenever possible), pharmacotherapy, and allergen immunotherapy. Intranasal corticosteroids are the most effective modality for treating allergic rhinitis and their sensory attributes are important in patient compliance (Jitendra,Hinamanshu 2015).

As prevention is better than cure thus usage of an air purifier makes sense not only in places with high pollution level but also in places with high dust, pollen, animal dander, etc

USER GROUP

The target user group is the MIG (Middle Income Group). Affordability being a factor and as the current designs available don't fully cater to this particular income group.

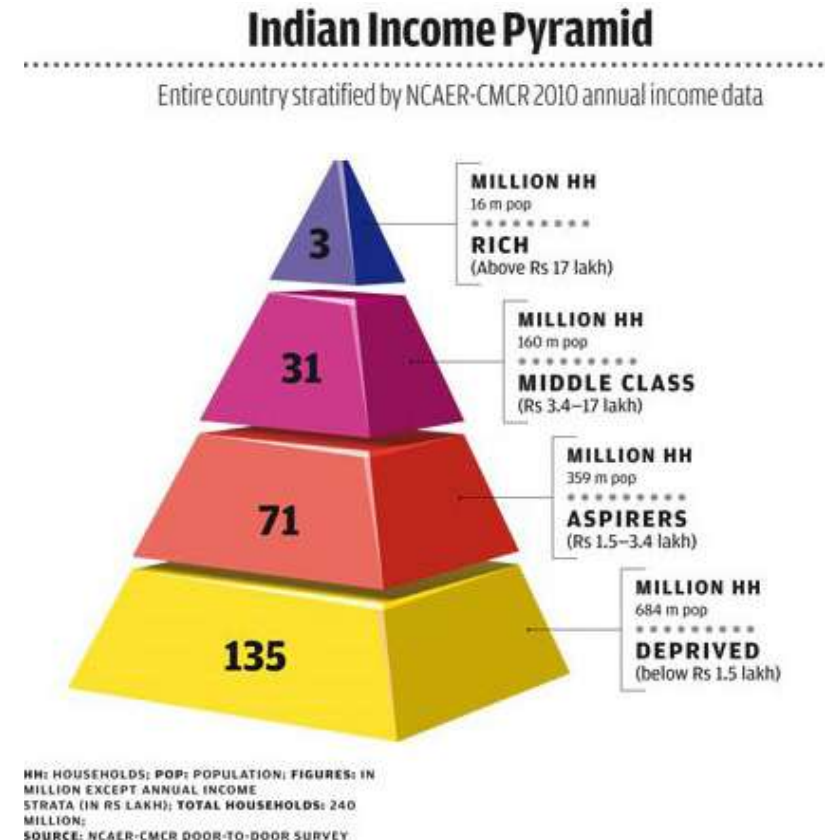


fig. 4 Division of Indian Income Groups©NCAER

Air Purifier Sales in India Will be Driven by Increasing Pollution Levels and Rising Health Consciousness among Consumers : Ken Research

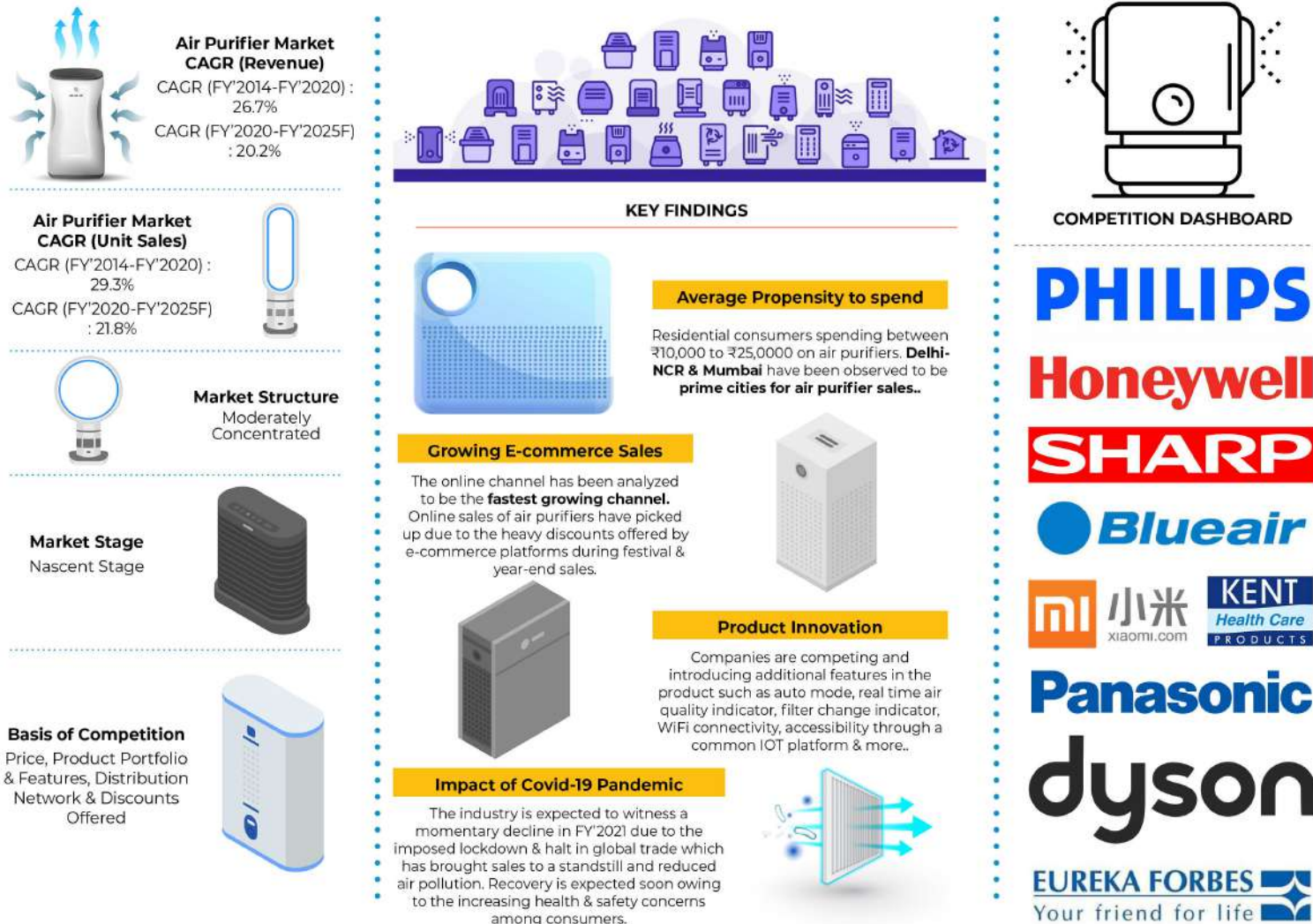


fig. 5 Air Purifier market statistics, ©Ken Research.

INITIAL DESIGN BRIEF

*“To Design an Air Purifier for the
middle income group, keeping in mind
Design Aesthetics and Usability factors”*

RESEARCH

WHAT IS AN AIR PURIFIER?

An air purifier or air cleaner is a device which removes contaminants from the air in a room to improve indoor air quality. These devices are commonly marketed as being beneficial to allergy sufferers and asthmatics, and at reducing or eliminating second-hand tobacco smoke.

Air purifiers evolved in response to people's reactions to allergens like pollen, animal dander, dust, and mold spores. Reactions (sneezing, runny nose, scratchy eyes, and even more severe consequences such as asthma attacks) are the result of antigens found in the home. These antigens are major triggers of asthma.



fig. 6 Air Purifier for home spaces, ©Eureka Forbes.

Air purifiers remove a portion of these particles, thus reducing allergic-type responses.

Due to their extremely small size, allergens are able to pass through a standard vacuum cleaner bag and redistribute into the air where they stay for days. Even a single microgram of cat allergens is enough to invoke an allergic response in most of the people who are allergic to cats. Other airborne particles—such as bacteria and viruses—can cause illnesses, some of which are fatal. There are many reasons—allergies, asthma, fatal illnesses—that millions of air purifiers are sold around the World every year.

HISTORY

Air purity has been a concern as long as human beings have lived in groups. One of the reasons that hunter-gatherers are nomadic is that they periodically need to move away from their garbage dumps and latrines. In A.D. 61, the Roman philosopher Seneca complained about the miasma of chimney smoke that constantly hung over Rome. In 1306, King Edward I of England banned the burning of coal in London due to the heavy pollutants left in the air.

The Industrial Revolution of the eighteenth and nineteenth century only worsened the problem. Burning coal to produce electricity and fuel trains produced a dark cloud of smoke over every major center of industry in the world and covered entire cities with soot. To deal with this problem, engineers built higher smoke stacks to move

airborne waste further away from the source. Regardless of how high the stacks got, the people down wind complained about the ashes and the acid gases from coal combustion (the source of acid rain) destroying their crops. Air pollution took another turn for the worse after World War II when automobiles became the primary means of transportation in the industrialized world. Automobile smog has provided New Delhi with the worst air quality in the world.

WORKING

Air purifiers have a relatively simple set-up: a fan that sucks in air, and one or more filters. These filters — usually paper, fibers such as fiberglass, or a mesh — capture and neutralize pollutants and particles as air passes over them, before the clean air is recirculated

into the living space.

They're effective at filtering out most polluting particles, although some are likely to still remain on soft and hard surfaces like furniture or walls. The particular airborne particles that get pulled out of the air depend on the type of air purifier and filter used.

Most filters trap relatively large, coarse molecules measuring 5 microns or less, like dust mites and pollen. But how do air purifiers work to filter smaller particles? High-efficiency filters use a dense network of fibers and several layers of intricate weaves to remove pollutants and allergens measuring as small as 2.5 microns, around the size of animal dander. Some air purifiers have ultraviolet filters and use light to destroy biological impurities such as mold and bacteria, while those with activated charcoal can remove gases like volatile organic compounds (VOCs) and smoke particles. As such, air purifiers can help with allergies, to a certain extent.

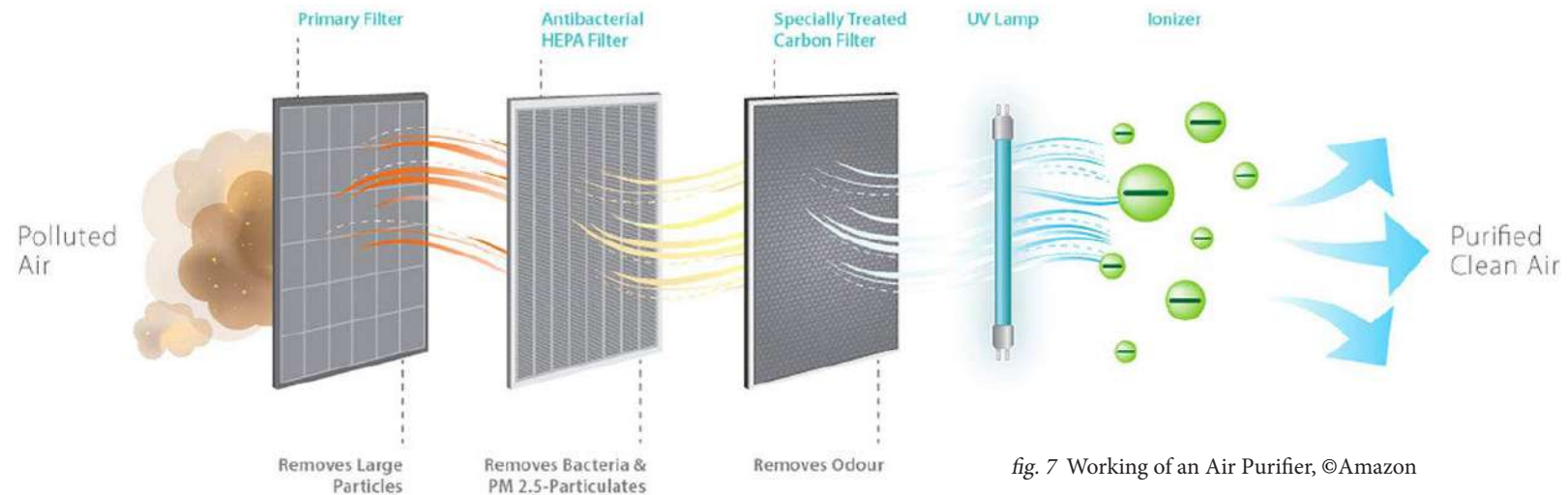


fig. 7 Working of an Air Purifier, ©Amazon

RESEARCH

PARTS OF AN AIR PURIFIER



fig. 8 Exploded View of an Air Purifier

Before designing any object a study is needed to understand the necessary components that are being used in the product. a similar research on product parts was done to get an insight about all of them. The major parts of an Air Purifier are

1. OLED/Digital Display (Pre-Mannufactured)
2. 24 V DC Motor (Pre-Mannufactured)
3. Centrifugal fan for unidirectional air flow (Pre-Mannufactured)
4. Air Quality Detector (Pre-Mannufactured)
5. Motherboard (Pre-Mannufactured)
6. Filters(Technology Constant, Shape can be changed)
 - Prefilter
 - Carbon filter
 - Hepa Filter
 - Other Filters(UV, Plasma, etc)
7. Main Housing (Can Be changed)
8. Front and Back Hatch/Panel (Can Be changed)
9. Cord (Pre-Mannufactured)

Most of the parts of an Air Purifier are pre-manufactured with limited change available in Main housing, Hatch or panels and Filters. Motors, Fans, Motherboard and Display can also be changed but need Technical expertise of that of an engineer. So these parts were not altered as a part of this project.

