

When pollution haze is outside, you can still have fresh air in your room with the help of Window Purifier



01

Snow | Baoling Yang |



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Snow, Baoling Yang, the designer of this book is an industrial design student in SEU-Monash Joint Graduate School in 2014. She graduated from Mechanical Engineering Department in Dalian University of Technology in which she received formal education about engineering.

Although with the background of engineering, she has a passion for design. She taught herself photoshop at her first undergraduate year, and won three prizes about design in her undergraduate school. She then took formal education about design at her graduate school, dreaming to be a great designer to bring benefit to the human beings.

She admires all great designers, ranging from an ordinary people who design scissor-cut to great architect who design a palace. Among the many design styles, she prefers deconstructivism, postmodernism and minimalism, holding the belief of LESS IS MORE. And she will try her best to advance towards the goal of being a designer who provide people with the most delightful and comfortable designs.

In this book, she wrote about her design process of Window Purifier-- a new type of air purifier to clean the air. She introduced from the beginning of a concept all the way to the real model was made, involving interview of target user, technology research, and so on.



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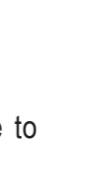
Acknowledgements

This book is done with help of many people, and I would like to express my gratitude to them all.

First and foremost, my thanks goes to Ian Wong, our supervisor, for his constant encouragement and guidance. He has walked me through all the process of learning, giving me lots of constructive feedbacks. Not only does he guide us in class, he also introduced me to other designers who also gave me pertinent feedback.

Second, I'd like to thank Ethan who gave us an introduction about design in China, and helped us make things done in Suzhou. Walsh Bernie is who I'd also like to pay gratitude to. His fantastic hand drawing attracted me into the design. I'd always remember hand drawing in my future work.

Last but not least, my thanks goes to all other people who have helped me, including Andrew-- designer from frog design, staffs in the air purifier exhibition, many other people who filled in my questionnaire and all students who have helped me with my project.



Ian Wong



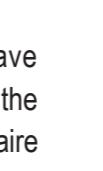
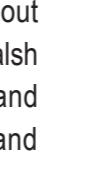
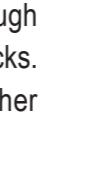
Ethan



Walsh Bernie



Andrew



Other people who have helped me

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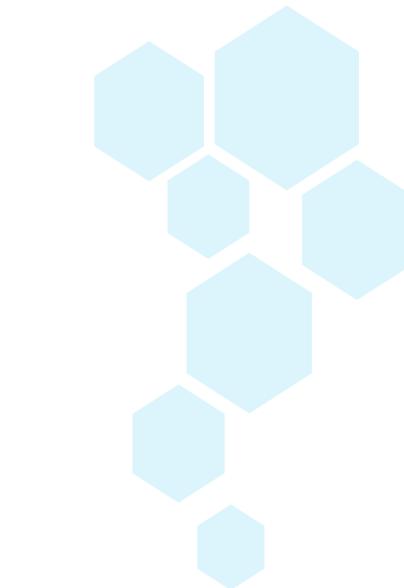
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1

Introduction

1.1 ABSTRACT

TOPIC- Breathe

This project focuses on improving the quality of ambient air that people are breathing, providing people with a fresh, comfortable living environment which mimics that of the nature.

As the air quality deteriorates with the development of manufacturing industry in China, people have an increasing rate of getting respiratory disease. Breathing polluted air every day brings damage to people's health, particularly to vulnerable people such as pregnant women, newborn baby, patients and the old. Therefore, it's significant to design a product to purify the air.

This project develops a product that purify the indoor air. Different from other air purifier, this product is not a machine that lays somewhere in your room, but a "lung" on your window that helps your room breathe.



1.2 BACKGROUND



1.2.1 Air Pollution in China

Air pollution has become increasingly serious with the development of the manufacturing industry in China. Every year, air pollution cause diseases among a large number of people. It occurs in forms of fog and haze which contains tremendous PM2.5 which might cause long-term health impacts among people.

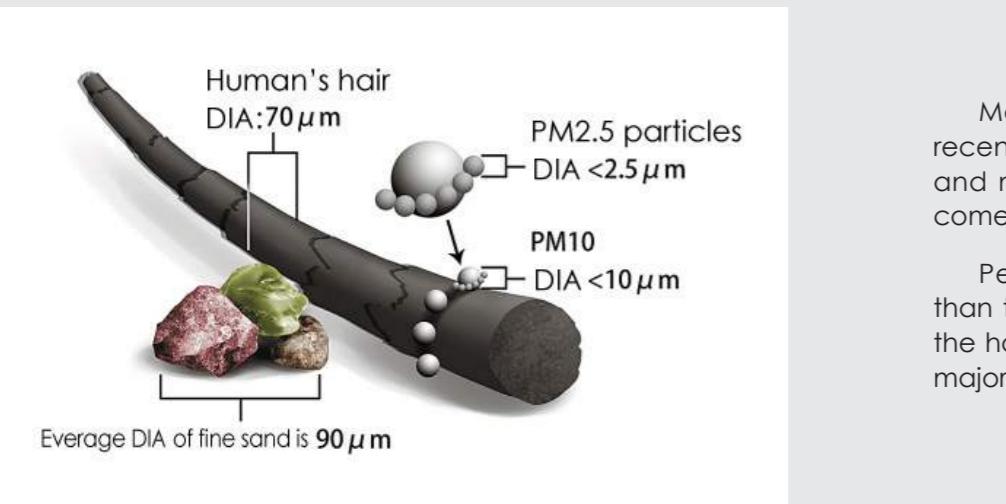
Air pollutants indoors also consist of substances such as oil fume, dust, smoke, formaldehyde, etc. It has been linked to increased incidences of cancer, heart disease, stroke and respiratory illnesses.

It is urgent and also of great significance to improve the air quality to prevent all kinds of diseases and improve people's health.

1.2.2 What is PM2.5

PM2.5, particles below the size of 2.5 micrometers, are major pollutants in the air which could cause fog and haze. When inhaled into our lungs, PM2.5 can easily go through our lung and enter our blood stream, thus bringing damage to our body. Today this is considered to be a major cause of heart and vascular diseases as well as different forms of cancer.

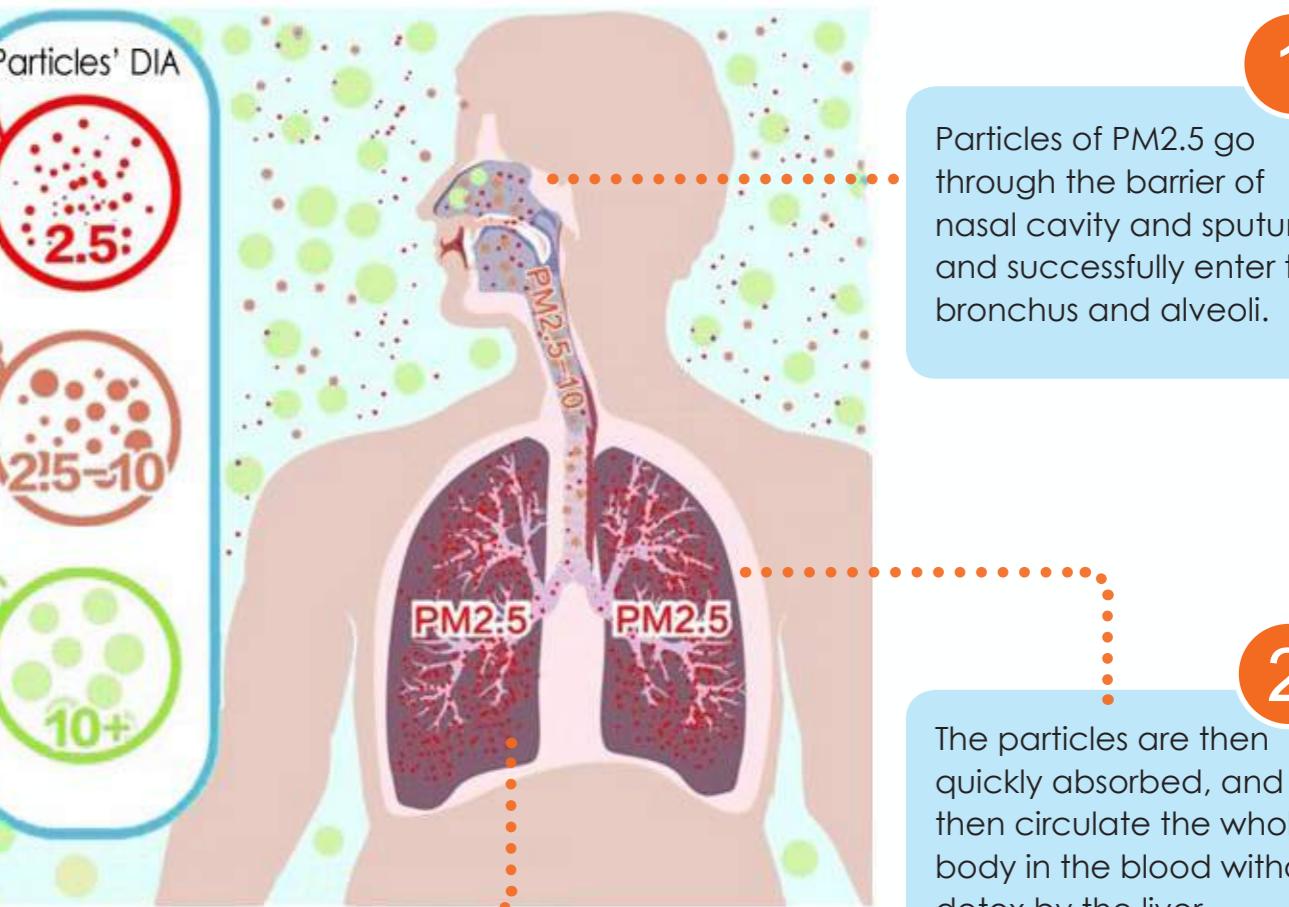
A number of different lung problems are caused by the same small size particles. During the last couple of years it has been proven that allergic and asthma reactions have become 10 -100 times more aggressive than it does in the past.



Many cities in China have been struck by fog and haze in recent years. People have to wear masks when they go outside, and masks have been the best selling product when the haze comes.

People tend to stay indoor with the window closed rather than to go out and put themselves in the haze. How to keep out the haze and stay in an environment with fresh air has become a major concern of people.

How PM2.5 damages our health



Particles less than 2.5μm's large can easily get into bronchus and alveoli, and then is absorbed by our body.

1
Particles of PM2.5 go through the barrier of nasal cavity and sputum, and successfully enter the bronchus and alveoli.

2
The particles are then quickly absorbed, and then circulate the whole body in the blood without detox by the liver.

3
The particles in the blood can damage hemoglobin's ability of delivering oxygen, and cause many diseases to immune system.



1.3 PROJECT SETTING

Where there is a need for clean air, there is a need for an air purifier, such as house, factory, hospital, office, classroom, restaurant, etc.



1.4 THE USER

All people living in a polluted environment and wishing to improve the air quality are the target user. In particular, vulnerable people such as babies, patients and old people are in special need of air quality and thus requires an air purifier.

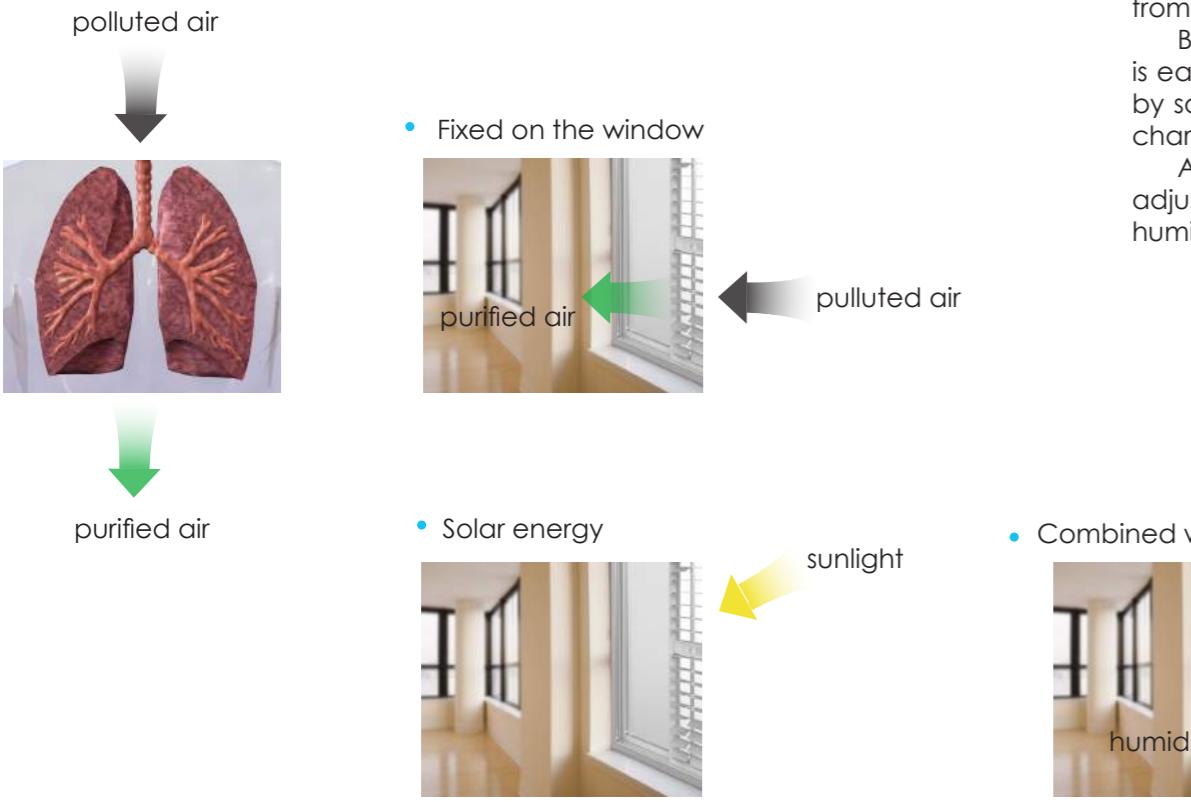
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Task Clarification



2.1 PROJECT OBJECTIVES

- To remove contaminants in indoor environment and improve air quality.
- To improve living conditions and provide people with a comfortable and suitable environment.



This project will develop a new type of air purifier to clean the air. Different from ordinary air purifier that lays somewhere in your room, this air purifier is in the window!

The window air purifier is to a house what lung is to body. While breathing in air with numerous dust and hazardous substance, the lung stops bad particles from entering the blood. Likewise, the window air purifier will filter the air before it enters the room, thus protecting the air indoors from being contaminated.

Because the purifier is fixed on a window, it is easy for it to receive sunlight and be powered by solar energy. Therefore, it doesn't bother with charging.

Apart from air purifying, this design will also adjust the humidity in the room to maintain the humidity in a most comfortable level.

2.2 RESEARCH METHOD





2.2.1 Story Board

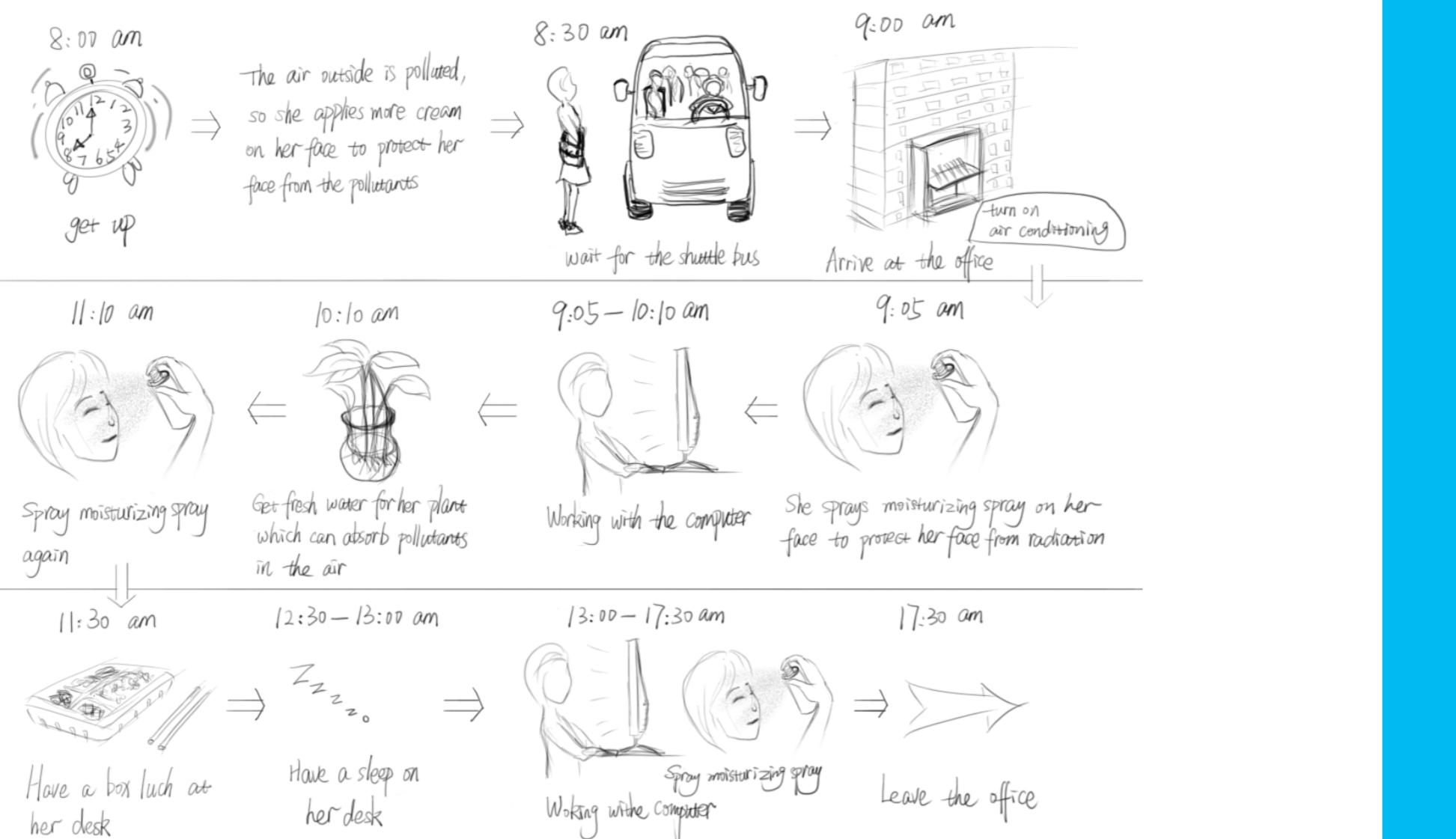
A day of a beautiful lady who cares a lot about her face.



Miss Gu

Age:25

Graphic Designer in
Shanghai Formost
Group



Interview with a general sales manager in a machinery company



Mr Shen

Age:35

General Sales Manager
in Suzhou Sidanke
Machinery Company



Mr Shen works in a machinery plant where many CNC machine tools work every day, which leads to the bad air quality in the office next to the machine room.

The company in which he works locates in a manufacturing district where many plants surround it. The air quality of the district is definitely worse than it is elsewhere in Suzhou.

Therefore, Mr Shen purchased an air purifier and put it in his office. He told me that one of their clients is Beiang Air Purifier Co. Ltd. They manufacture the plastic shell for the air purifier. Therefore, there are many air purifiers in their plant to help clean the air. And he said that the air purifier benefits him a lot.



2.2.2 Existing Product Research

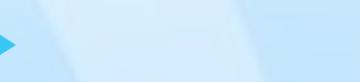


Considering the existing product, my design will focus on the innovative side. It may not necessarily small, but it should not take too much space in the room, such as embedded on the wall or hang on the ceiling.



2.2.3 Sunrise to Sunset

Natural



Filters

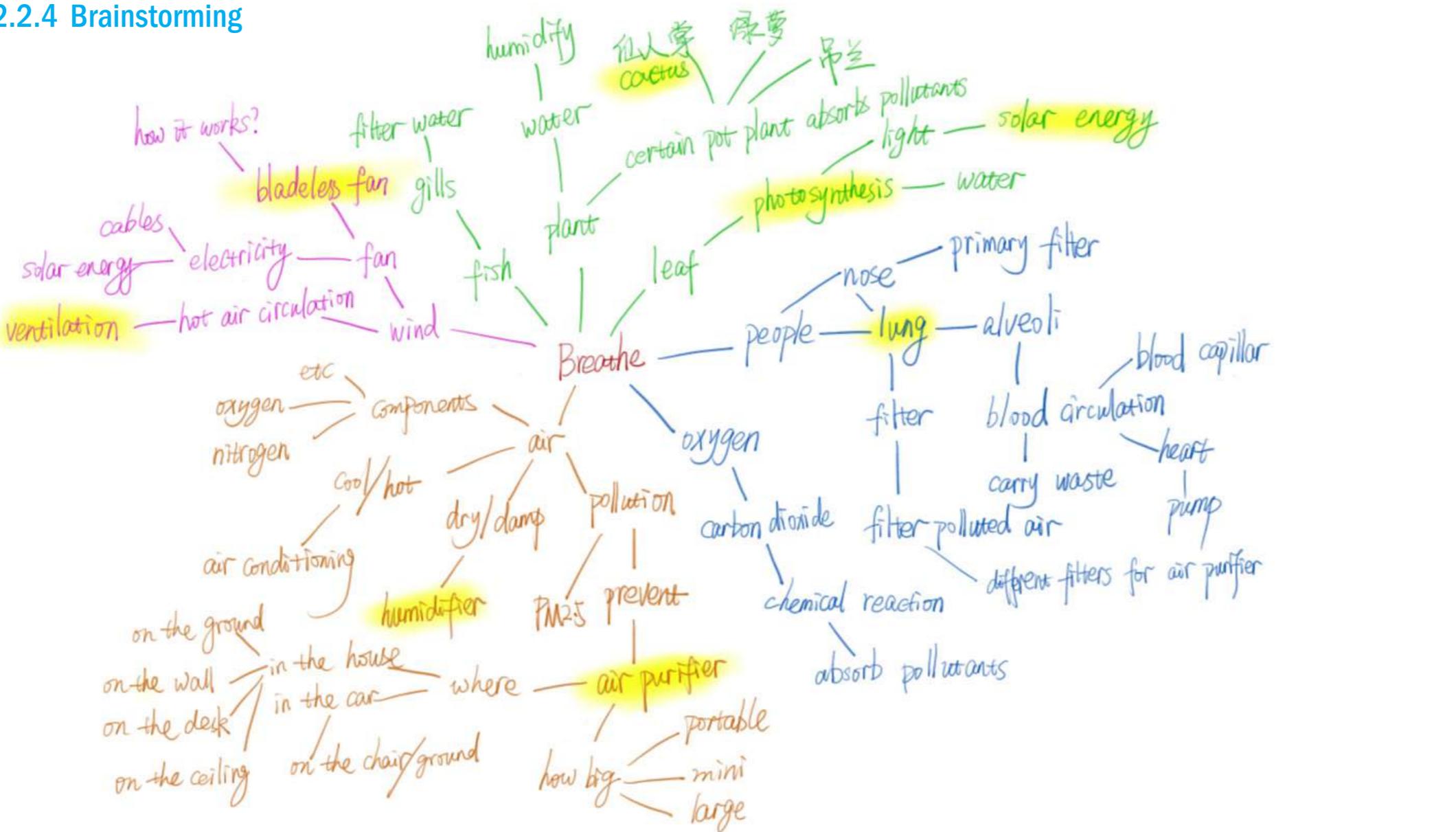


2.2.3 Sunrise to Sunset

Molecular complexation



2.2.4 Brainstorming



2.2.5 Questionnaire

1. Which of the following environmental problem influence you most?

- A. Climate Warming B. Air Pollution C. Water Pollution

2. Does the air need improving?

- A. Yes, it does. B. No, it doesn't.

3. Does outdoor air influence you most or indoor air?

- A. Outdoor air B. Indoor air

4. Do you get sick with polluted air?

- A. No B. Yes (1. rhinitis 2. pharyngitis 3. dizziness 4. asthma 5. others)

5. Have you seen pollution haze? If you do, does it damage your health?

- A. No B. Yes (How does it impact you _____)

6. (Multiple-choice) What will you do if the outdoor air is polluted?

- A. Put up mask B. Close the window C. Stay indoor

7. (Multiple-choice) What will you do if the indoor air is polluted?

- A. Open the window for ventilation B. Grow plant that absorb air pollutants C. Buy an air purifier

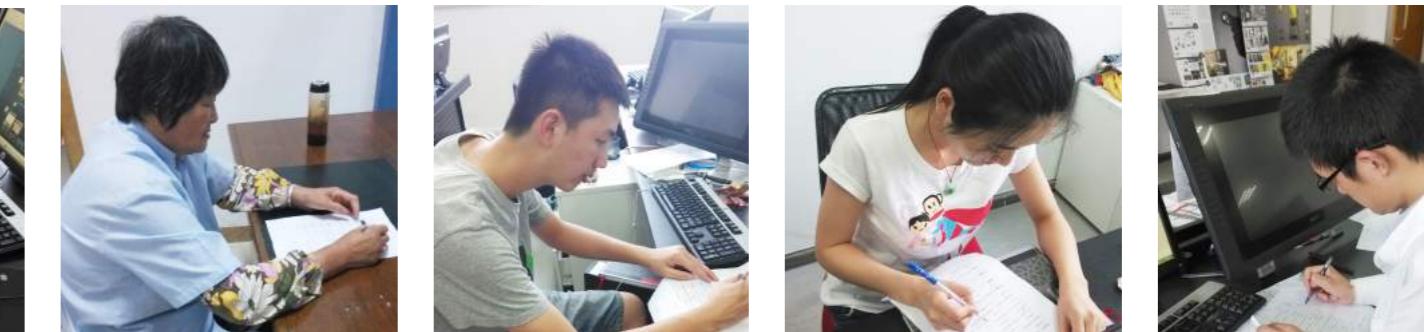
8. (Multiple-choice) Why don't you purchase an air purifier?

- A. Too expensive B. Take up too much space in room C. Too much power consumption

9. (Multiple-choice) What's your ideal air purifier?

