Design of an Air Cooler

Product design

Project III

Anand Asinkar

02613003

Prof: **Suresh Sethi**

Guide

Prof: **Milind V. Rane**

Co-guide

Industrial Design Centre

Indian Institute of Technology

Powai, Mumbai 400 076

Approval

The product design, project III entitled
‘ **Design of an Air Cooler’** by **Anand Asinkar**, is approved in partial fulfillment of the requirements of the Masters of Design degree in Industrial Design

Guide	:	Suresh Sethi
Co-Guide	:	Milind V Rane
Chairperson	:	Karunakaran
Internal examiner	:	V.P.Bapat
External examiner	:	Rajan Vernekar

Acknowledgements

I would like to express my gratitude to my guide, Prof. Suresh Sethi for his unprecedented guidance throughout the project.
Also my Co-Guide Prof:Dr.Milind.V Rane for initiating and guiding me through the project.

I am thankful to all the IDC faculties for their constructive criticism and valuable suggestions.

I am also thankful to Pushkar for the user study.

I would also like to thank my friends who have helped me knowingly or unknowingly at different times during the project.

Abstract

The principle of evaporative cooling has been in use for increasing the humidity of air in dry climatic regions. A cooler is based on the same technology. The coolers available today use honeycomb technology. New technology based on the same principle for coolers gives new challenges to translate it into a product. This technology has some clear advantages; one of them is volume of the product. The project aims at creating a marketable product based on this technology.

CONTENTS

1. Introduction to the Project

1.1 Introduction

Air coolers are a life line for the people staying in dry areas. The principle of evaporative cooling has been in use for increasing humidity in the air. People living in dry areas need humid air, an air cooler is a product of achieving humidity in air. So the product has to achieve the more than just the function.

Water is a greatest source for cutting down the temperature in a dry climate. The cooler is based on the same principle. Temperatures in the dry zones can shoot up to 50C with very low humidity levels. Coolers don't actually cool the air but throw water content into the air, which naturally cools the air. But over the years the technology has remained the same with some minor modifications.

A new technology based on the same principle for coolers gives new challenges to translate it into an air cooler. These can be the context of use or the size or the advantages in terms of utility and also cost. The project aims at creating a product, that is ultimately a marketable product.

Terminology

Punkha : a wedge shaped device used in ancient India to propel air manually

Evaporative cooling : In short hot air loosing heat due to water

Blower : A cylindrical fan with fins

Humidity : Amount of water content in the air

1.2 History of Air-cooling

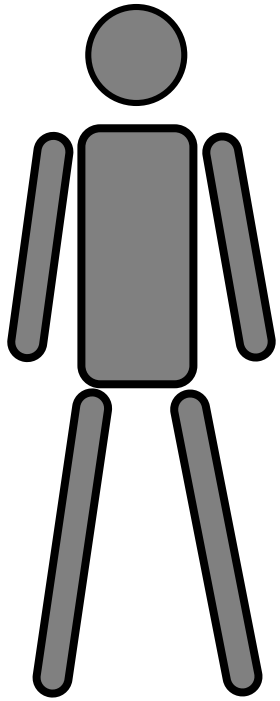
The ancient Egyptians, Greeks and Romans used *wet mats* (what we would call cooling pads today) to cool indoor air. They hung the mats over the doors of their tents and other dwellings. When wind blew through the mats, evaporation of the water cooled the air inside. The people of India later used this method to cool the royal palaces.

In 1500AD Leonardo do Vinci built a water driven fan to ventilate a suite room for the wife of his patron. This was probably the first attempt to provide an automatic way of changing the condition of the air in an enclosed space.

In India the *Punkha* (fan), was a large blade, which extended downwards from the ceiling . operation was done manually by pulling the rope.

During the 1500's the first mechanical fan was built to provide ventilation. In 1800, textile manufacturers in New England began using water evaporative systems to condition the air in their mills. The systems consisted of large "cooling towers" with fans that transported the water-cooled air inside buildings.

In 1939 "swamp cooler" type devices were produced and presented relief from heat for homes and facilities. They cooled the temperature on certain days, when the relative humidity was low, around 8 %.



37 Centigrade / 98.6 F

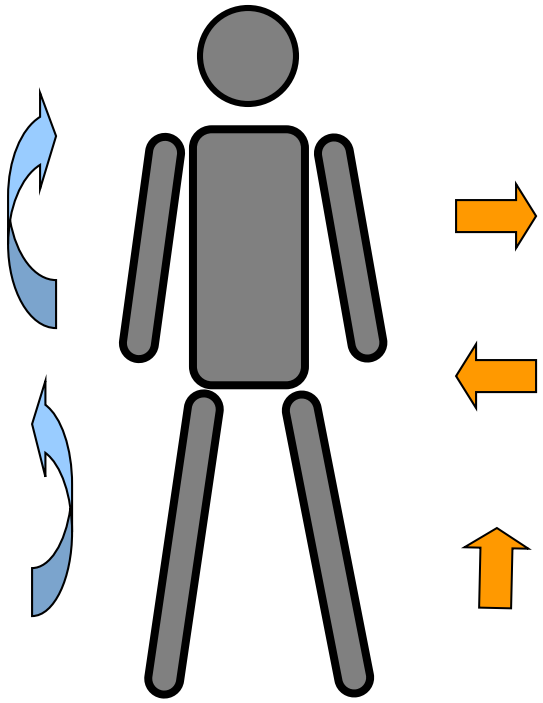
22 C – 26.5 C comfort range

45 % - 50 % relative humidity

1.3 Human Comfort Zone

The normal temperature of human body is 37C or 98.6 Fahrenheit. The temperature range within which the human body feels comfortable is 22C to 26.5C or 72F to 80F. Also the relative humidity i.e. the water content in the atmosphere is important which should be about 45% to 50%.

An understanding of the way by which the body maintains this temperature, which helps in understanding the way the air conditioning process helps keep the body comfortable. All food taken into the body contains heat in the form of calories. The calorie is used to express the heat value of food. The calorie is the amount of heat required to raise the temperature of one kilogram of water one degree Centigrade. As the calories are taken into the body, they are converted into energy. This energy is then stored for future use. The conversion processes generates heat. All body movements also add to the heat generated by the conversion processes and use up the stored energy for body comfort, the body must give off all of the heat produced. Since body produces more heat than it needs, heat must be constantly given off or removed.



The constant removal of heat from the body takes place through three natural processes, convection, radiation and evaporation which occur at the same time.

1.4 Conditions that affect the body

Removal of heat from the body.

Air movement helps rate of evaporation and therefore rate of removal of heat.It also helps convection and body heat is carried away. Also heat on surrounding surfaces is removed faster.

The human body constantly looses the heat to the surroundings by

Convection,

Radiation and

Evaporation

An air cooler uses the processes of evaporation to create the comfort conditions.

Convection

Heat flows from a hot surface to a cold surface. For example, heat flows from the body. This surrounding air is below the surrounding the body skin temperature. Convection takes place when a body is still without any movement. The body gives off heat to the cool surrounding air. The surrounding air becomes warm and moves upwards. As the warm air moves upward, cooler air takes its place, and the convection cycle is completed.

Radiation

Radiation is the processes by which heat moves from a heat source to an object by means of heat rays. This principle is based on the phenomena that heat moves from a hot surface to a cold surface. Radiation also is not affected by ambient air temperature but the temperature of surrounding surfaces affects it. The body quickly experiences the effects of sun radiation when one moves from a shade to a sunny area. Radiation effects are also experienced when the body surface closest to a fire becomes warm while the opposite body surface remains cool. Just as the heat from the sun and the fire moves by radiation to a colder surface ,the heat from the body moves to a colder surface.

Evaporation

Evaporation is the process by which moisture becomes vapor. As moisture evaporates from a warm surface, heat is removed and the surface is cooled.

This process takes place constantly on the surface of the body. Moisture is given off through the pores of the skin. As the moisture evaporates from the skin, it removes heat from the body. The body can produce more heat than can be removed by these processes. This excess of heat is indicated by perspiration that appears as drops of moisture on the body. This is experienced when flow of air from an electric fan evaporates sweat from our skin. But in case of desert cooler water gets evaporated and as a result of it air looses heat creating comfort conditions in room.

2. The Project

2.1 Appliances for human comfort

2.2 Fan/cooler/air conditioner

2.3 Position in the market

2.4 Need for design

2.1 Appliances for human comfort

Ceiling Fan

Table Fan

Air Conditioner

Humidifier

Air cooler

Fan
Fans can be Ceiling fans, Wall mounted or table fans and exhaust fans. Ceiling fans mainly regulate the temperature due to air movement which the fan generates. So the air movement helps in convection, radiation and evaporation.

Humidifiers
It works on the same principle as air cooler. In areas of extreme cold or extreme heat, the water content in the air is so low that it starts drying up the skin. A humidifier has a water container and a fan which throws moisture into the air.

Air Cooler
Air cooler works on the principle of evaporative cooling. Air coolers are independent units which put water content into the air which in turn reduces the air temperature.

Air Conditioner
Air conditioner are devices which regulate the temperature inside a room by reducing it. They also decrease the humidity in the air and cool down the air.

All these appliances are used in different regions according to the climatic conditions and are essentially an attempt to achieve the human comfort levels as mentioned before.

2.2 Fan/cooler/air conditioner

A fan is the most commonly used appliance throughout household and also almost in every kind of indoor and semi indoor spaces.

Among the three, a fan is used simultaneously with an air cooler. A fan increases the air movement and helps to cool down the air.

Among these it is the cheapest alternative.

An air cooler is used mostly in dry areas. It has to be used indoors only. It needs continuous replacement of air.

A fan is simultaneously used with the cooler. The cooler market falls between a fan and an A/C.

A cooler is expensive than a fan and cheaper than an air-conditioner.

An air conditioner is used in all kinds of areas. But it extensively used in areas with high humidity. It needs to have a closed a closed environment.

An A/C falls into higher price range. Higher middle class or higher class can afford to buy an A/C.

It's the most expensive appliance.

2.3 Position in the market

A cooler is looked upon as a middle class product. But the fact is that for any of the categories, in dry areas it is advisable to use a cooler than an air conditioner because the humidity level is already low and an air conditioner makes the sir more drier.

The fact remains that a cooler is mostly brought by middle and higher middle income groups. Some coolers are also targeted towards higher income groups only.

Class	Fan	Cooler	A/C
Lower Middle	●		
Middle	●	●	
Higher Middle	●	●	●

Hence to give options cooler are also made targeting different categories of people. Also coolers models are made according to the volume of the rooms. Upper class always sees any product from point of view of value of the product. They can afford to buy the higher category of coolers also.
Middle class people prefer a portable unit which has got multiple use or portability. Whereas window units have to be kept in a fixed position.

2.4 Need for design

An air cooler has a very specific market for the buyers. Evaporative air cooler is not a widely accepted product. In this case the moisture content of the air is seldom controlled unless like new models which have humidity control. In most of the cases the forms look outdated without ant kind of expression or a strong statement.

Making an air cooler is a very old practice. Since the technology is very simple, local manufacturers fabricate these coolers in sheet metal. Then they brand these units in their own regions. The local market is the biggest threat to big manufacturers also because they have a larger share of the market.

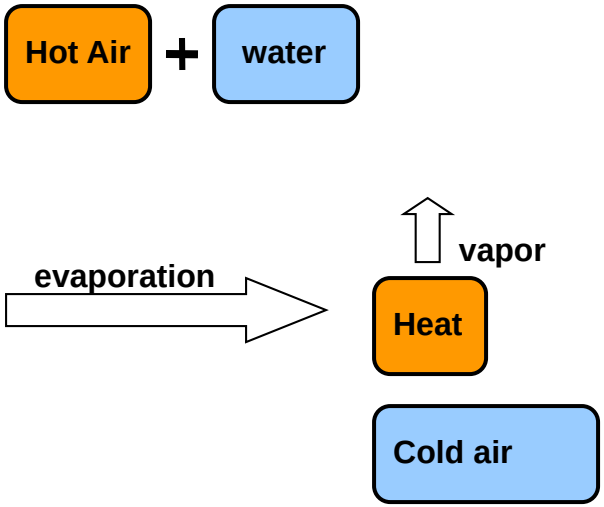
Room coolers are widely used in India. They are also called desert coolers since they give cooling at desert atmospheric conditions. A desert atmospheric condition is high temperature and low humidity. As far as Indian market is concerned, people are aware that water content addition is better than using air conditioners in dry areas. Still an air cooler is the cheapest form of cooling available in the middle and higher middle income group.

The drawback of use of these coolers is they cannot be use din costal areas where the temperature shoots up but at the same time humidity also goes up.

3. Working and Understanding

3.1 Principle working
3.2 Different technologies
3.3 Advantages / Disadvantages
3.4 Different kinds of coolers
3.5 Components of an air cooler

3.1 Principle working



What Is Evaporative Cooling

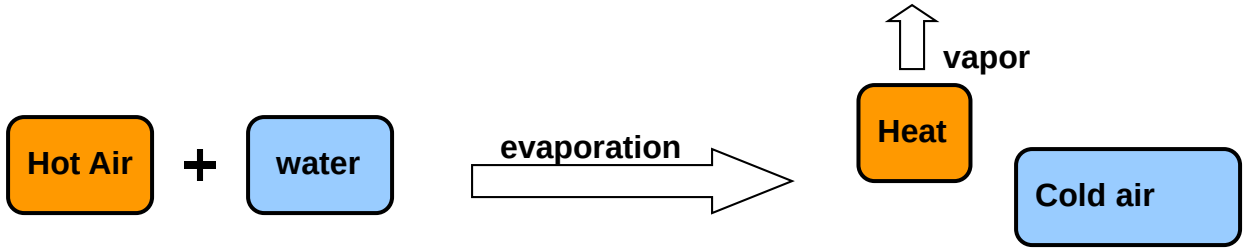
When water evaporates from the surface of something, that surface becomes much cooler because it requires heat to change the liquid into a vapor. A nice breeze on a hot day cools us because the current of air makes perspiration evaporate quickly. The heat needed for this evaporation is taken from our own bodies.

As air comes in contact with water it absorbs it. The amount of water absorbed depends largely on how much water is already in the air. The term *humidity* describes the level of water in the air. If the air holds 50% of its capacity, the humidity would be 50%. If the humidity is low, then the capacity to hold more water is higher, and a greater amount of evaporation takes place.
When the air contains large amounts of moisture, the humidity is said to be high. If the air contains only a small amount of moisture, the humidity is said to be low. When the air holds as much moisture as possible at a certain temperature, the air is *saturated.* At saturation, the temperature and the dew point are the same. The amount of humidity varies according to the temperature and location. The warmer the air, the more moisture it is able to hold.
The amount of water in the air compared to the amount required for saturation is called *relative humidity*. If the air contains only half the amount of moisture it can hold when saturated, the relative humidity is 50%.