Main Housing

Main housing can be changed as it only acts a package for the internal components which are pretty common in most of the air

purifiers in the market. Few parameters that govern its design are easy manufacturing and assembly. Also it should be built with least gaps to facilitate in a unidirectional air flow needed to purify the air via the filters. Can be manufactured in **ABS, HIPS, PVC, HDPE, PPE** (high-impact polystyrene, polyvinyl chloride, high-density polyethylene, or polypropylene). **Injection Moulding** is used to get desired parts of exact dimensions.

Filters

Most of the filters have a hard case housing of plastic and internal meshes of relevant cleaning materials. Commonly pre-filter is made of PVC or Aluminium mesh and the outer body of **HDPE** or **PPE**. Similarly the carbon filter uses hexagonal shaped Extruded Plastic Section of **HDPE** or **PPE**. Finally the HEPA filter is made out of fine glass threads and outer body of metal or **HDPE** or **PPE**.

Fan

Suction fan to create air flow is also used in an air purifier. Usually made out of **HDPE** or **PPE**. Injection moulded.

Motor

24 V DC Motor is used for suction in the air purifier. Dimensions - 66mm Height x 42.3mm Dia. (Rear heat chamber can be reduced)

RESEARCH

TYPES OF AIR FILTRATION TECHNIQUES

HEPA

HEPA filters are made out of very fine glass threads with a diameter of less than 1 micron (a micron is 0.00004 in, 0.001 mm). By comparison, a human hair has a diameter of about 75 microns (0.003 in, 0.07 mm). The fine glass threads are tangled together and compressed to form a filter mat. Because the individual threads are so small, most of the mat consists of air. The openings in the mat are very small, generally less than 0.5 micron (0.00002 in, 0.0005 mm). HEPA filters will collect particles down to 0.3 microns (0.00001 in,



fig. 9 HEPA filters fiberglass fibers under a microscope.

0.0003 mm) in diameter. Even though the filter may only be 0.10 in (2.5 mm) wide, it would consist of 2,500 layers of glass threads.

Ionizers nad Ozone Generators

Though they produce slightly different molecules, ionizers and ozone generators work in a very similar way. They produce either ions or ozone, both of which have a charge. Normal particles floating in the air have a neutral charge, so when they come in contact with the ions or the ozone they end up with a charge, too. That causes them to stick to surfaces around the room instead of floating through the air.

Some people, especially those with respiratory issues, usually find their lungs irritated by the ozone in the air.

Electrostatic Filters

Like ionizers and ozone generators, Electrostatic precipitators rely on electrostatic forces to remove particles from the air. They work by creating a cloud of free electrons through which dust particles are forced to pass. As the dust particles pass through the plasma, they become charged, making them easy to collect. Electrostatic precipitators can collect particles down to a diameter of 0.01 microns (0.00001 mm).

Activated Carbon Filters

Neither HEPA filters nor electrostatic precipitators can remove volatile organic compounds from the air, therefore do nothing to reduce odors. For this reason, most air purifiers are equipped with

a pre- or post-filter composed of activated carbon.

Activated carbon is produced by heating a carbon source (coconut shells, old tires, bones, etc.) at very high temperatures in the absence of oxygen, a process also known as pyrolysis or destructive distillation. Pyrolysis separates the pure carbon from the other materials contained in the raw material. The pure carbon is then exposed to steam at 800°C (1,500°F). The high temperature steam activates the carbon. The activation process forms millions of cracks in the carbon grains. These cracks have diameters of about 0.002 microns (0.000002 mm). Because there are so many cracks, the activation process provides the carbon with an enormous surface area per weight—about 1,000 m²/g. The millions of cracks provide locations where organic compounds can be adsorbed. In addition, the surface of the carbon carries a residual electrical charge that attracts non-polar chemicals (chemicals that do not have separated positive and negative charges) to it. Activated carbon is very effective at adsorbing odor producing compounds.

UV Lights

Ultraviolet lights are germicidal. An air purifier with a UV light has the power to take care of microbes, sometimes even viruses. When the air passes through a chamber which is UV lit, it automatically kills germs and viruses in few minutes.

PARTICLE SIZES

To understand the working of filters sizes of the particles were also looked at for a better understanding.

Particles	Average Size (microns, μm)
Zika virus	45nm
T4 Bacteriophage	225nm
Coronavirus COVID-19 (SARS-CoV-2)	0.1-0.5μm
Bacterium	1-3μm
Light dust particle	1μm
Dust particle: PM2.5	≤2.5μm
Respiratory droplets containing COVID-19	5-10 μm
Red blood cell	7-8 μm
Dust particle: PM10	≤10μm
Pollen grain	15μm
White blood cell	25μm
Visibility threshold (what the naked eye can see)	10-40 μm
Grain of salt	60 μm
Fine beach sand	90 μm
Human hair	50-180 μm

 Not Filterable
  Partially Filterable
  Fully Filterable

fig. 10 Range of particle sizes in nature

THE RELATIVE SIZE OF PARTICLES

From the COVID-19 pandemic to the U.S. West Coast wildfires, some of the biggest threats now are also the most microscopic.

A particle needs to be 10 microns (μm) or less before it can be inhaled into your respiratory tract. But just how small are these specks?

Here's a look at the relative sizes of some familiar particles ▸

HUMAN HAIR 50-180 μm ▸
FOR SCALE

FINE BEACH SAND 90 μm ▸

GRAIN OF SALT 60 μm ▸

WHITE BLOOD CELL 25 μm ▸

GRAIN OF POLLEN 15 μm ▸

DUST PARTICLE (PM₁₀) <10 μm ▸

RED BLOOD CELL 7-8 μm ▸

RESPIRATORY DROPLETS 5-10 μm ▸

DUST PARTICLE (PM_{2.5}) 2.5 μm ▸

BACTERIUM 1-3 μm ▸

WILDFIRE SMOKE 0.4-0.7 μm ▸

CORONAVIRUS 0.1-0.5 μm ▸

T4 BACTERIOPHAGE 0.225 μm ▸

ZIKA VIRUS 0.045 μm ▸



Pollen can trigger allergic reactions and hay fever—which 1 in 5 Americans experience every year.
Source: Harvard Health

The visibility limits for what the naked eye can see hovers around 10-40 μm .



Respiratory droplets have the potential to carry smaller particles within them, such as dust or coronavirus.



Wildfire smoke can persist in the air for several days, and even months.

SOURCES Cleanstream, Daniel Lovetrey, EPA, Financial Times, News Medical, Science Direct, SCMR, Susan Sokolowski, Petroclear, U.S. Dept. of Energy
COLLABORATORS RESEARCH + WRITING: Carman Ang, Inan Ghosh | DESIGN + ART DIRECTION: Harrison Schell



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@visualcap



visualcapitalist.com

fig. 11 Particle sizes in nature, ©visualcapitalist.com

BENCHMARKING

The benchmarking of Air purifier was done on the below mentioned parameters. Most of the product selected used were kept to be entry level or mid range products as the target audience to be catered was the MIG (Middle income group).`

- Type of Air Purifier
- The range(Area Covered)
- Power input
- No. of filters present
- Size and efficient use of space
- Weight
- Regulations if any
- Price
- Design Language
- Pros and Cons

Total of 12 Products were reviewed based on the above defined parameters. The data from collected and collated from various websites.

CADR

CADR, the Clean Air Delivery Rate, is a metric that was developed as a way of measuring the performance of residential air purifiers. The CADR rating reflects the volume of air in CFM (cubic feet per minute) that is cleaned of particles of certain sizes.

to Calculate, $CADR = \text{Area of Room} / 1.55$



Hall/Lobby - Large Area
Usually >240sq.ft.



Bedroom- Medium Area
Usually >144sq.ft.



Bedroom- Small Area
Usually >100sq.ft.

fig. 12 Classification of Rooms based on Area per square feet

RESEARCH

Product Name	Type	Area Covered	Power	Filetrs	Dimensions	Weight	Price INR
Coway Air Mega 200	Hall	361 Sq. Ft.	38w	2(Carbon+Hepa)	38x64x18 cm	7.5 kg	₹ 23,000
Coway Air Mega 150	Hall	353 Sq. Ft.	38w	2(Carbon+Hepa)	38x50x20 cm	6.7 kg	₹ 20,700
Dolphy 75w Automatic	Hall	388 Sq. Ft.	75w	2(Pre+Hepa)	56x23x38 cm	6.2 kg	₹ 24,999
Philips 2000 Series	Hall	388 Sq. Ft.	60w	3(Pre+Carbon+Hepa)	59x24x36 cm	8.2 kg	₹ 13,609
Dr. Air	Hall	350 Sq. Ft.	35w	2(Pre+Hepa)	55x33x20 cm	6.5 kg	₹ 18,000
Moonbow Vayo (Hindware)	Hall	538 Sq. Ft.	70w	2(Carbon+Hepa)	56x25x38 cm	7.0 kg	₹ 21,999
Toshiba CAF-W83XIN	Hall	645 Sq. Ft.	60w	4(Pre+Carbon+Hepa+Ionizer)	81x29x29 cm	10 kg	₹ 24,999
Mi Air Purifier 3	Hall	484 Sq. Ft.	38w	3(Pre+Carbon+Hepa)	52x24x24 cm	4.8 kg	₹ 10,999
Livpure Smart O2	Hall	750Sq. Ft.	70w	4(Pre+Carbon+Hepa+Ionizer)	71x33x33 cm	5.8 kg	₹ 24,999
Honeywell Air Touch U1	Hall	550 Sq. Ft.	50w	4(Pre+Carbon+Hepa+UV)	75x32x32 cm	9.7 kg	₹ 20,999
Sharp FX J80M-H	Hall	680 Sq. Ft.	42w	3(Pre+Carbon+Hepa)	73x42x29 cm	11.2 kg	₹ 24,790
Glen 6032	Hall	590 Sq. Ft.	45w	3(Pre+Carbon+Hepa)	68x24x39 cm	6 kg	₹ 23,011
Glen 6031	Hall	450 Sq. Ft.	45w	3(Pre+Carbon+Hepa)	66x41x28 cm	6.6 kg	₹ 9,970
Trusens	Hall	375 Sq. Ft.	28w	4(Pre+Carbon+Hepa+UV)	66x41x28 cm	4 kg	₹ 22,800

fig. 13 Comparision of few Top Market Products

BUTTONS, CONTROLS & VISUALS

Functions available in an Air purifier should govern the number of buttons and controls. and many studies suggest that usage of physical buttons increase the usage by muscle memory and ergonomics based on tactile feedback. The following functional controls are usually available in an air purifier

Physical Touch Controls

- ON/OFF Switch
- Modes
 - Regular - Standard normal usage
 - Power - High usage
 - Sleep - Smart Automatic adjustment based on detector
- Fan speed
 - Fast
 - Medium
 - Slow
- Timer
- Child Lock
- Display Light On/Off toggle

Visual Interface Elements

- AQI Display Numbers
- AQI Display Light
- Filter Replacement Light
- Active Functions Display
- Blinking light for Error

Visual Elements

- Hatch Opening Sign
- Vent Pattern

VISUAL STUDY OF CURRENT MARKET & TRENDS

Lots of products in the market were looked at to create a harmonious product which follows the visual aesthetics of that of an air purifier of MIG . Three major brands on the Indian MIG were considered for visual study namely as Bajaj Electricals, Havells and Jaipan.