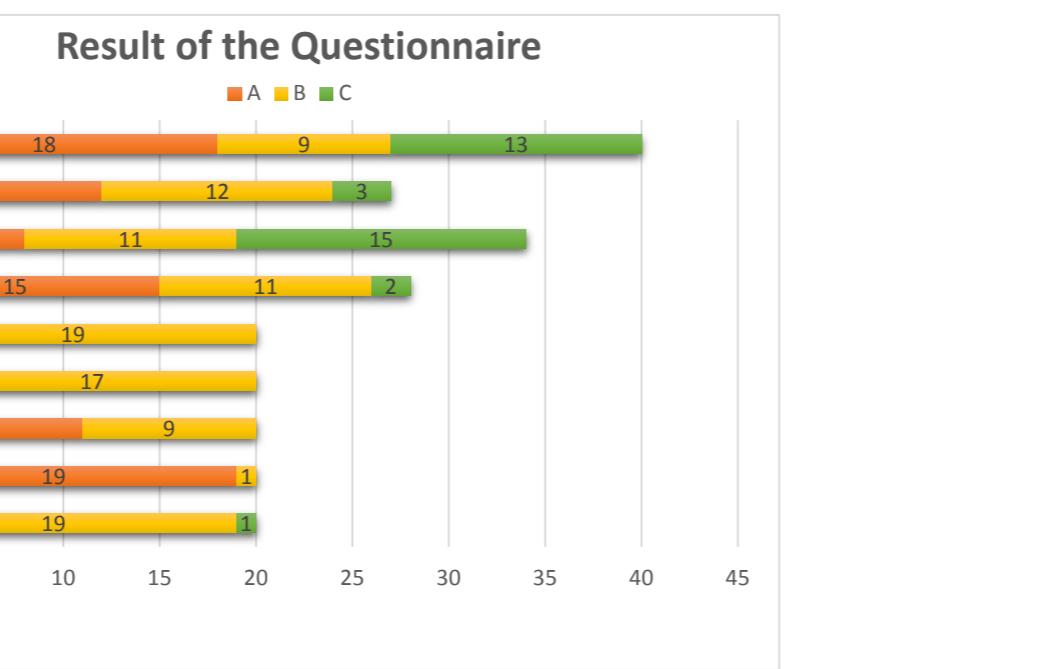
- A. Automatic control B. App control C. Embedded in the wall so it doesn't take up too much room

This questionnaire was done by 20 people, 10 out of them did print version while 10 others did electronic version. Their identities vary from students, sales manager, front desk staff to old people, etc.



Here is the result of the questionnaire.

- ① 19 out of 20 people think that air pollution has the most impact on them than another two environmental problems, and the air needs improving.
- ② Most people have seen haze, and got some problems with their health in the haze.
- ③ Few of them would like to buy an air purifier when the air indoor is bad, because mostly of the high price and the space it might take in the house.
- ④ They prefer a smart air purifier which doesn't take up too much space in the house.



Suggestions for air purifier as follows:

- ① Use chemical reaction for purification rather than just physical filtering.
- ② Cheap and simple.
- ③ Low power consumption, solar energy is appreciated.
- ④ Smart, and be able to show air quality.
- ⑤ Be able to humidify or dehumidify.
- ⑥ Small or embedded in somewhere rather than taking up much space.
- ⑦ Low noise.
- ⑧ If it's movable, it should be able to be moved easily.





Beiang Air Purifier

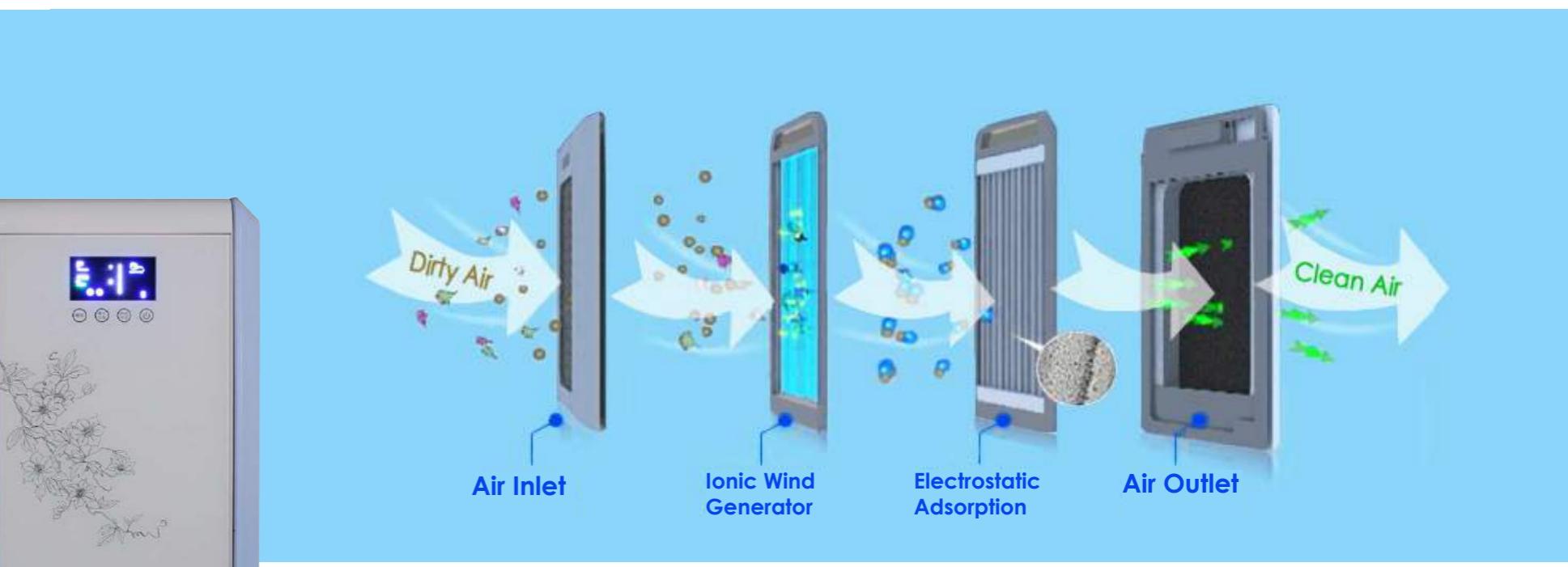
2.2.6 Factory Trip

We visited **Beiang Technology Ltd.** in Suzhou. It is a new air purifier company and uses the latest technology. A product manager received us and introduced to us the product in their company. With her introduction, we learned a lot about the structure and technology of air purifier.

The company uses the latest technology -- electrostatic adsorption and ionic wind. There is no filters or fans inside. The air purifier uses plasma field to generate wind instead of fans, and uses steel panels to adsorb pollutants by electrostatic adsorption. Instead of having to change filters every week, the users just need to wash the steel panels, thus saving money in purchasing filters.

Despite its splendid technology, the air purifier is not well-designed, people can not discern the control panels and corresponding functions. Due to cost, the company doesn't attach much importance to the appearance and design of the product.

What we learned today helps us a lot in our product design.



1. Polluted air goes through the prefilter in the air inlet for the first stage purification.
2. The air goes through the ionic wind generator and becomes partially ionized.
3. Bacteria are killed by free radicals in the plasma, and some macromolecules like formaldehyde are decomposed into water and carbon dioxide.
4. The partially ionized air is accelerated in the electric field and collides with other particles, thus making most dust ionized.
5. The ionized dust is driven to electrostatic adsorption electrode by electric field, and finally adsorbed by the electrode.
6. Fresh air keeps going and goes through the air outlet and circulates in the room.



2.2.7 Exhibition Trip



This is an air purifying mask which cleans the air before it is breathed into our body.

It comprises a mask, a tube and a filter. The filter is hung at the backpack to filter the air and then send clean air through the tube to the mask for breathing.

This seems to be a good design, however, the filter is too large and too heavy to carry around. The inventor said that they developed the product in six months, thus lacking refining.

2.2.7 Exhibition Trip





2.2.7 Exhibition Trip

Here we are in a stall where an air purifier for cars using solar energy, which relates to my project. However, solar energy doesn't offer all the energy the purifier needs. As it is told by the staff, solar energy offer 70% of the energy while the rest energy is provided by electricity.

I asked the staff if there was a window air purifier. His answer is "Yes, there is. But it is still under development, and not come to the market yet".

2.2.8 Predicting the Trend-- Solar Energy and Smart Home

New technologies are changing the world! Two technology trends may impact most on this project, that is, the use of solar (led by Tesla Motors), and smart home (led by Apple).

In this project, both solar energy and smart home will be applied to the design to make a fashionable one.



Tesla Motors

Super Charger Station with **Solar Panel Roof**



Apple

Release of iOS8 which includes **HomeKit**





Solar Energy-- Tesla



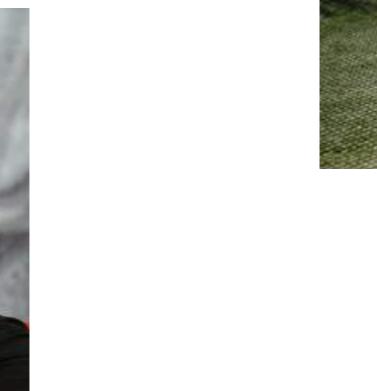
New Energy Vehicle-- Tesla Motors

With the development of new technology on new energy resource, more and more products are keeping up with the new energy trend. Tesla motors, for example, have made great progress in using new energy-- **solar energy**.

Tesla Motors is an American company that designs, manufactures, and sells electric cars and electric vehicle powertrain components. The company developed super chargers for the car, and built a large number of charge stations, the roof of which is made of solar panel, in USA, which made it possible to drive from the east coast of America to the west coast by an electric car.

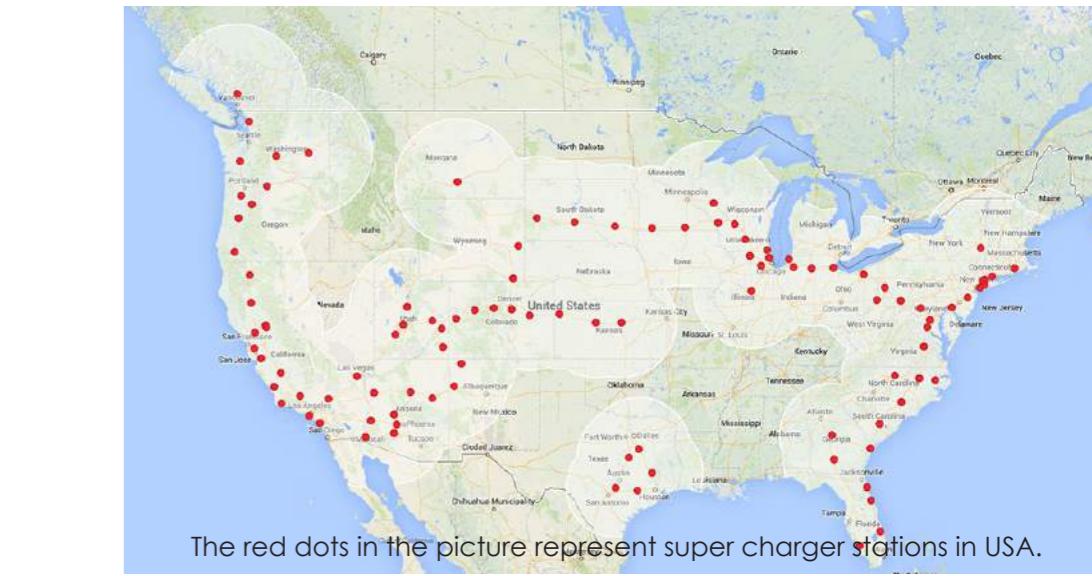


TESLA MOTORS



The super charger stations utilize canopies covered with solar panels to offset energy use and provide shade. Over the next few years, they plan to cover more stations in sunny locales with solar canopies as part of our commitment to the environment.

A properly equipped Model S can charge for free at any Supercharger once enabled, unlike gas stations that require you to pay for each fill-up. Simply pull up and plug in, take a quick bathroom or food break, and get back on the road. The number of super charger stations has been large enough to provide energy for tesla motors to go from the east coast to the west coast.





Smart Home-- Apple

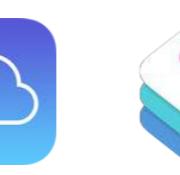


HomeKit

HomeKit is a new framework for communicating with and controlling connected devices in a user's home. Apps can enable users to discover devices in their home and configure them, or you can create actions to control those devices. Users can group actions together and trigger them using Siri.



Apple released iOS 8 in the Worldwide Developers Conference 2014. iOS 8 contains four Kits: PhotoKit, CloudKit, HealthKit and HomeKit, each of which leading a trend respectively in photo editing, cloud service, personal health care and smart home.



PhotoKit



CloudKit



HealthKit



HomeKit

2.2.9 Literature Review

This part researches different types of air purifier, humidifier and bladeless fan, all of which contribute to the development of the concept of Window Purifier.

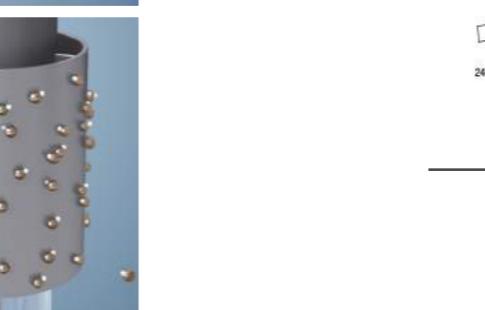
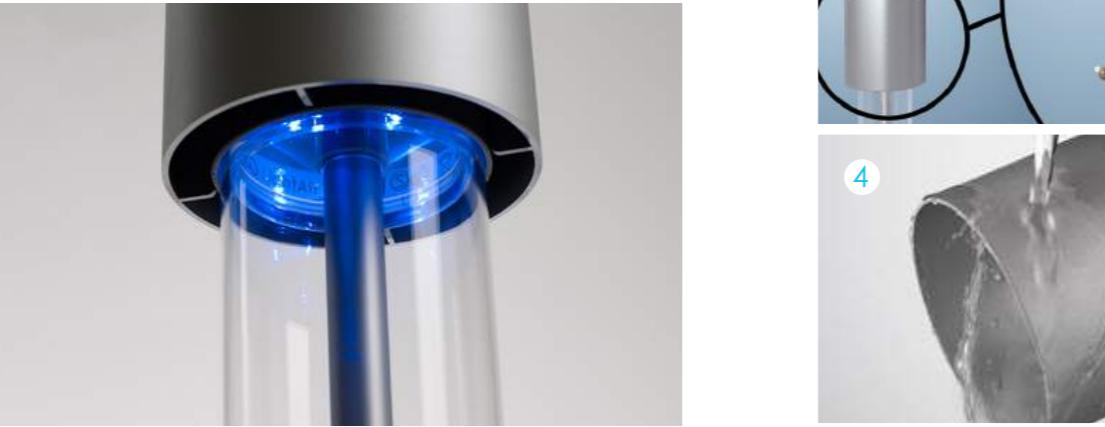




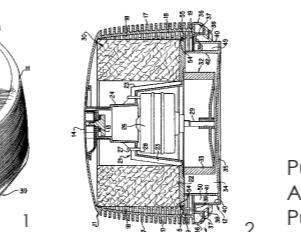
LightAir IonFlow 50

- Electrostatic Adsorption

1. Lightair IonFlow 50 generates billions of electrons per second that transforms into negative ions.
2. The negative ions charge the particles in the air negatively
3. Once the particles have been negatively charged they are attracted by the positively charged collector which essentially acts like a large magnet for dirt. IonFlow 50 is especially effective in removing the smallest particles in the air, which are considered the most hazardous to our health.
4. When necessary, the collector can be easily removed, rinsed in water and then reused.



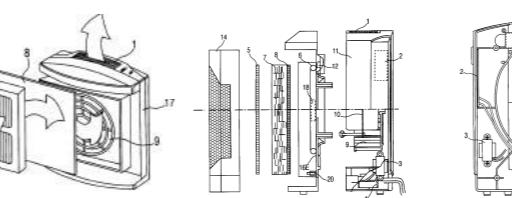
Portable room air purifier



Publication number US5435817 A
Application number US 08/246,383
Publication date Jul 25, 1995

Ultraviolet air purifier

Publication number US6464760 B1
Application number US 09/671,583
Publication date Oct 15, 2002

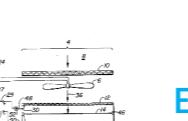


A portable air purifier having an internal filter element through which air is drawn by a centrifugal fan and wherein the air is discharged generally uniformly and radially by passing between at least one generally arcuate scroll and a surrounding deflector.

A portable air purifier comprising:

- a housing having an air inlet and a base having an air outlet;
- a filter means disposed between said air inlet and said base;
- a fan means disposed within said housing;
- a motor means for driving said fan means to draw air through ;
- at least one generally arcuate scroll mounted between said fan means and said air outlet.

The invention relates to an apparatus for removing contaminants from the ambient atmosphere, having a housing with an inlet opening and an outlet opening, filter media and ultraviolet light source, and a motorized fan for maintaining a flow of air through the housing from the inlet opening to the outlet opening.



Publication number US4253852 A
Publication type Grant
Application number US 06/092,784
Publication date Mar 3, 1981

Electrostatic precipitator

An improved electrostatic air purifier and ionizer combining the functions of filtration, precipitation and generation of negative ions.

An air purifier and ionizer for use in an enclosed area comprising:

- a housing having a passageway extending therethrough;
- a first electrode mounted within said passageway;
- a second electrode mounted within said passageway spaced from and downstream of said first electrode, the active surface of said second electrode consisting essentially of gold; and
- means for imposing an electric field between said first and second electrodes with an interelectrode voltage potential such that said second electrode is negatively charged with respect to said first electrode.





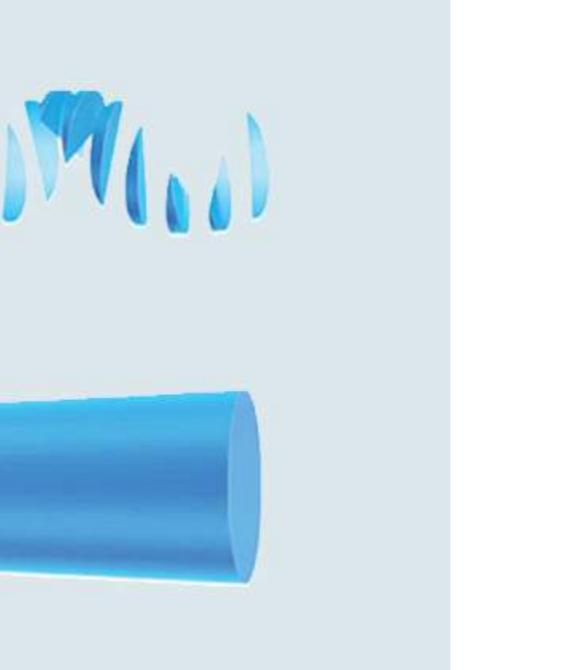
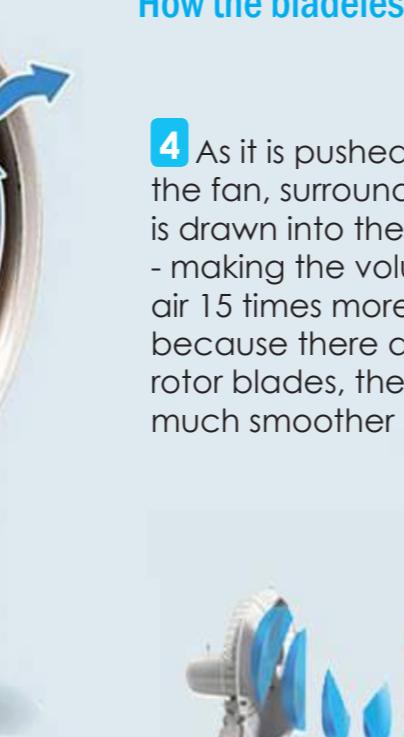
1 27 liters of air a second is sucked in through small vents in the base by a 40watt electric motor

2 The air is propelled through 3mm slit in the frame at 55mph

3 Air passes over an airfoil-shaped ramp which channels its direction

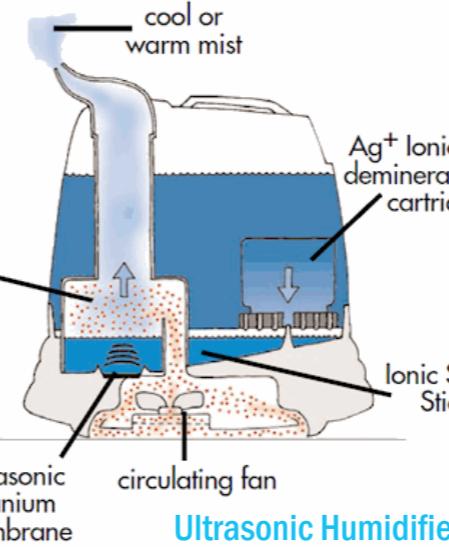
Motor
Air intake

Air flow
Forward flow



How the bladeless fan works

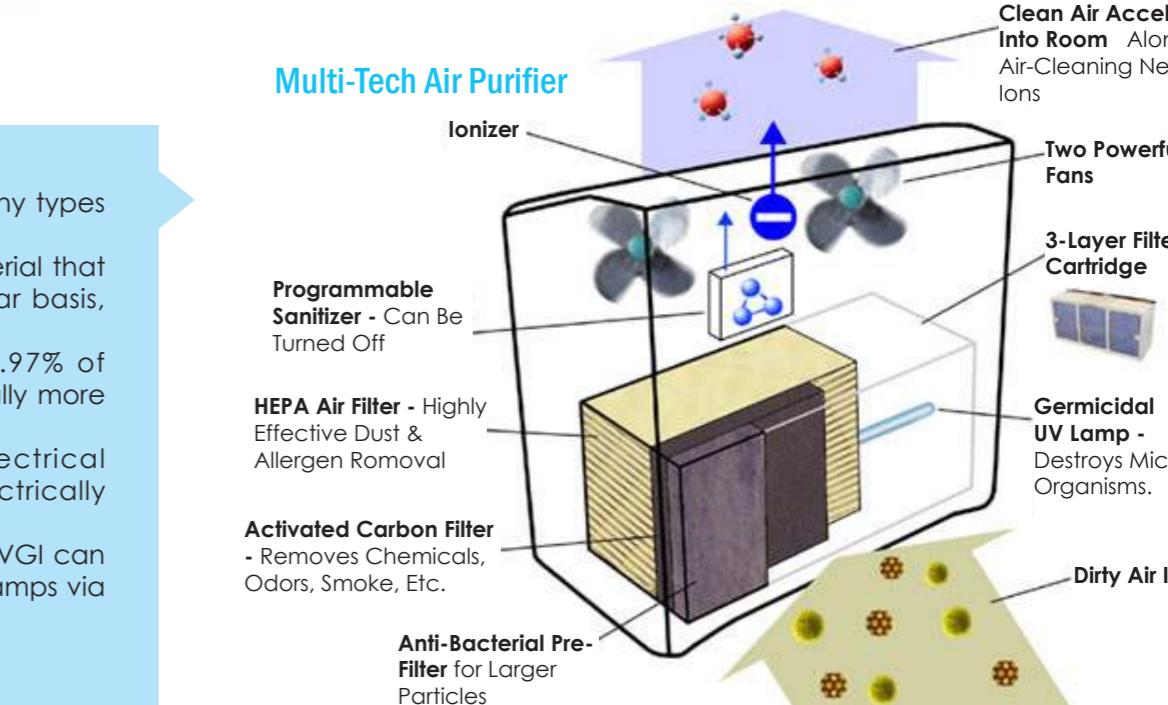
4 As it is pushed out of the fan, surrounding air is drawn into the airflow - making the volume of air 15 times more and, because there are no rotor blades, the air is much smoother



Ultrasonic Humidifier

An ultrasonic humidifier uses a metal diaphragm vibrating at an ultrasonic frequency to create water droplets that silently exit the humidifier in the form of a cool fog.

Ultrasonic humidifiers use a piezoelectric transducer to create a high frequency mechanical oscillation in a film of water. This forms an extremely fine mist of droplets about one micron in diameter, that is quickly evaporated into the air flow. Unlike the humidifiers that boil water, these water droplets will contain any impurities that are in the reservoir, including minerals from hard water.



Multi-tech air purifier combines many types of purification, as follows:

Activated carbon is a porous material that can adsorb chemicals on a molecular basis, but does not remove larger particles.

HEPA filters remove at most 99.97% of 0.3-micrometer particles, and are usually more effective for particles which are larger.

Ionizer purifiers use charged electrical surfaces or needles to generate electrically charged air or gas ions.

Ultraviolet germicidal irradiation - UVGI can be used to sterilize air that passes UV lamps via forced air.