Dry air can absorb moisture through evaporation. When water evaporates, it absorbs heat.

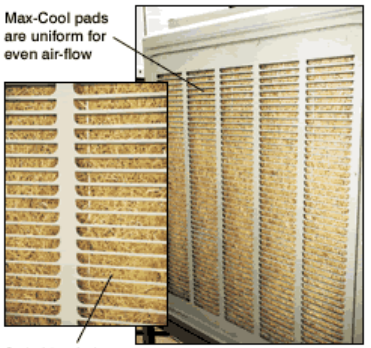
A special type of fan is used to increase the rate of evaporation and make the air cooler, as well as distributing the cool air throughout the home.

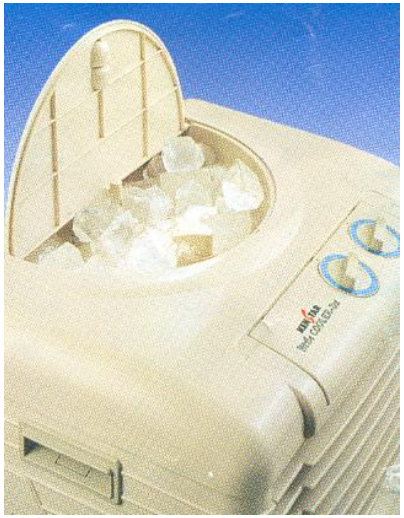
Conversion of sensible heat to latent heat is the principle of an evaporative cooler.



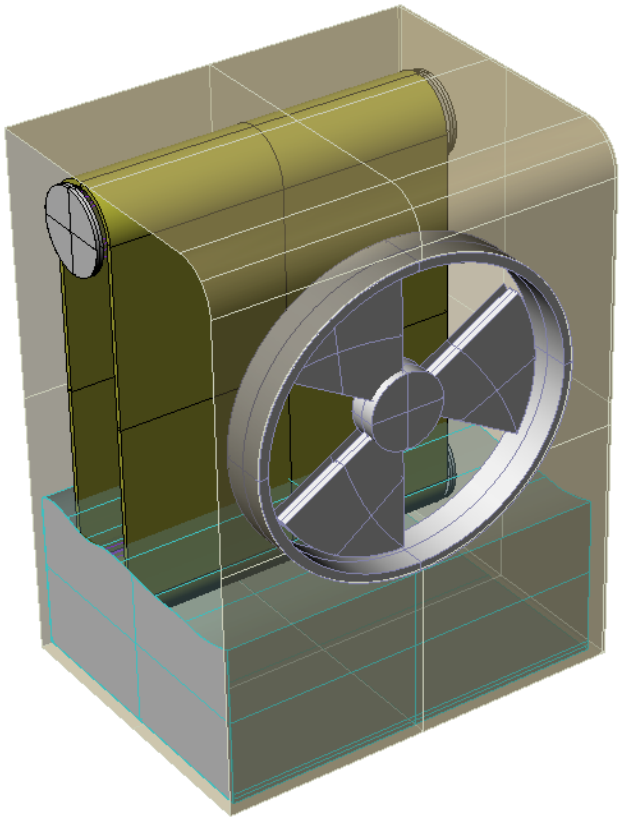
3.2 Different technologies

Honey comb / grass





Wet cloth without honey comb



3.3 Advantages

Comparison to an Air Conditioner

Evaporative coolers are energy efficient since the blower motor only has to move the air and not compress a refrigerant gas

The blower motor in a residential unit =1/3 to 3/4 horsepower

water pumps = 1/20th horsepower

When compared to 3 and 5 horsepower compressors needed for refrigerated air, plus the fans for cooling and condensing

Evaporative coolers require only about one-tenth as much energy for home cooling

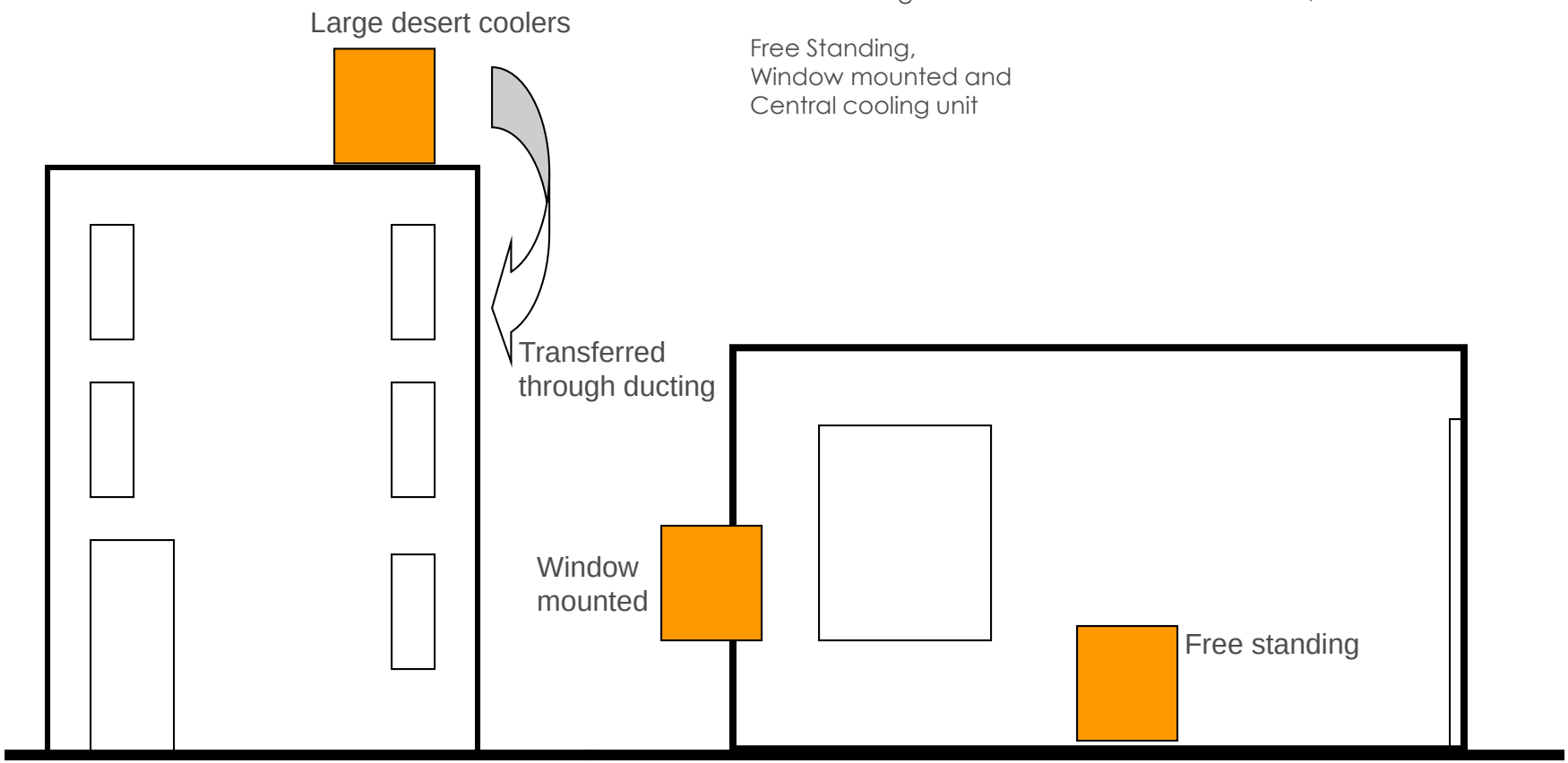
The evaporative cooler can easily be serviced by any home owner Whereas the A/C needs to be serviced by the technician

Replacement parts for evaporative coolers are inexpensive and readily available at most hardware stores

3.4 Different kinds of coolers

Depending on the place or position of use of the unit, an air cooler can be categorized into three different kinds viz ;

Free Standing,
Window mounted and
Central cooling unit



Window Air coolers

Floor standing Air coolers

Types of Air coolers

Window Air coolers

Floor standing Air coolers

The capacity of an evaporative cooler is measured in CFM, or cubic feet per minute. A small unit may be 2,500 CFM, while a whole house unit will be 6,000 CFM or larger. For example, a modest home with three bedrooms, living room and kitchen, may have 850 square feet of floor space with ceilings 7 feet high. The resulting volume is 5,950 cubic feet. A 6,000 CFM cooler would replace 100% of the air in this home each minute

3.5 Components of an air cooler

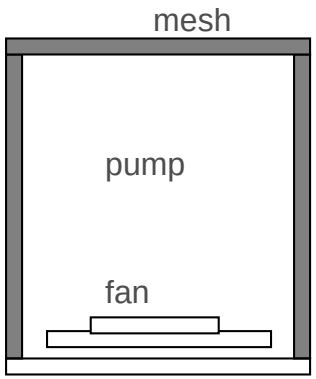
Basic Components

Fan / Blower

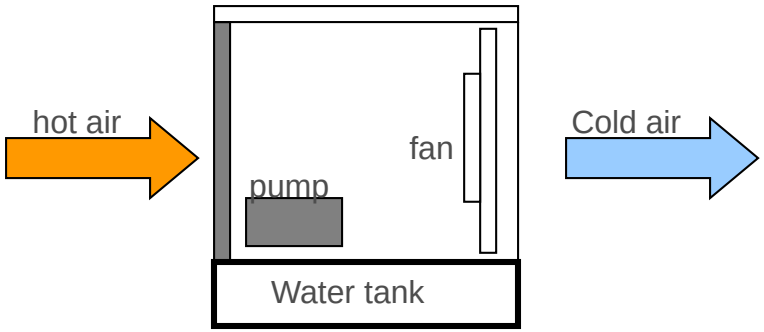
Motor

Pads (grass/honey comb)

Water pump



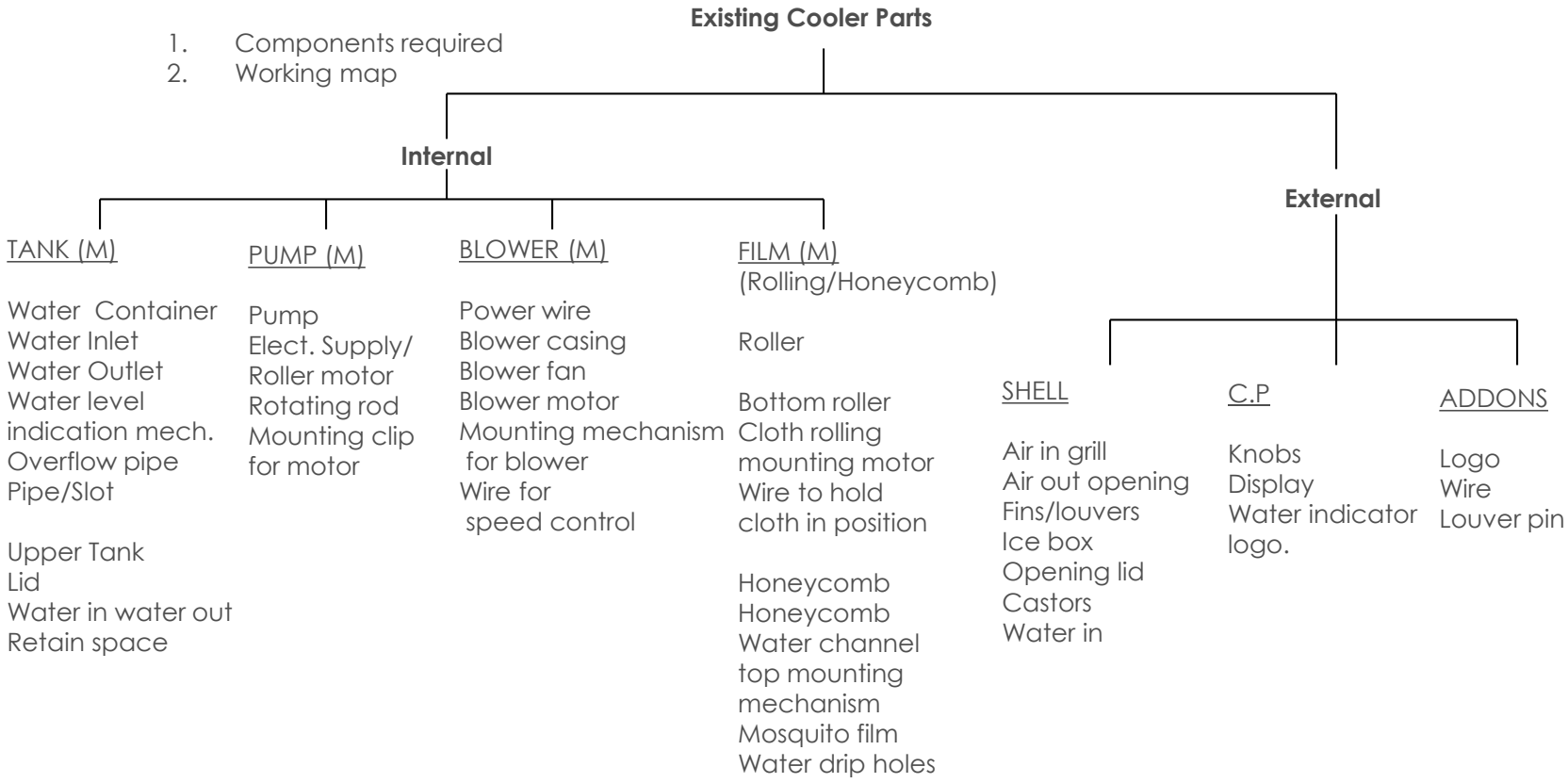
plan



section

Component Chart

1. Components required
2. Working map



Market study

3.6 Available products in the market

3.7 Available products in the international market

3.8 Aim of market study

3.9 Before conducting the study(dealer feedback)

3.6 Available products in the market

The product pictures shown below are mainly categorized into Indian brands and their specifications and Air coolers in the international market. Some of the product information like symphony was collected during the market study. And other information was collected through brochures or internet search.