Results From Controls(Knobs & Buttons) study

- Visual Marking elements(Colour or Material) are present to denote position or mode
- Click mechanism to give feedback in state change
- Aligned buttons when multiple are present
- Contrast against Background (Colour, Material or change in level)
- Lights can also be integrated to suggest active state
- Intensity of Light can vary

Results from Handle study

- Dual material for look and feel
- Smooth edges to avoid discomfort
- Silicon/rubber on the lower side for better grip
- Power Grip Dia of 1.25-2 inch (30-50mm)

RESEARCH

Results of Vent study and current Market Trend

- Parametric based are being used generally
- Dynamic Lattice structures
- Non uniform designs
- Smaller holes so toddlers don't put fingers
- Not too small for good Air suction

Results of Colour Study

- Usage of white, off-white and light grey is fairly common as white's association clean and pure is that is derivative of colour theory
- Contrast colours for controls to create visual markers for fasters navigation

Brands indentity words from Visual Study of Products

Bajaj

- Warm
- Cool colors
- Harmonious
- Symmetry
- Curves
- Stable
- Strong
- Rigid
- Bold
- Dynamic

Havells

- Warm
- Harmonious
- Retro
- Techy
- Symmetry
- Curves
- Bold
- Stable
- Functional

Jaipan

- Vibrant
- Warm
- Harmonious
- Symmetry
- Curves
- Stable
- Energetic

ELDERLY CONSIDERATION

One of the dominant challenges in medical based products is that it also caters to user base which has deteriorating health and other physical restrictions. To design a better interaction I looked at researchs that focused on Grip Dia of Handles and Weight lighting capabities of elderly 60+. The Ideal gripping dia as per ergonomic

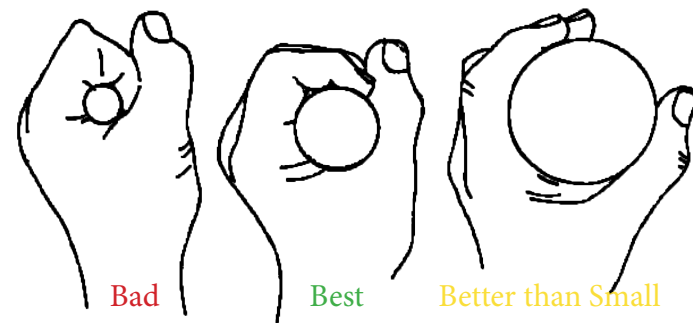


fig. 14 Gripping Diameters for best power grips.
studies was around 1.25-2 inches (30-50 mm).

Some studies recommended a one-handed carrying weight limit of approximately 9-10 kg for men and 6-7 kg for women above the age group of 60 years for a distance of around 6 meters.

MARKET STUDY (MARKET VISIT)



fig. 15 Few products that were present in the market to Test

RESEARCH

USER STUDY



USER INFO

Vandana sethi, 56, Female	Cent. Delhi, Shastri nagar	Family of 2, daughter in foreign	House wife
---------------------------------	-------------------------------	--	------------

PRODUCT

Mi 2c	Some research done by daughter	Using since 3 year	Bought because of pollution, Allergic as well	Bought as Base level model. Best in price
feels big difference	→ Sneeze decreased effectively	Not much aware about filters		

USAGE

Mostly she operates it	Used whole night and few hours in daytime	Usually kept in living room or bedroom on Ground or elevated.	Manually picked from bottom to move daily	→ Usually shifted around the house daily based on the user
Clean it every two weeks - 10 days				

ISSUES

Only one button; Navigation problem	No handle are available , No wheels	You've to separate top head to clean
--	---	--

fig. 16 Usage images of the product

AIR PURIFIER RE-DESIGN



fig. 17 Usage images of the product

USER INFO

Neeta
Arya,
58, female

Cent. Delhi, RK
Ashram marg

Family of 3

Ministry of
Defense

PRODUCT

Coway Air
mega 150

did a little
research
before buying

About an year

Bought as
People around
were using,
has sleep
apnia

Knows about 3
level of
filtration
available

feels there is
large
difference



Sleep quality
increased

USAGE

She operates it

Used more in
night
sometimes in
day when
feeling bad

Usually kept in
bedroom on
Ground

Clean pre filter
every two
weeks

If AQI indicator
on phone is
giving
notification

Clean pre filter
every two
weeks

ISSUES

No Display

No handle are
available , No
wheels

Hard to open
the rear panel

No app
integration

RESEARCH



USER INFO

Shobhit
gautam,
30, male

South Delhi,
Malviya Nagar

Family of 2,
Rented flat
lives with
brother

Design PG,
currently
working

PRODUCT

Sharp FU-
AZ8E,
Base model

was gifted by
friend

Using since 1.5
year

Felt there was
some level of
change in
smell

only pre and
Hepa filter
available

USAGE

Mostly
operated by
himself

Used mostly in
night after
office

around the
year

Always kept in
bedroom on
Ground

Never shifted

Never
cleansed till
now

Physical usage
no app
integration

ISSUES

No visible info
available
about filtration

Handle groove
on rear is
available , No
wheels

Length of cord

Space Issue

Hard to open
back hatch

fig. 18 Usage images of the product

AIR PURIFIER RE-DESIGN



fig. 19 Usage images of the product

USER INFO

Rajendar
Sethi,
72, Male

Cent. Delhi,
Shastri nagar

Family of 2,
sons in foreign

Bank Manager,
Retired

PRODUCT

MI 2s

Bought by son

Using since 4
years

Bought as
Pollution was
increasing; Self
initiative

Bought as
Base level
model

feels the
difference

No knowledge
of filters

USAGE

Mostly she
and her father
operate it

Used as per
need;

Clean it once
in 2 months

Change filter
as per
indicator
status

Mostly kept in
one room

Cleaned only
once in a
season

App is
available;
Don't use it.

ISSUES

No handle are
available ; No
wheels

No handle are
available ; No
wheels

RESEARCH

PROBLEM IDENTIFICATION



Img. 1 Title Issue due to rear placement of handle, Creating offcenter weight

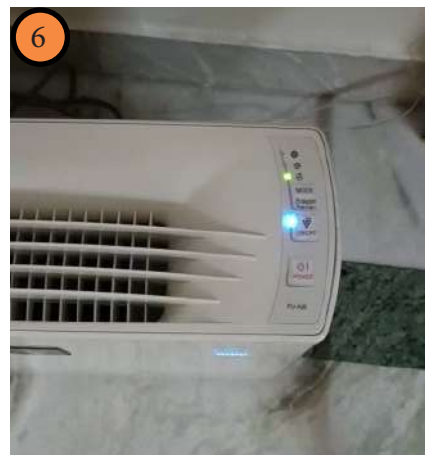
Img. 2 Only 1 button available for all controls

Img. 3 No handles available so user needs to press side panels to pick the object,
Vent on top which catches dust when product is not in use.

AIR PURIFIER RE-DESIGN



Img. 4 Hatch opening locks on side, Which can be pressed while lifting the object



Img. 5 Color indicator for AQI very small

Img. 6 Vent placed on top, Handle offcenter on rear, No AQI Info Given



Img. 7 No provision for Hatch opening so the user has to forcefully insert finger nails between the gaps, No AQI info, No Handle

RESEARCH

USER STUDY

The user study was done as a part of research asking the people about their general usage and perception around the product. The study was conducted in an interview form for which 5 users from New Delhi were chosen.

PROBLEM IDENTIFICATION

Few problems were directly highlighted from the interview. After the interview was conducted short videos of product usage were also taken to make a customer time journey map. Following issues were targeted for re-design of the Air Purifier

- Placement of Handle
- Placement of Display
- Placement of AQI via lights
- Removing top vent
- Introduction of standard set of buttons
- Provisions to open hatch for filter cleaning
- Easy replacement of filter
- Wheels in heavier models for portability

Based on the problems identified above Design Brief was changed to accommodate all the factors.

STORYBOARDING



DESIGN RE-BRIEF

“To Design a range of Air Purifiers for middle income group keeping in mind usability, serviceability, portability, ergonomics, aesthetics, interface/navigation, visual semantics as features.”

IDEATION

MOODBOARD

To draw inspiration from Moodboard was created of the particular Target market.

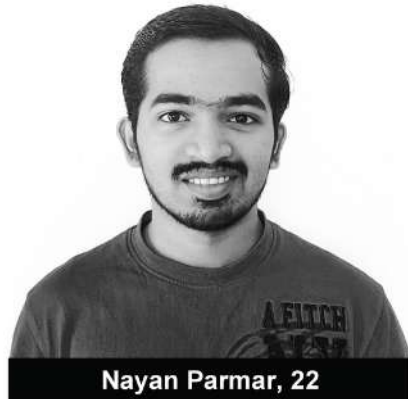


DESIGN DIRECTIONS EXPLORED

- Pick and move by handle - Tower design with groove in top center to act as handle or rotating handle
- Trolley based -Trolley type handle and wheels



USER PERSONA 1



Draftsman (Fresher)

Location

Hauz Khas, New Delhi

Salary

3.2 LPA

Family

Nuclear (4 Members)

Income group

Lower Mid Income group

About

Nayan is a Mechanical engineering Diploma holder. Very dedicated to his time and dislikes social media. He likes to go to parks and picnic spots frequently.

Goals

He is health conscious person and wants to stay fit. To save a lot so can gain financial stability soon. Be active.

Frustrations

Medical issues rising in the national capital. Family falling sick frequently nowadays. Difficulty in sleeping.

USER PERSONA 2



Policy Maker

Location

Dwarka, New Delhi

Salary

12.5 LPA

Family

Nuclear (4 Members)

Income group

Upper Mid Income group

About

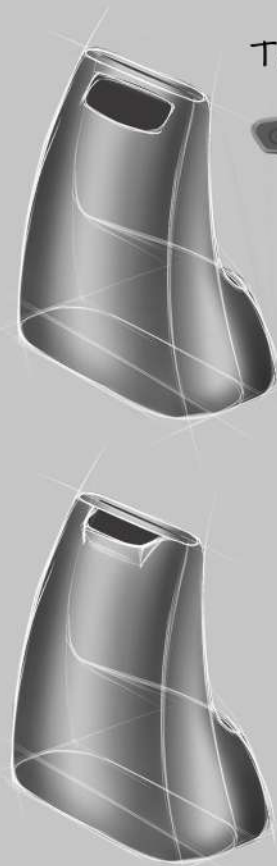
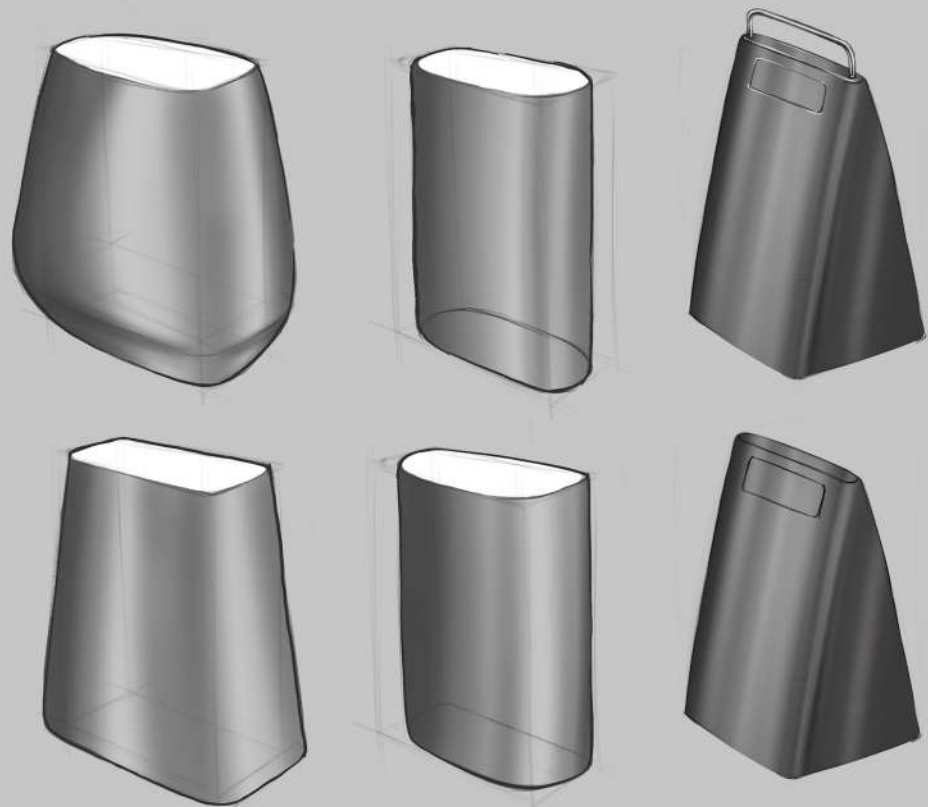
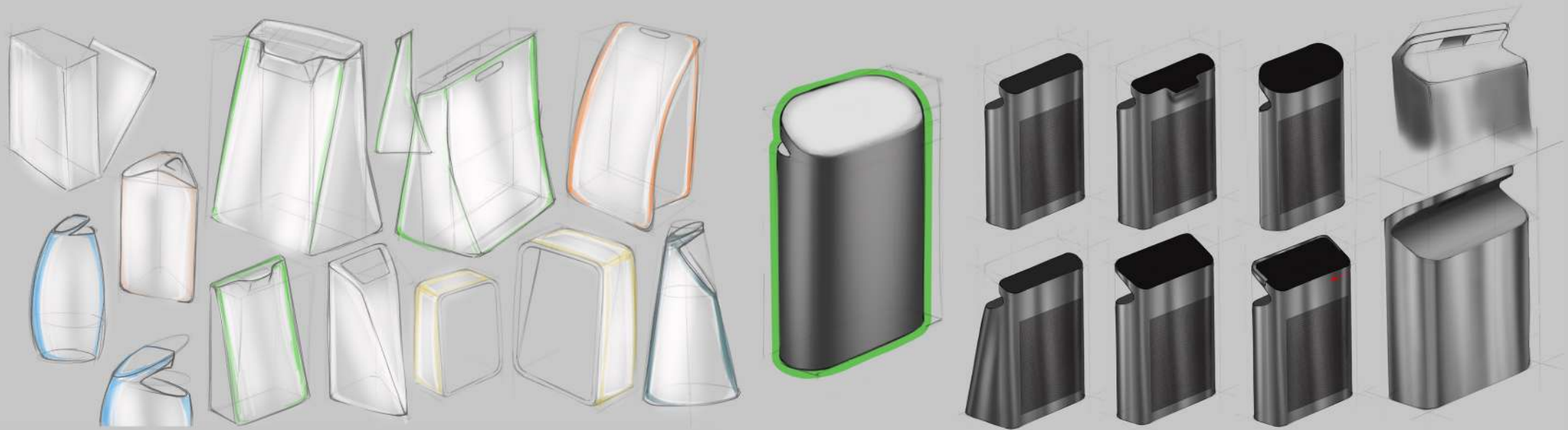
Rameshwar is a Policy Maker. Rameshwar is the only earning member as both kids are studying in college. Recently health has started deteriorating.