3

Concepts

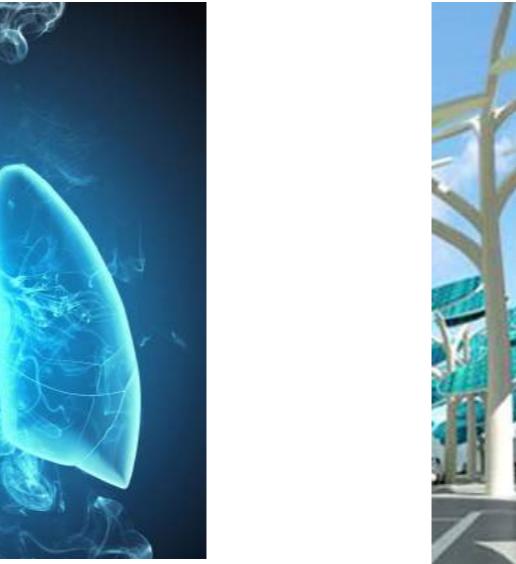
3.1 CONCEPT INSPIRATION



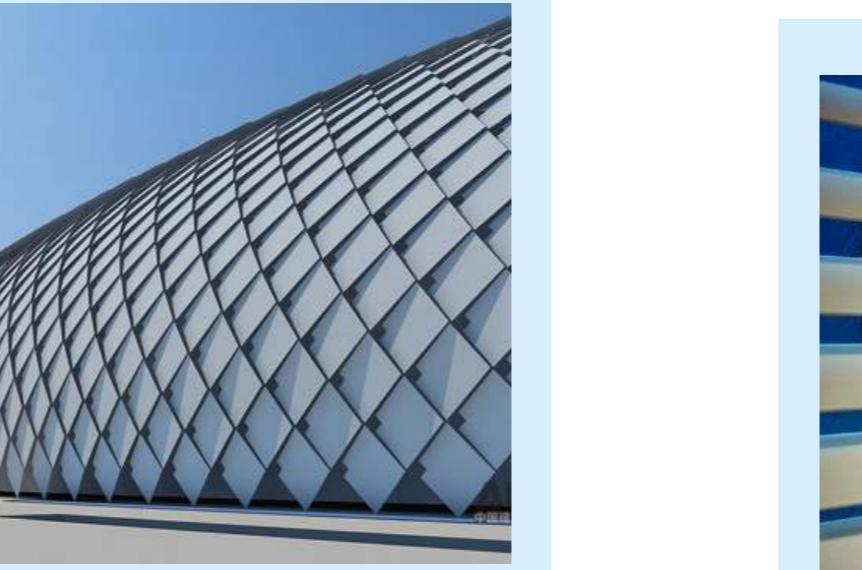
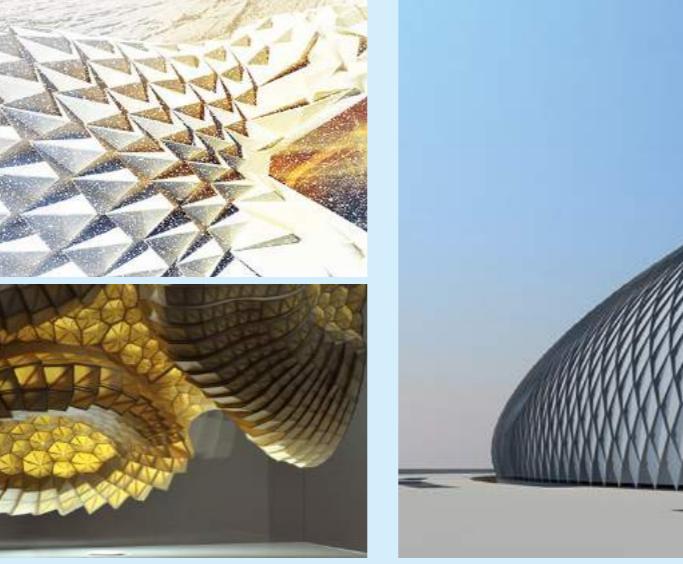
The lifted-up triangle on the roof of Terminal 3 in Capital Airport



The repetitiveness of hexagon in the honeyhive



The lung that breathe for the body



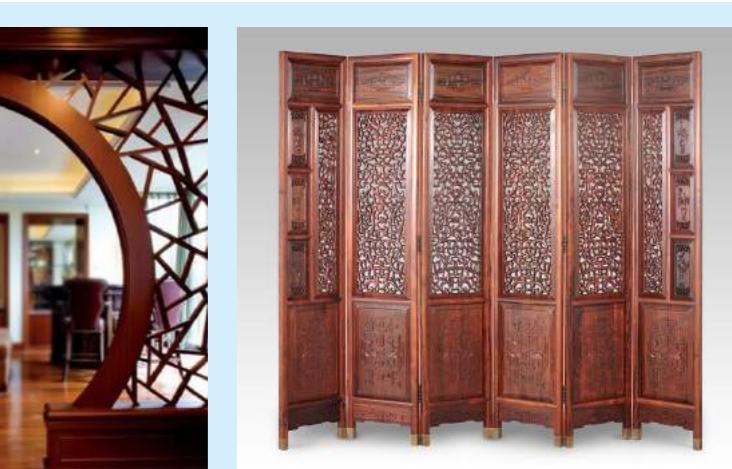
The beauty of repetitiveness and change



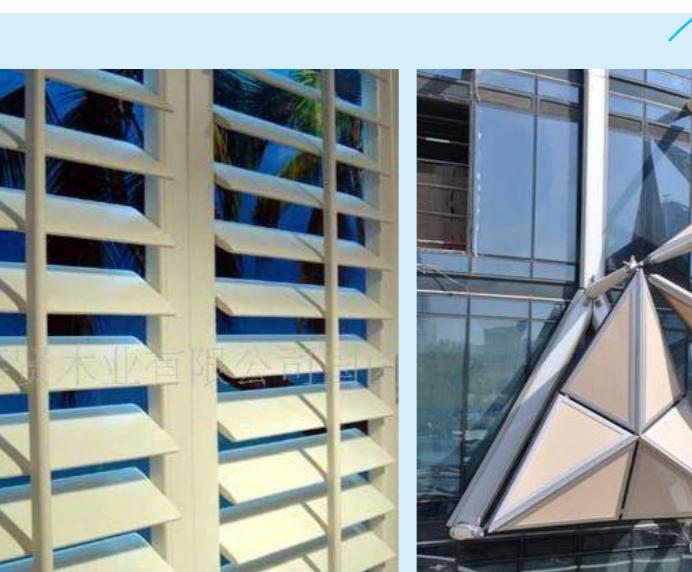
The solar panel that utilize sunlight to generate electricity