Jumbo Cool
750 sq.ft
2600 m3/hr
51 litre
trolley optional
L=690
B=650
H=780

Ninja
100sq.ft
650 m3/hr
15litre
trolley optional
L=442
B=435
H=645

Sumo
600 sq.ft
1800 m3/hr
40 litre
trolley optional
L=625
B=543
H=966

Kaizen
350 sq.ft
1300 m3/hr
51 litre
trolley optional
L=690
B=640
H=480

Chotta Sumo
300 sq.ft
1100 m3/hr
40 litre
trolley optional
L=587
B=535
H=655

Hi cool
250sq.ft
710 m3/hr
20litre
trolley
optional
L=500
B=380
H=840

Mini Kaizen
200 sq.ft.
600 m3/hr
25litre
trolley optinal
L=555
B=500
H=420

Turbo cool
9704

500sq.ft

wood wool

40 litres

trollry optional

300w

25kg

L=640

B=540

H=910

Turbo cool junior 9705

25 sq. meters

1770 m3/hr

40 litres

trolley optional

wood wool

22kg

300w

L=640

B=540

H=550

Little cooler plus 9702

80 sq.ft

roatating synthetic pad

3 speed

10.5 litres

125w

10kg

ABS body

L=465

B=335

H=660

Tall cooler-9820

120 sq.ft

1360 m3/hr

castors

honey comb

15 litres

13kg

150w

L=420

B=430

H=970

Coolest 2000
140 watts
15 litres
100sq.ft
800m3/hr
cellulose paper
castors

Coolest DC
285w
40 litres
550 sq.ft
2675 m3/hr
cellulose
stationary

2000 DLX
140w
15 litres
100 sq.ft
800m3/hr
cellulose paper
castors
humidity control + night lamp

Portable
160w
14litres
110sq.ft
800m3/hr
cellulose

Coolest DB 2000
325w
50litres
350 sq.ft
2200m3/hr
ABS body
wood wool

Available products in the International market

Available products in the International market

Aim of market study

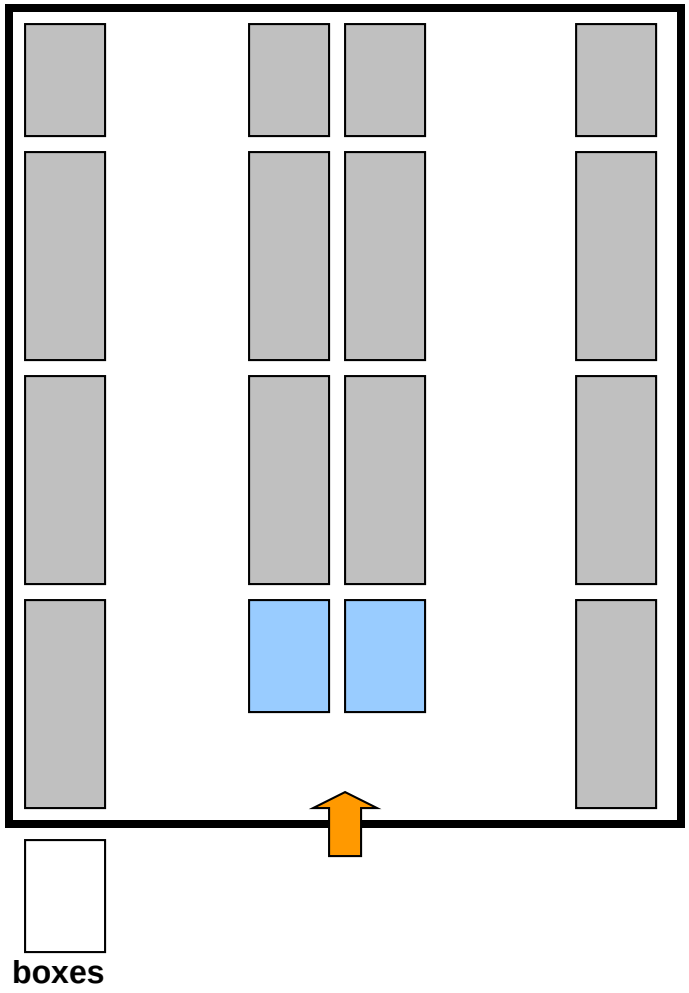
Knowing the marketing departments perspective
Understanding the local market and consumer demands

Reason for launching the product
Criteria for selecting the segment
Demand
Availability of the product
Percentage of sale
Reliability
Reason for the consumer to select the range
Awareness about the product
Top listed products
Manufacturers in the same category

Dealers

What looks sell more
What do the customers ask for
What features do they ask for
Different companies in the same category
Hardware performance
Colour, styling and utility
Sale of the air coolers

Display in Showrooms



Feedback market study

Important criteria is to maintain the price of the product

To give a higher capacity than available but less than heavy duty unit

Refreshed look

Sale : Symphony 6000 units- mumbai, Kenstar 13000 units

Availability: the whole range not available

Users criteria: less aware about styling but look for colour, space and capacity

Local market is the biggest competition since cheaper

4. User Study

4.1 Questionnaire
4.2 User survey
4.3 Inferences and insights
4.4 Problem identification
4.5 Proposal

4.1 Questionnaire

The user study was mainly conducted in hot and dry area like Pune. Another criteria was that they were mainly units used in a residential scenario. The study was also conducted during the beginning of summer season when the subjects had already started using the air coolers or were trying to clear the dust off the units. This also gave an insight that the units were not used throughout the year but during a period when the summers started and during the summer season up till the arrival of rains. The use of the units varies from 2 months to 5 months in dry areas and very dry areas respectively.

Some of the questions asked were;

Which member of the house bought the unit.

How old was the unit.

Duration of use in a year. (no. of months)

What happens when not in use.

Who all can operate the unit.

Actually making the user perform the task.

Information about use and Control panel use.

Operational problems with the unit.

Places in the house where it is used.

Number of water fills during the operation.

Music room corner

Mosquito net

4.2 Activity analysis

USER NO.1 (higher middle class)

Mrs. Ajgaonkar

Location: Pune

Model: Kenstar Little Cooler Plus 6-7 yrs old

Purchased by herself because needed a portable cooler

Duration of use: April to May

Stored in music room when not in use

The maid is asked to operate it under the mistresses supervision

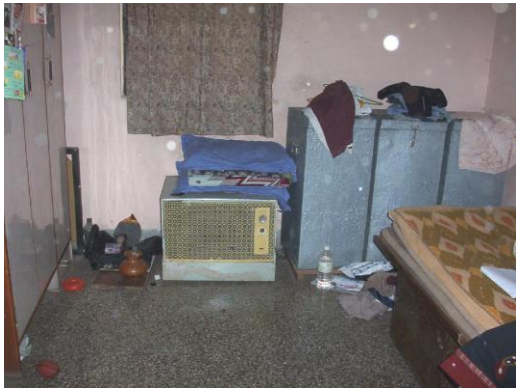
Top opening for water inlet and also as ice box

Water poured with a vessel

Ice cubes being put into the ice box

Drain cock is to be removed from inside the tank

Rear panel seperated



Place of storage when not in use

Very small opening to pour in water

Kept on a teapoy for portability

USER NO.2 (middle class)

Mr. Pushkar Kale

Location: Pune

Model: Unknown, 25-30 yrs old

Gifted to the family

Duration of use: March end to July end

Preferred over a ceiling fan

Everybody operates

Actually a window unit

Extension board required for portability

Leakage due to metal body

Steel body rusts badly due to water

Mounting for the blower

Side and rear panels covered with dry grass

Stored above the cupboard when not in use

Unit when mounted on the trolley

USER NO.3 (higher middle class)

Mrs. Joshi

Location: Pune

Model: Crompton Greaves

She needed a compact cooler

Duration of use: April to June

Portability was important

No space for ice box

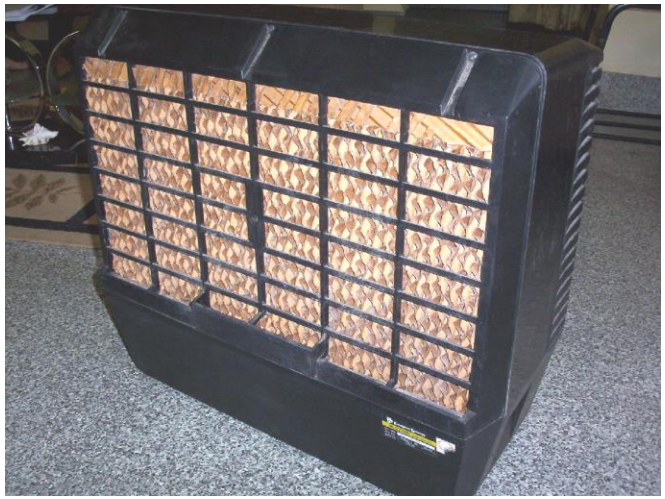
Spillage due to movement

No spanning of airflow

Difficult dismounting from the trolley

Trolley does not relate to the body

Use of a blower instead of fan



Honey comb at the rear face

Control panel

Window unit used
as a portable unit

USER NO.4 (higher middle class)

Mrs. Devle

Location: Pune

Model: Videocon 6-7 yrs old

Portability was important

Due to hot ceiling in summers, have to

Use it throughout the house

Operated by the male member of the house

Window unit used as a portable unit

The front grill

Window unit
therefore openings
on all three sides

USER NO.5 (middle class)

Mr. Kini

Location: Mumbai

Model: Usha Lexus 2yr old

Use mainly in month of may

2-3 vessel fill ups

Remains ON all night

Used as a fan and an Air cooler also

Operated only by Mr. Kini

Water filled up by
a small vessel

Portable

Kept in puja ghar
when not in use

Cleaning required
every year

Fixing of the rear
panel-no tool
required

Used in bedroom
and living room

Wire is left open

4.3 Inferences and insights

Inferences

- The tower unit is the most desired due to less occupancy of space.
- But a lack of intermediate segment I.e. between 20-30 liter capacity and 40 liters capacity
- The cooler if incorporated with more features for an year round use.
- Window units are used as portable units.
- Multiple use like both window mounted and free standing.
- Portability very important but simultaneously avoiding water spillage.
- Establishing product semantics through external form.
- Water capacity w.r.t blower output to last for longer periods
- Control knobs to be able to be operated in dark also.

Insights from the actual users

- Operated only by elders in the house
- Cleaning done by the maid under housewives supervision or the owner himself/herself.
- Stored always on the floor because of the volume, but if small as seen is also kept on top of a cupboard.
- Mosquito jali conceived as to cleaned to get fresh air.
- Water to be filled with a pipe, but vessels used.
- Faster the speed is considered wrongly as more humidity.
- Steel body rusts with water and humidity.
- Tank always remains filled with settlements.should also be window mounted to capture cold air in the night.

Insights from activity analysis

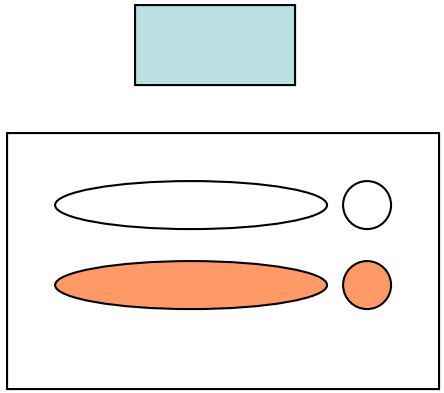
- Ice box is also water inlet, but water is filled in through rear only.
- The unit is taken to the bathroom to fill it up to avoid water spillage in the house.
- Lot of objects are kept on top when the unit is not in use.
- The water inlet does not suggest the intake.
- Shifting the unit every time for direct airflow.
- Height of the unit too low to move around.
- Tools are used to open the rear panel for cleaning.
- No feedback as to how much the temperature is reduced.
- Feedback as to water is over, also required.
- Control panel visibility in the night required.

Space

- When not in use should be able to be used as something else.
- Or small enough to be able to be stored under the bed.
- Small footprint to save space in already small flats.

4.4 Problem identification

Problems with existing designs (user complaints)



Better looks

No alarm for water level

Height of air flow

Difficult to move when filled

Castor gets broken

Knobs broken

Water spillage due to use of grass

Storage

Air spread

Filling water tedious and spillage

Wire reach

Water drain problem

Shake and check water level

4.5 Proposal

A tower air cooler for residential use for mainly hot - dry climate

Minimum occupancy of floor space and also stable

Larger area of air throw using a vertical blower

A year round use of the product

Water capacity about 20 – 30 liters

Air output to cover an area of approximately 250sq.ft area

Design of control knobs incorporating humidity control

Portability with the help of larger castors

Usability considerations like sequence of use

Ice box firmly fixed and in an ideal position

Larger intake for water or separable water tank to avoid spillage

Product to fit in harmony with the surroundings

Producing an identity for the product (showrooms)