Goals

He believes in spending high for a good life and invest in health. Avoid health issues for as long as he can, takes precaution.

Frustrations

Breathable air is getting scarce in the National capital. Can see dense fog inside home nowadays.

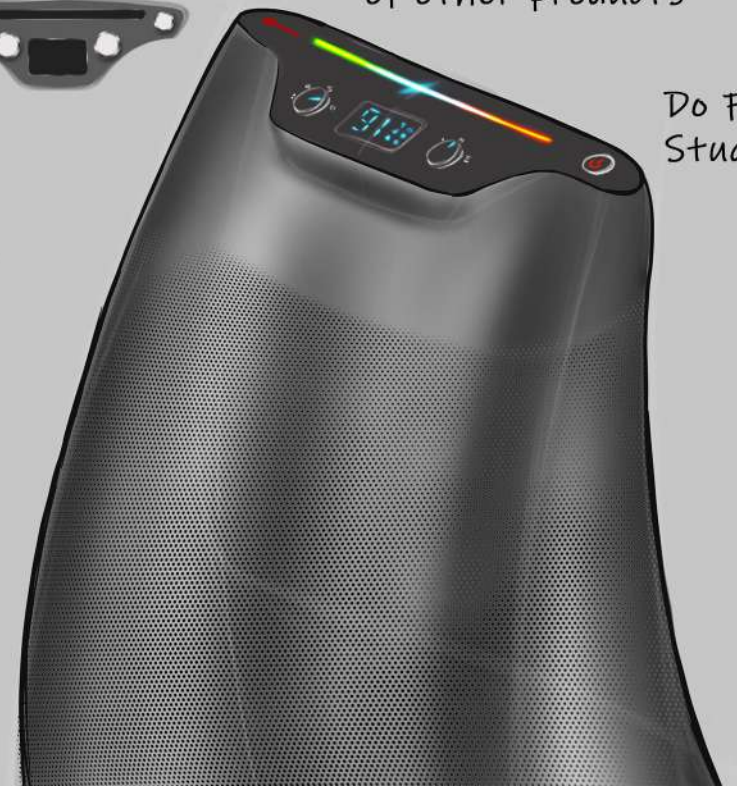


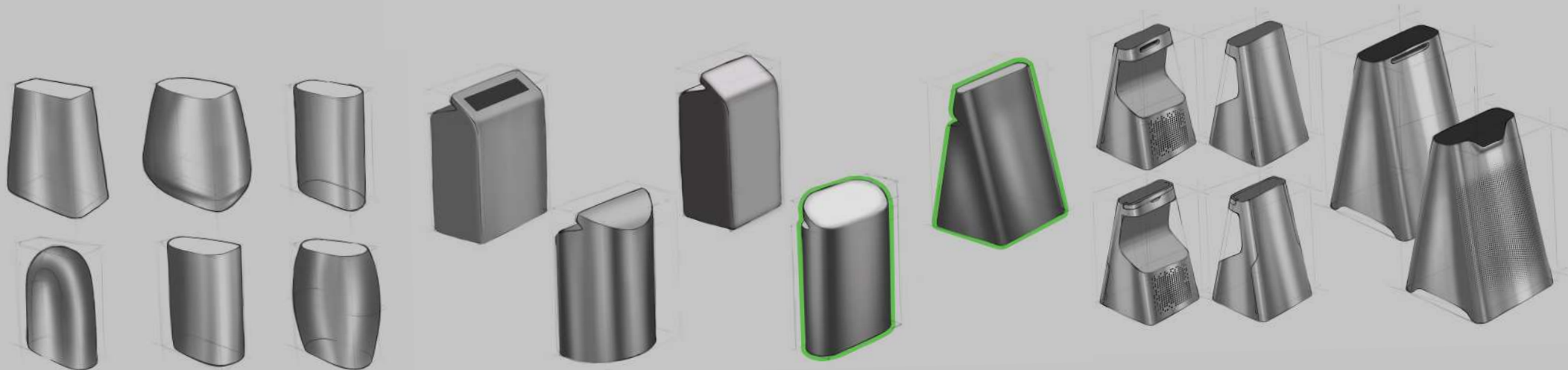
Too much playful



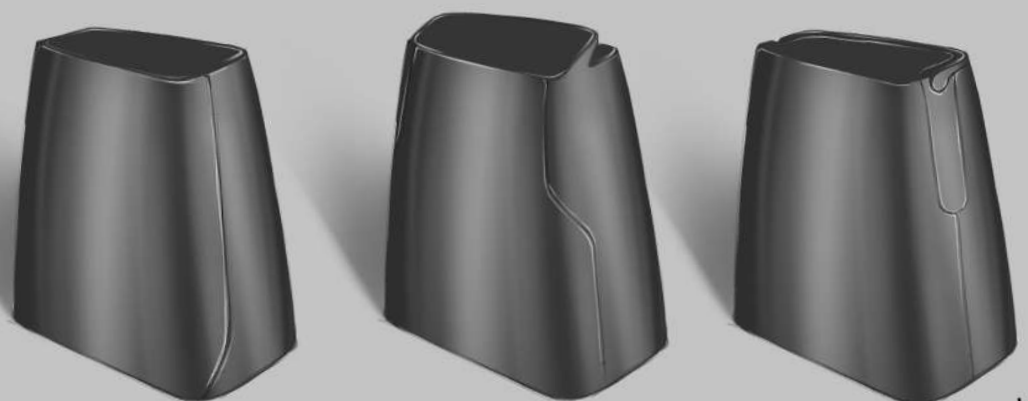
Needs to be part
of other products

Do Form
Study

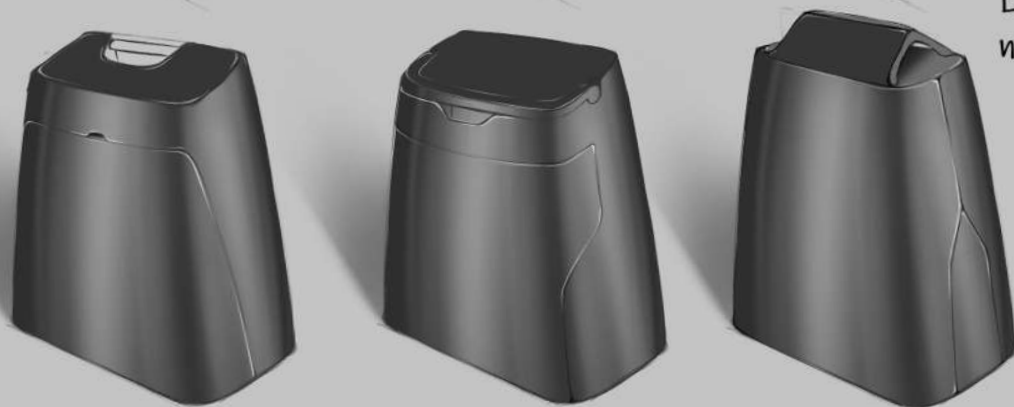




Needs more visual elements

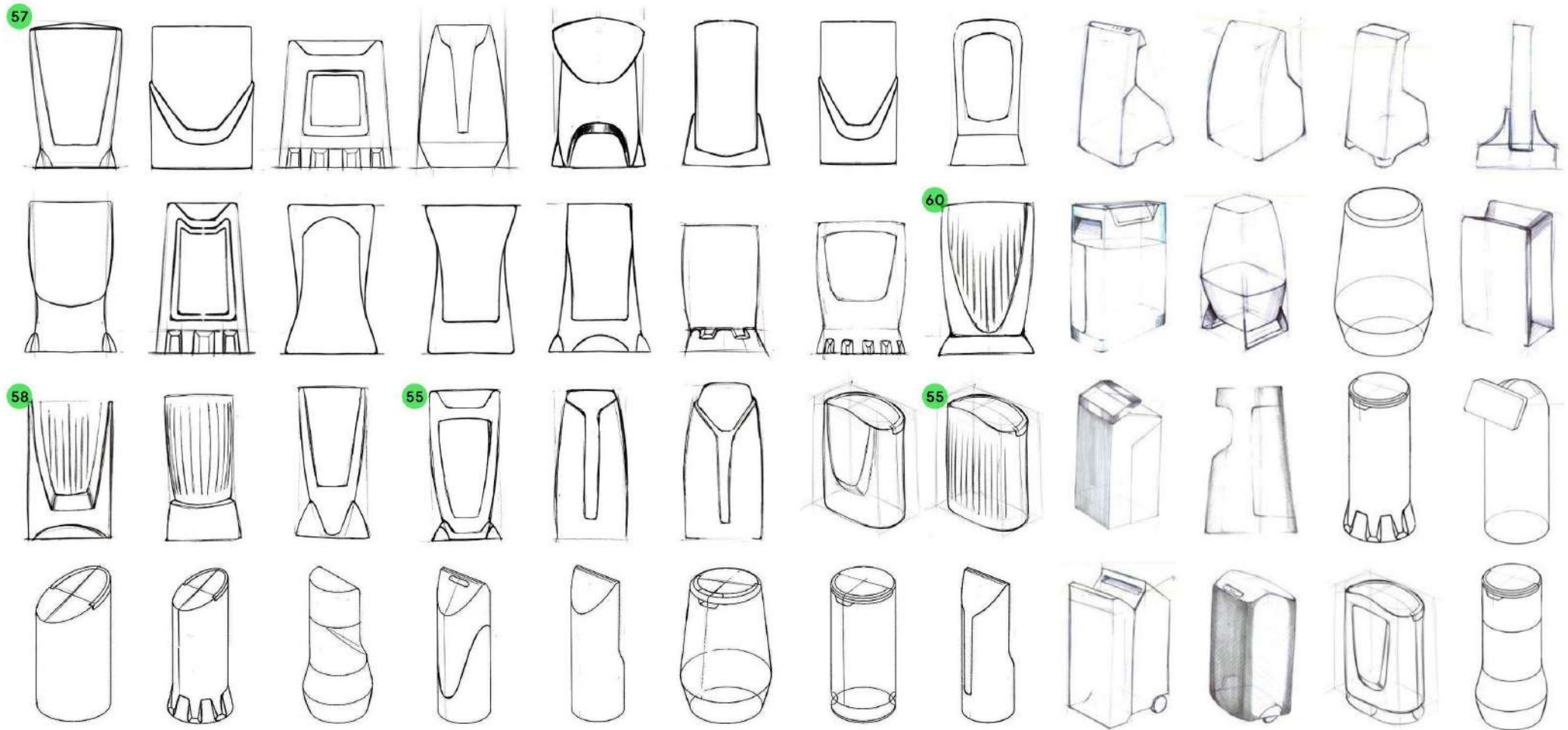


Looks Premium
not mid income



too much clean

FINAL SET OF IDEATIONS



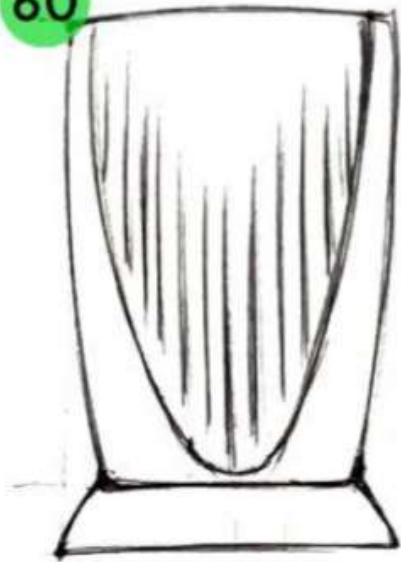
Going back to form generation after jury comments on earlier sketches. Forms were developed again based on visual cues from products of the earlier brands that were studied for visual semantics. Fellow design students were asked to look at boards formed from the brand studied. The evaluation of below forms was done to

comparison to those boards giving visual direction for final forms.