The beautiful pattern of Chinese wood furniture

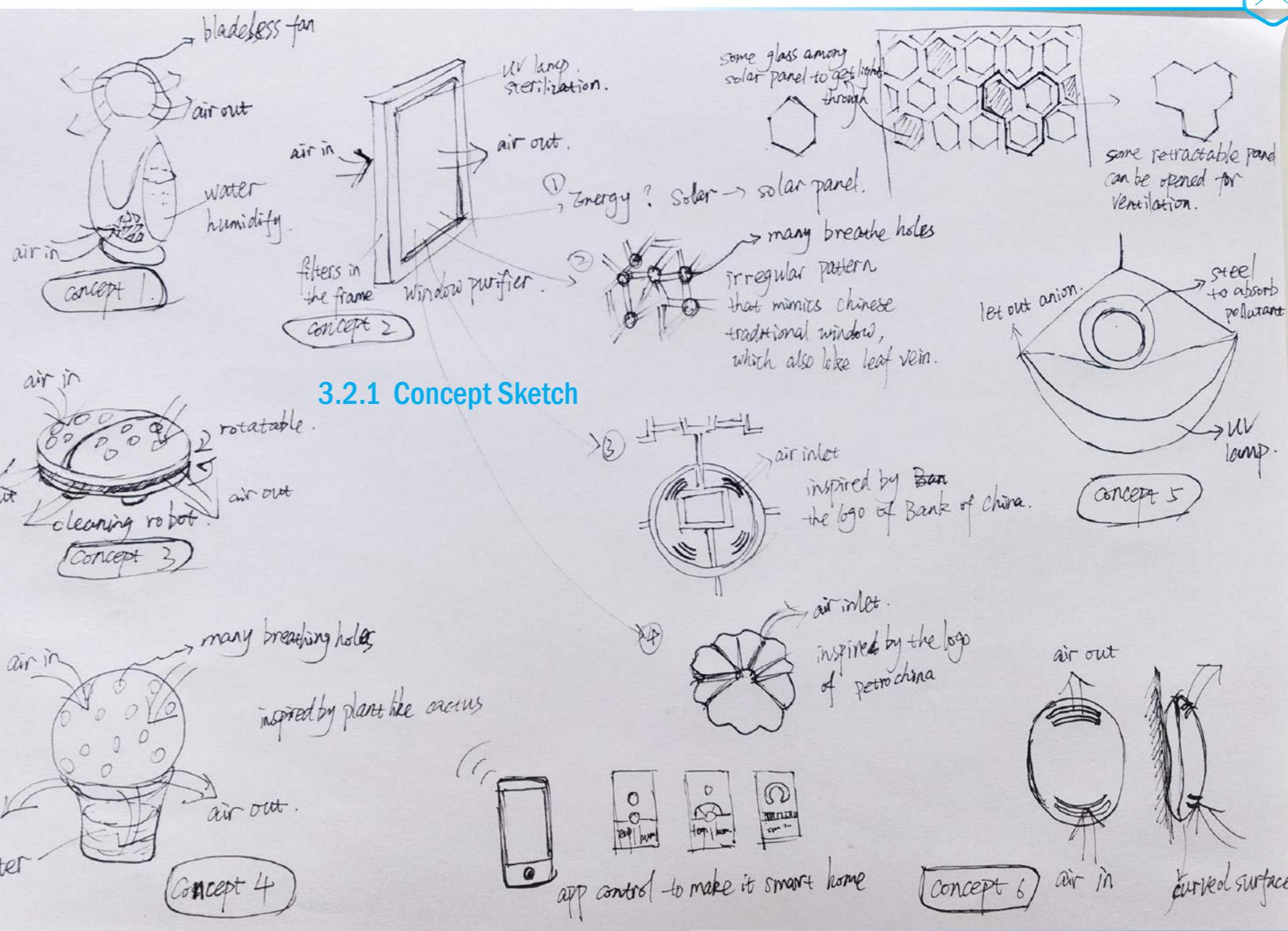


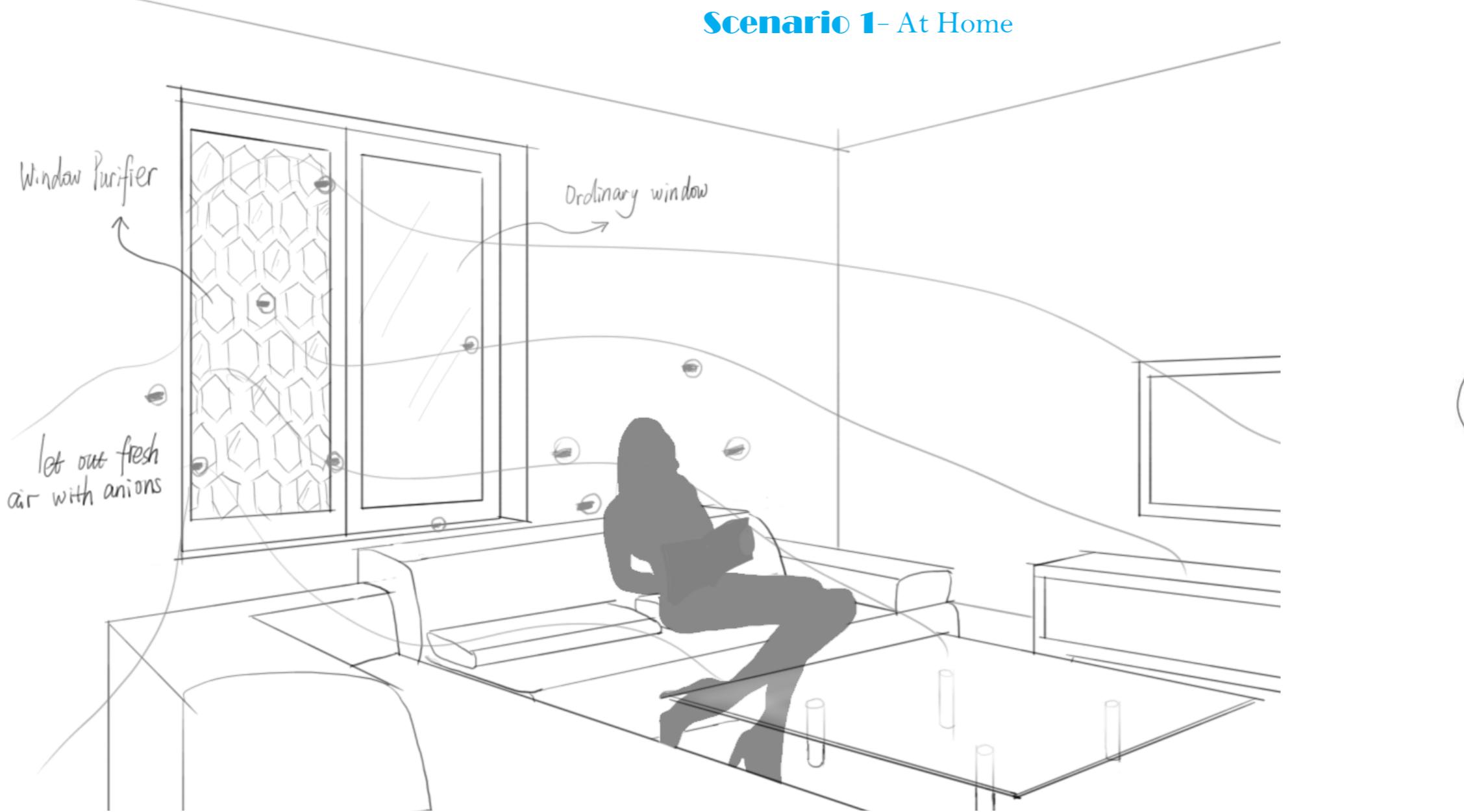
The retractable panel for shading



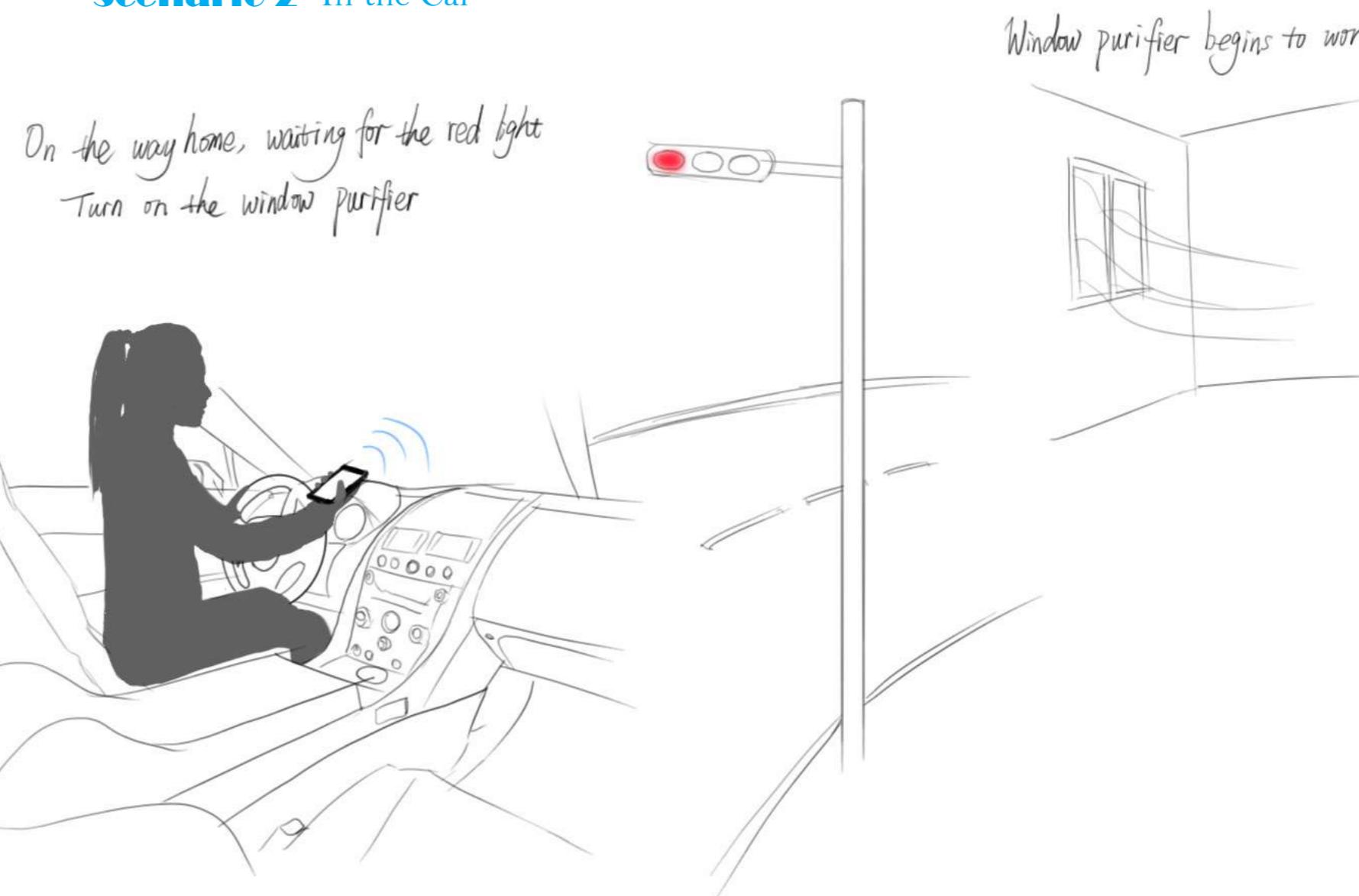


3.2 CONCEPTS

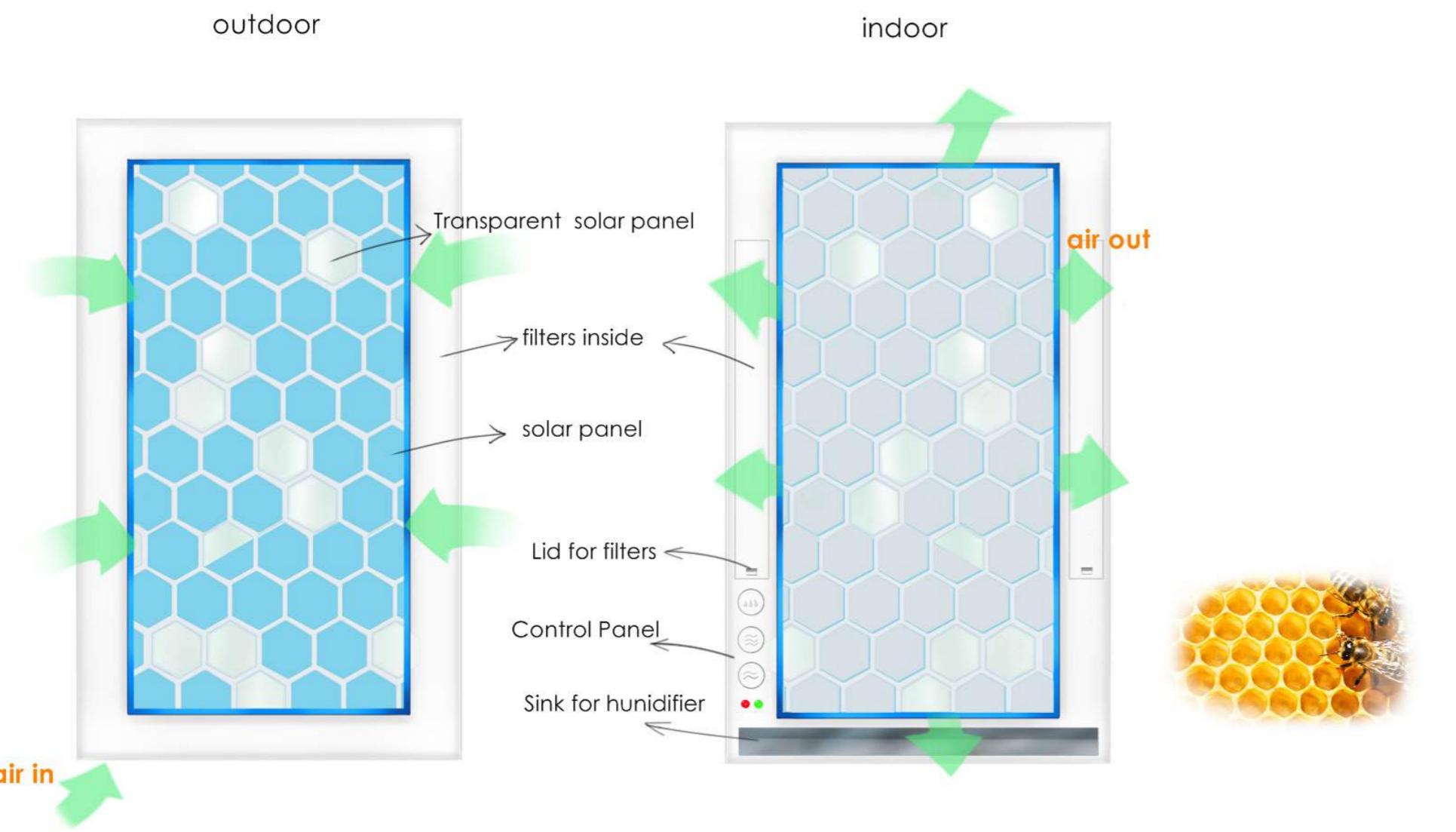




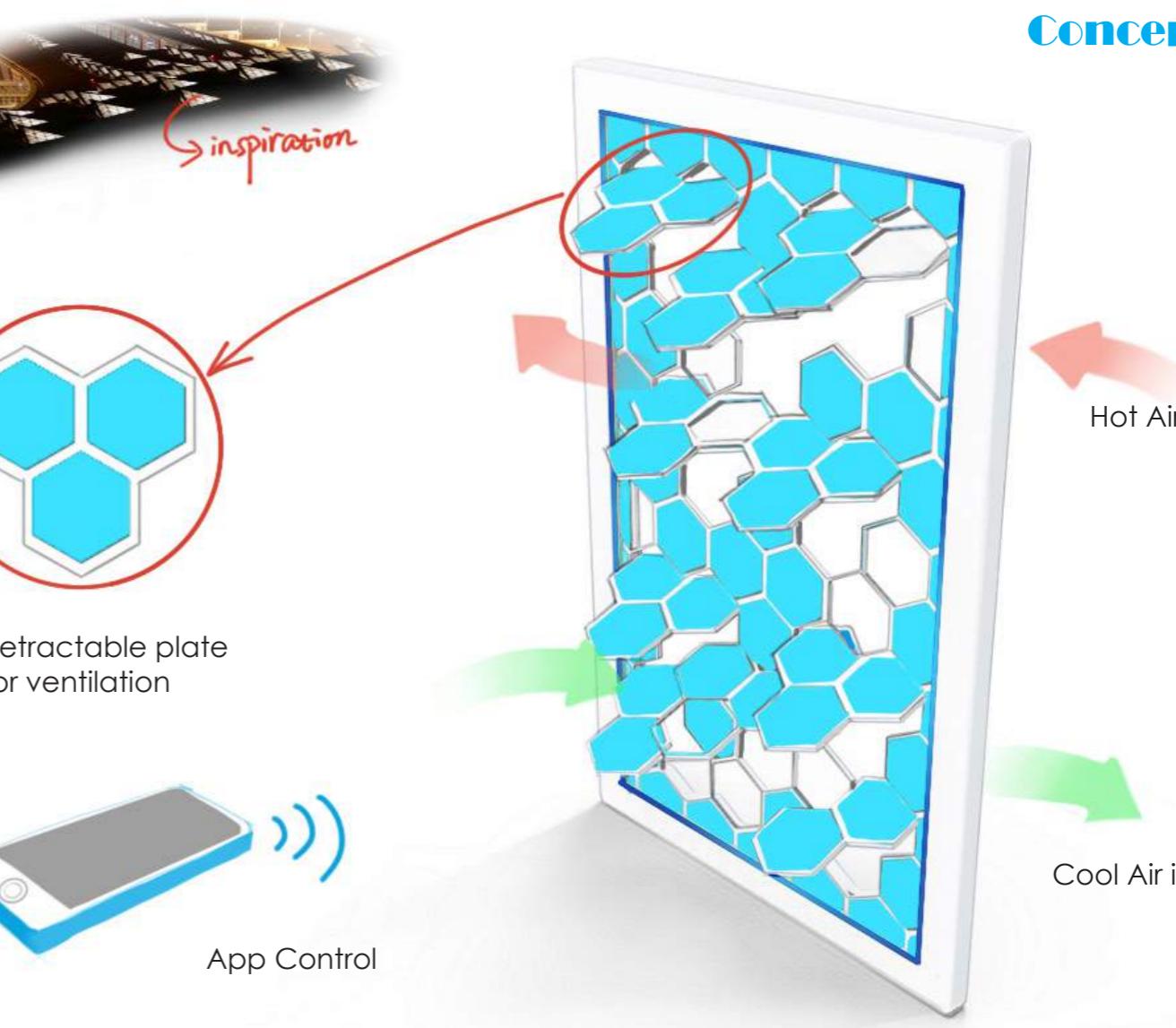
Scenario 2- In the Car



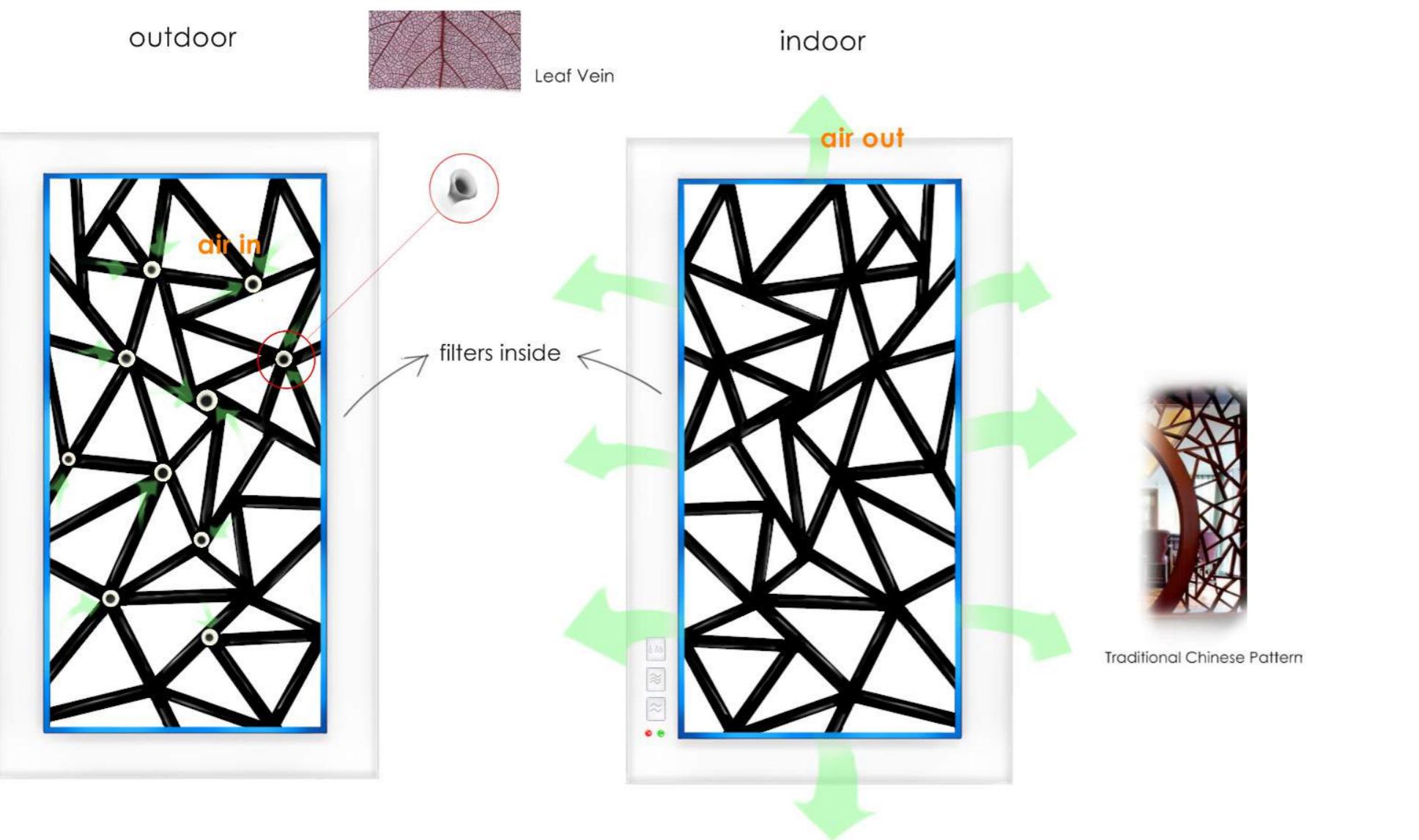
Concept 1



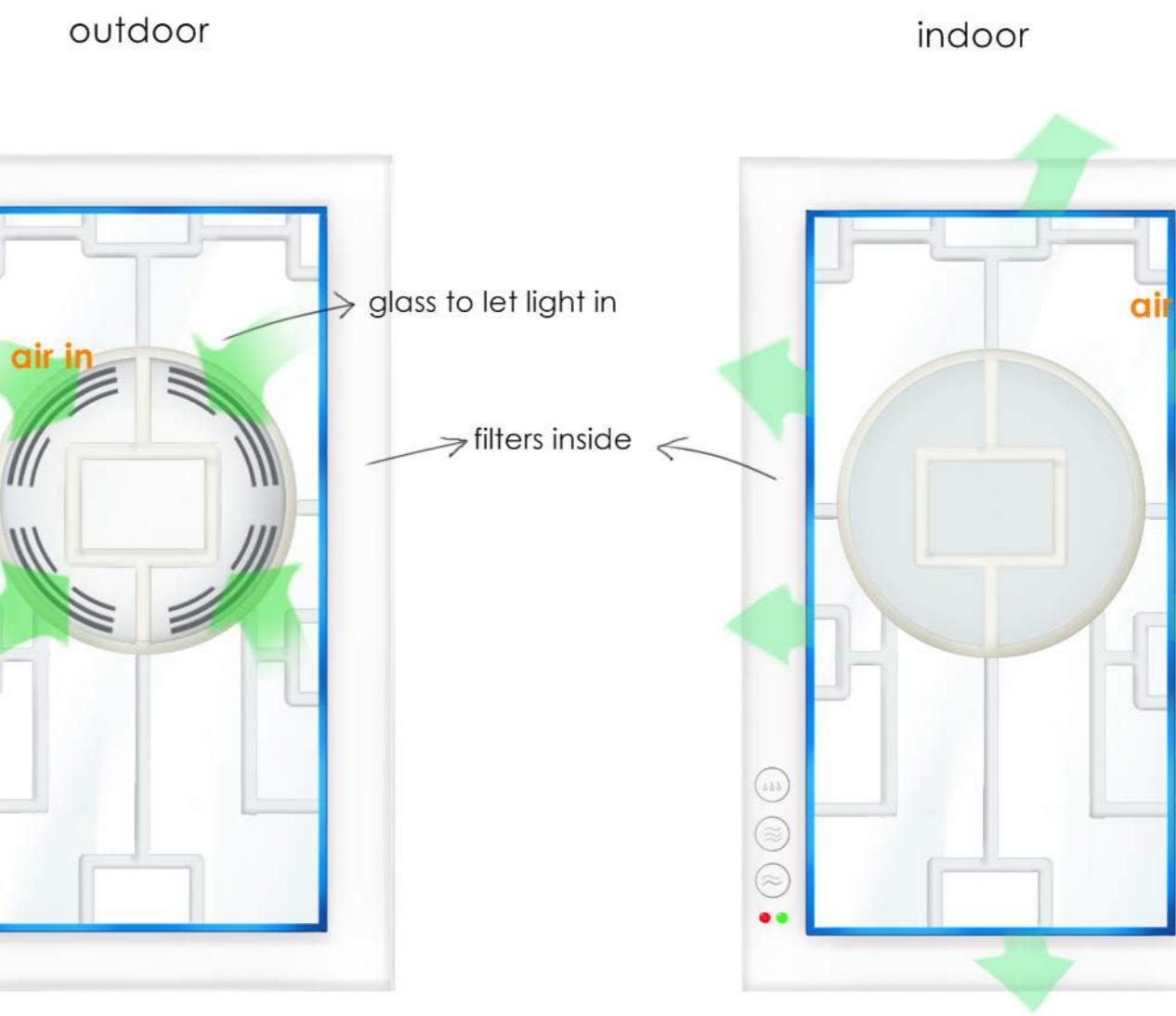
Concept 1



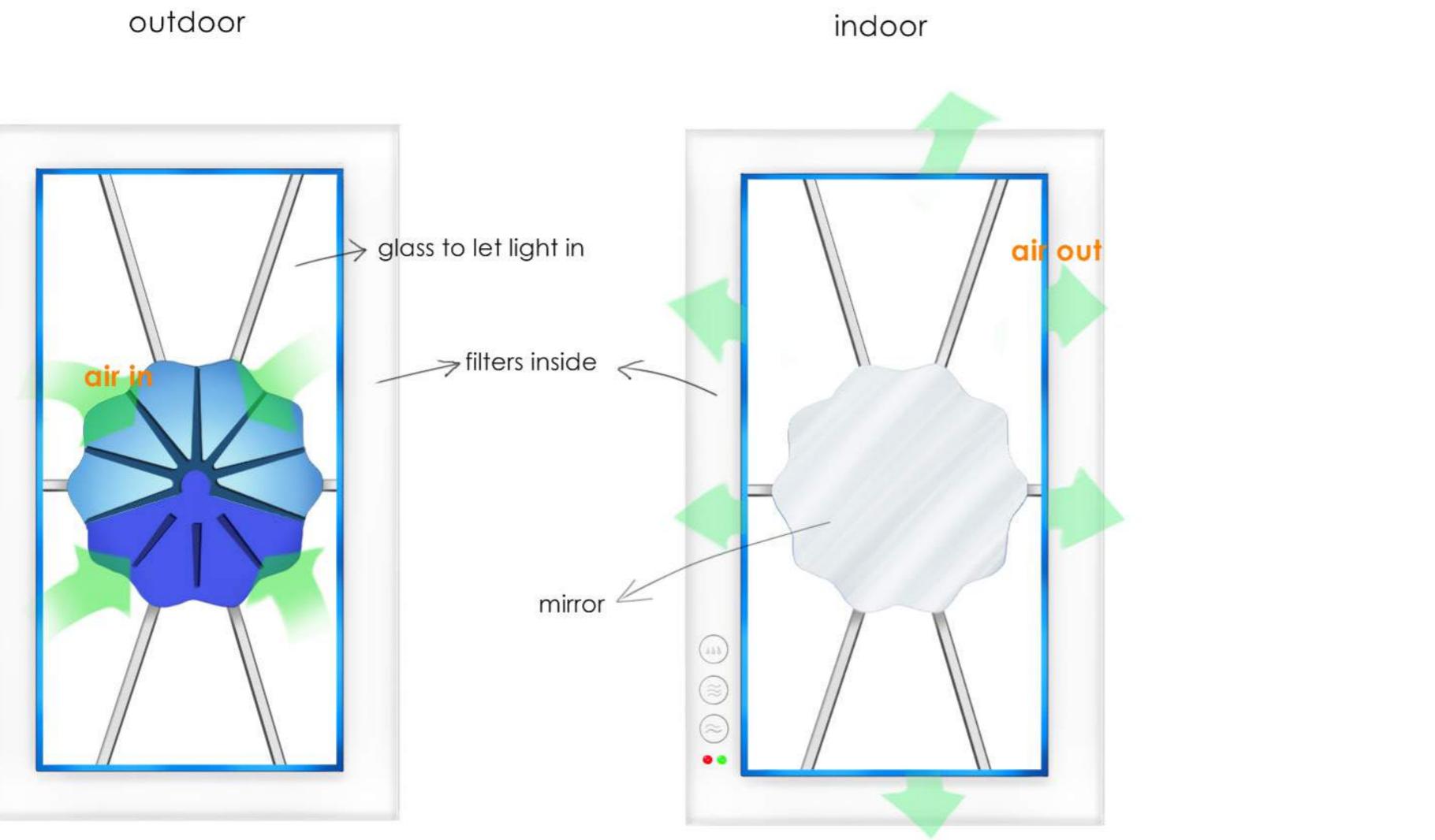
Concept 2



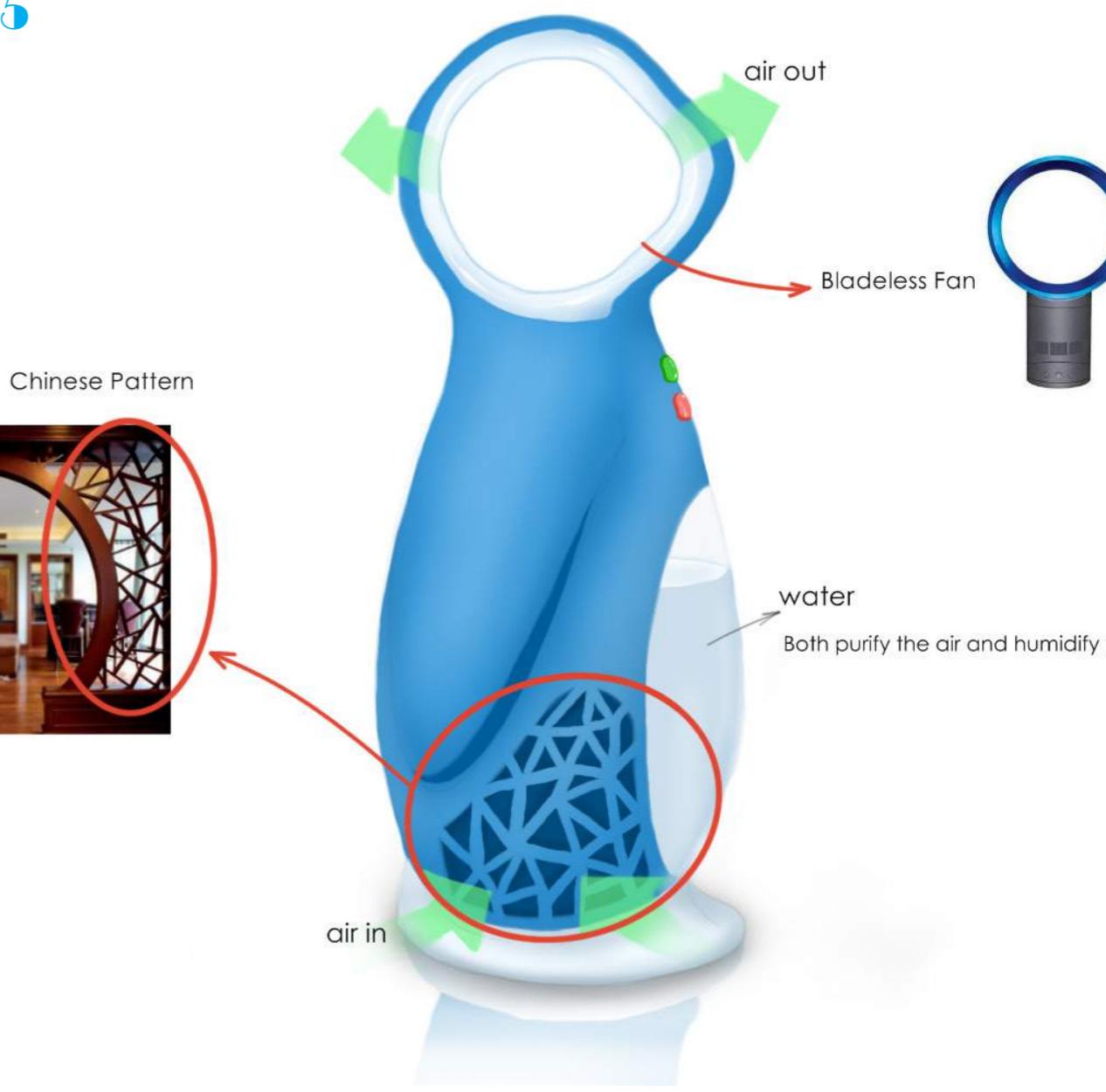
Concept 3



Concept 4

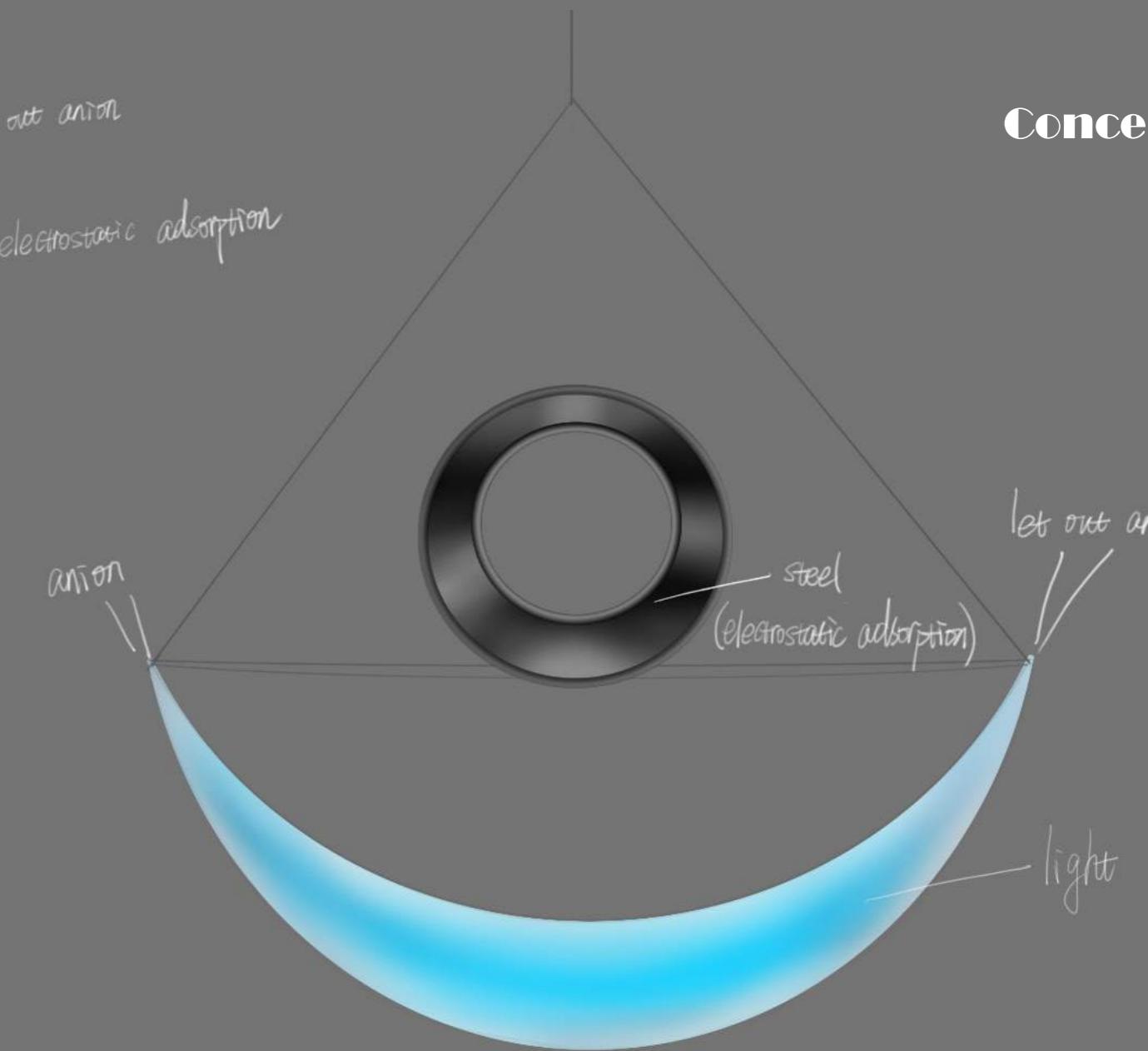
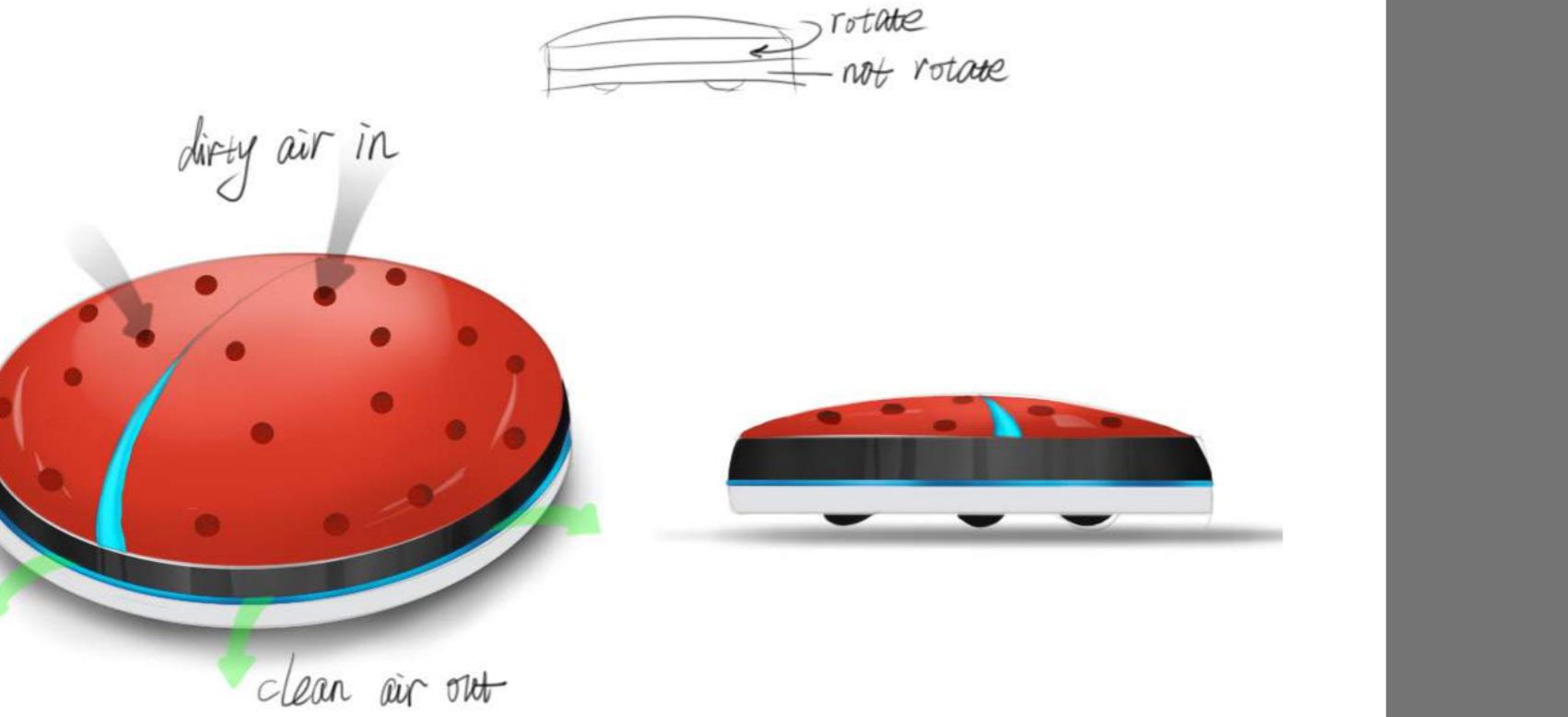


Concept 5



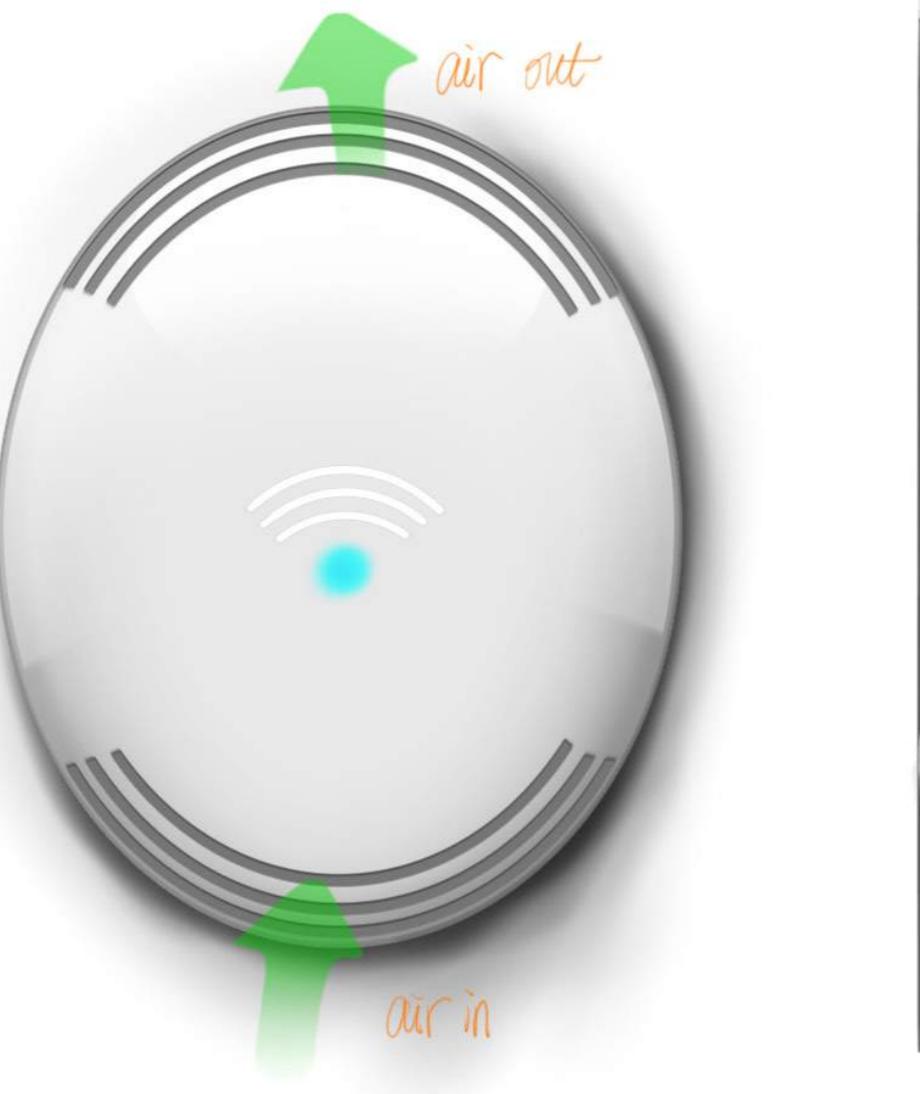


Concept 6

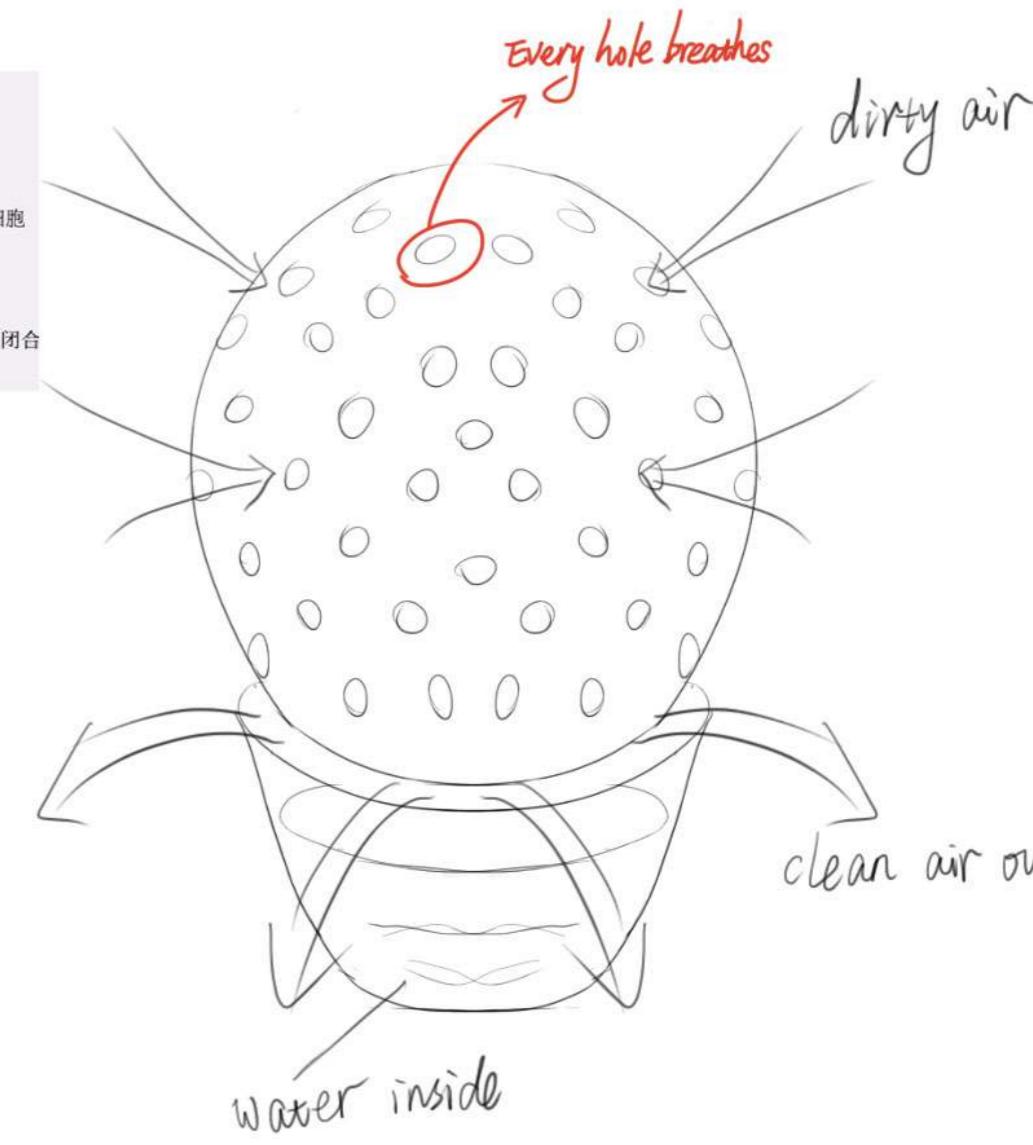
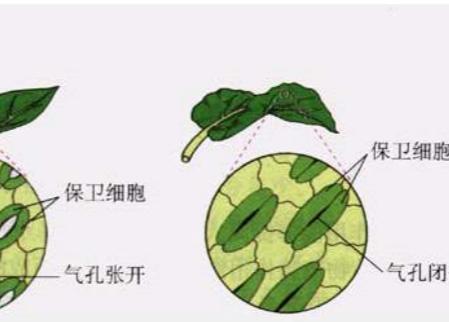