Ease of assembly and disassembly of parts ….snap fit

Thermostat control in the cooler

Warning thro sound for running out of water

Changeable skin to give customized options to suite the context

Parts to be easily able to clean and replaced

Design of packaging for the product

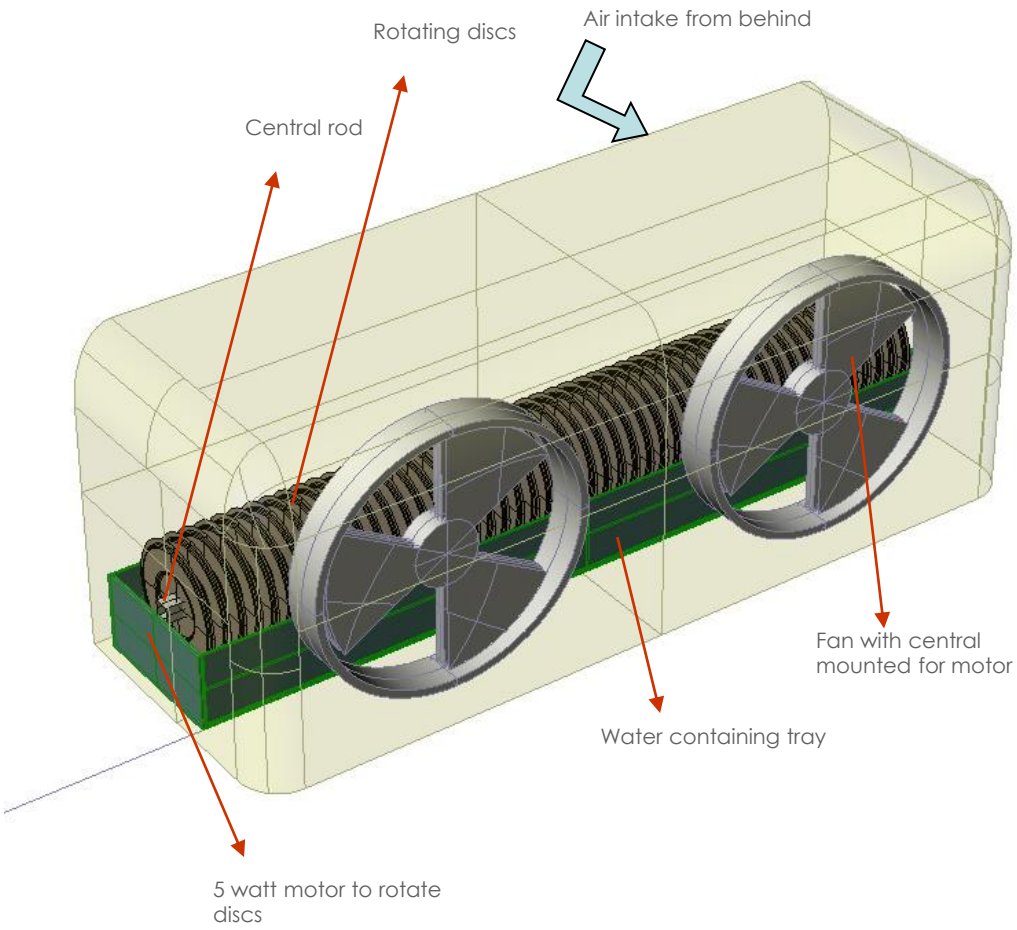
5. New Technology

5.1 Working (of Novel Contacting Device)

5.2 Components

5.3 Advantages

5.1 Working (of Novel Contacting Device)

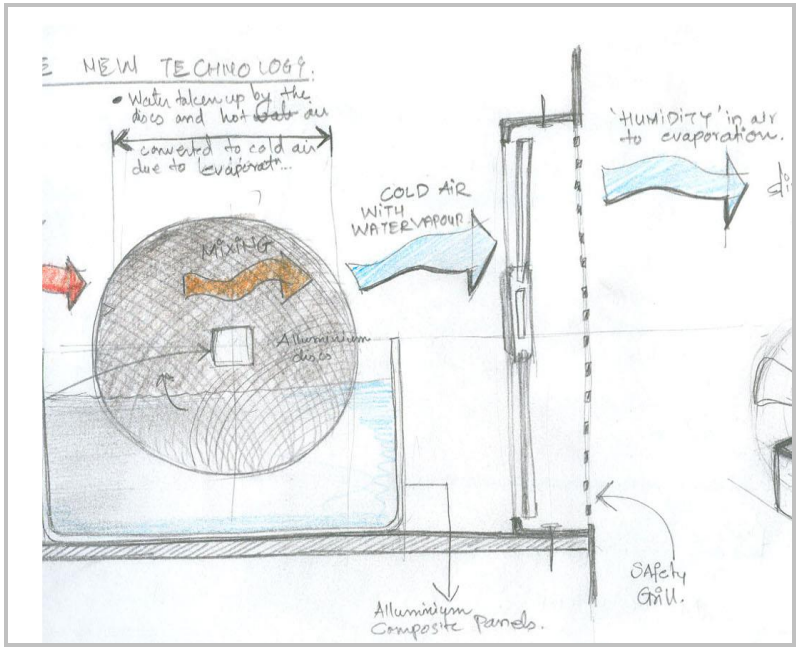


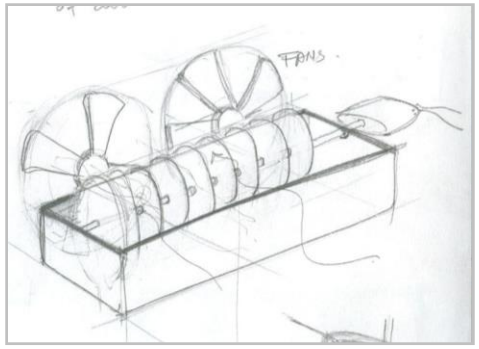
The new technology called 'Novel Contacting Device' is the technology working on the same principle of evaporative cooling is being attempted to be used into an air cooler. This technology gives new parameters and a new definition to the product.

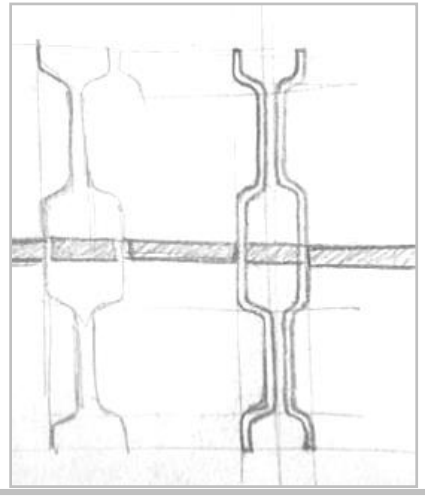
This technology is patented by Prof: Dr. Milind V. Rane of Mechanical Engineering Department of IIT Bombay. It works on a very simple principle of intersecting airflow with a water body to add moisture into the air. The system also gives the flexibility of using a fan or a blower.

Components

1. Rotating Discs: These are essentially alluminium discs with a diameter of 150mm. These discs are made out of alluminium mesh. The diameter and the material of the discs can be varied as desired.
2. Central rod: This is essentially the member which cuts across the discs to hold them in position. It also acts as the drive shaft for the discs to rotate.
3. Water tray: this is the part into which the discs are half immersed into the water. The water tray dimensions may change as the capacity or the output of the cooler changes.
4. 5W motor: This is the motor which rotates the rod which in turn rotates the discs half immersed in water.
5. Fan/Blower: This is a ready unit fit into the mechanism. Depending on the capacity of the cooler respective devices can be used .







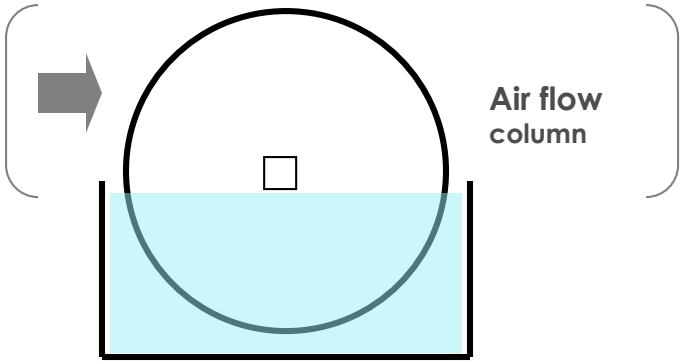
Working

The alluminium discs are placed beside each other. A number of such discs are inserted into the shaft. The number of discs would depend on the velocity of air desired. The discs are punched in such a way that they themselves form the spacers and also lock each other into position.

This whole assembly is immersed in a tray filled with water. The discs are left half immersed in the water. The shaft(rod) then id attached to a motor which would rotate the ehole mechanism when half immersed in water.

A fan or a blower is place in front of this whole unit, which would pull air and hence air will pass through the gaps. (as shown in the left picture)

The fan and the shaft motor are started simultaneously. The discs start rotating when half immersed in water at 4-5 rpm. In the processes they get wet. When the fan/blower starts pulling up the air, the air is forced to pass through the discs since very less clearance of around 2-5mm is to be left on the top and also the sides of the discs. The air passing through forms air columns. So there is no straight blocking of the air current generated by the fan. But at the same time the dry air gets moisturised. Because of this the pressure drop inside the unit is very less and the fan/blower works to almost its full effeciency.



Calculations

Area of the room up to 250 sq.ft or 25 sq.m

CFM recommended 1250 cu.ft (half volume of room)

Velocity of air = 2 m/s (passing thro the discs)

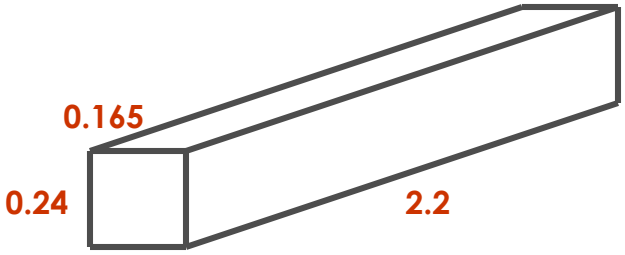
Air delivery = 0.167 sq.m

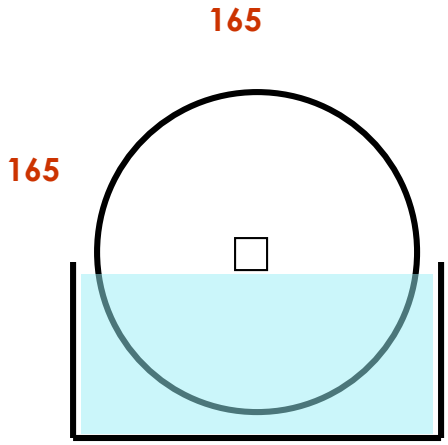
Length of unit = 2.2m

Volume = 0.09cu.m

Comparing to similar unit,volume = 0.16 cu.m

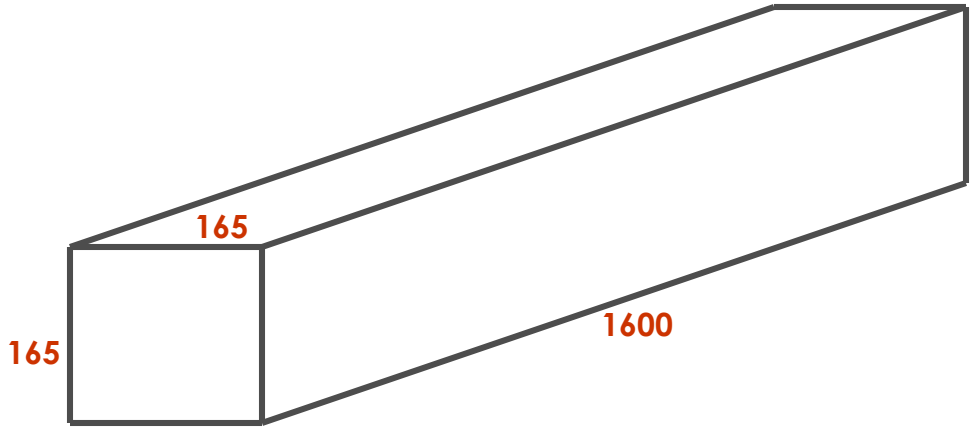
So, old volume = 1.7 times new volume



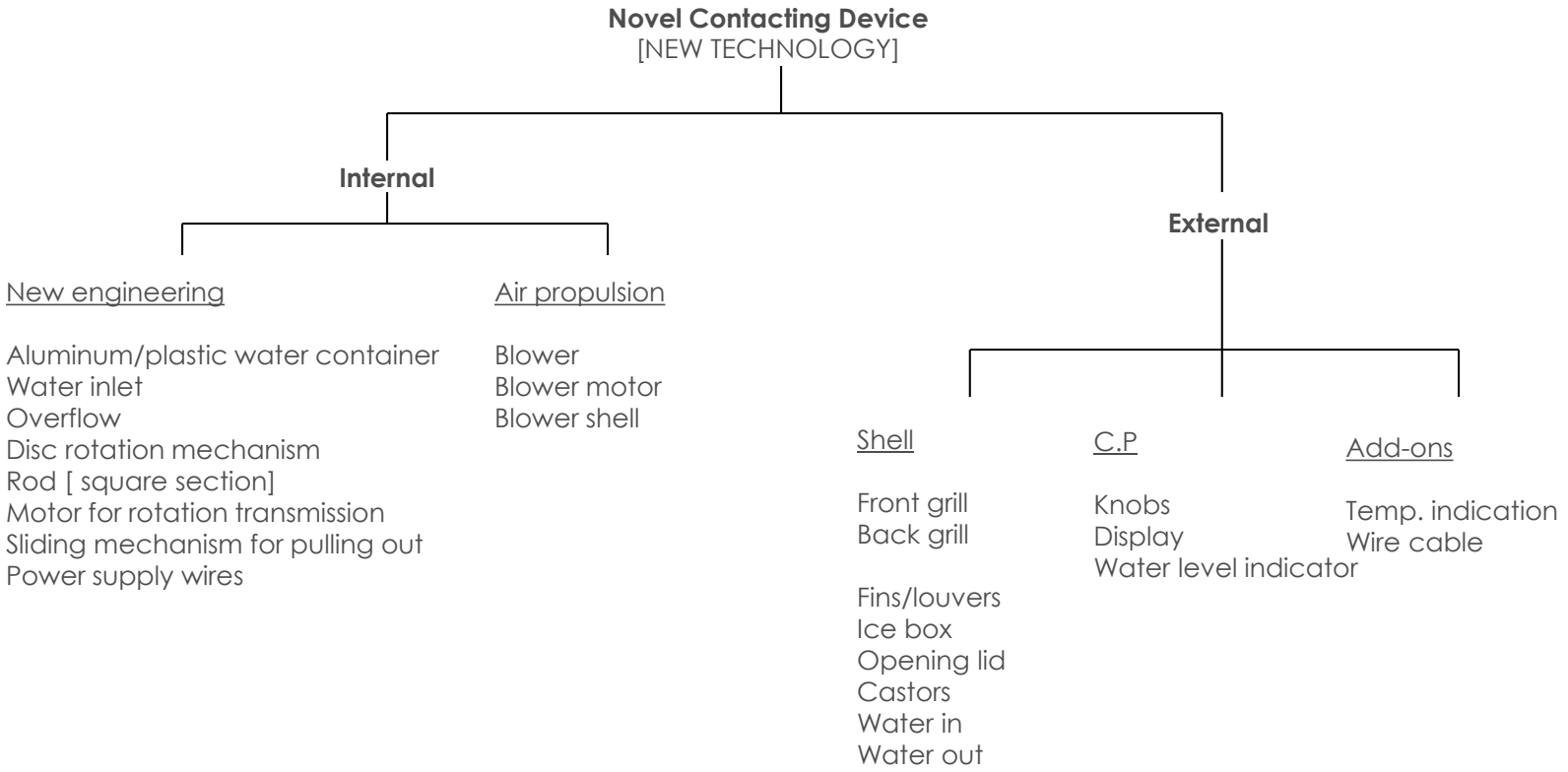


Velocity of air = 2.4 m/s (passing thro the discs)

Length of unit = 1.6m



5.2 Components



5.3 Advantages

Elimination of use of panels with honey comb or dry grass on the screens to retain water

The surface area is occupied by the discs and therefore very less volume components are required

Formation of air path columnar shape facilitates the Airflow

Flexibility for use of number blower and/or fans

Flexibility to form various combinations according to the space requirement

The air intake does not state the exterior of the unit. smaller air intake can be used with more number of discs or larger diameter