Brief for Evaluation - Please draw a comparison between the brand boards and given sketch to look for most visual similar looking forms . To be Evaluated out of 10.

AIR PURIFIER RE-DESIGN

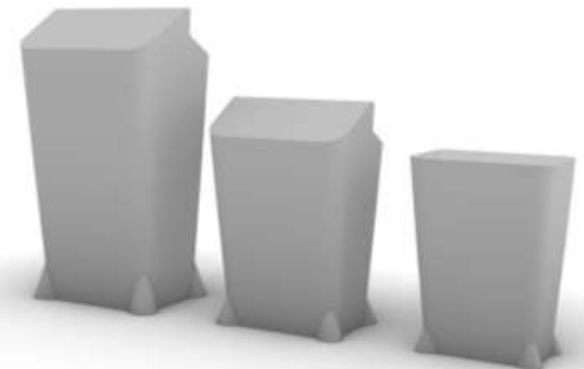
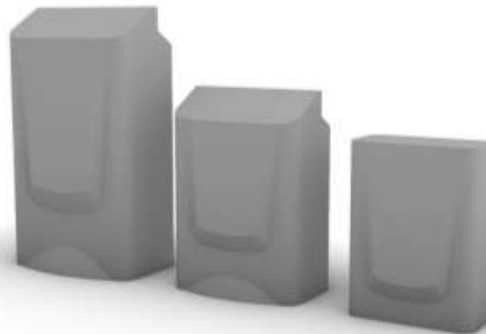
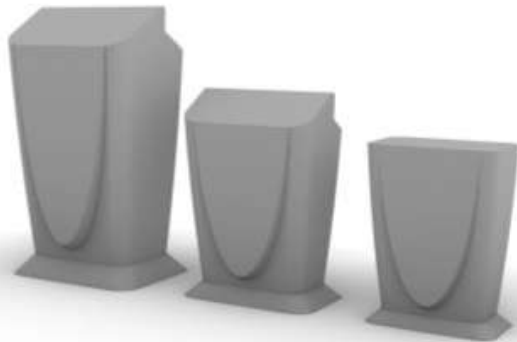
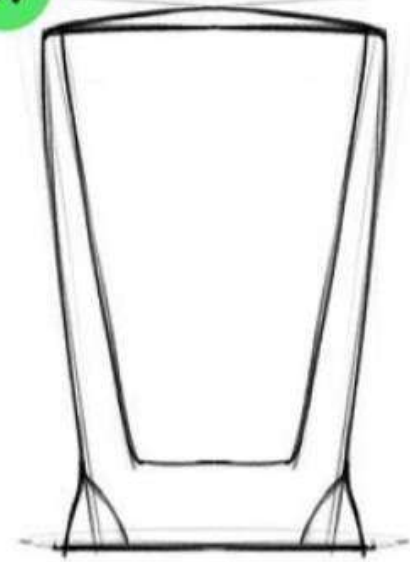
60



58



57



35

Forms selected based on evaluation done by fellow design students were used and further range of each sketch was developed in a set of 3. Sets based on 3 small, medium and large spaces as defined earlier.

IDEATION

DESIGN DETAILS

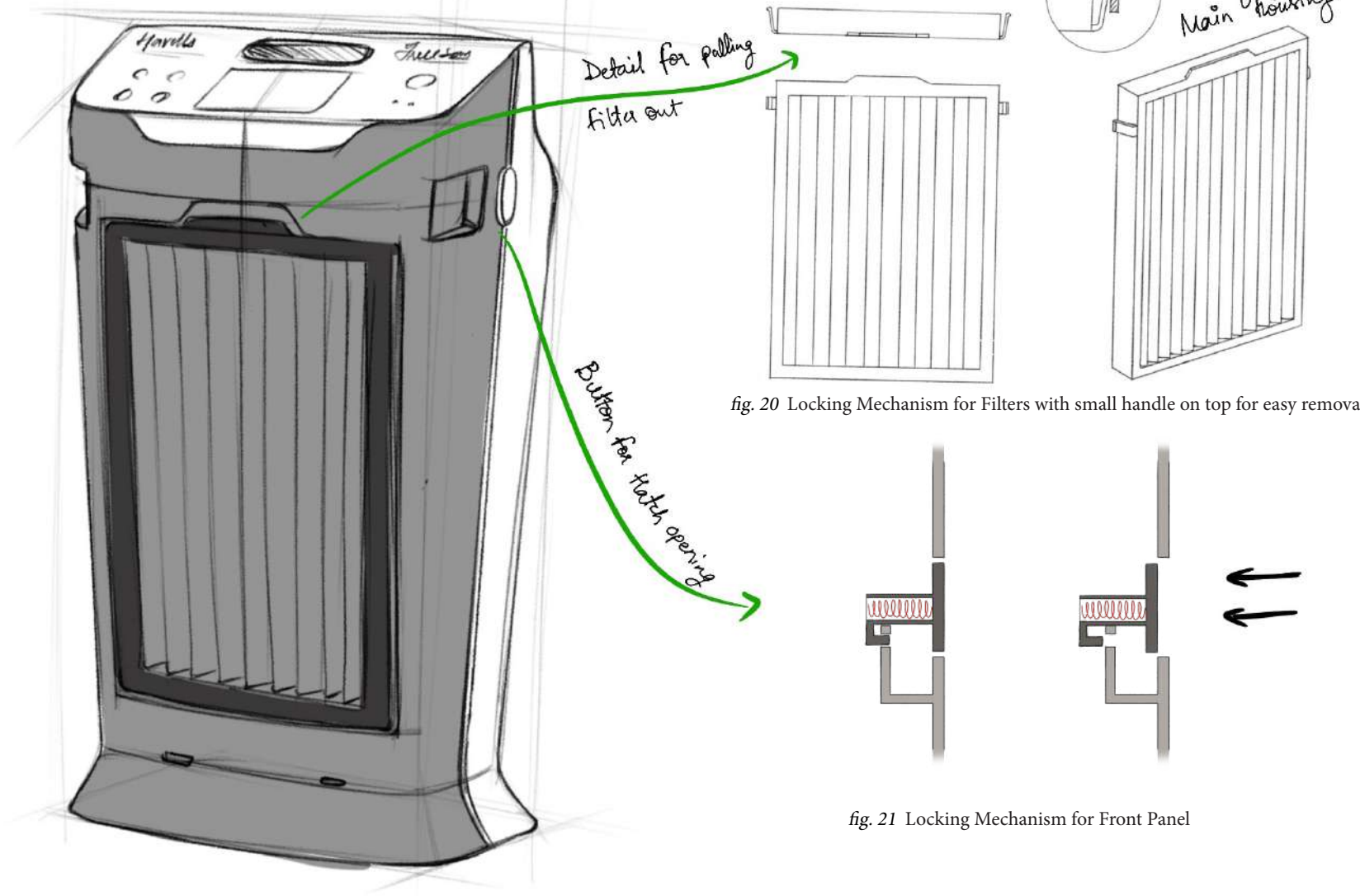
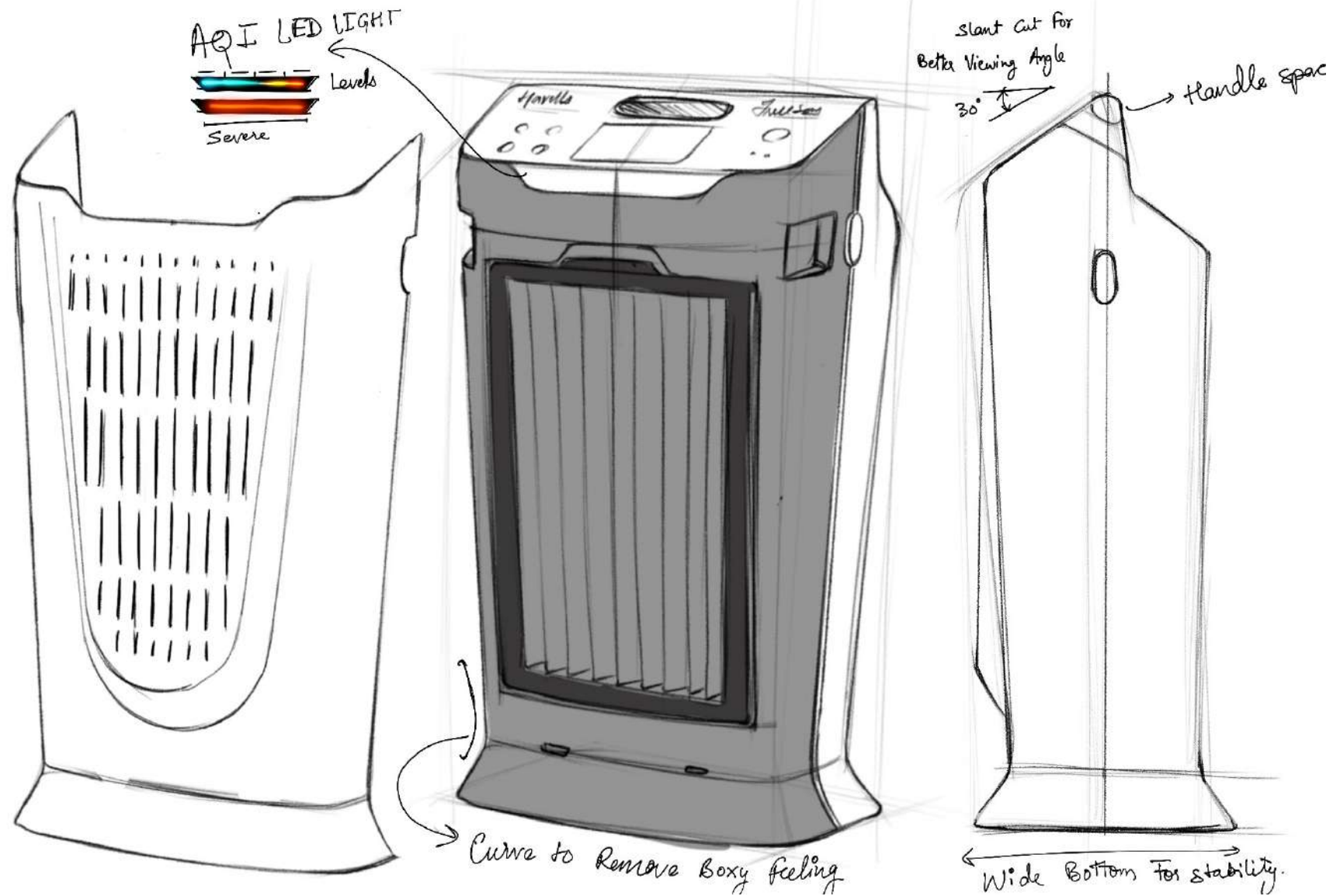