Concept 7

Concept 8

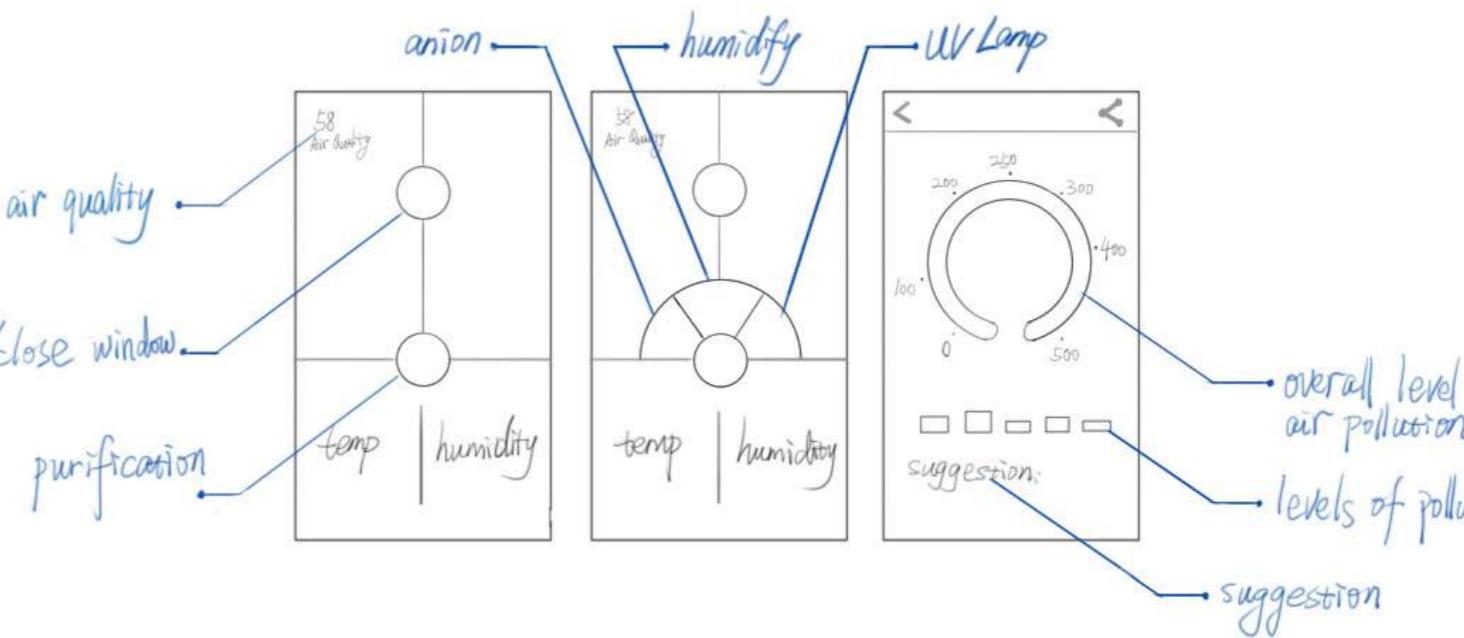
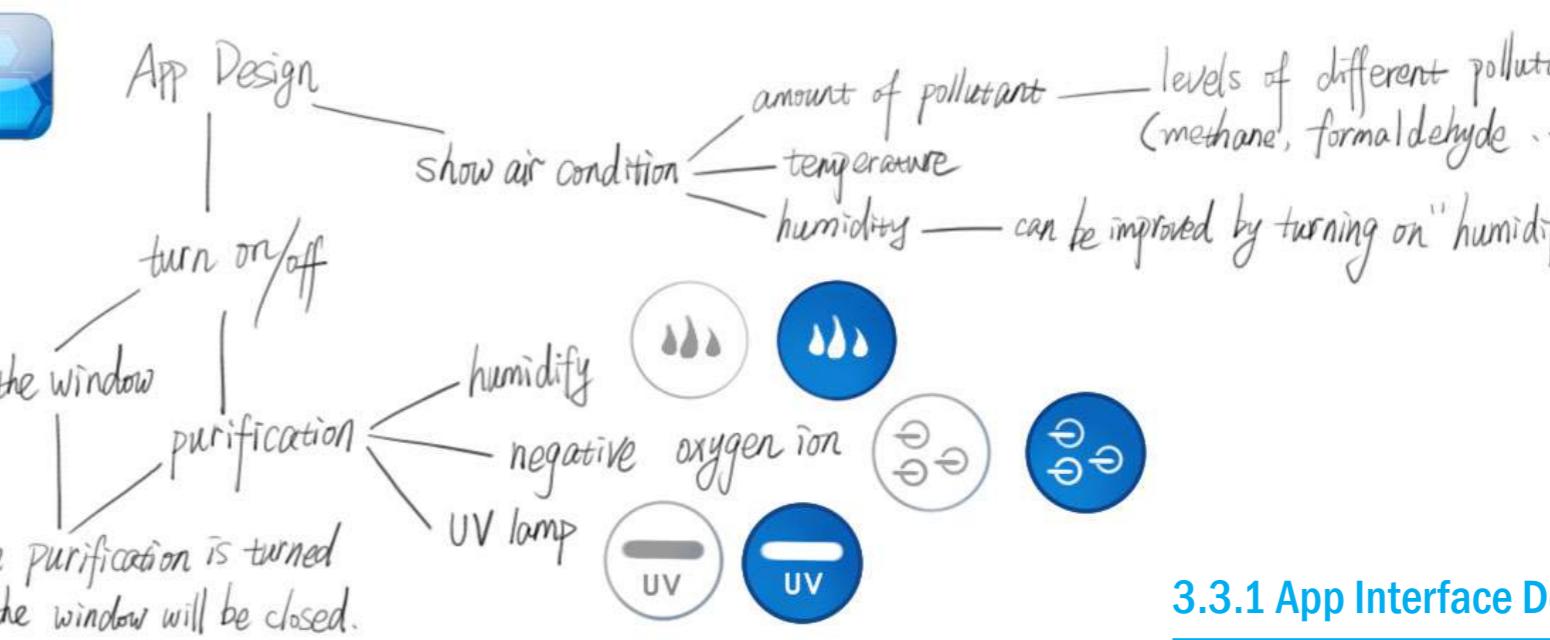
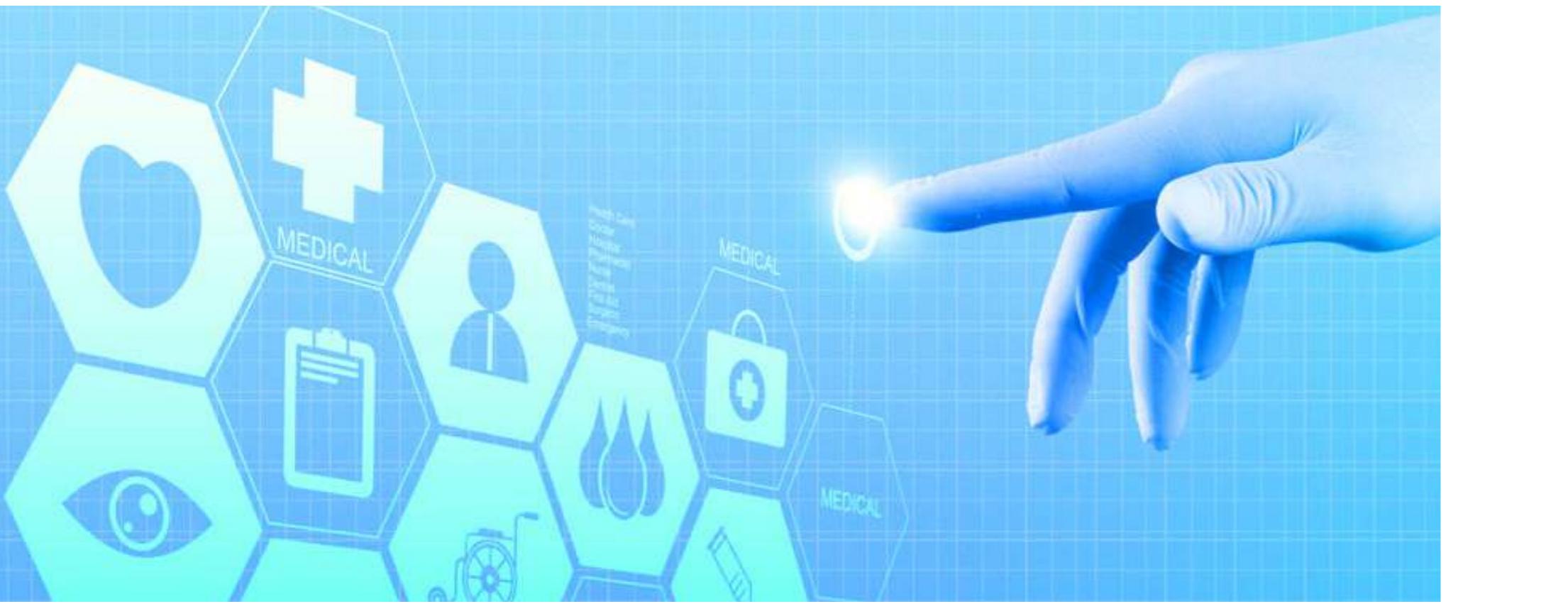


Concept 9



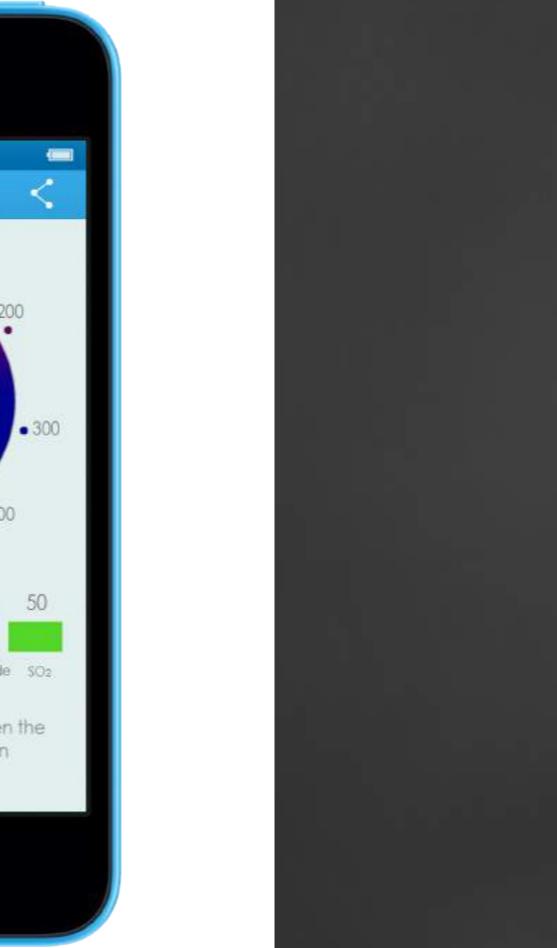


3.3 APP INTERFACE DESIGN





App Interface Designed with Photoshop



The app "Purify" is designed for controlling the window purifier at any time and at any place. With the app, you can also monitor the air quality in your room and turn on the air purifier only when it's needed.



3.3.2 Interaction Design of App Interface with Axure



App Icon-- Purifier



3.4 Final Concept



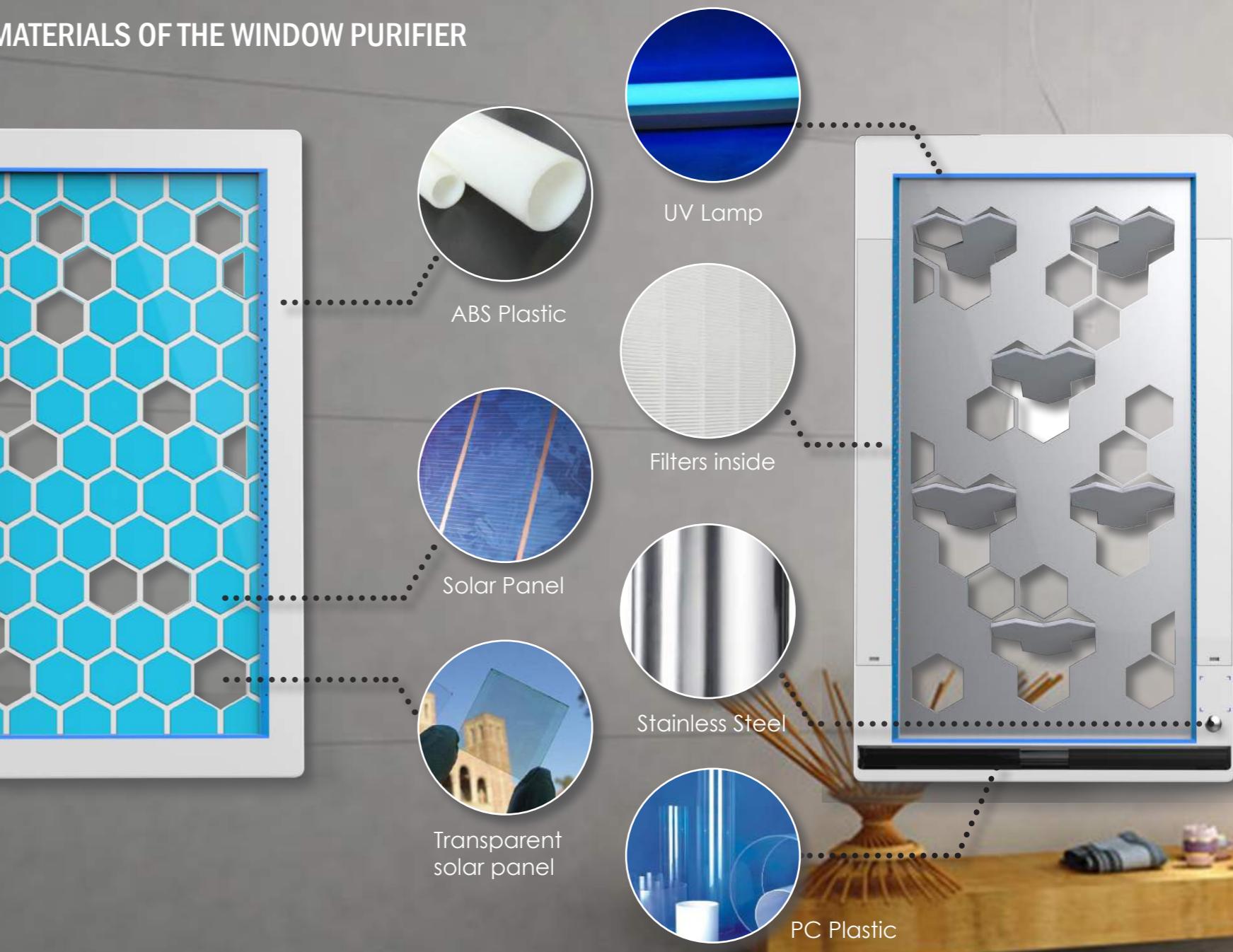
4

Manufacturing

4.1 MATERIAL RESEARCH



4.1.1 MATERIALS OF THE WINDOW PURIFIER



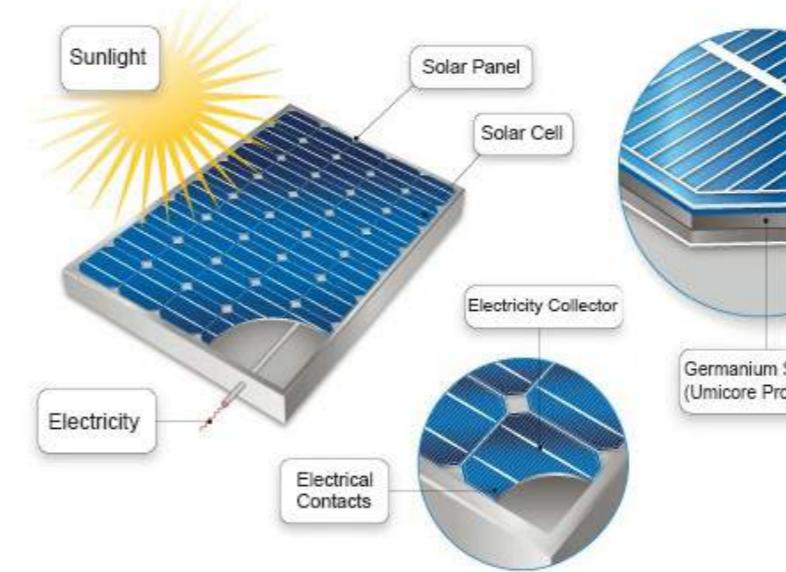


4.1.1 Different types of Solar Panel



Introduction of solar panel

A solar panel is a set of solar photovoltaic modules electrically connected and mounted on a supporting structure. A photovoltaic module is a packaged, connected assembly of solar cells. A solar cell (also called a photovoltaic cell) is an electrical device that converts the energy of light directly into electricity by the photovoltaic effect. It is a form of photoelectric cell, defined as a device whose electrical characteristics—e.g. current, voltage, or resistance—vary when exposed to light.



solar panel and solar cell



A single solar module can produce only a limited amount of power; most installations contain multiple modules. A photovoltaic system typically includes a panel or an array of solar modules, an inverter, and sometimes a battery and/or solar tracker and interconnection wiring.

Many products, particularly those require constant wireless power, are installed with solar panel. To provide enough energy, the solar panel should be as large as possible, and at best, should be able to rotate to the sun in order to get more sunlight to generate electricity. With solar panel, the product enjoys limitless power and get rid of annoying electric lead.



Application of solar panel

Printable Solar Panel



Printed solar cells

Printable solar panel is a new technology that incorporate organic photovoltaic solar cells and can be printed off on a similar machine which currently prints Australian bank notes. The solar cells will be printed using photovoltaic ink and existing printing technology. The printable organic solar cells have been developed by a collaboration between the Commonwealth Scientific and Industrial Research Organisation (CSIRO), the University of Melbourne, Monash University and industry partners. The Victorian Organic Solar Cell Consortium (VOSCC) is the research collaboration that aims to commercially produce these flexible, cost-effective, printable, plastic solar cells.

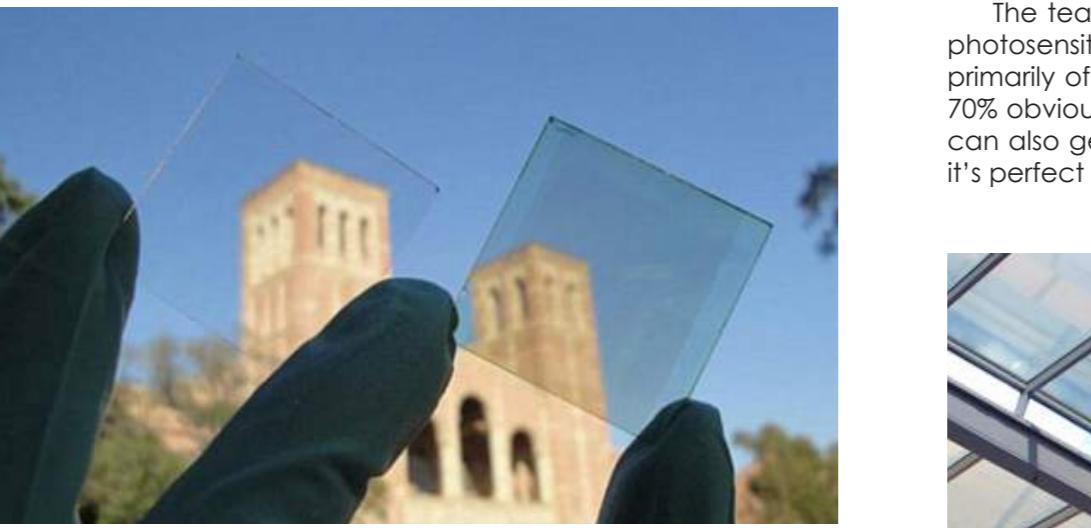


Printed solar panel in A3 size



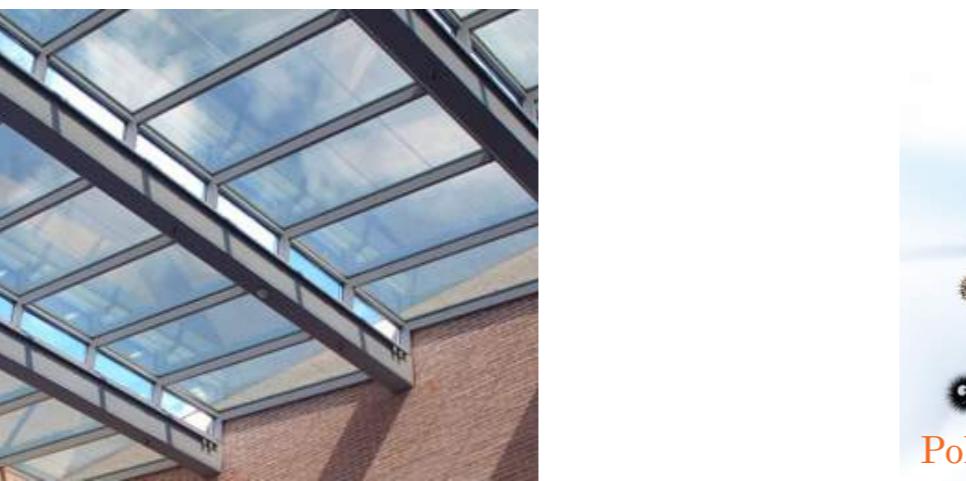
Machines used for printing banknotes in Australia may soon be producing solar cells.

Transparent Solar Panel



Polymer solar cells is a kind of transparent solar cell developed by scientists at the University of California at Los Angeles (UCLA). The great new transparent solar powered cell from which are able to make solar panels could be placed on houses and buildings without blocking out sunlight. The material is adjustable and easier, and most importantly, could be generated in big quantities for a economical price.

These results open the potential for visibly transparent polymer solar cells as add-on components of portable electronics, smart windows and building-integrated photovoltaics and in other applications.



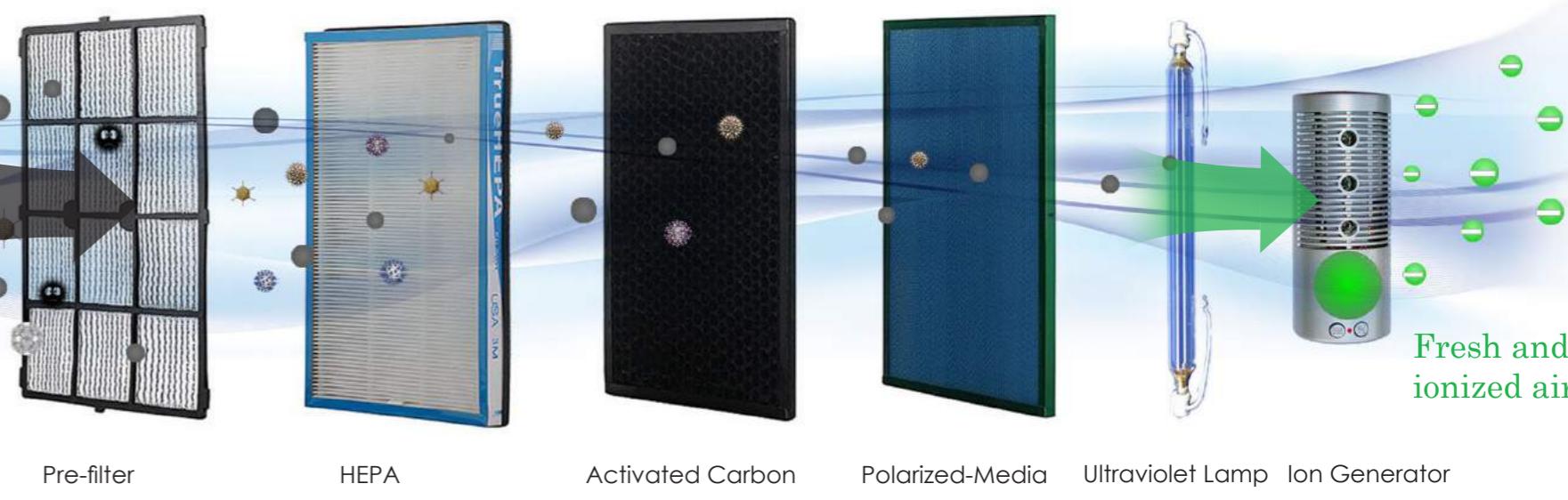
These achievements produce a ability for development of a completely transparent polymer solar cell that could be applied to portable digital instruments, such as "smart" windows, photovoltaic incorporated into buildings along with other applications – said group leader Yang Yang, a professor of materials science at UCLA.

The team of UCLA confirmed that the solar cell obtained from photosensitive polymer (plastic) produces energy by absorption primarily of infrared light rather than just visible light, that's why it's 70% obvious to the human eye. Because it absorbs infrared light, it can also get light through without bringing in too much heat, thus it's perfect for the house.

4.1.2 Filters

A particulate air filter is a device composed of fibrous materials which removes solid particulates such as dust, pollen, mold, and bacteria from the air. A chemical air filter consists of an absorbent or catalyst for the removal of airborne molecular contaminants such as volatile organic compounds or ozone.

In an air purifier, there are usually several kinds of filters and other components working together to filter the air. The order of the filters is usually as shown below.





Different Air Filters

HEPA filters remove at most 99.97% of 0.3-micrometer particles, and are usually more effective for particles which are larger. In dusty environments, a HEPA filter may follow an easily cleaned conventional filter (prefilter) which removes coarser impurities so that the HEPA filter needs cleaning or replacing less frequently. HEPA filters do not generate ozone or harmful byproducts.



Filter HVAC at MERV 14 or above are rated to remove airborne particles of 0.3 micrometers or larger. A high efficiency MERV 14 filter has a capture rate of at least 75% for particles between 0.3 to 1.0 micrometers. Although the capture rate of a MERV filter is lower than that of a HEPA filter, a central air system can move significantly more air in the same period of time.



Activated carbon is a porous material that can adsorb volatile chemicals on a molecular basis, but does not remove larger particles. Activated carbon is merely a process of changing contaminants from a gaseous phase to a solid phase, when aggravated or disturbed contaminants can be regenerated in indoor air sources.^[6] Activated carbon can be used at room temperature and has a long history of commercial use. It is normally used in conjunction with other filter technology, especially with HEPA.



Polarized-Media Electronic Air Cleaners use an active electronically-enhanced media to combine elements of both electronic air cleaners and passive mechanical filters. Airborne particles become polarized as they pass through the electric field and adhere to a disposable fiber media pad. Polarized-media technology is non-ionizing which means no Ozone is produced.



4.1.3 ABS Plastic

Acrylonitrile butadiene styrene (ABS) is a common thermoplastic.

The most important mechanical properties of ABS are **impact resistance** and **toughness**. A variety of modifications can be made to improve impact resistance, toughness, and heat resistance.

The **impact resistance** can be amplified by increasing the proportions of polybutadiene in relation to styrene and also acrylonitrile. Impact resistance does not fall off rapidly at lower temperatures. Stability under load is excellent with limited loads. Thus, changing the proportions of its components ABS can be prepared in different grades. Two major categories could be ABS for extrusion and ABS for injection moulding, then high and medium impact resistance.

The **toughness** will be influenced to some extent by the conditions under which the material is processed to the final product. For example, molding at a high temperature improves the gloss and heat resistance of the product whereas the highest impact resistance and strength are obtained by molding at low temperature. Fibers (usually glass fibers) and additives can be mixed in the resin pellets to make the final product strong.





4.1.4 PC Plastic Properties

Polycarbonate(PC) is highly **transparent** to visible light, with better light transmission than many kinds of glass.

Unlike most thermoplastics, polycarbonate can **undergo large plastic deformations** without cracking or breaking. As a result, it can be processed and formed at room temperature using sheet metal techniques, such as bending on a brake. Even for sharp angle bends with a tight radius, heating may not be necessary.

Main transformation techniques for polycarbonate resins:

- extrusion into tubes, rods and other profiles including multiwall
- extrusion with cylinders into sheets (0.5–20 mm) and films (below 1 mm), which can be used directly or manufactured into other shapes using thermoforming or secondary fabrication techniques, such as bending, drilling, routing, laser cutting etc.
- injection molding into ready articles



F-22 cockpit canopy



PC sheeting in a greenhouse



Laboratory safety goggles



CD and DVD

Polycarbonates (PC) are easily worked, molded, and thermoformed. Because of these properties, polycarbonates find many applications, including electronic components, construction materials, data storage, automotive, aircraft, and security components, medical applications, phones, etc.



T304 stainless steel is widely used in the food and food preparation industry. Surgical equipment and hypodermic needles are some medical uses for this grade of stainless steel. Corrosion resistance makes it a prime choice for marine hardware. It is able to withstand hot and cold temperatures, which is why it is used for cryogenic tanks.

4.1.5 Stainless Steel Properties

Oxidation: High oxidation resistance, and up to 26% is used for harsh environments.

Acids: Generally highly resistant to attack from acids. Type 304 is resistant to sulfuric acid at room temperature, even in high concentrations, but type 316 and 317 are only resistant at low concentrations.

Electricity: Similarly to steel, stainless steel is a relatively poor conductor of electricity, with a few percent of the electrical conductivity of copper.

Magnetism: Ferritic and martensitic stainless steels are magnetic. Austenitic stainless steels are non-magnetic.

Organics: Types 316 and 317 are both useful for storing and handling acetic acid, though 317 provides the greatest level of resistance to corrosion. Type 304 is also commonly used with formic acid though it will tend to discolor the solution.



4.1.6 How to paint metal



1 Read the labels. Make sure your primer and your coat of paint are compatible. If not, your paint job might as well be irrelevant. Check the dry time, too, to make sure you don't put more primer on than you can possibly paint the next day.



2 Clean off all loose paint, dirt, grease and grime from the surface of your metal. Failure to do so will result in a lousy paint job that does not stick to the metal and will peel off easily. Give your metal a thorough rub down even if you don't think it is necessary.



4 Apply a zinc-chromate primer if you are working with rusted metal. Scrape all the loose rust and residual dust off first, and then coat it with this special primer.