Very less pressure drop 0.5mm water column

Disc rotation motor takes only 5 Watt power

6. Design

6.1 Initial product brief

6.2 Explorations

6.3 Ergonomic considerations

6.4 Final design brief

6.5 Concepts

Based on Technology Evaluation

6.7 Design concepts

6.1 Initial product brief

A air cooler unit for Residential use for mainly hot - dry climate

Minimum occupancy of floor space and also stable

Water capacity about 20 – 30 liters

Air output to cover an area of approximately 250sq.ft area

Portability

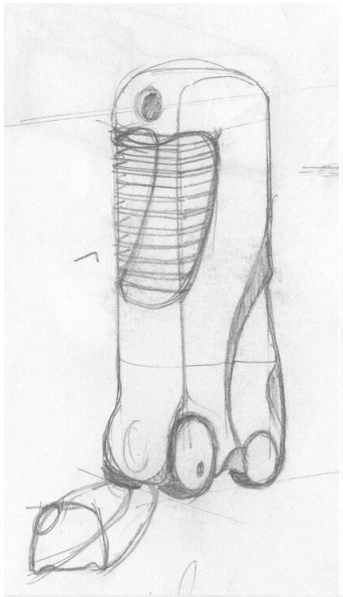
Water tank

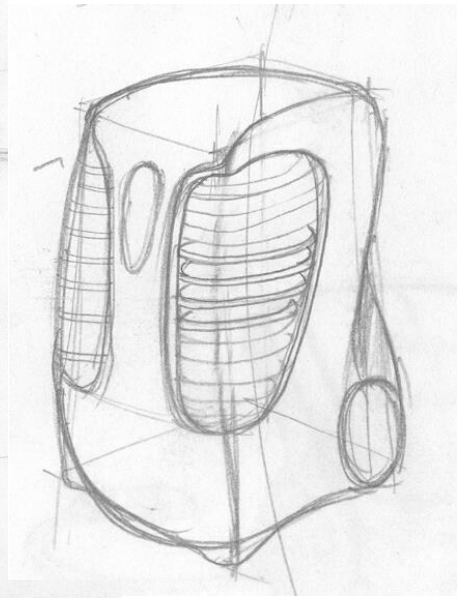
Ease of assembly and disassembly of parts …. snap fit

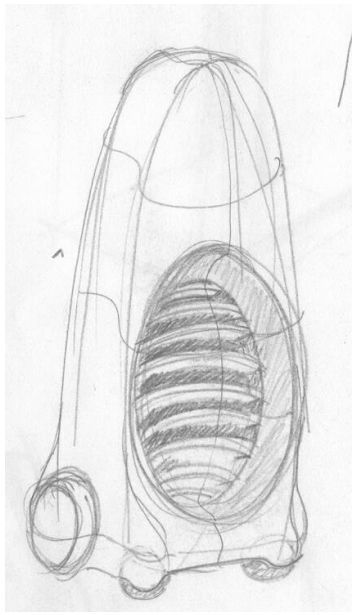
Parts to be easily able to clean and replaced