fig. 20 Locking Mechanism for Filters with small handle on top for easy removal

fig. 21 Locking Mechanism for Front Panel

AIR PURIFIER RE-DESIGN



IDEATION

NAVIGATION CONTROLS

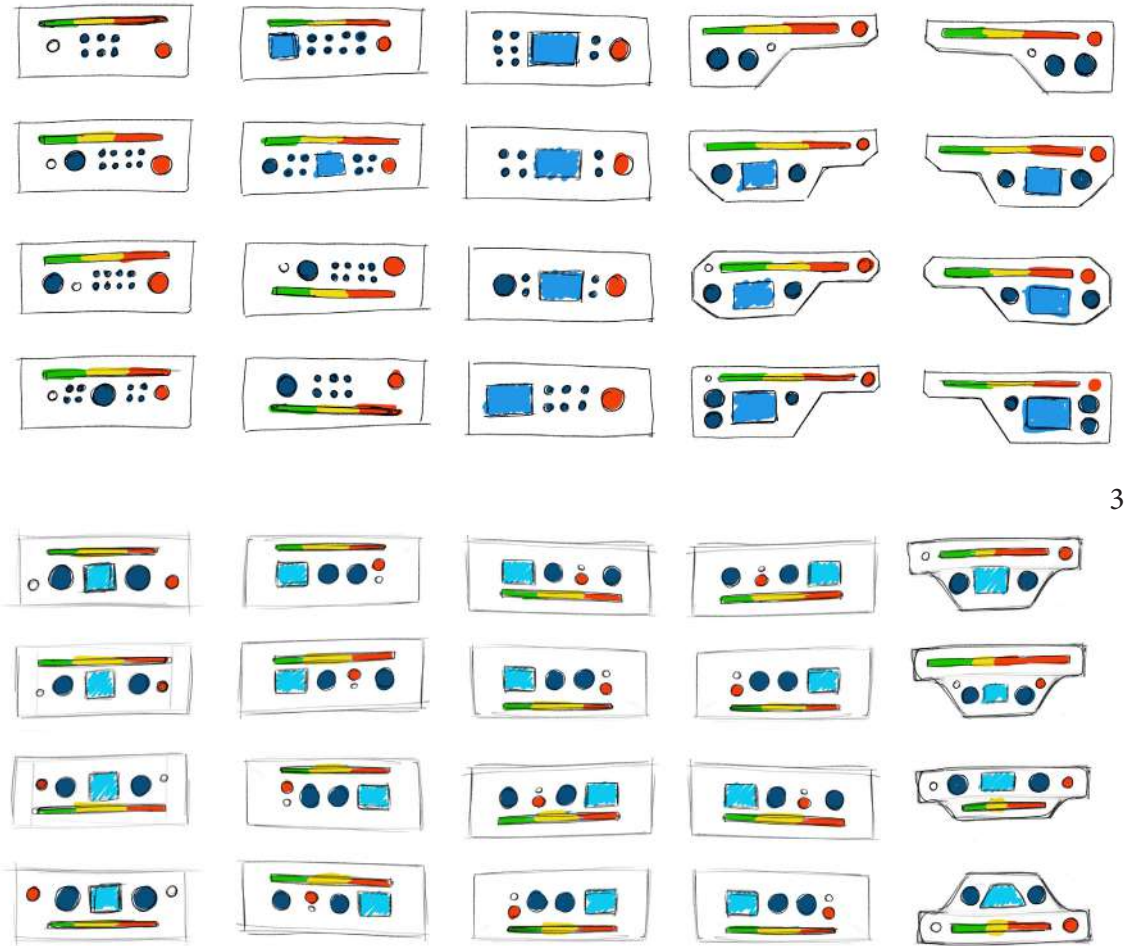
For navigation and controls I started to ideate based on 1 features that were available in the product. Push-buttons were selected based on the ease of use and cost factor which was to be kept in mind regarding the target audience being Middle income group.

As taught in a previous course about PID (Product Interface Design) and Gestalts laws were applied for the creation of these ideations of top Control panel.

Visual Elements kept

1. ON/OFF button
2. Screen
3. Indicator Lights for Error & Filter Replacement
4. Screen On/Off Button
5. Four Set of Buttons
 - Mode
 - Fan Speed
 - Timer
 - Child Lock

A lot of iterations were tried then final set was selected and further evaluated by group of test users which were asked to navigate through the controls and tell what elements gave them what indication of usage.



NAVIGATION TESTING

The Display pattern on the right (*fig. 19*) was liked by most people based on the ease of usage. Further, finalising the selection.

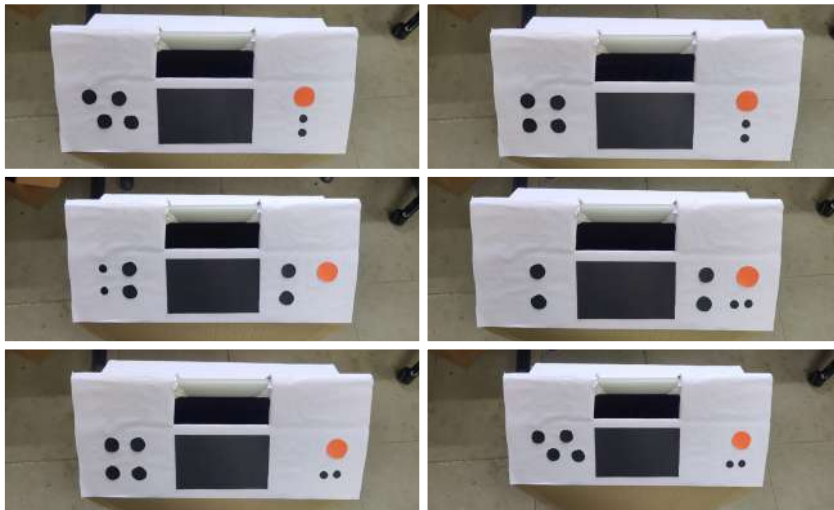


fig. 22 Final set of Display Controls evaluated by peer group based on visual heirarchy and usage ease.

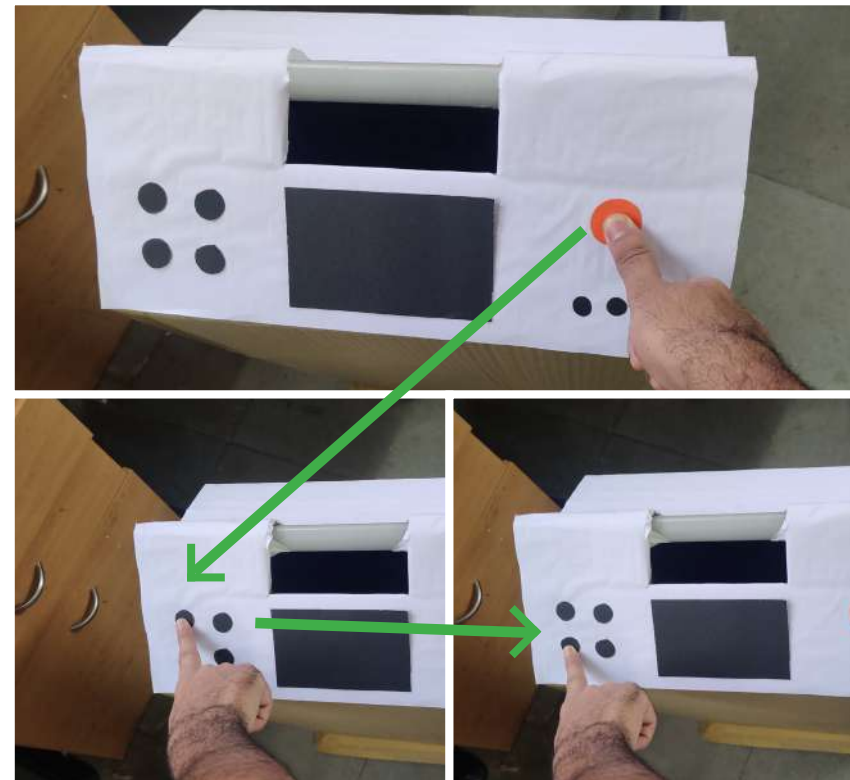


fig. 23 Path Follwed by people based on visual heirarchy of elements.

FINAL DESIGN

MOCKUP MODELS



fig. 24 Small Scale Thermocol mockup for Checking Forms

RIG MODEL



fig. 25 Actual Scale Rig Model

USER TESTING

After making the rig model it was tested for portability issue while keeping 7 kg of weight attached to the Rig model. The user were

asked to move it for 6-10 meters and tell about the experience. No tilting was noticed as weight evenly distributed in the whole model because of the centered handle.



fig. 26 User Testing for Handling and Portability testing

FINAL DESIGN

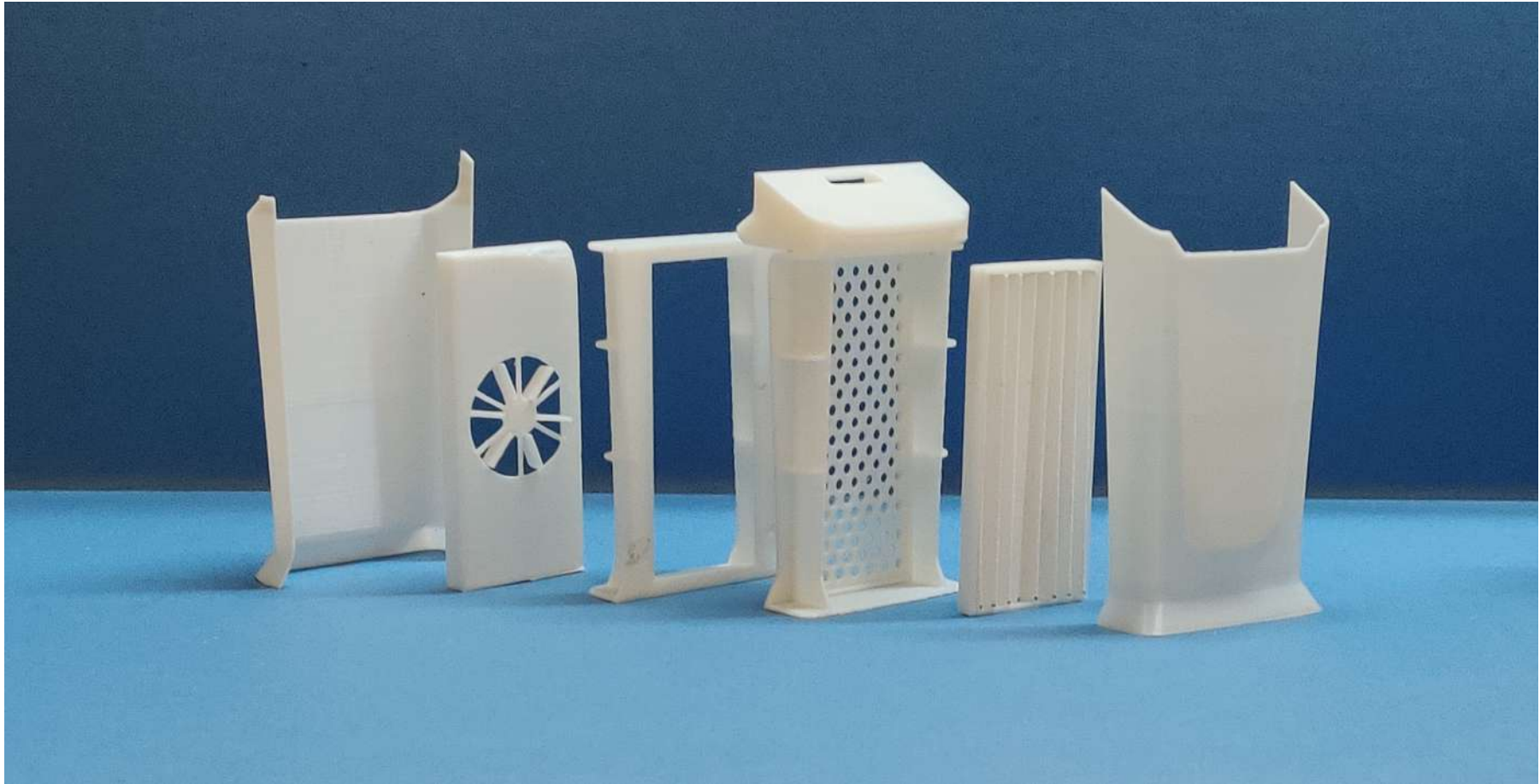
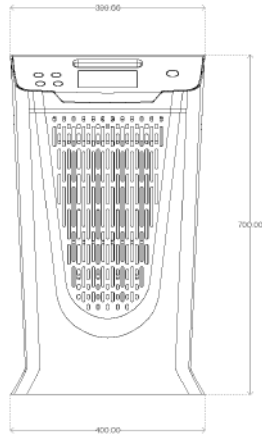