5 Double coat with primer. Because metal is extremely prone to the effects of oxidation, more primer is often better for the metal. Not only will it help the top coat of paint stick to the surface, but will also make the metal less vulnerable to rust, far into the future.



3 Sand down your metal. By sandblasting the surface of your metal, you are ensuring an even longer-lasting and more durable paint job. The rougher your metal, the more it will stick to the surface.



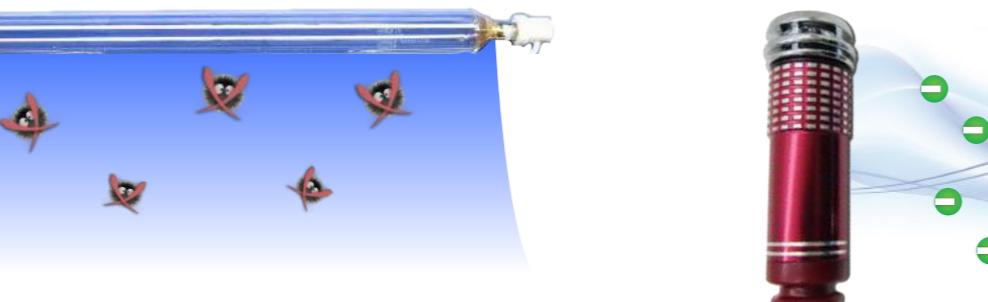
6 Paint. Acrylic latex paint is usually the best bet for metal. By being careful and applying your paint evenly on the surface, you can save yourself some major hassles in the future.

4.2 TECHNOLOGY RESEARCH



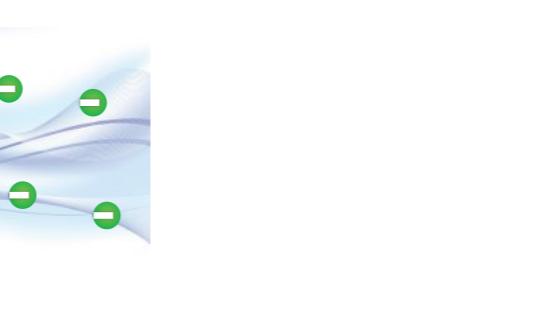
4.2.1 UV Lamp& Anion Generator

UV Lamp and Ion Generator are two types of purification other than filters. Different from the passive way of purification of filters, UV Lamp and Ion Generator purify air by an active way. UV Lamp emit ultraviolet light to sterilize while Anion Generator let out anions to have chemical reaction with pollutants in the air.



Ultraviolet germicidal irradiation - UVGI can be used to sterilize air that passes UV lamps via forced air. Air purification UVGI systems can be freestanding units with shielded UV lamps that use a fan to force air past the UV light.

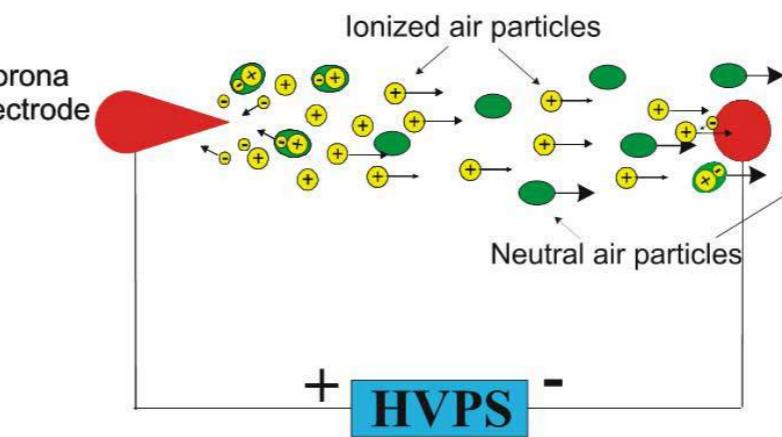
Key to this form of sterilization is placement of the UV lamps and a good filtration system to remove the dead micro-organisms. For example, forced air systems by design impede line-of-sight, thus creating areas of the environment that will be shaded from the UV light. A UV lamp will keep micro-organisms from forming in those naturally damp places.



Ionizer purifiers use charged electrical surfaces or needles to generate electrically charged air or gas ions. These ions attach to airborne particles which are then electrostatically attracted to a charged collector plate. This mechanism produces trace amounts of ozone and other oxidants as by-products. Permanently mounted home and industrial ionizer purifiers are called electrostatic precipitators.

4.2.2 Ionic Wind

Ionic wind is the resulting localized neutral flow induced by electrostatic forces linked to corona discharge arising at the tips of some sharp conductors (such as points or blades) submitted to high-voltages relative to ground. Modern implementations belong to the family of electrohydrodynamic (EHD) devices. Ion wind production machines can be now considered electrohydrodynamic (EHD) pumps.



As ions are pulled by an electric field, they collide with neutral gas molecules and exchange momentum creating an ionic wind. As bulk air movers, ionic winds have many advantages including no moving parts, little acoustic signal, and minimal power consumption, and they have begun to be used in applications such as air filtration, flow control, and electronics cooling.

Three Advantages of Ionic Wind

1. High Efficiency

Sterilizing rate more than 99%, efficiently kill virus and bacteria. Collection efficiency more than 99%, CADR 225m³/h, efficiently remove allergens, nicotine, smog, formaldehyde, benzene and so on.

2. Energy Conservation

Low power consumption due to absence of fan. A 0.5 meter high purifier consumes no more than 30 watt, and less than 0.5 kilowatt-hours for running for 24 hours

3. No Noise

No fan is used in this technology to generate wind, so there will be no noise of fans. The sound of ionic wind is so low that you merely cannot hear it.

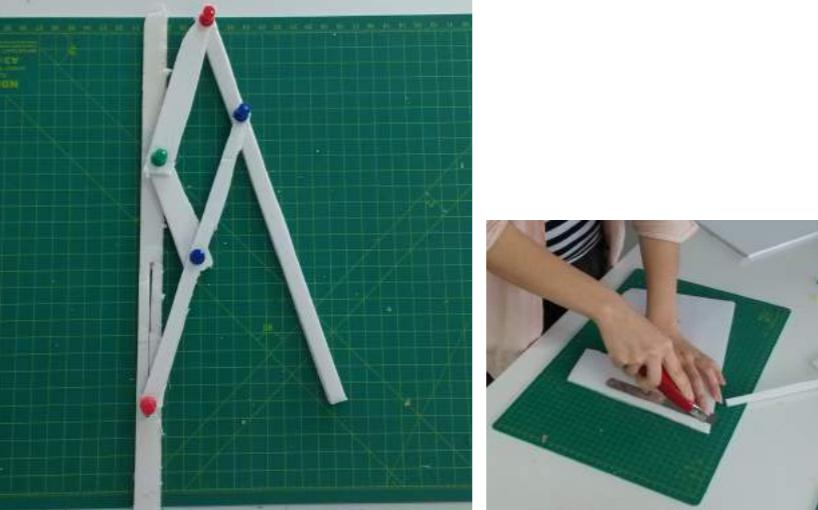
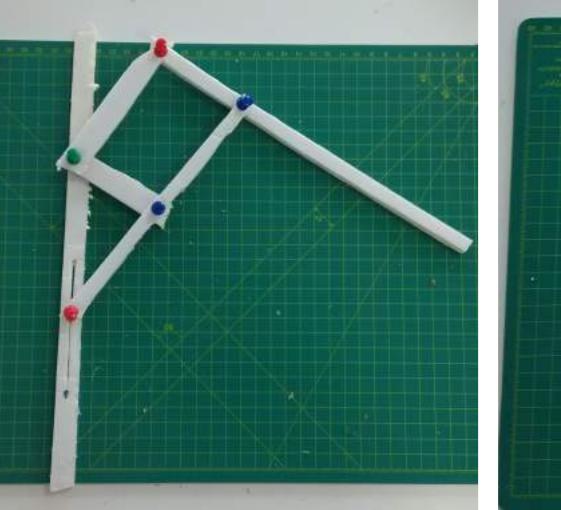


4.2.3 Ways of holding up the window

Way One

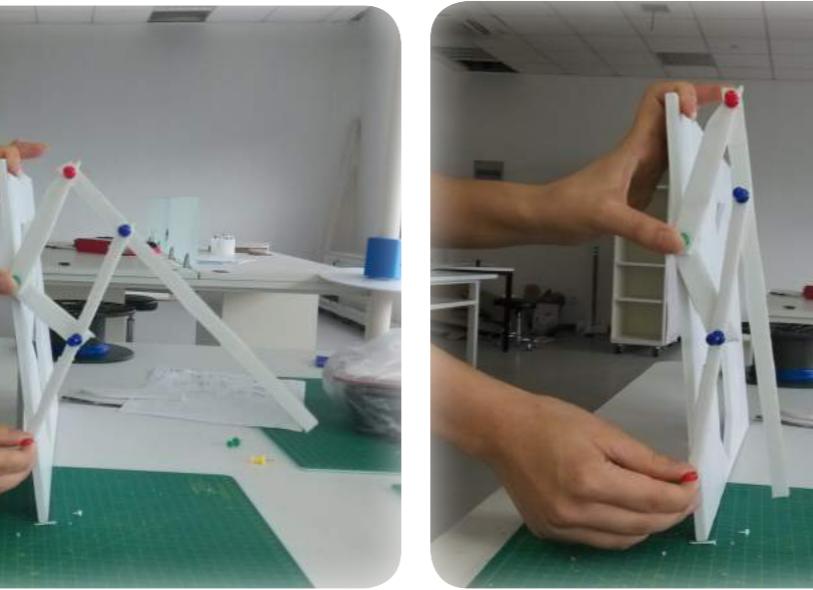
Four-bar Mechanism

The four-bar mechanism is widely used in window. However, it is too large to fit into a small plate like this.



Open the Window

Close the Window



Way Two

Slide Bar

The slide bar is what the window of our class room uses. However, it doesn't fit my window which is so thin in thickness.



Open the Window

Close the Window





Open the Window



Close the Window

Way Three

String

A string to pull one end of the plate, and the plate will rotate around the axis to open. It's good for one plate, but maybe too messy if it is used in six plates on the window purifier.



4.3 MAKING THE MODEL



4.3.1 ERGONOMICS RESEARCH



Push the on-off button



Touch the touchpad



Open the filter lid



Push the on-off button



Touch the touchpad



Open the filter lid

4.3.1 ERGONOMICS RESEARCH



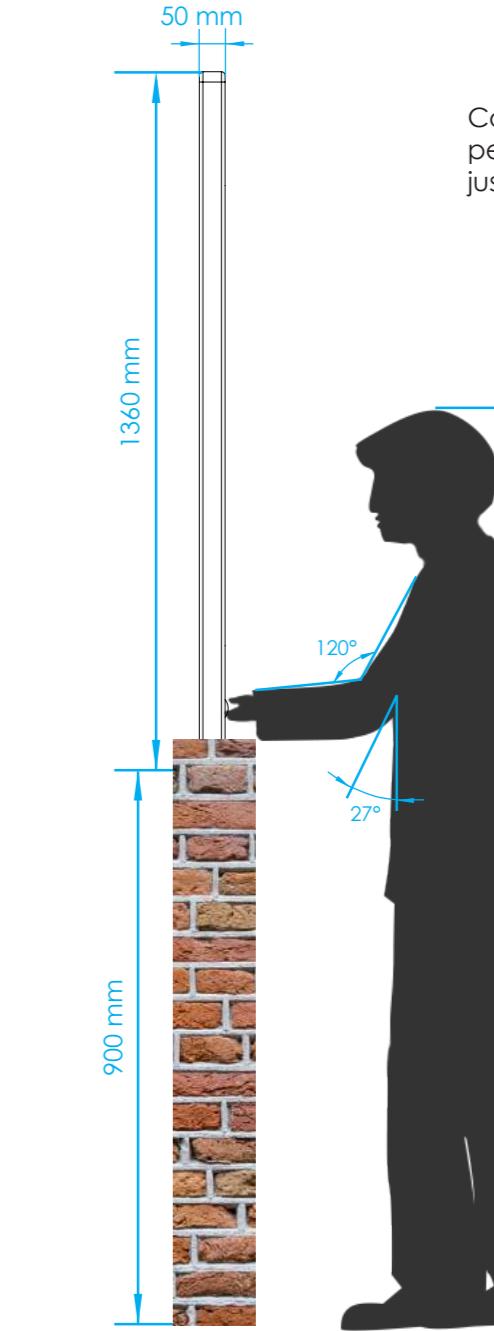
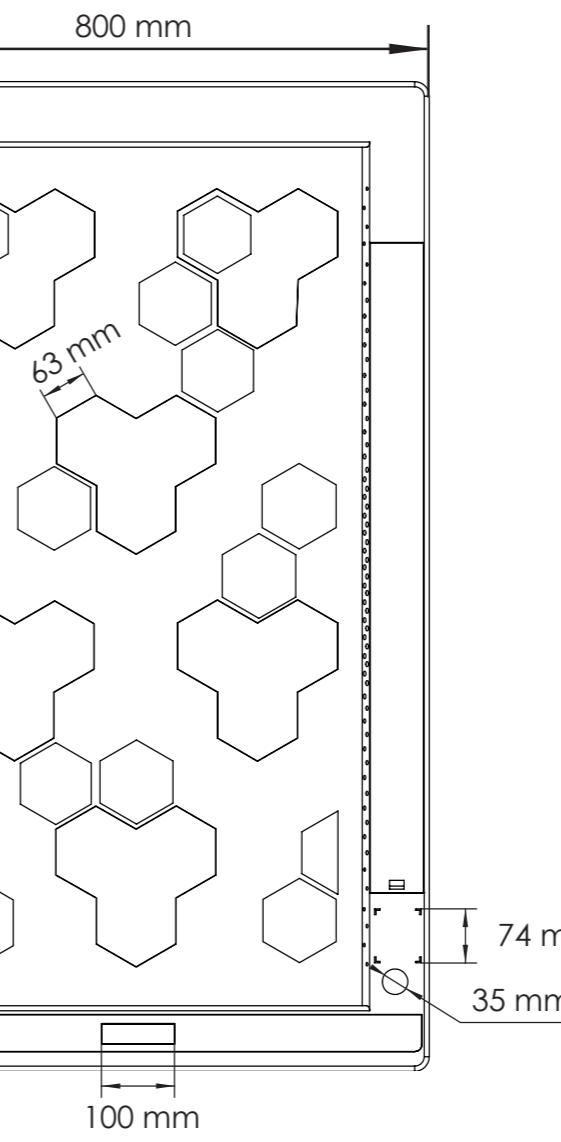
Push the on-off button



the touchpad



ECONOMICS RESEARCH



Considering the height of an ordinary person, the button and touchpad just the right size and right height.



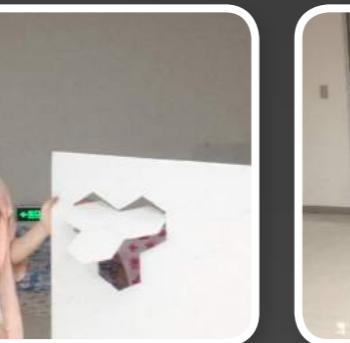
4.3.2 BODYSTORMING



the size of hexagon



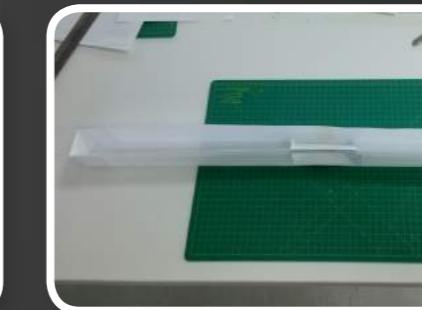
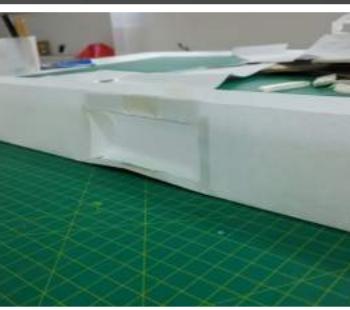
10



the small plate rotate and deco



— go to the store to cut the p



ke the sink which holds water for



4.3.3 TEST THE MODEL



Front side of the window



Back side of the window

Push the on-off button



Touch the touchpad



Hold the sink



Push the on-off button



Touch the touchpad



Hold the sink



As can be seen from the picture, the position of on-off button, touchpad and sink seem to be a bit low for tall student, but it suits fine for moderately short student.

Because higher part of the frame is filled with filter, the position of the button and touchpad can't be adjusted to higher position.

Considering that it suits fine for moderately short student, and brings little discomfort for tall student, the position of button, touchpad and sink will not be adjusted.