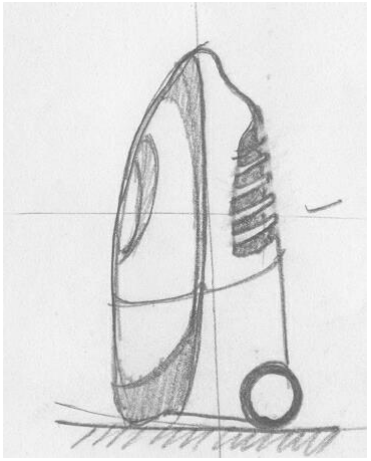
Design of packaging for the product

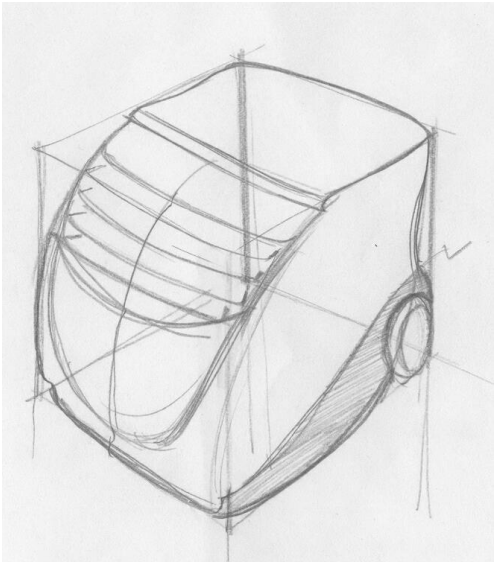
6.2 Explorations

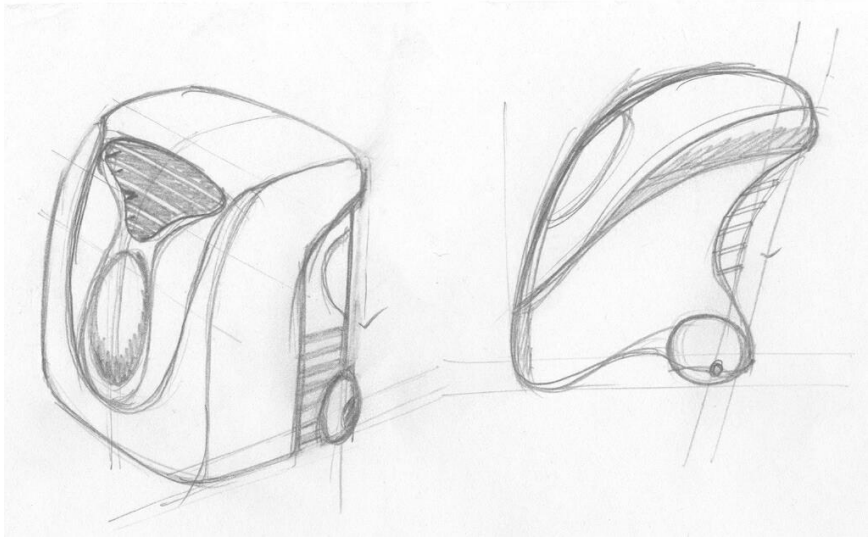


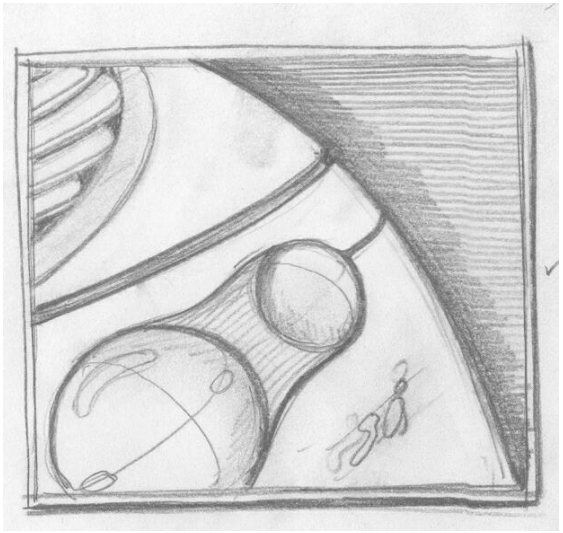


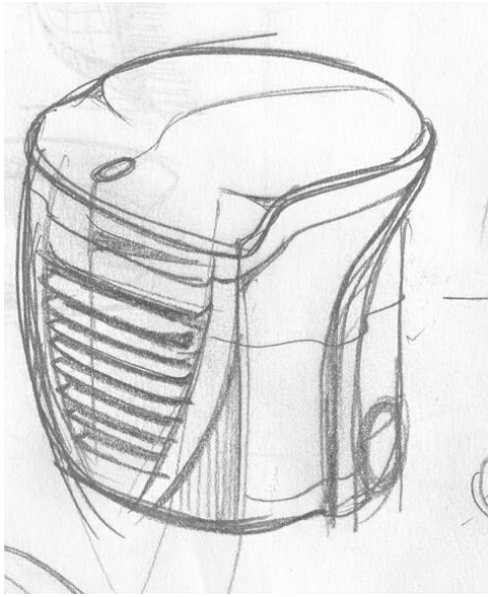


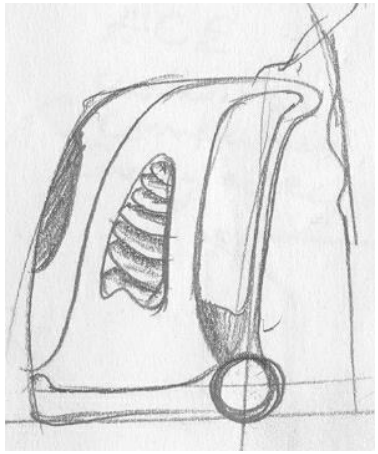


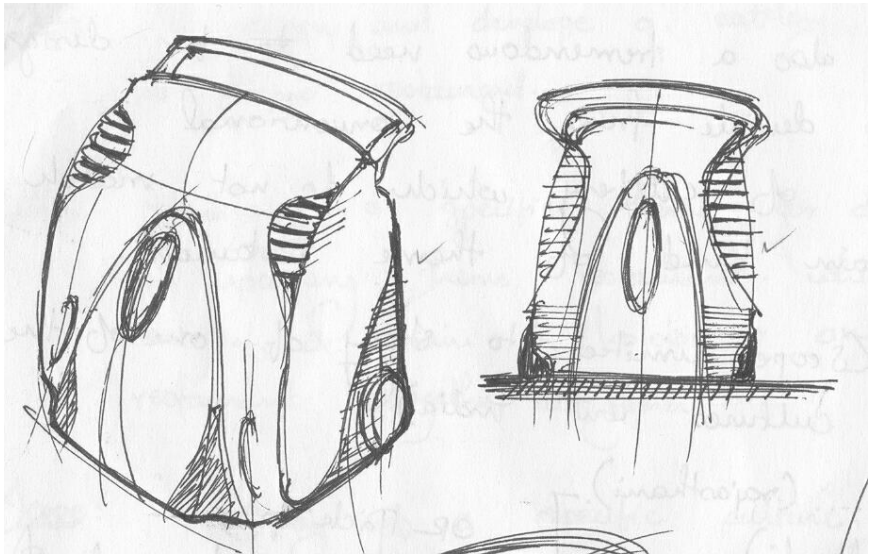




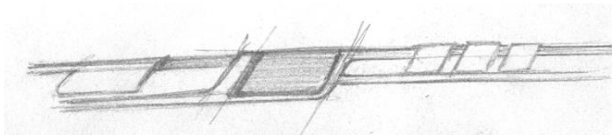


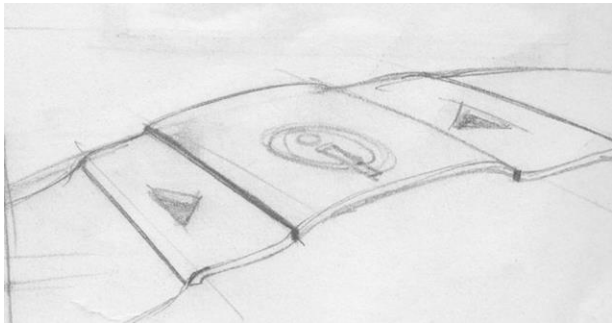


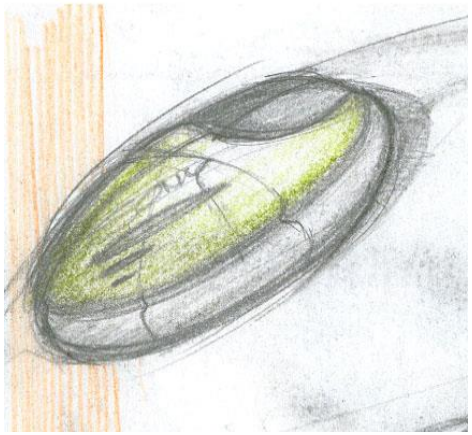


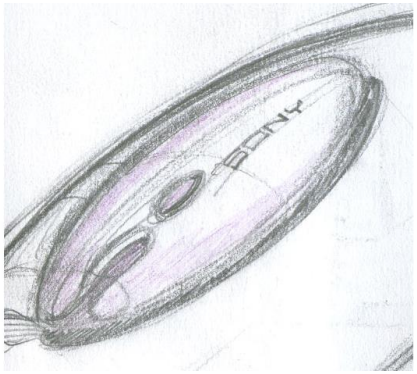


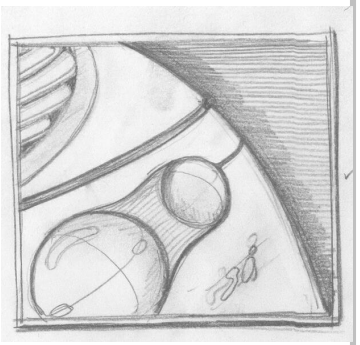
Explorations for Control Panel

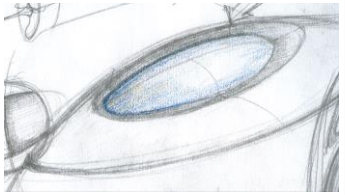


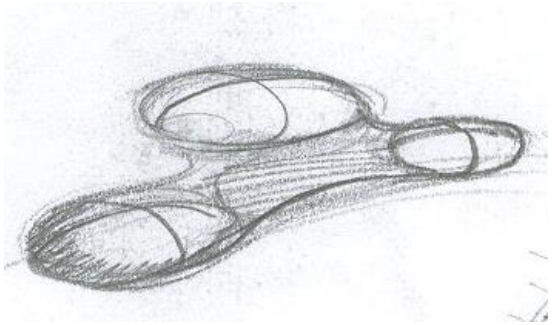


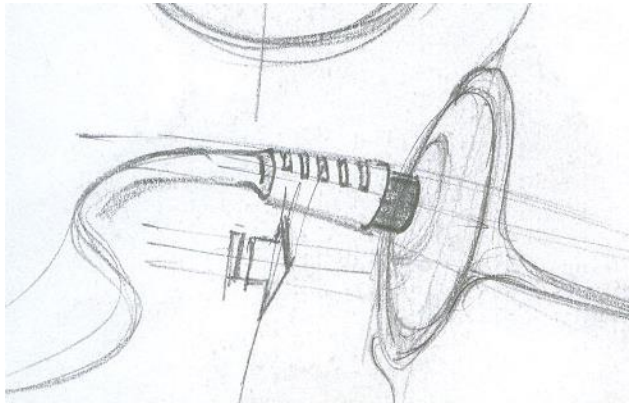


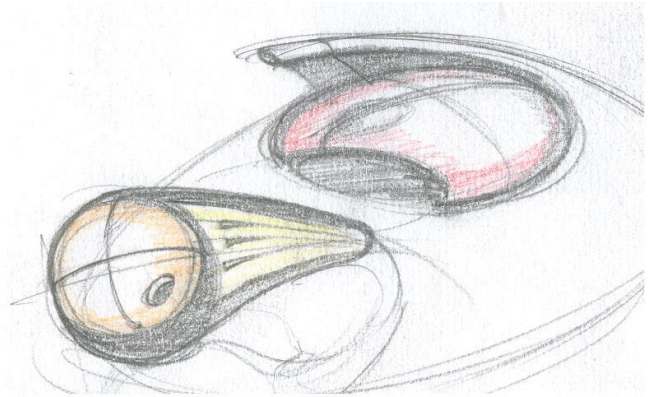


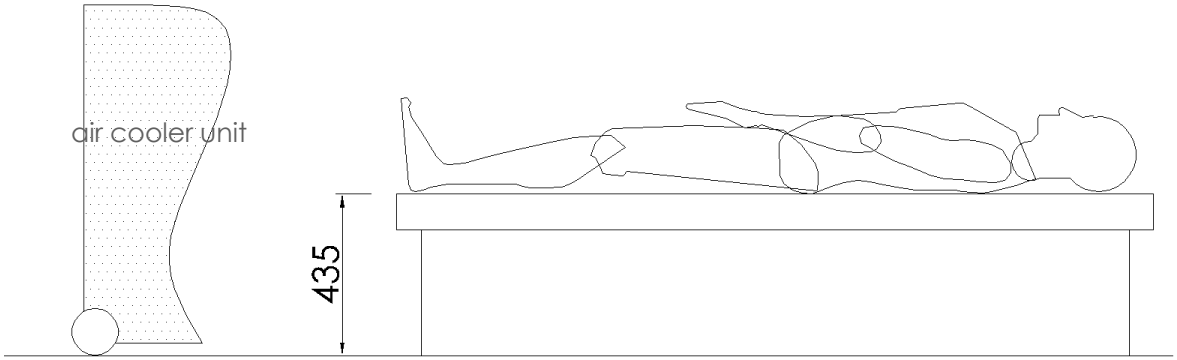










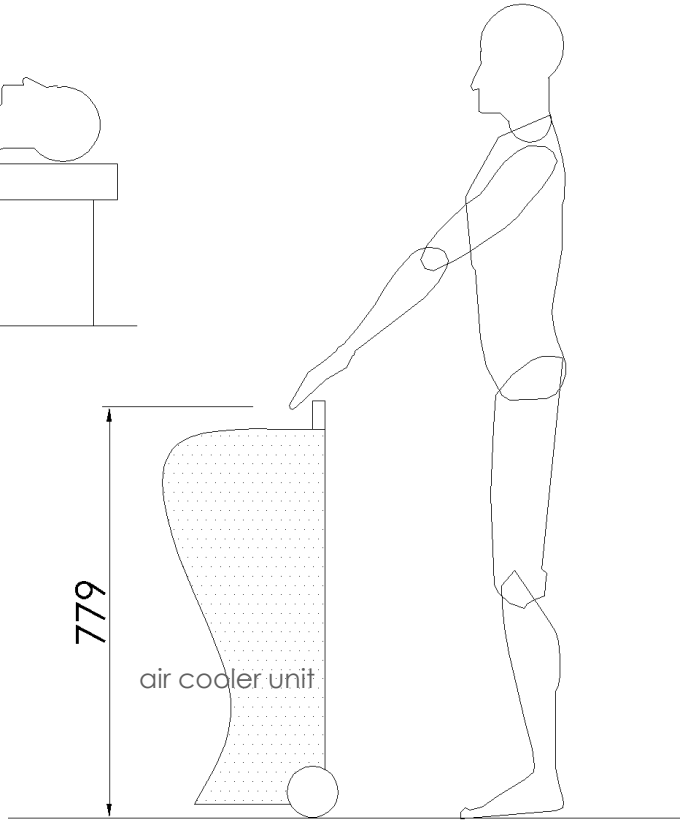


For Ergonomic Considerations,

The 50th percentile of combined dimension of the forward comfortable grasp reach while standing erect has been considered because when the unit is mounted on the trolley, the comfortable height for the grip is taken.

Also while sleeping on a bed, the unit has to be high enough to throw air across the width of the bed. The standard bed(polpiteal) height is 399mm for a 50th percentile of female population. Adding another 35mm as mattress thickness, an overall height of 435mm is taken. So the grill of the unit has to be on a higher position.

Also the width of the unit is not more than the width of the smallest air-conditioner due to possibility of window mounting.



6.4 Final design brief

Re-defining Product Brief

A air cooler unit for Residential use for mainly hot - dry climate

Minimum occupancy of floor space and also stable

Larger area of air throw using a blower

Water capacity about 20 – 30 liters

Air output to cover an area of approximately 250sq.ft area

Design of control knobs incorporating humidity control

Portability

Ice box firmly fixed and in an ideal position

Water tank

Ease of assembly and disassembly of parts

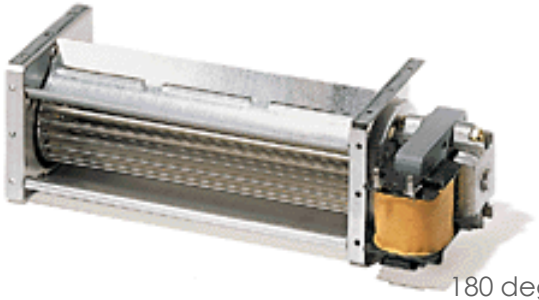
Giving a more important position to the product

Parts to be easily able to clean and replaced

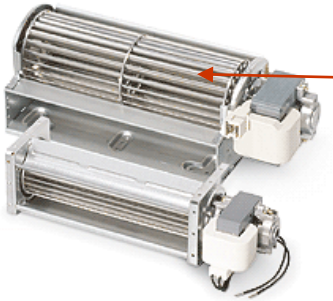
6.5 Concepts

Based on Technology

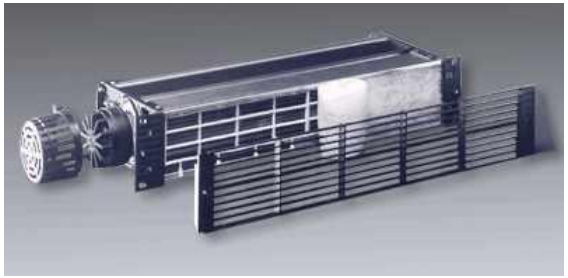
Evaluation



180 degree air flow



impeller



Advantages of using a blower over a fan

Even distribution of air over whole frame width

90 – 180 degree air flow

No warming of the cooling air as motor is placed out

Low air speed at inlet
High air flow provision with low back pressures

High efficiency

Good performance characteristics in relation with overall dimensions

A more compact option compared to the fan

Large variation in sizes and also capacities

More flexibility in adapting to a form …. Fan dictates

Basis for concept development based on technology

The concepts were made considering the clear advantages of the new internal mechanism

In a residential scenario, the situations in which the concepts would fit

Following points considered;

Volume/size

Portability

Multiple uses

Efficiency (air flow)

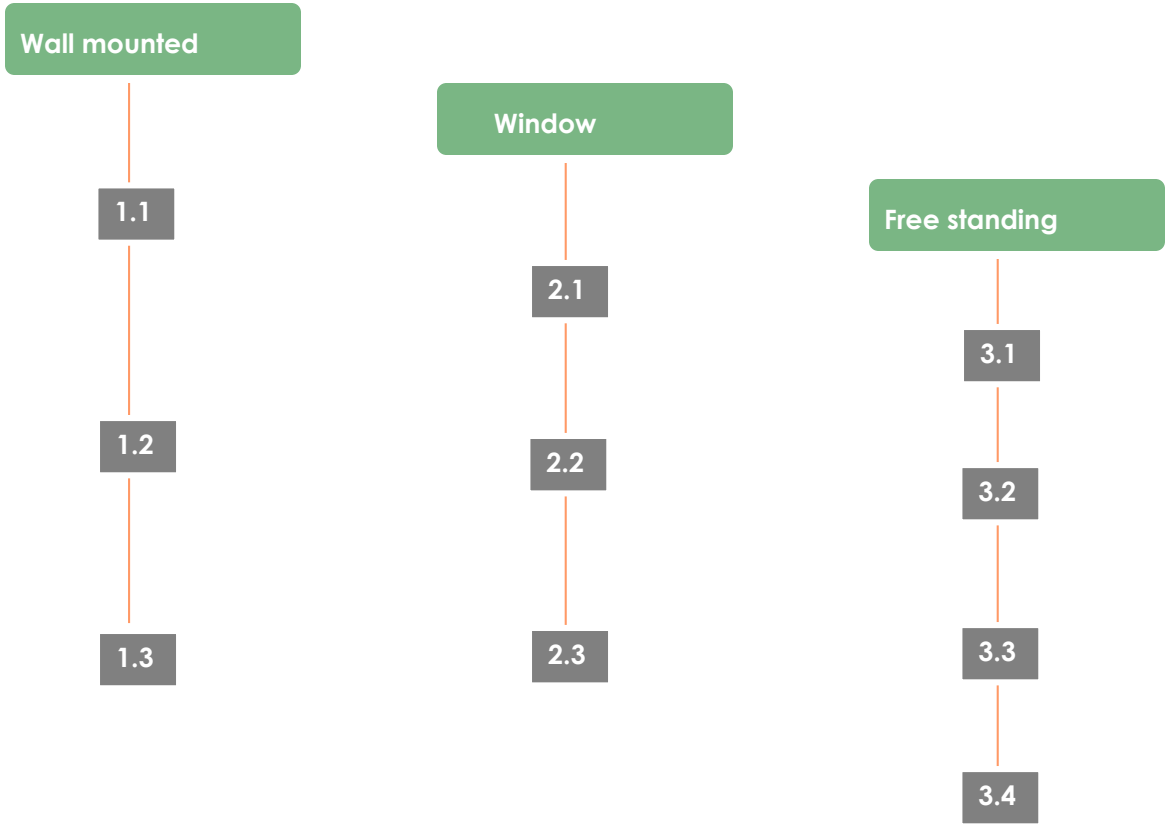
Power consumption

Air delivery

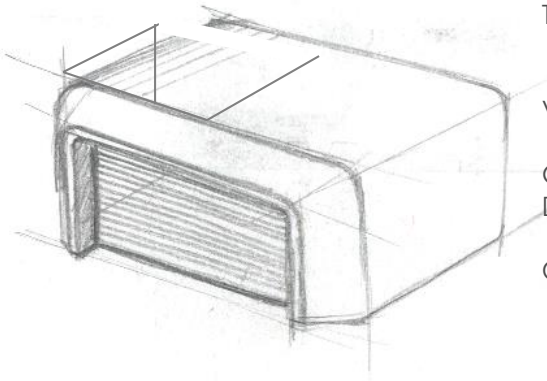
Components

Modularity

Concept Map based on the internal arrangement



Concept 1.1

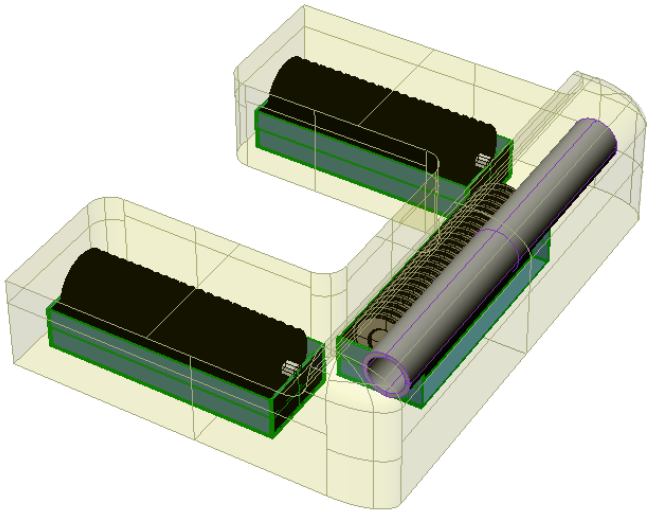


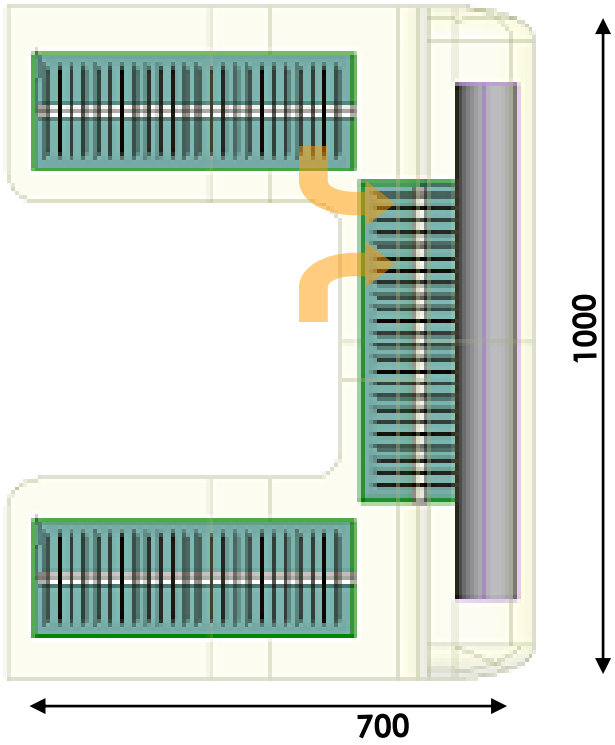
The length of the unit dictates the form

Very less in height

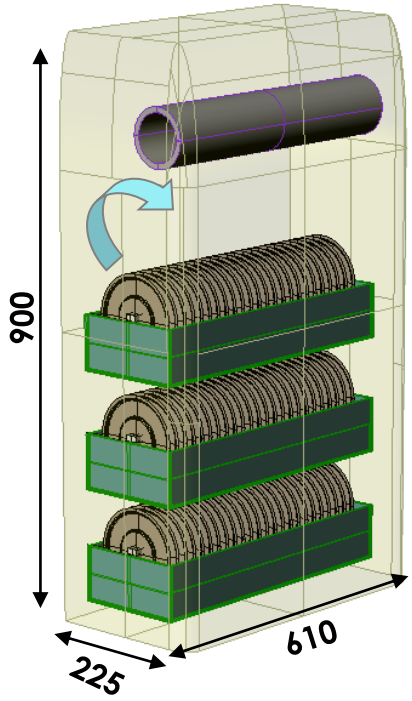
Gives more wide spread air flow Due to length of blower