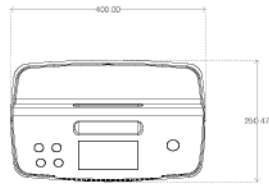
fig. 27 Small Scale 3D Print for Visual reference

AIR PURIFIER RE-DESIGN

DIMENSION DRAWINGS



Front

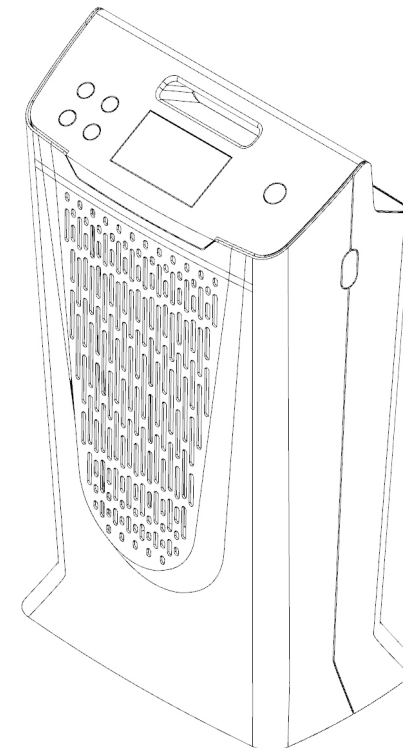


Top



Side

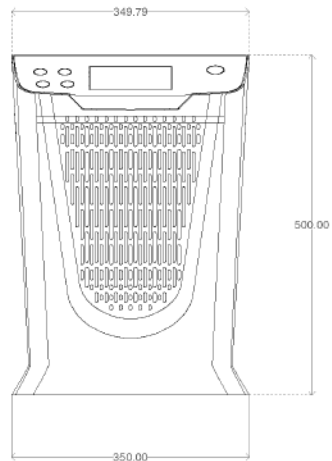
Design 1 - Large Area



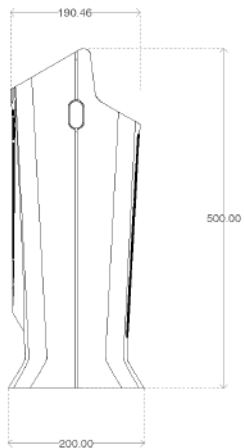
Perspective

*All Dimensions are in mm

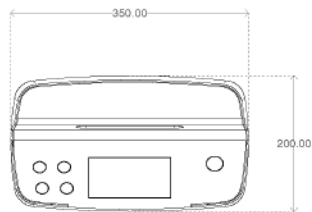
FINAL DESIGN



Front

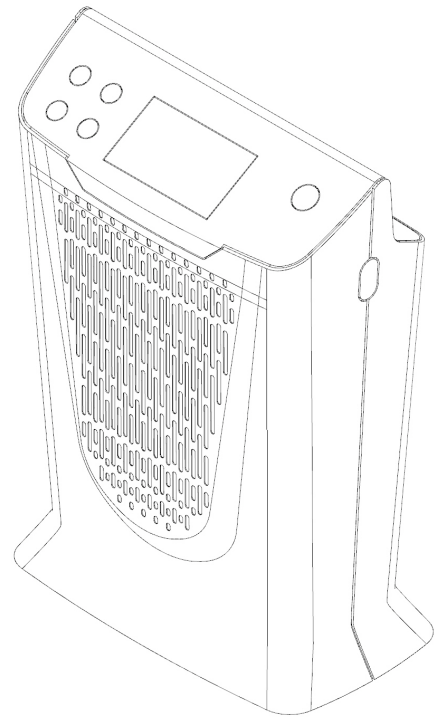


Side



Top

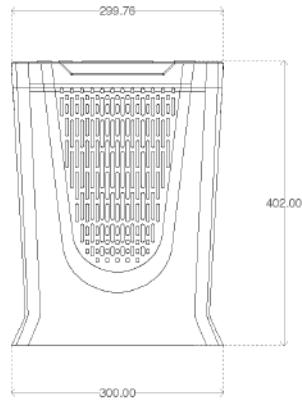
Design 2 - Medium Area



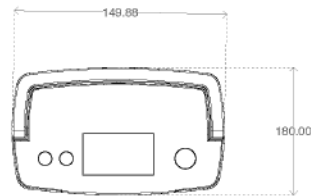
Perspective

*All Dimensions are in mm

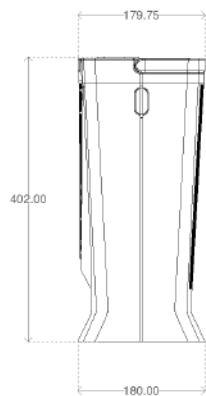
AIR PURIFIER RE-DESIGN



Front

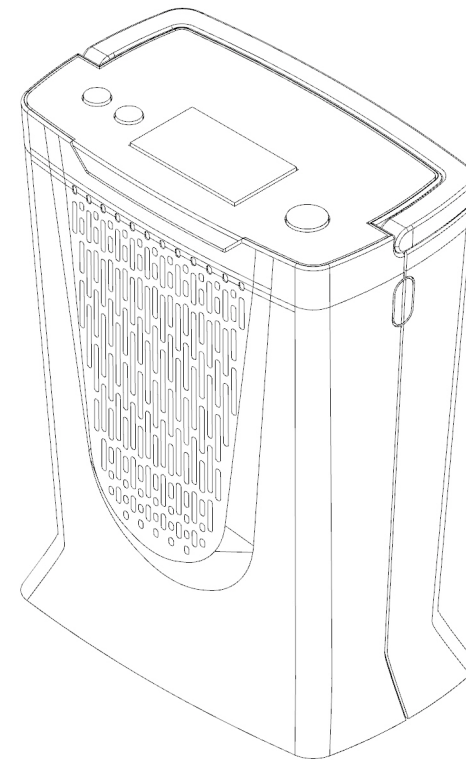


Top



Side

Design 3 - Small Area

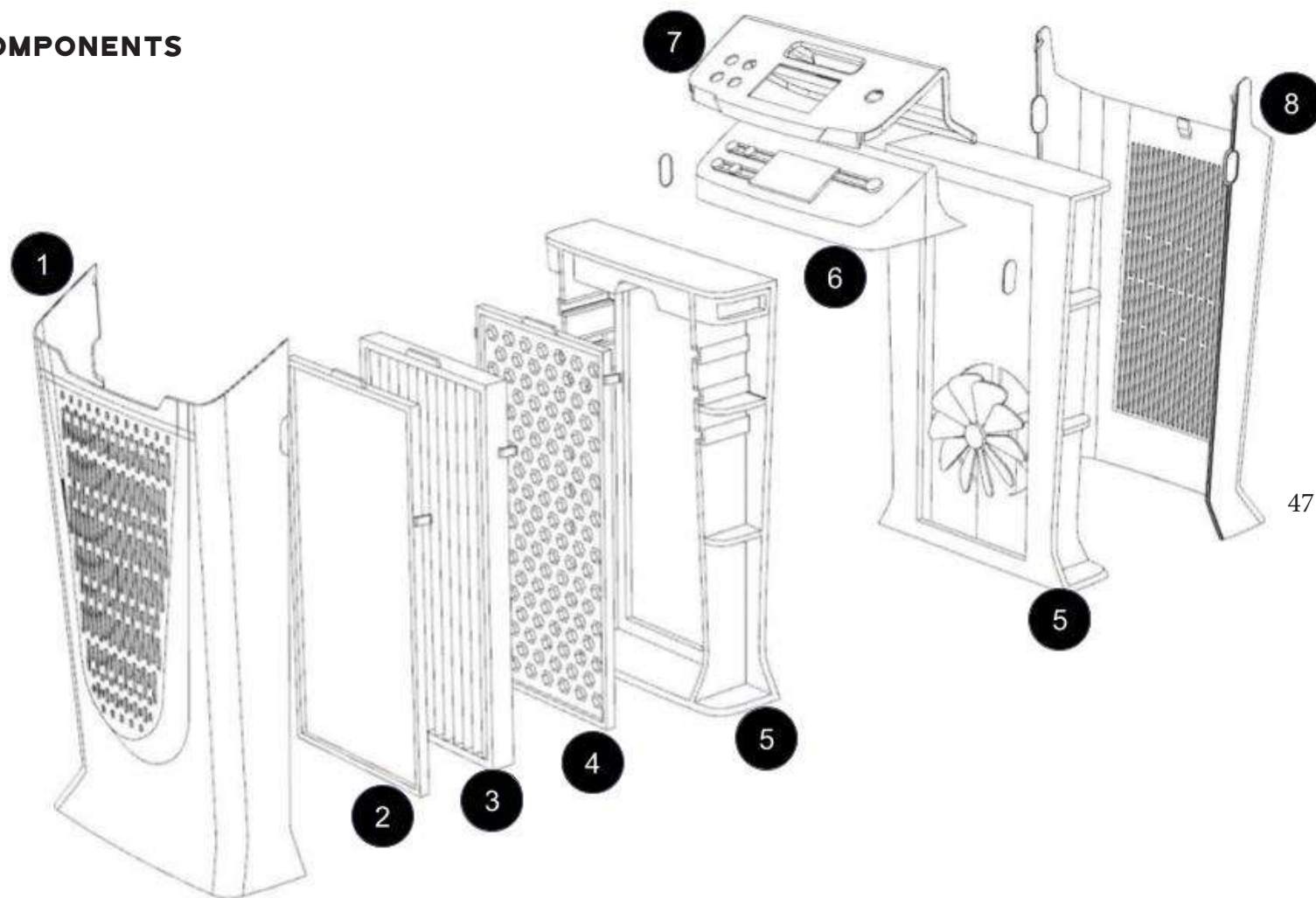


Perspective

*All Dimensions are in mm

EXPLODED VIEW OF COMPONENTS

1. Front Hatch
2. Pre-Filter
3. Hepa Filter
4. Carbon Filter
5. Internal Housing
6. Circuit & Display housing
7. Top Cover
8. Back Hatch