4.3.4 Renderings

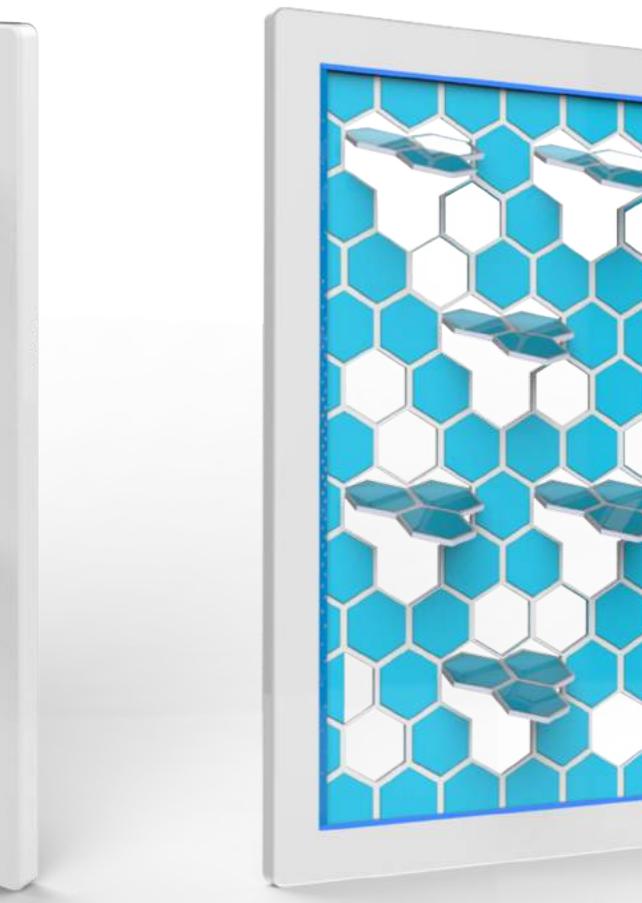
Render One

--all Plastic



Render Two

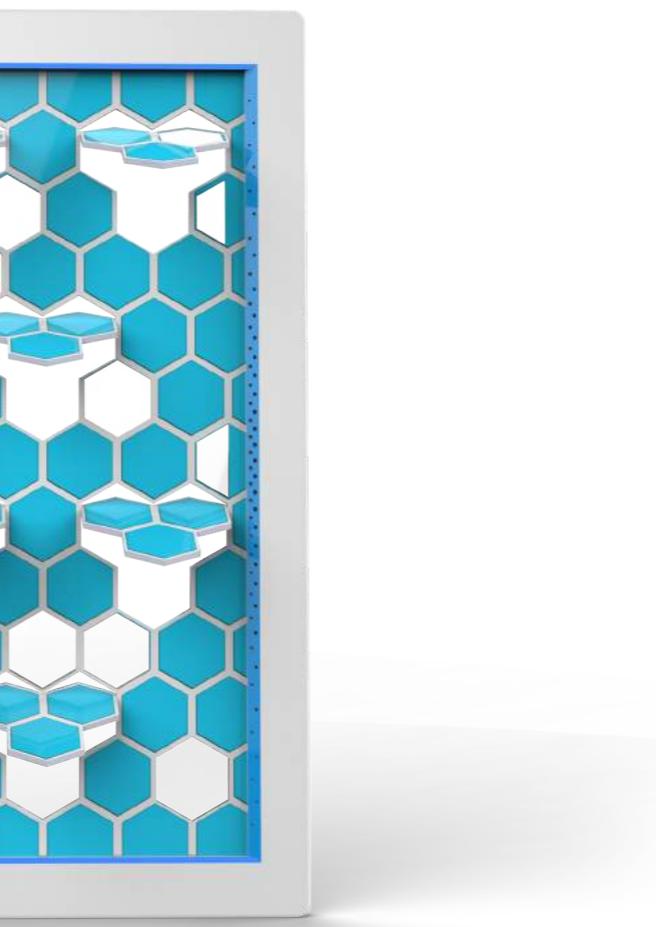
--all painted



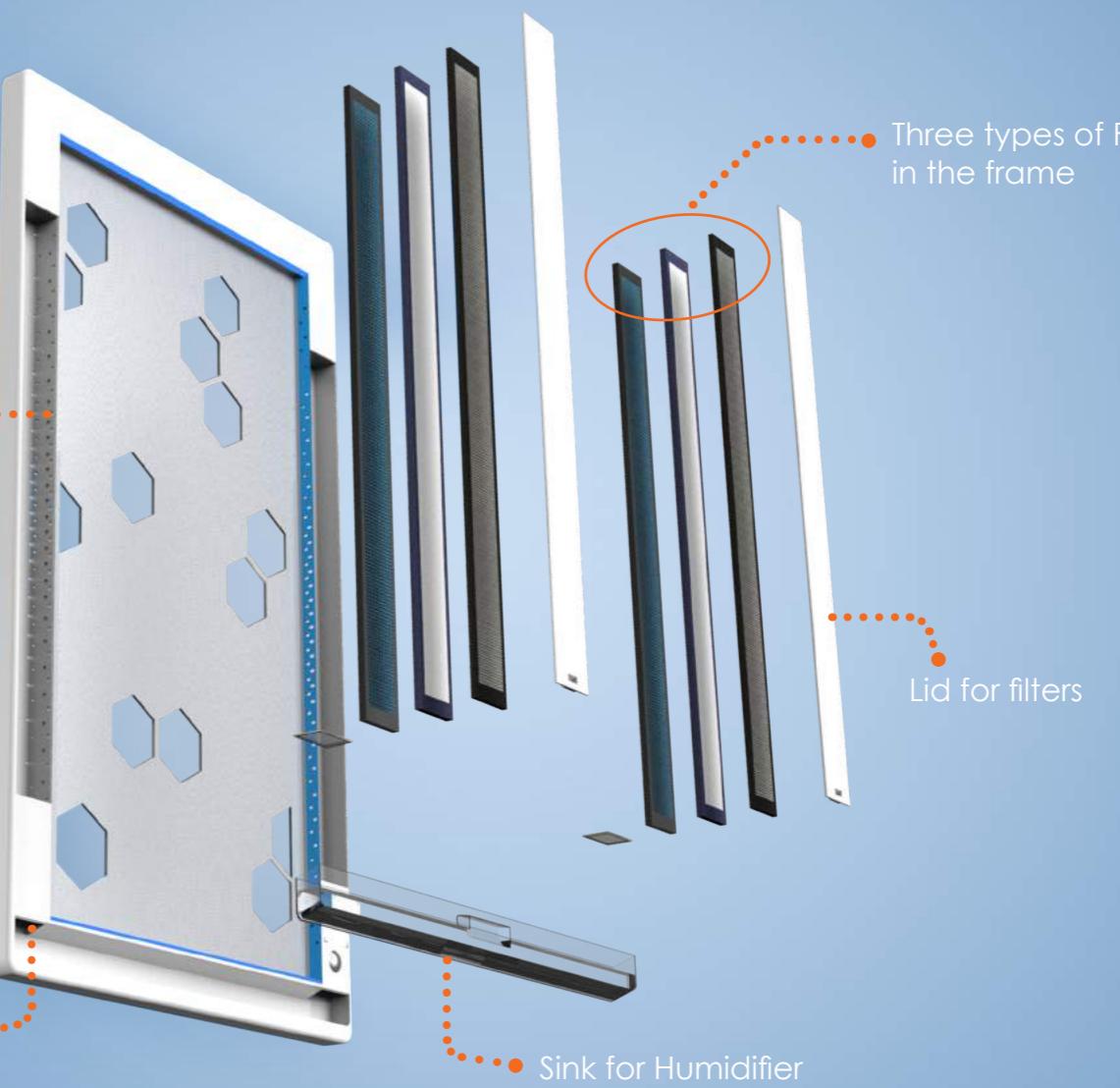


Final Render

--all painted

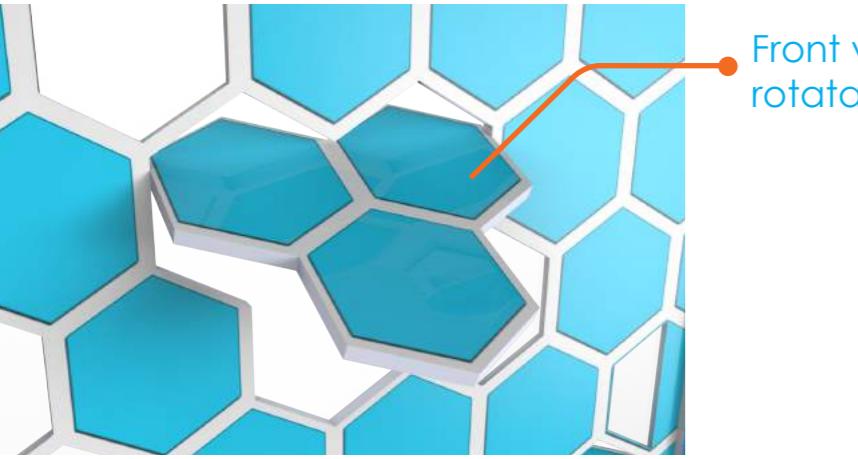


Explosive view

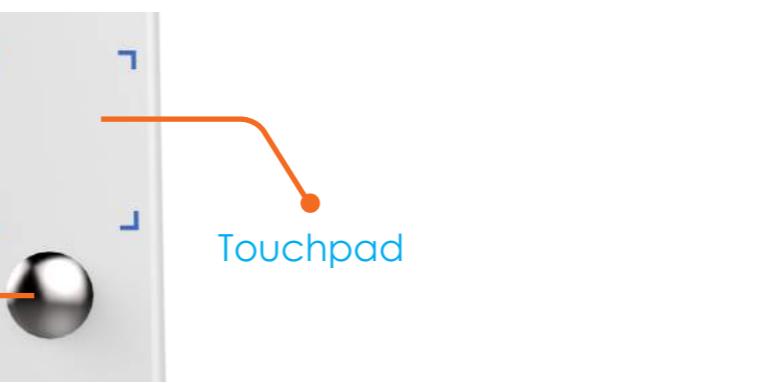




Details



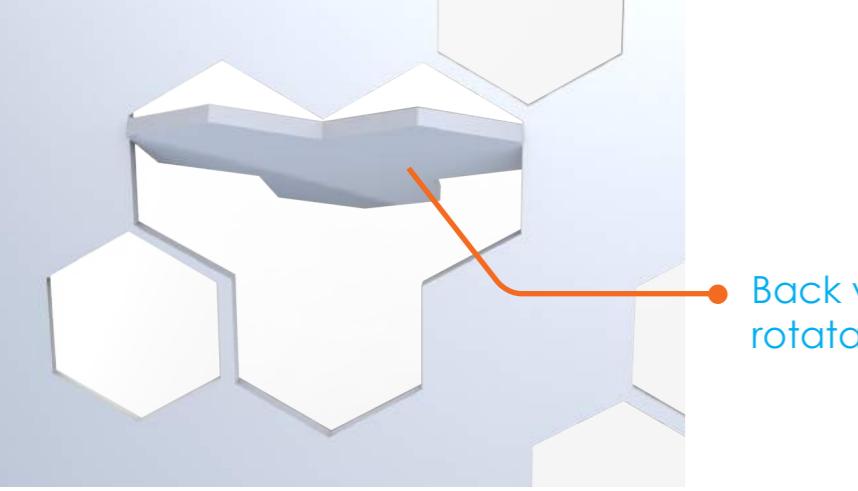
Front view of the rotatable plate



On-off button

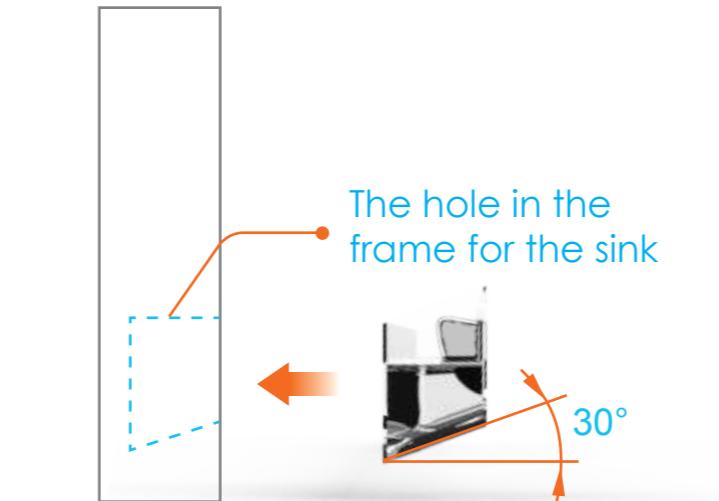


Air Inlet & Outlet



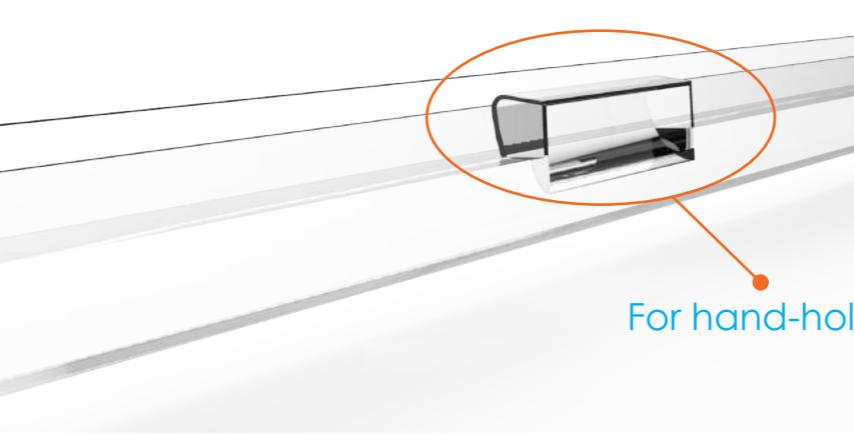
Back view of the rotatable plate

Sink

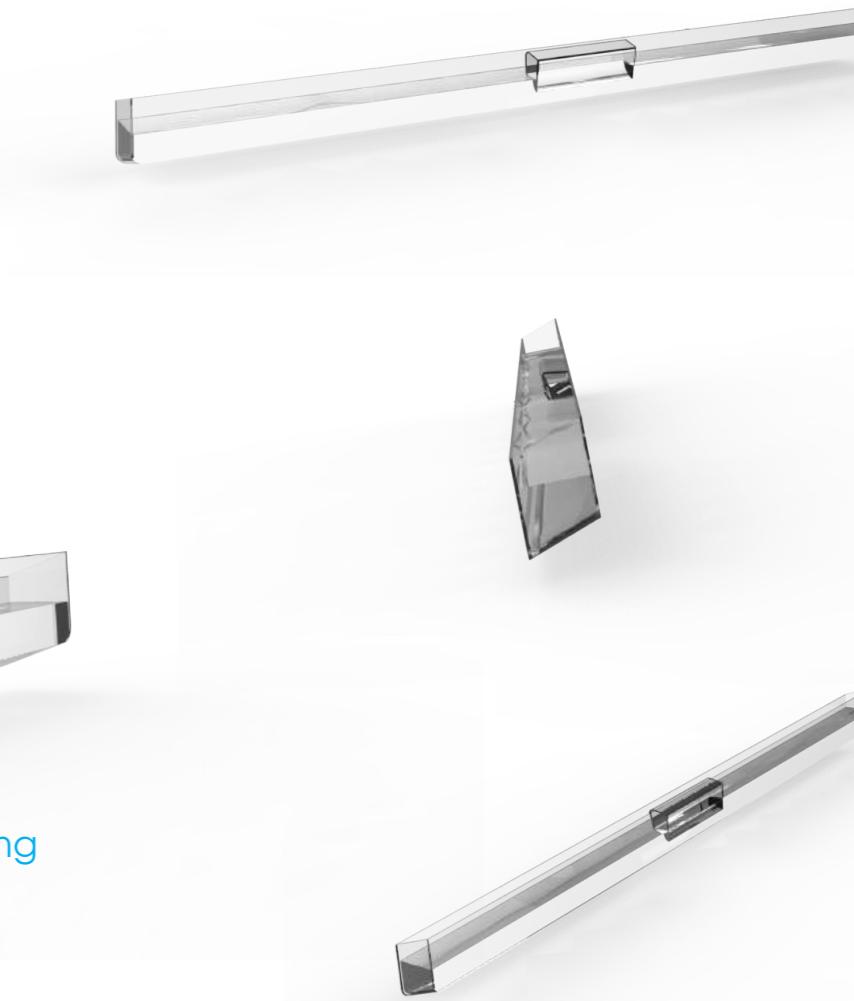


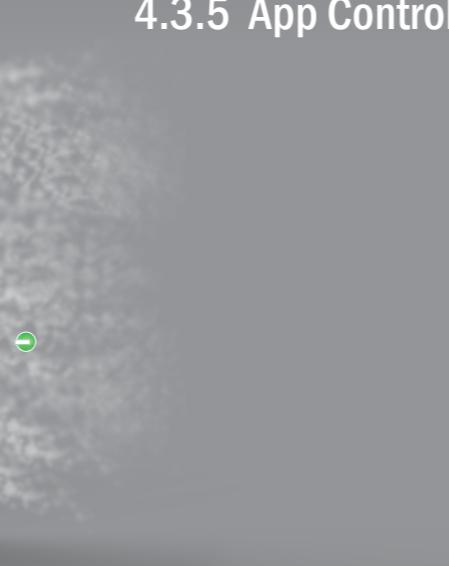
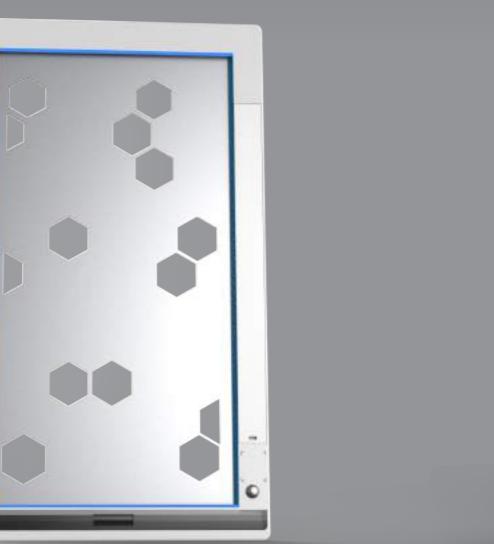
The hole in the frame for the sink

The inclination of the bottom makes it stay still in the frame rather than falling out



For hand-holding





When the Open is clicked, the window will be open and the Purify will be turned off automatically.



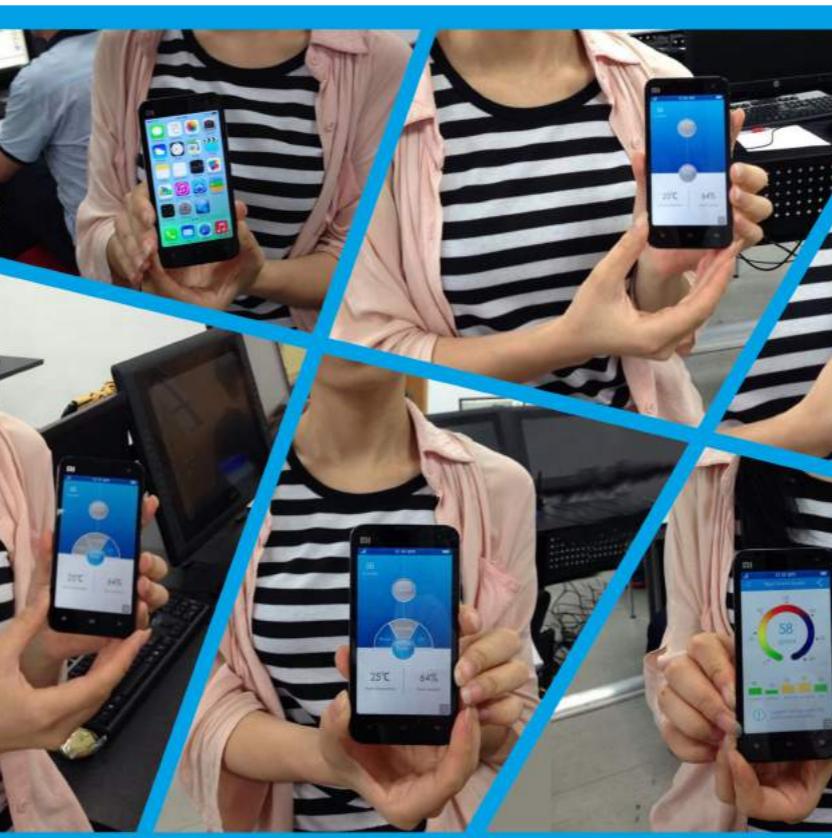
When the Purify is clicked, the window will be closed and three types of purifications will appear for choice.



You can either choose only purify or add any of the three types of purification as you want.



You can monitor the air quality in your room in real time with the app.



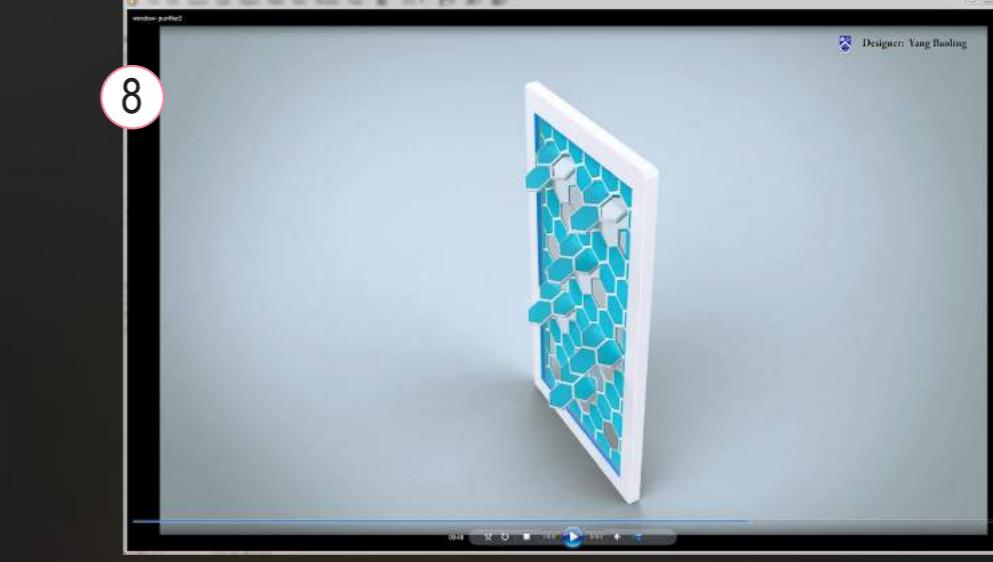
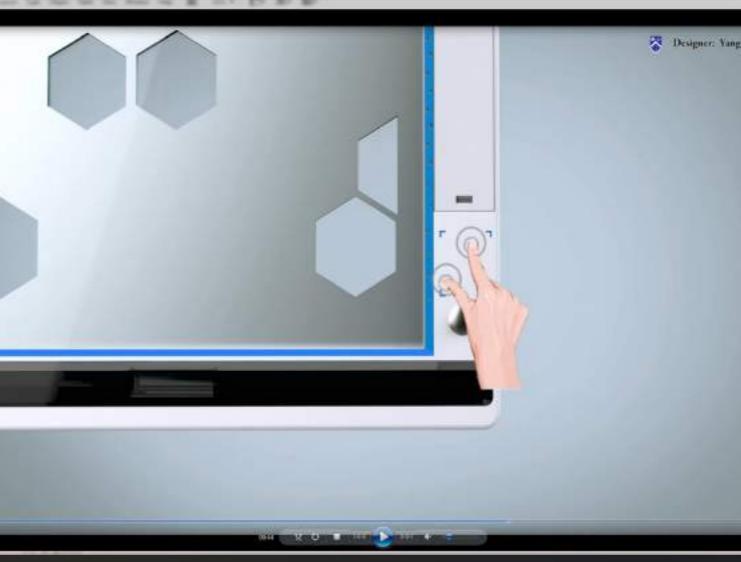
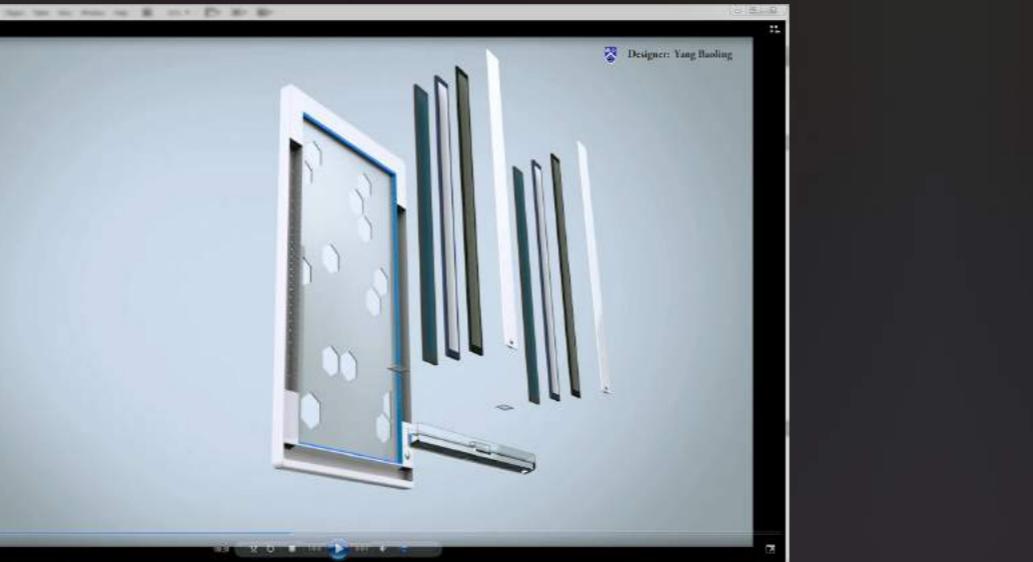
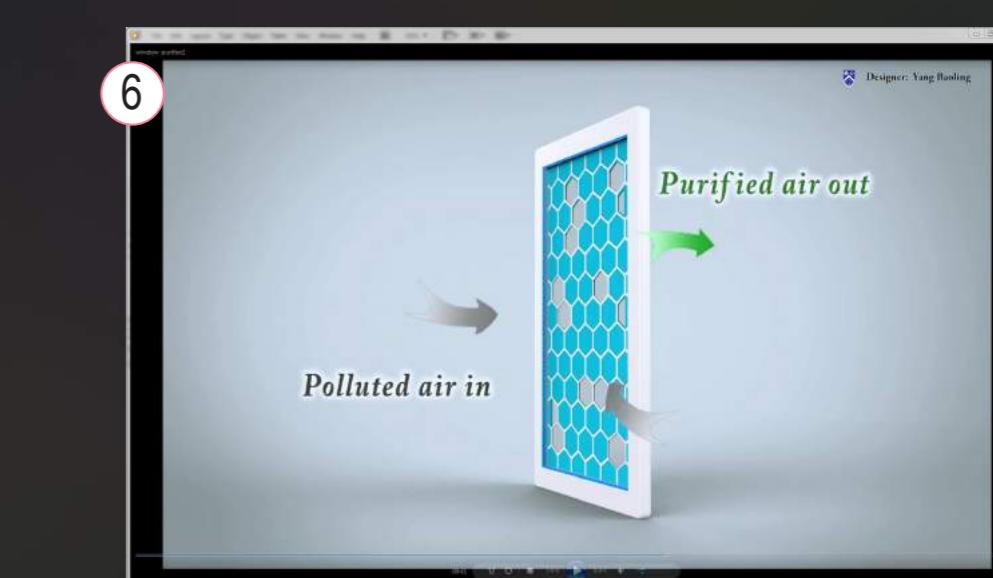
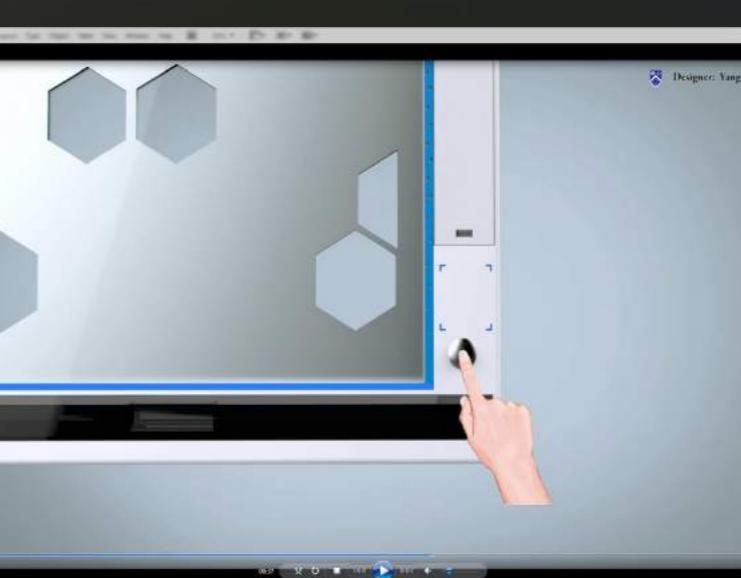
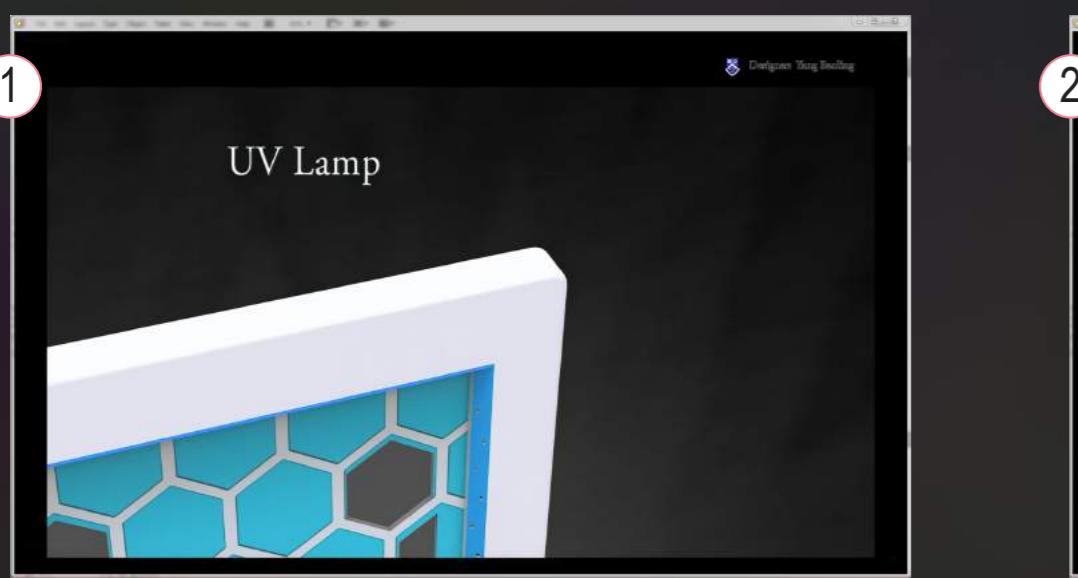
4.3.6 Test App Interaction on the Phone

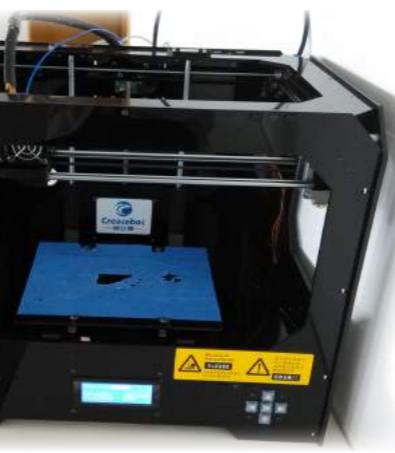
App Interation works very well on the phone. Each button goes to the right state when it is clicked, and the size of every button is perfect for fingers to click.

4.3.7 Animation

This animation is made with the combination of *Keyshot* and *Premiere*. *Keyshot* is used in the primary stage to render the movement of the model while *Premiere* is used in the post production stage to add captions, “hands”, app and music.



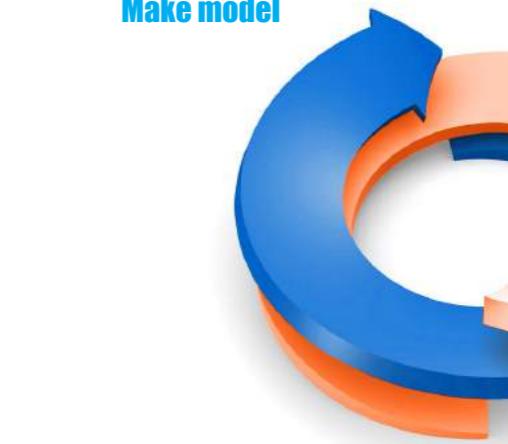




Supported material: ABS, PLA, PVA, PS

4.3.8 3D Print

Make model

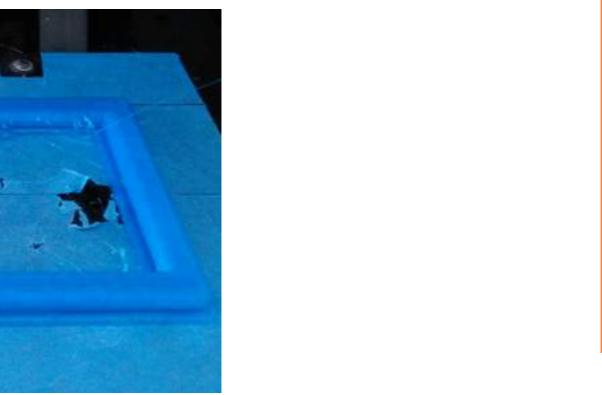
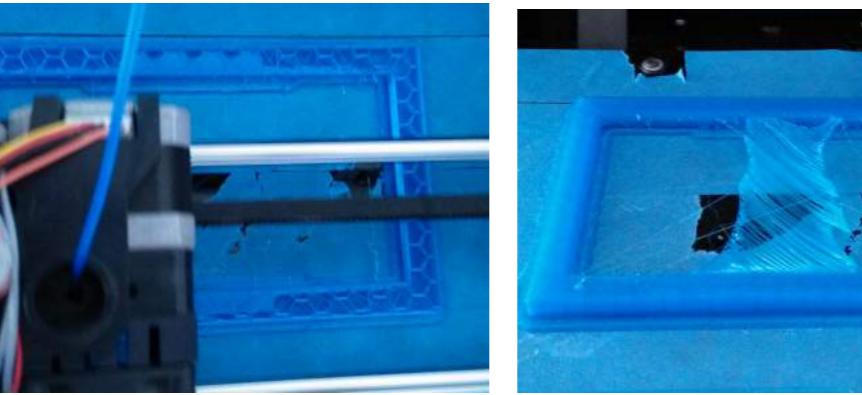
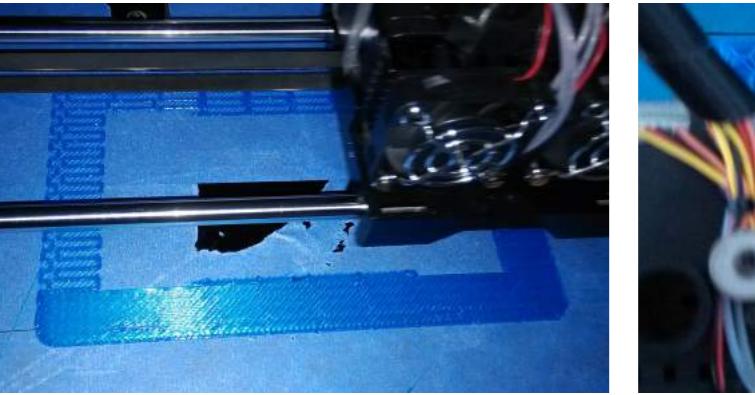
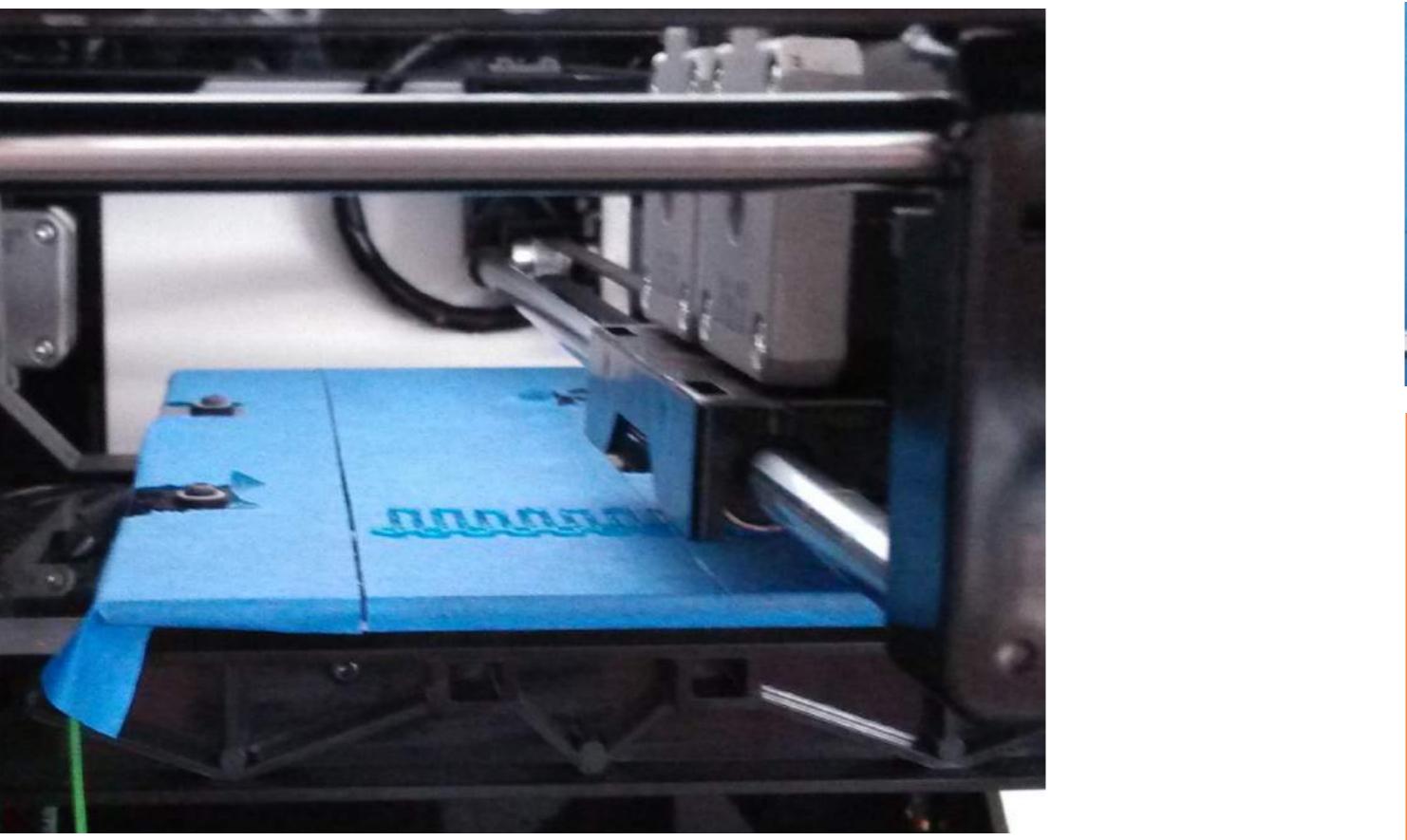


The goal of making model is to test and improve it. In the testing, you can find problems you never thought of while drawing or making virtual model in software. It's important to test the model before making a real one. A scaled 3D printed model is a good way to test the size of different parts of window purifier.