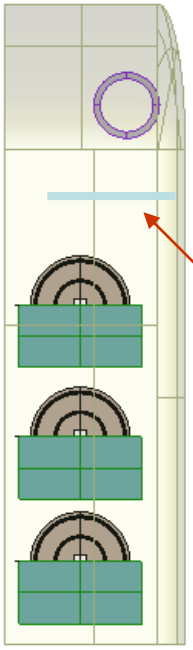
Can have a single water tank

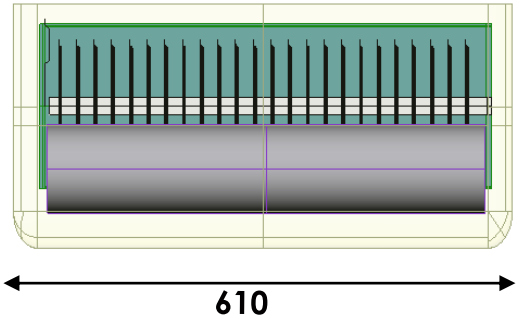




Concept 1.2







Separator wall

A very compact and slim arrangement

Multiple units can be fixed along width

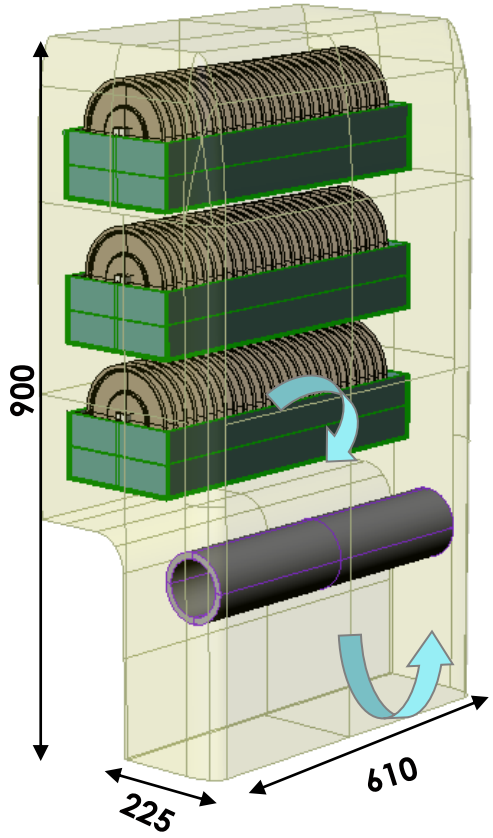
Tall unit for a longer reach of air-throw

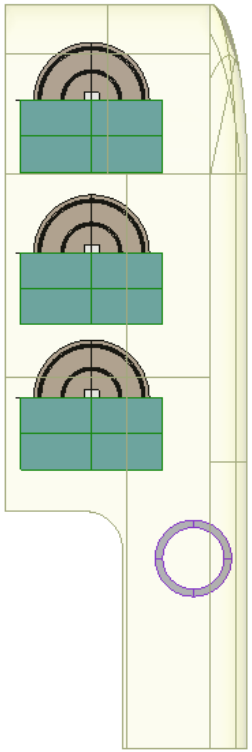
A very compact and slim arrangement

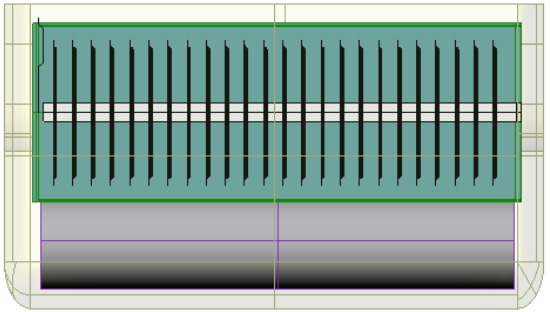
Multiple units can be fixed along width

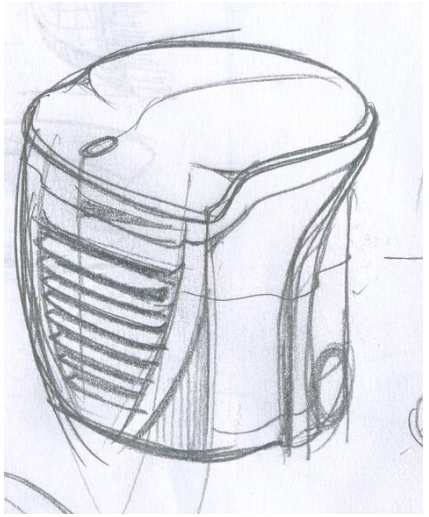
Disadvantage of blower at low level

Concept 1.3

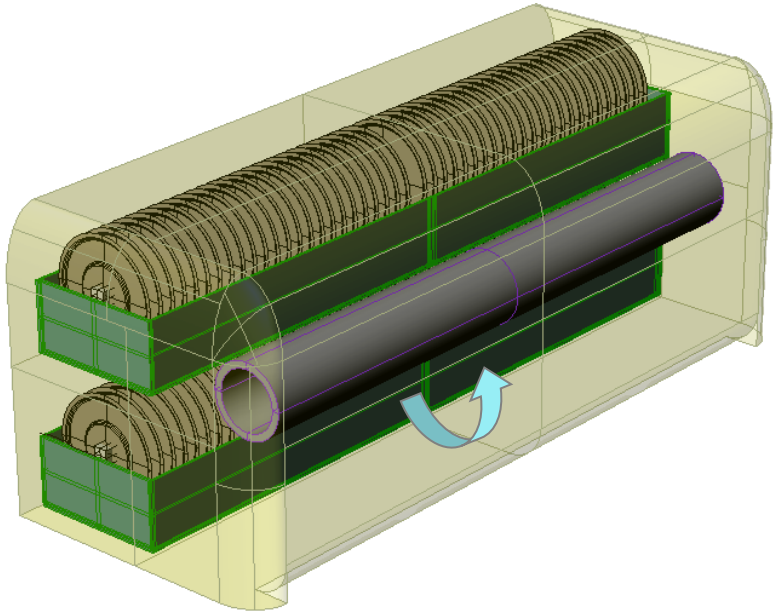


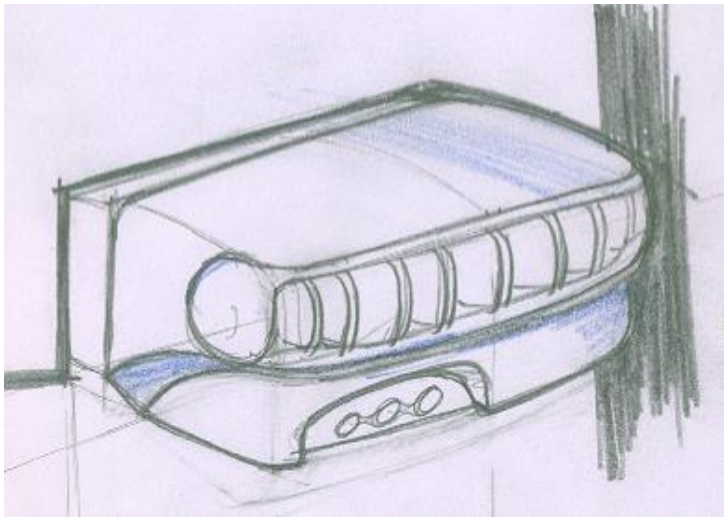


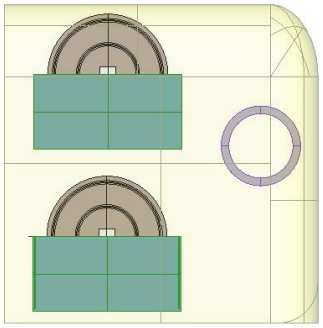


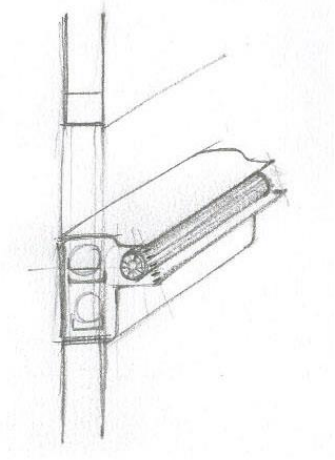


Concept 2.1

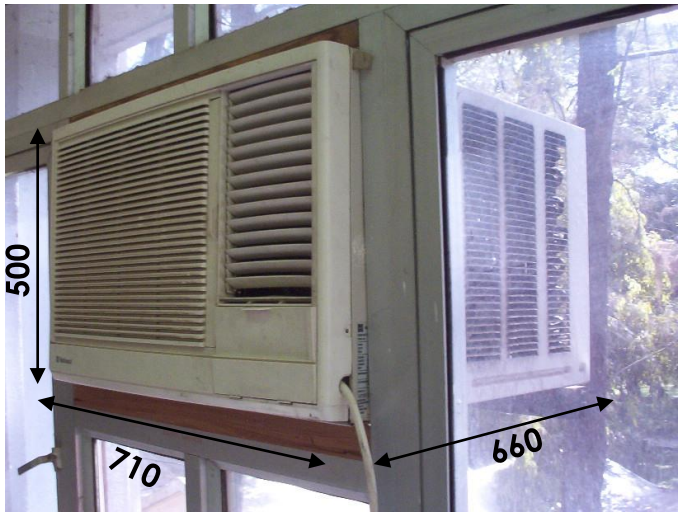








The advantage here being less number of trays, the water retaining time is higher



At this point of time; the concepts were evolved as window units.

So the dimensions of an air conditioner opening for a 710mm or 17inches wide air conditioner opening was considered.

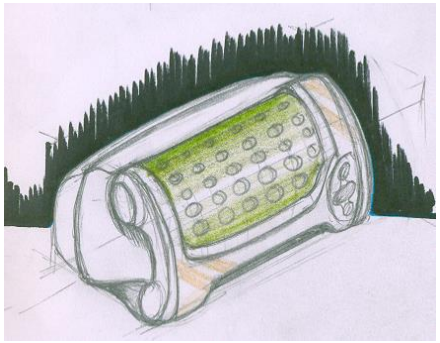
A cooler of the same size would fit inside the opening.

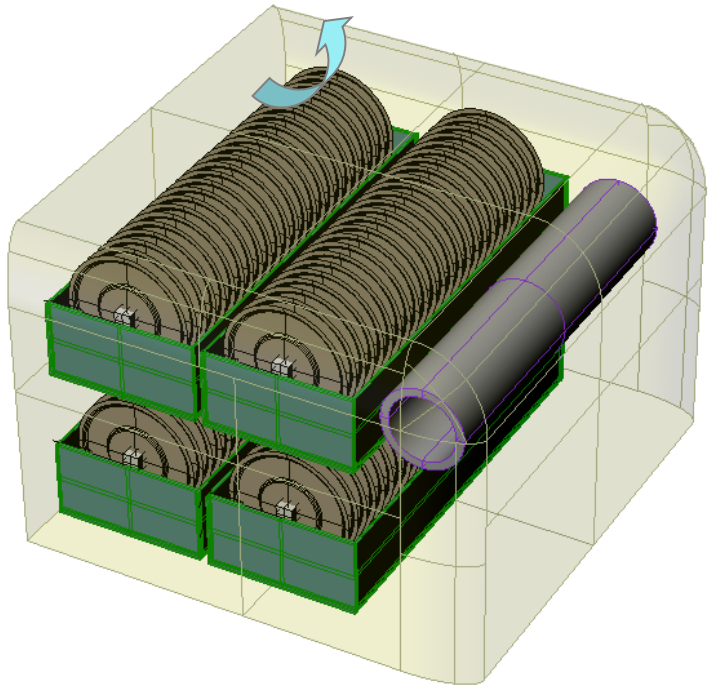
So It also gives an option in not so very dry areas to replace an air-conditioner with an Air cooler of the same dimensions.

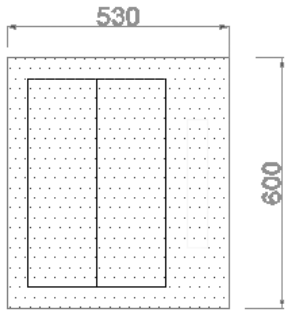
For the concepts hence, the width of the units is taken as equal to 650mm which is equal to the width of the smallest window mounted air conditioner.

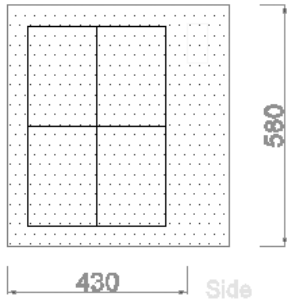
Though the height and the depth of the cooler may vary i.e. become less, the width is kept constant.

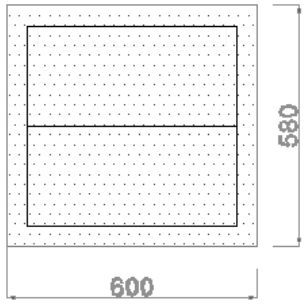
Concept 2.2



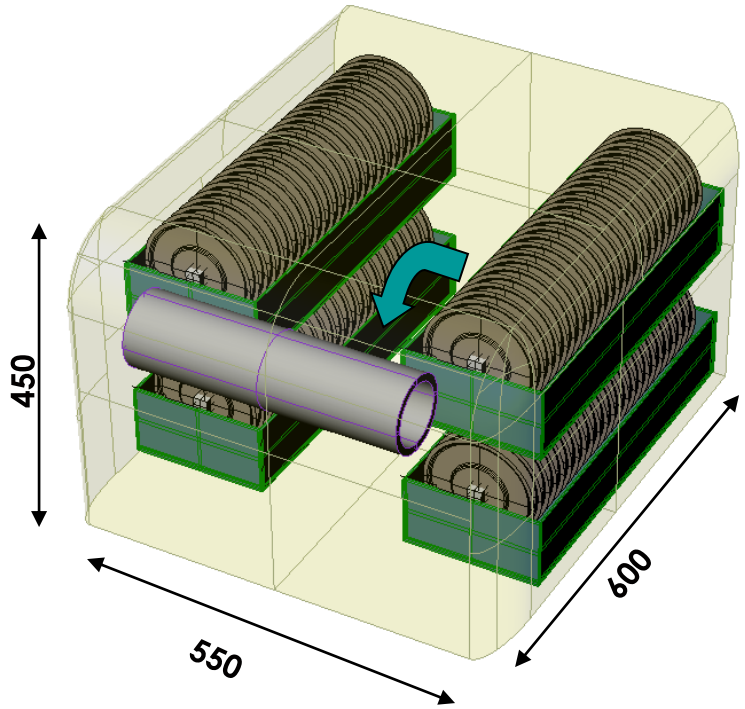


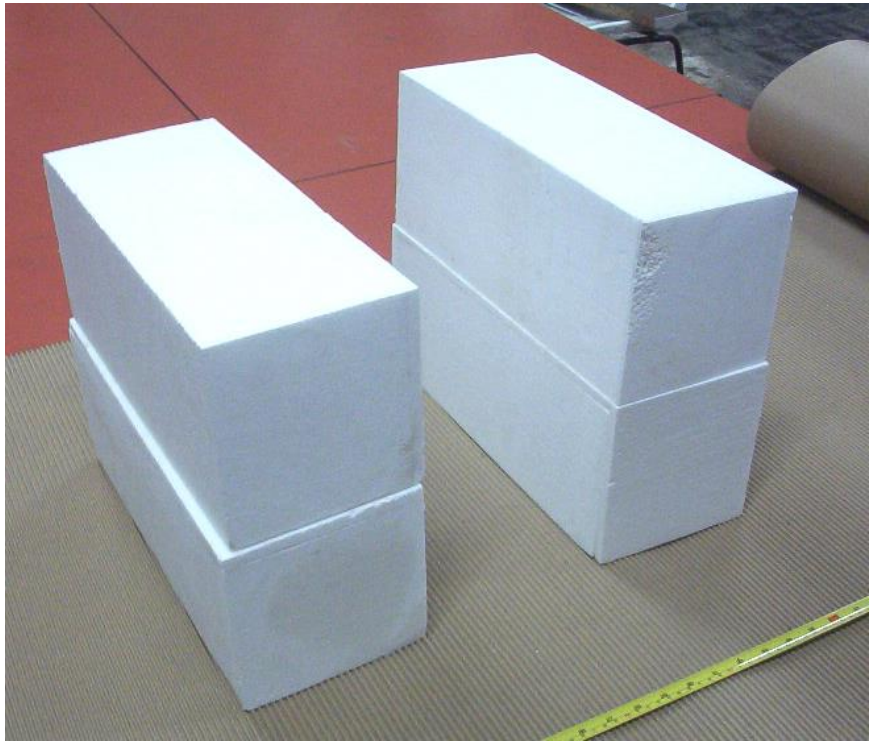






Concept 2.3





Concepts

Concepts based for unit to be compact

Essentially on lines of the existing air coolers of being portable

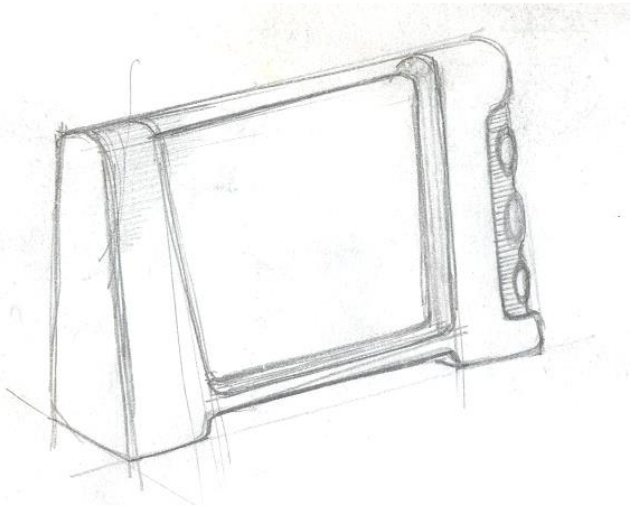
The concepts are developed based on the internal layout possibilities