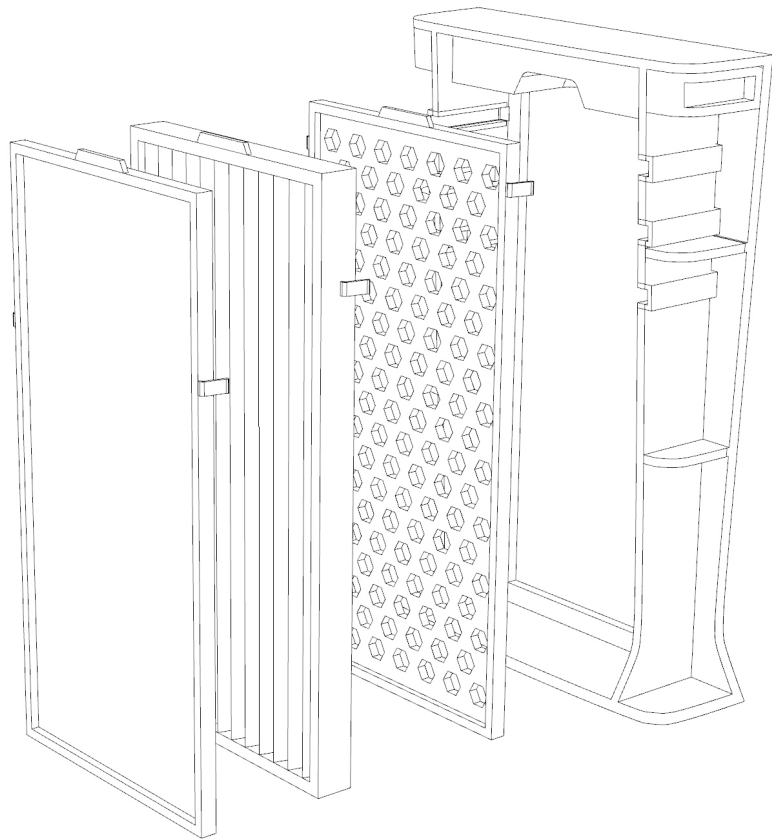


fig. 27 Filter Assembly

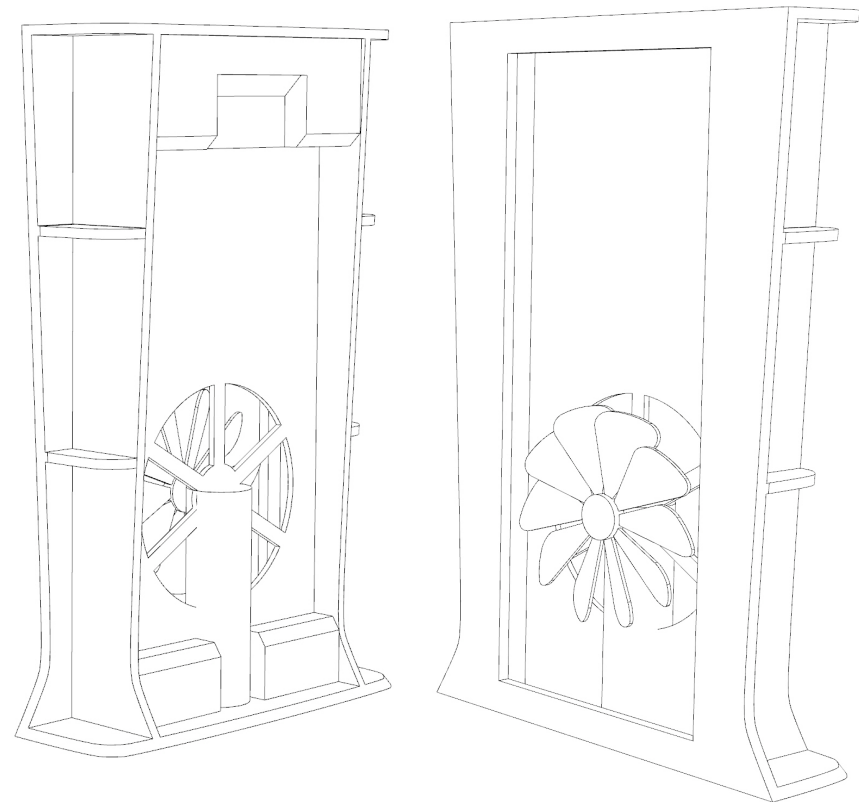


fig. 27 Internal Housing framee for Components

FINAL DESIGN

MANUFACTURING TECHNIQUES

Main Housing

Can be manufactured in ABS, HIPS, PVC, HDPE, PPE (high-impact polystyrene, polyvinyl chloride, high-density polyethylene, or polypropylene). Injection Moulding is used to get desired parts of exact dimensions.

Handle Gripping Area

Can be made in Rubber or Silicon. Injection Moulding or Compression Moulding to be used for mass manufacturing.

Display Panel

Can Be Moulded from acrylic sheet with cutouts for buttons.

Pre-Manufactured Items

1. Filters
 - Pre filter - (LxBxH)
 - HEPA 13 filter - (LxBxH)
 - Carbon filter - (LxBxH)
2. Fan - Height x Dia
3. Motor - 24V DC (Height x Dia) 4000RPM
4. Display - Led Display 5-3"
5. Electrical Components - Motor Driver, Led Lights
6. Air Quality Monitor - Standard

BILL OF MATERIAL (APPROX.)

Main Housing

Mould cost for injection moulding and material

Handle Gripping Area

Mould cost for injection moulding and material

Display Panel

Mould cost for injection moulding and material

Pre-Manufactured Items

1. Filters
 - Pre filter - less than ₹100
 - HEPA 13 filter - ₹500 to ₹1000 based on quality
 - Carbon filter - ₹100 to ₹250
2. Fan - less than ₹50
3. Motor - 24V DC 3000-4000RPM - ₹500 to ₹1000
4. Display - Led Display - ₹1000 to ₹1200
5. Electrical Components - Motor Driver, Led Lights - ₹200 to ₹300
6. Air Quality Monitor - ₹200

Cost estimate taken from different vendor costings on Indiamart and Alibaba.com. All costs based on bulk buying.

Total Cost of Manufacturing should lie around ₹4500 in bulk buying.

RENDERS









FINAL PROTOTYPE



FINAL DESIGN

CONCLUSION

From this project I gathered a lot of insights about the User group targeting and creating a product which follows both market aesthetics and user aspirational values.

As the primary objective of the project was to re-design the product for the Indian mid income group, it taught me how to work under cost constraints and develop ideas which look new and have different aesthetics than that of the current products while keeping the manufacturing components and costs as low as possible.

As the technology to manufacture an air purifier is very simple, cheap and production friendly this product can be easily targeted at the mid income group as it has become a necessity in many parts of our country. Creating a Scalable Business model.

FUTURE SCOPE

This Product would be becoming the need of every house in upcoming years. So, It would be good opportunity to look into more advanced cleanig and filtration techniques which don't effect the humans and need less additional added cost.

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2. Godish, Thad. Indoor Environmental Quality. New York: Lewis Publishers, 1999.
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1. Christiansen, S. C., et al. "Exposure and Sensitization to Environmental Allergen of Predominantly Hispanic Children with Asthma in San Diego's Inner City." Journal of Allergy and Clinical Immunology (August 1996): 288-294.
2. Varshney, Jitendra, and Himanshu Varshney. "Allergic Rhinitis: an Overview." Indian journal of otolaryngology and head and neck surgery : official publication of the Association of Otolaryngologists of India vol. 67,2 (2015): 143-9. doi:10.1007/s12070-015-0828-5

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2. "Filter Media." Mac Equipment. 3 June 2001. < <http://www.macequipment.com> >.

3. <http://www.madehow.com/Volume-7/Air-Purifier.html>
4. https://en.wikipedia.org/wiki/Air_purifier
5. https://www.electrolux.in/appliances/air-purifiers/?gclid=Cj0KCQiA1NebBhDDARIsAANiDD2K9tVSR1XOBDBoqkxq3QA6GGaxWT6nh5M06COGfhWbeBJGWGH2oW8aAuXqEALw_wcB&gclsrc=aw.ds
6. <https://www.livescience.com/how-do-air-purifiers-work>

APPENDIX

Img Index

1. https://kenresearch.com/uploads/images/india_air_purifier_market.jpg
2. <https://www.visualcapitalist.com/wp-content/uploads/2020/10/relativesizeofparticles.html>

Benchmarking of Aspirational Products by User Interviewed

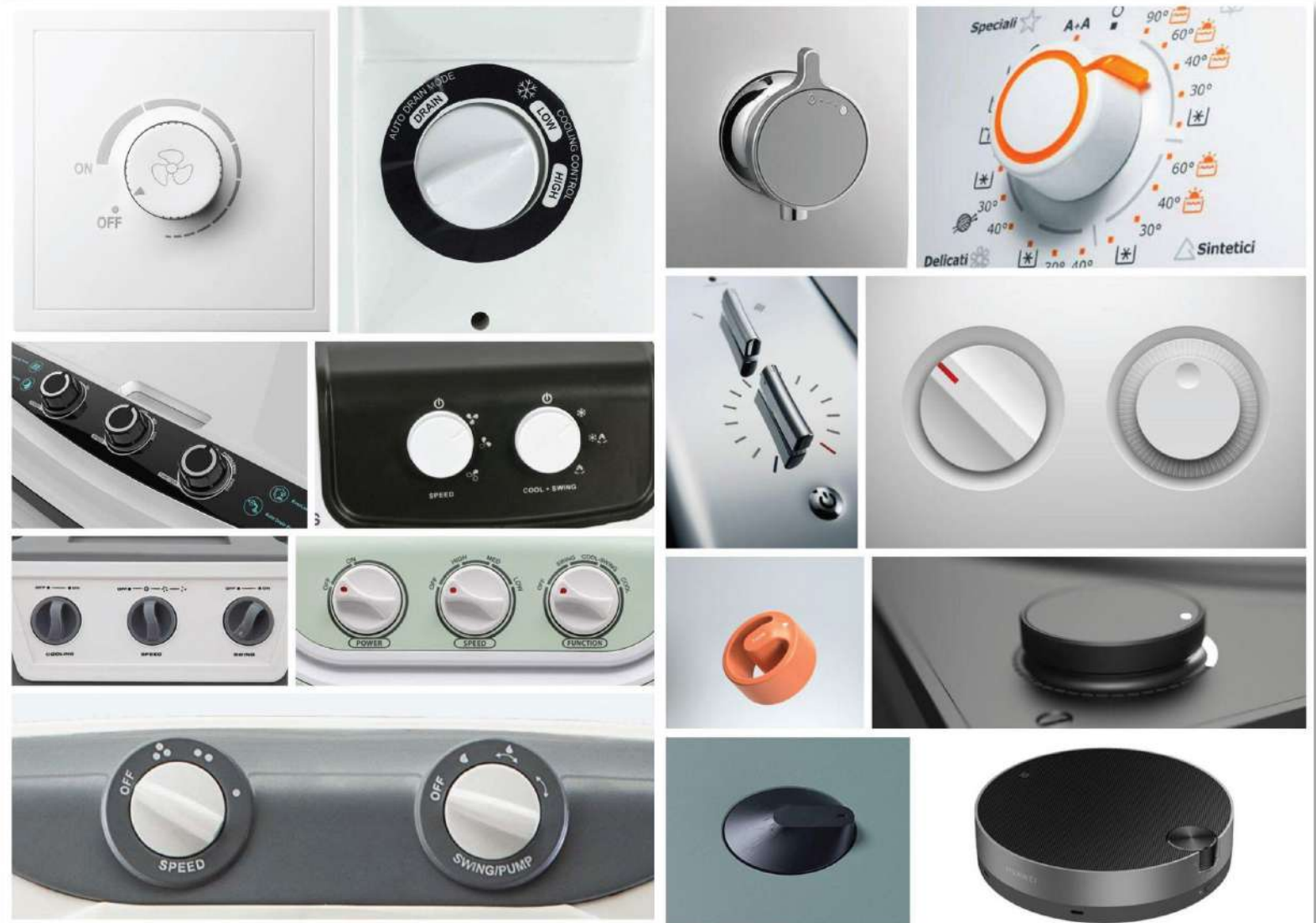


Controls Study Board

Controls Study

Results

- Visual Marking elements (**Colour or Material**) are present to denote position or mode
- Click mechanism to give feedback in state change
- Aligned buttons when multiple are present
- Contrast against Background (**Colour, Material or change in level**)
- Lights can also be integrated to suggest active state



Handle Study

Results

- Dual material for look and feel
- Smooth edges to avoid discomfort
- Silicon/rubber on the lower side for better grip



Vent Study

Results

- Parametric based
- Dynamic Lattice structures
- Non uniform designs



Brand Board of Bajaj used for Study

Bajaj

- Warm
- Cool colors
- Harmonious
- Symmetry
- Curves
- Stable
- Strong
- Rigid
- Bold
- Dynamic



Brand Board of Havells used for Study

Havells

- Warm
- Harmonious
- Retro
- Techy
- Symmetry
- Curves
- Bold
- Stable
- Functional



Brand Board of Jaipan used for Study

Jaipan

- Vibrant
- Warm
- Harmonious
- Symmetry
- Curves
- Stable
- Energetic



Form Analysis Review From Peer group based on brand boards



Design	Zaid	Aryan	Sagar	Hazique	Prathmesh	Naiga	Bibin	Jahnvi	Total
1	8	6	8	7	8	4	7	8	57
2	5	5	7	3	5	4	8	5	42
3	2	5	3	5	6	5	4	4	34
4	2	6	8	3	7	4	4	4	38
5	0	5	6	3	3	5	3	5	30
6	2	6	7	8	8	2	8	8	49
7	3	6	7	4	7	3	8	8	46
8	4	4	6	7	7	3	6	5	42
9	3	4	7	5	6	2	5	3	35
10	6	7	6	5	5	6	4	8	47
11	4	6	6	5	5	5	6	9	46
12	3	6	7	5	6	4	7	7	45
13	3	8	7	6	7	4	6	5	46
14	2	6	6	6	3	5	5	7	40
15	5	4	6	6	3	6	5	5	40
16	8	7	7	6	9	7	7	9	60
17	7	6	7	7	8	7	7	9	58
18	6	6	6	6	7	7	6	9	53
19	5	5	7	8	7	6	6	8	52
20	8	7	6	8	7	6	6	7	55
21	6	6	8	6	5	3	6	7	47
22	5	6	7	5	5	2	5	7	42
23	9	7	7	6	5	4	8	8	54
24	9	6	8	6	4	7	7	8	55
25	4	6	6	7	4	5	6	3	41
26	2	6	6	3	5	6	6	4	38
27	0	7	5	2	6	6	5	3	34
28	1	8	6	5	5	3	7	4	39
29	2	7	6	5	3	2	6	6	37
30	4	8	7	6	4	3	6	5	43
31	5	8	8	5	3	2	7	8	46
32	3	7	7	4	2	4	6	6	39
33	2	8	6	5	5	5	5	8	44