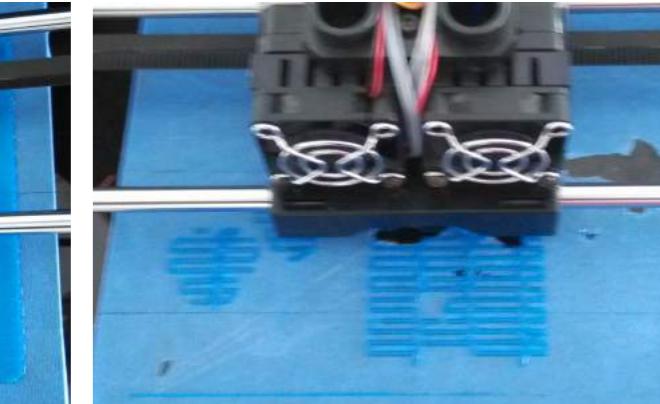
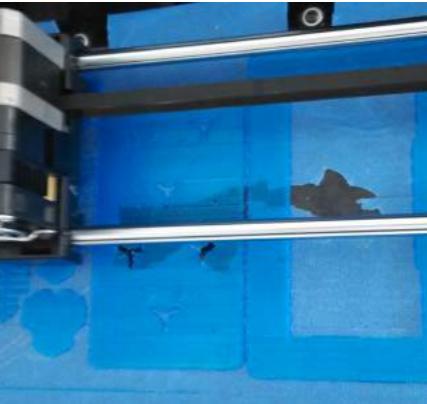
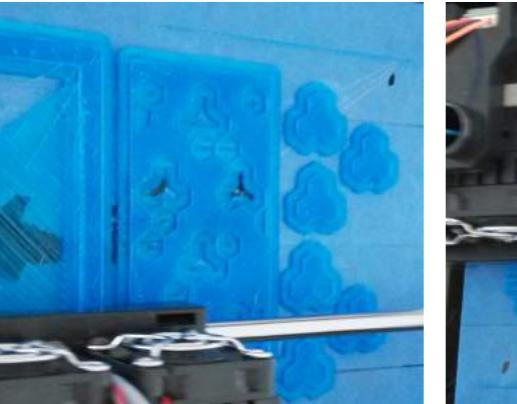
①

Print the assembly model. However, a problem occurred in this process. Only the frame was printed out, other parts were missing. So I have to print another one.

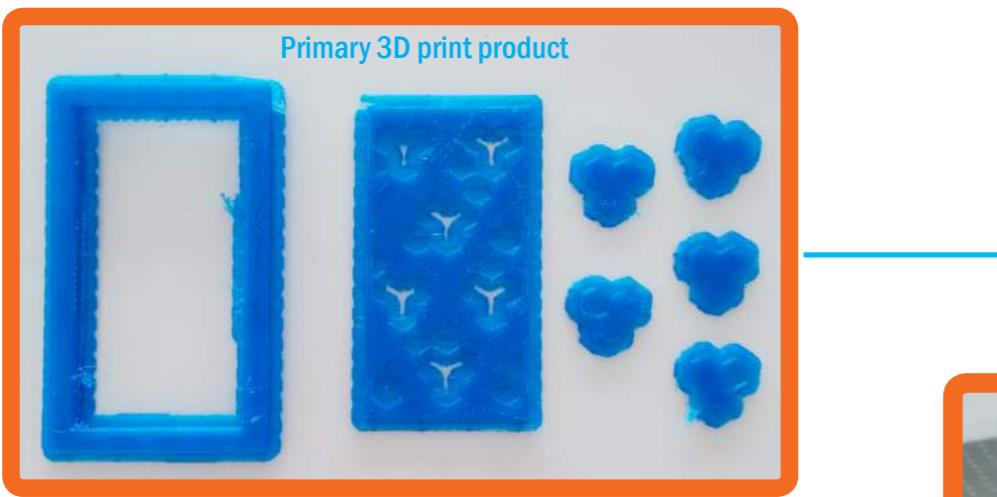


②

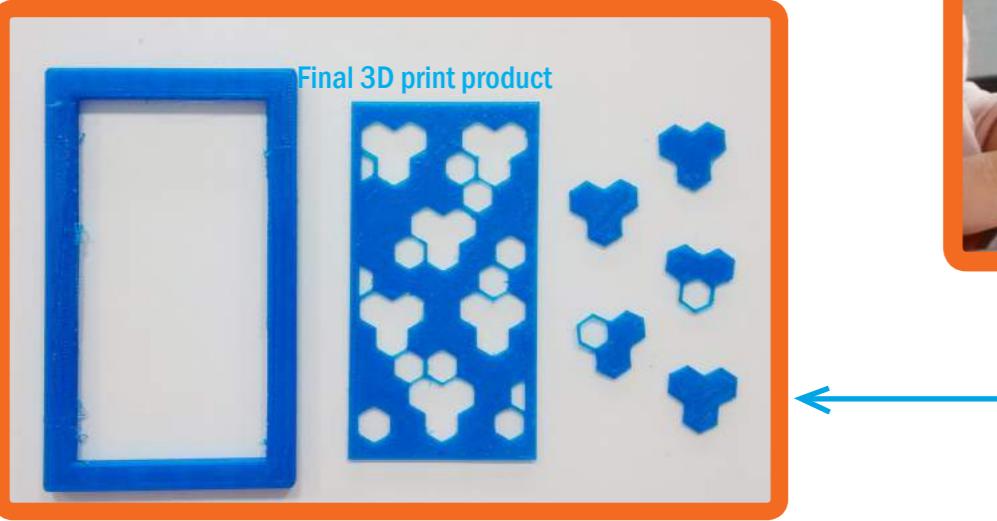
The second time, I took the assembly model apart, and printed them one by one, and then assembled them after printing.



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Primary 3D print product



Final 3D print product

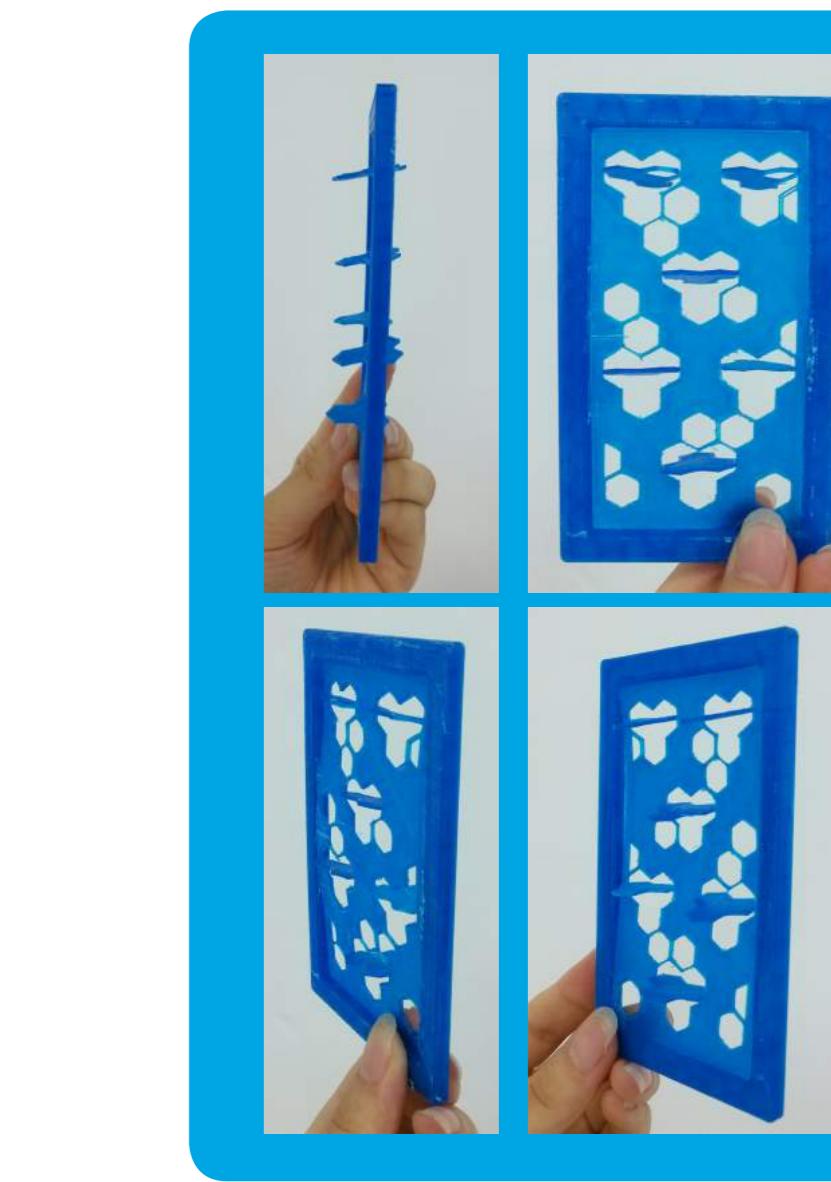
③

Polish the 3D print product in preparation for assembly



Polish the 3D print product

Assembling





4.3.9 Prototype Making



Cutting the rotatable plate with CNC machine



Load the file in CNC machine





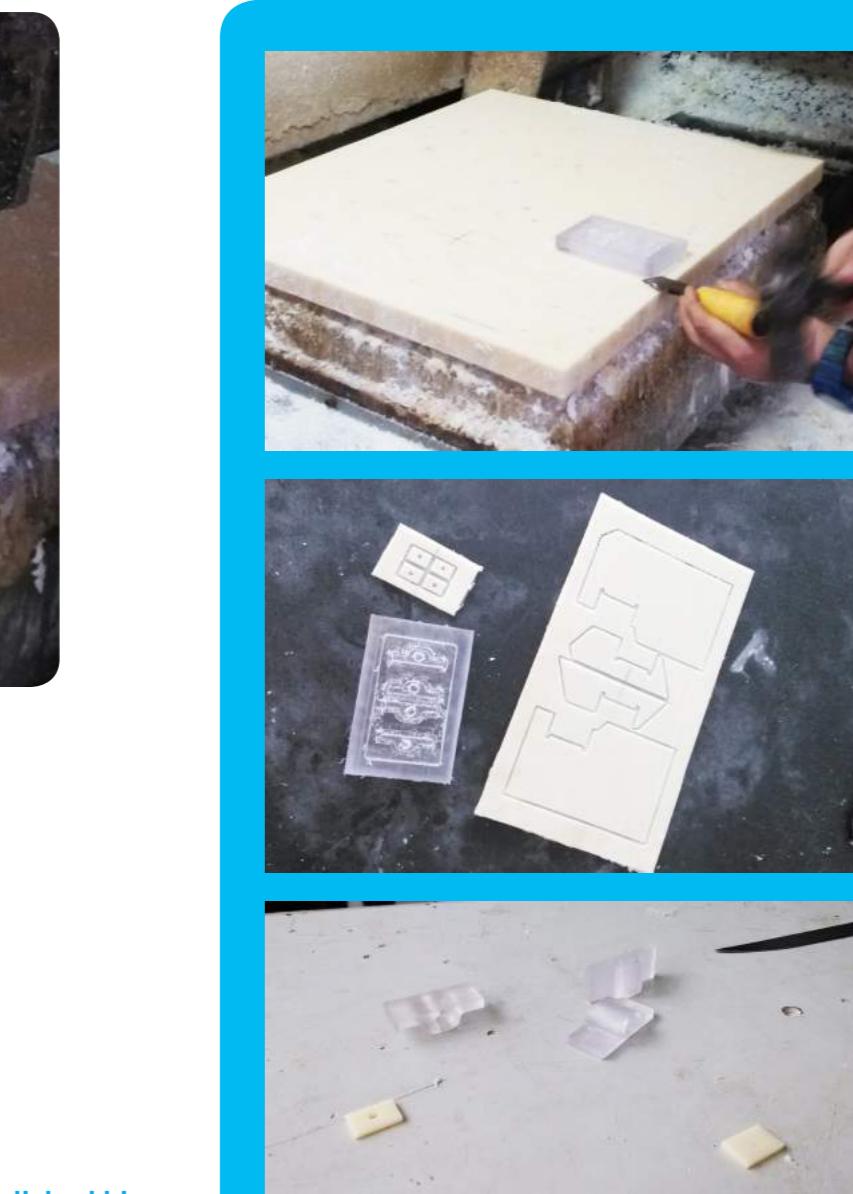
Cutting the positioning board for the hinge



Cutting the hinge on CNC machine

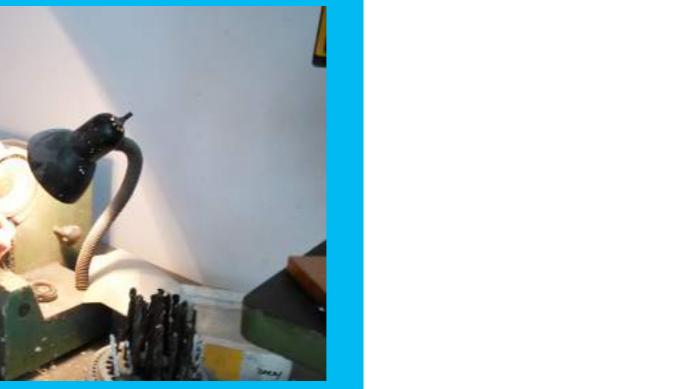
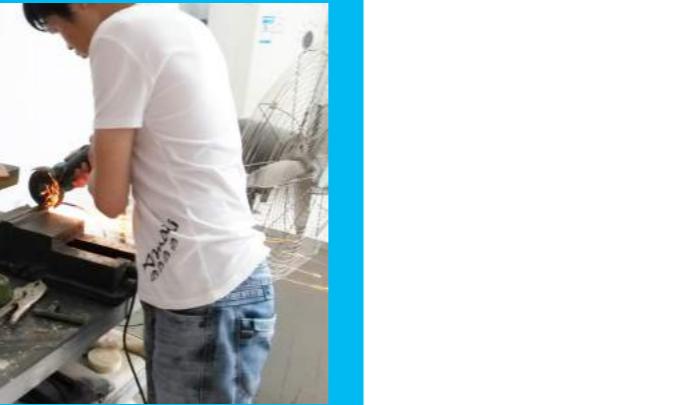
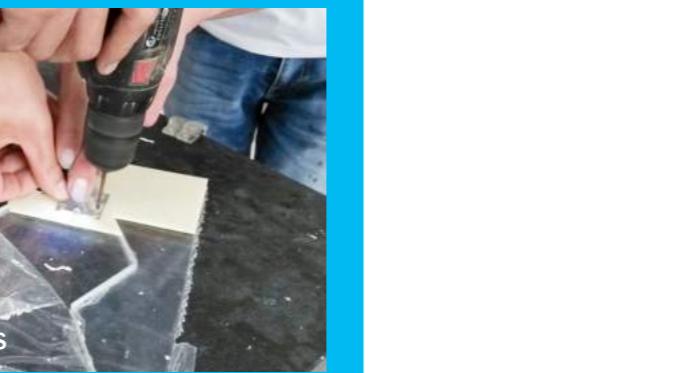
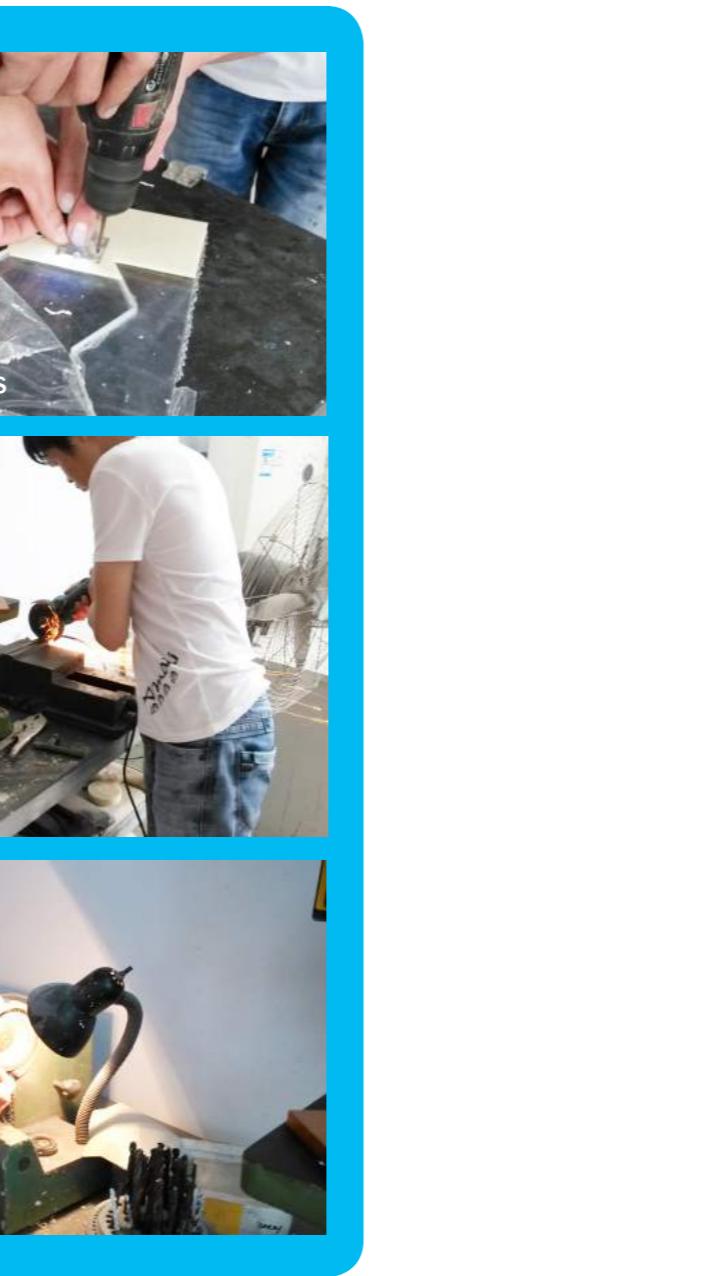


Polished hinge





Screw on the hinge on the rotatable plate

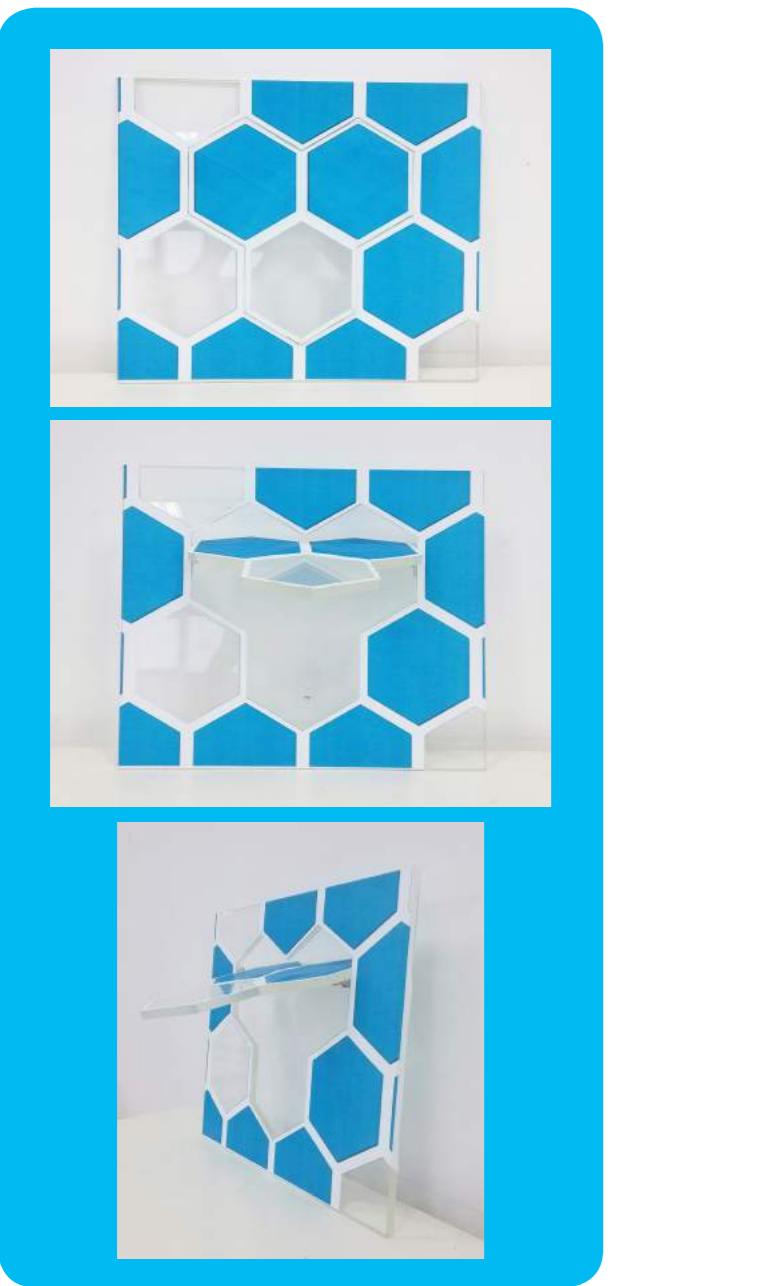


Closed rotatable plate



Opened rotatable plate

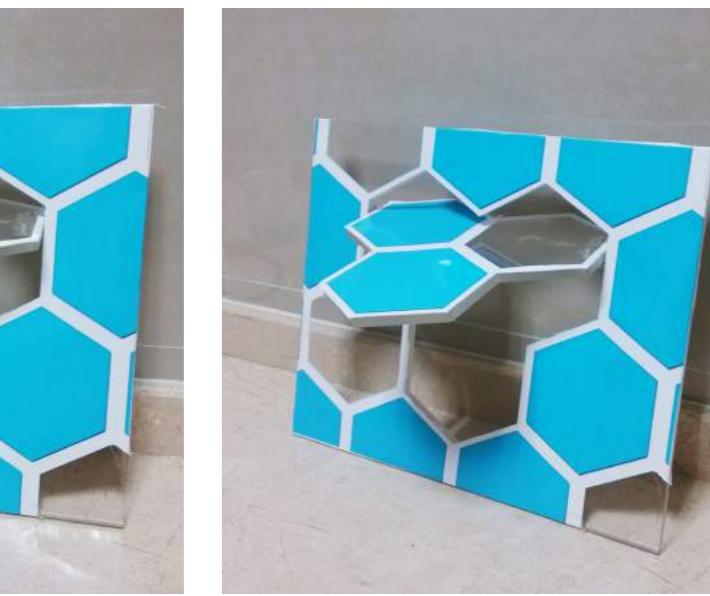




Decorate the Model



Decorate the Model with another paper







5

Appendix



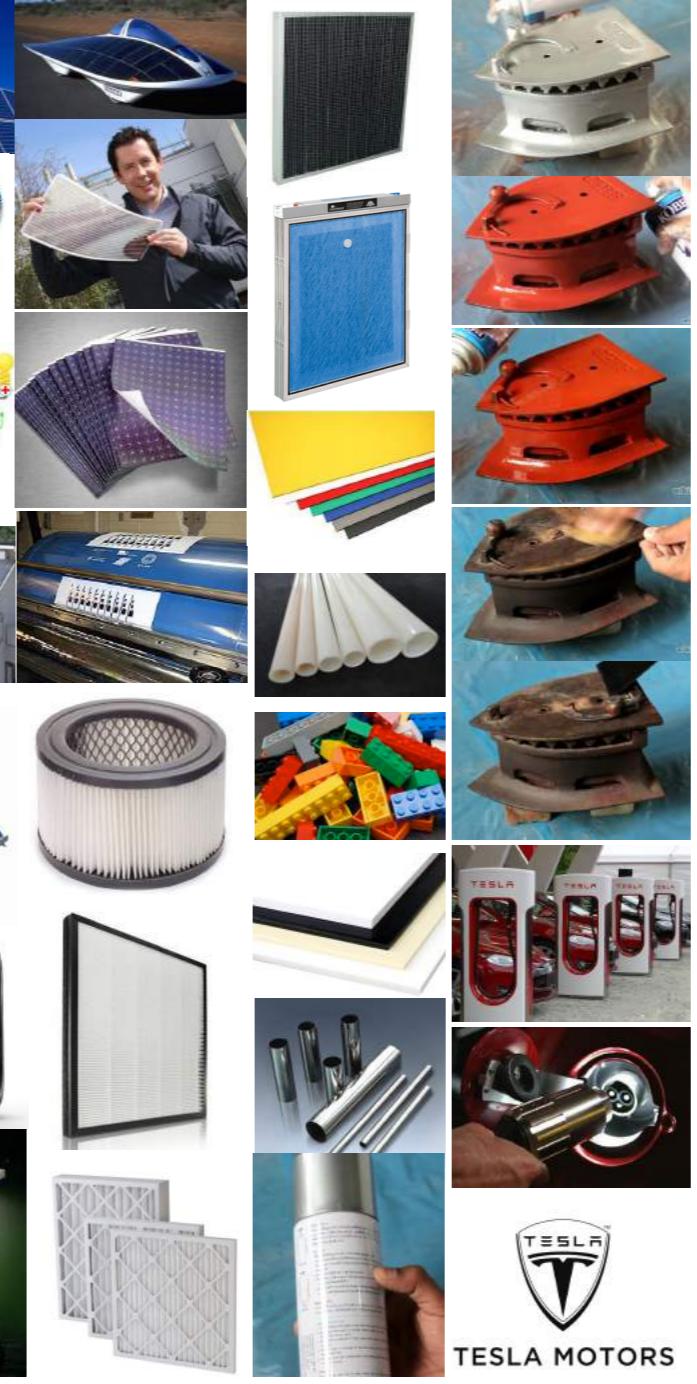
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