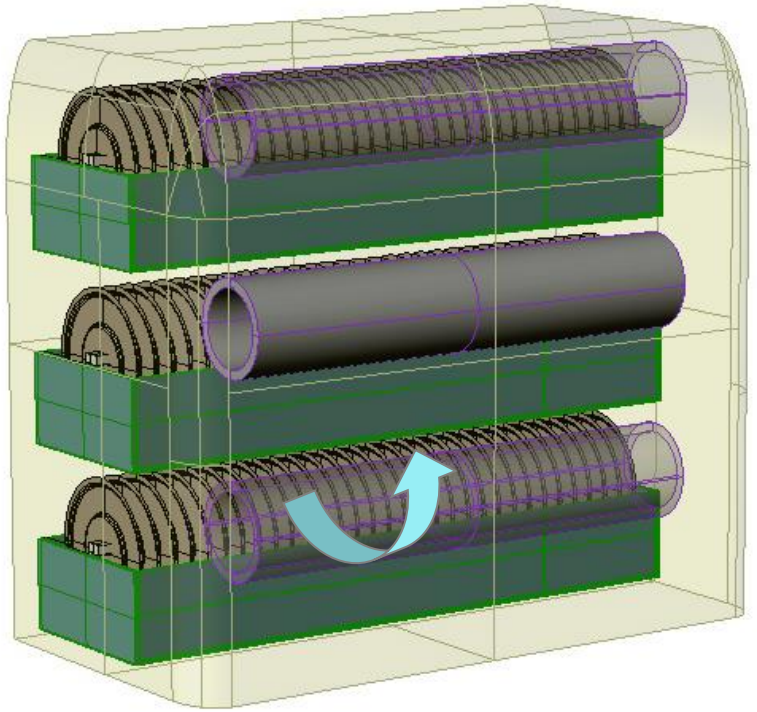
Concepts considering use of both fan and a blower

Attempt to optimize the volume of the unit

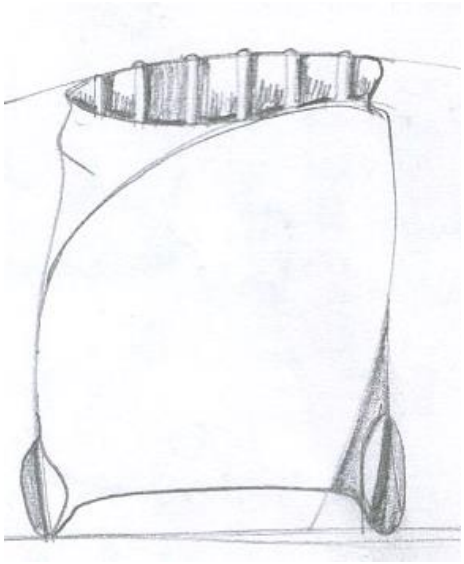
Internal layout considering air efficiency

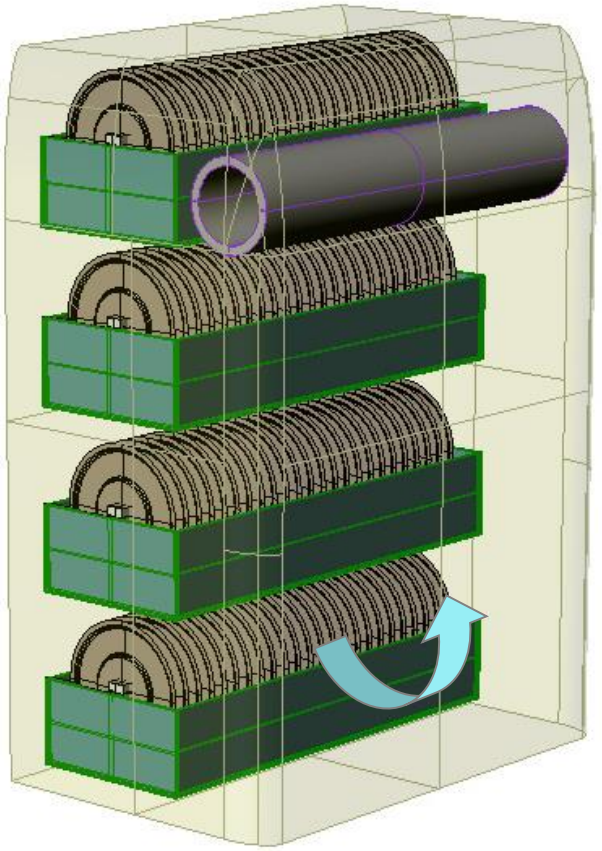
Concept 3.1

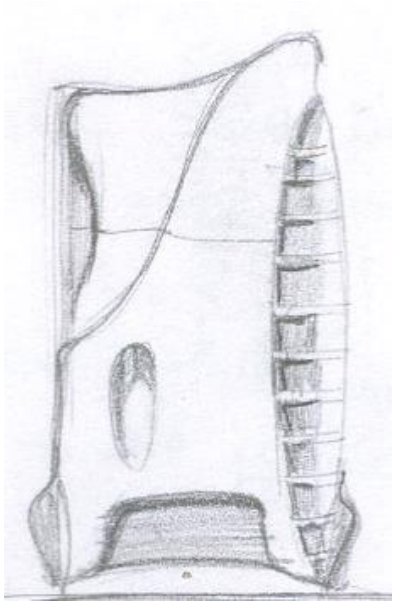




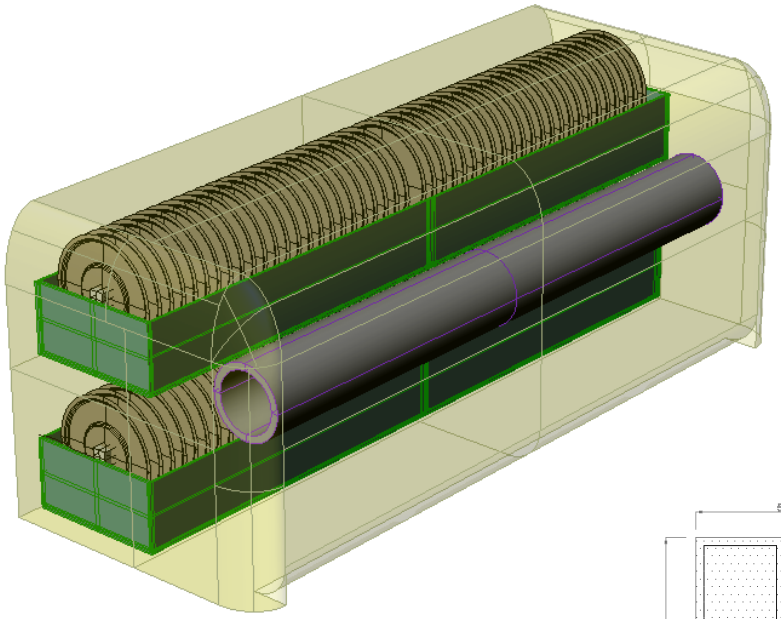
Concept 3.2

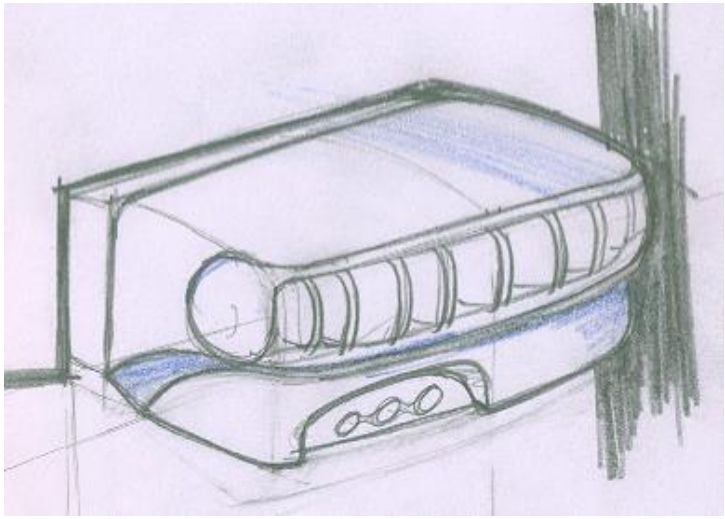




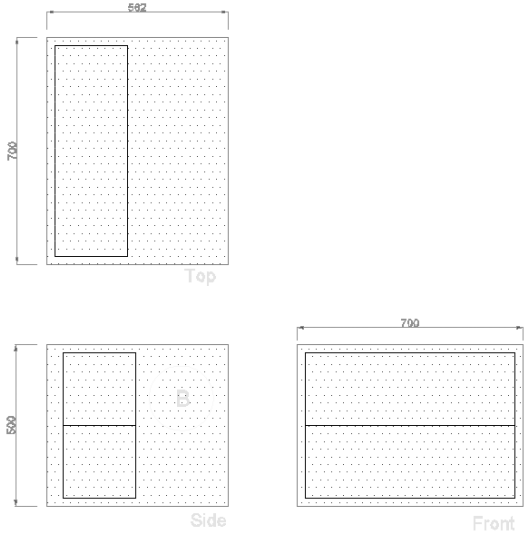


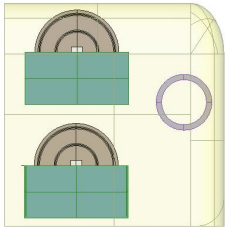
Concept 3.3



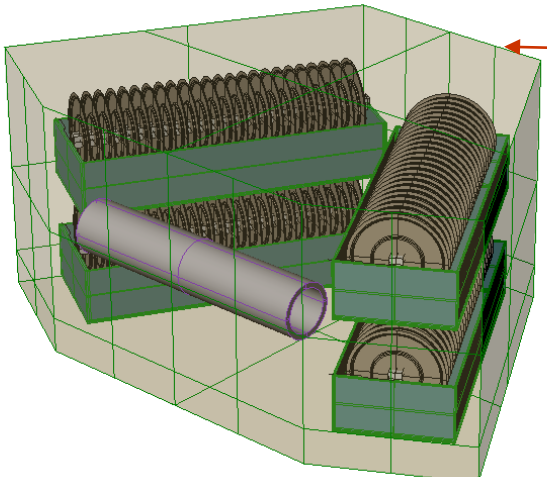


The advantage here being less number of trays, the water retaining time is higher

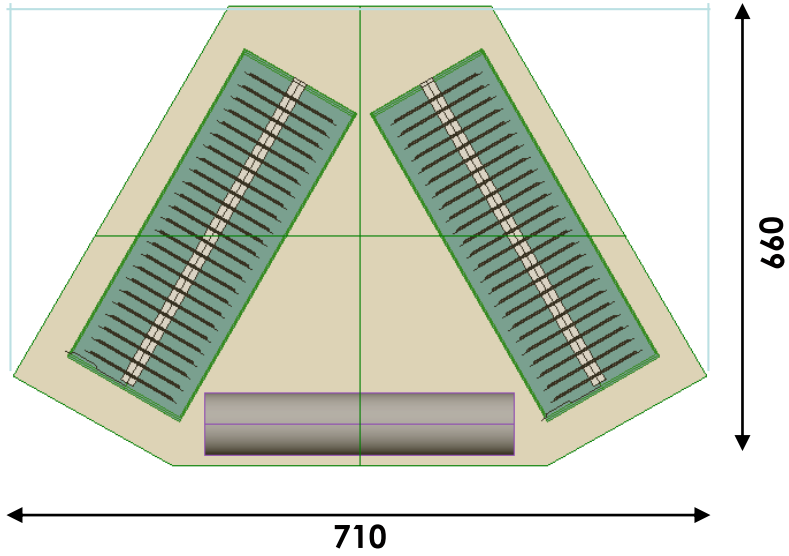


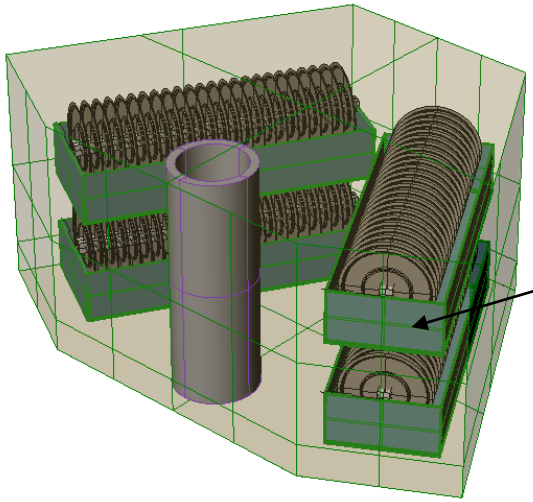


Concept 3.4



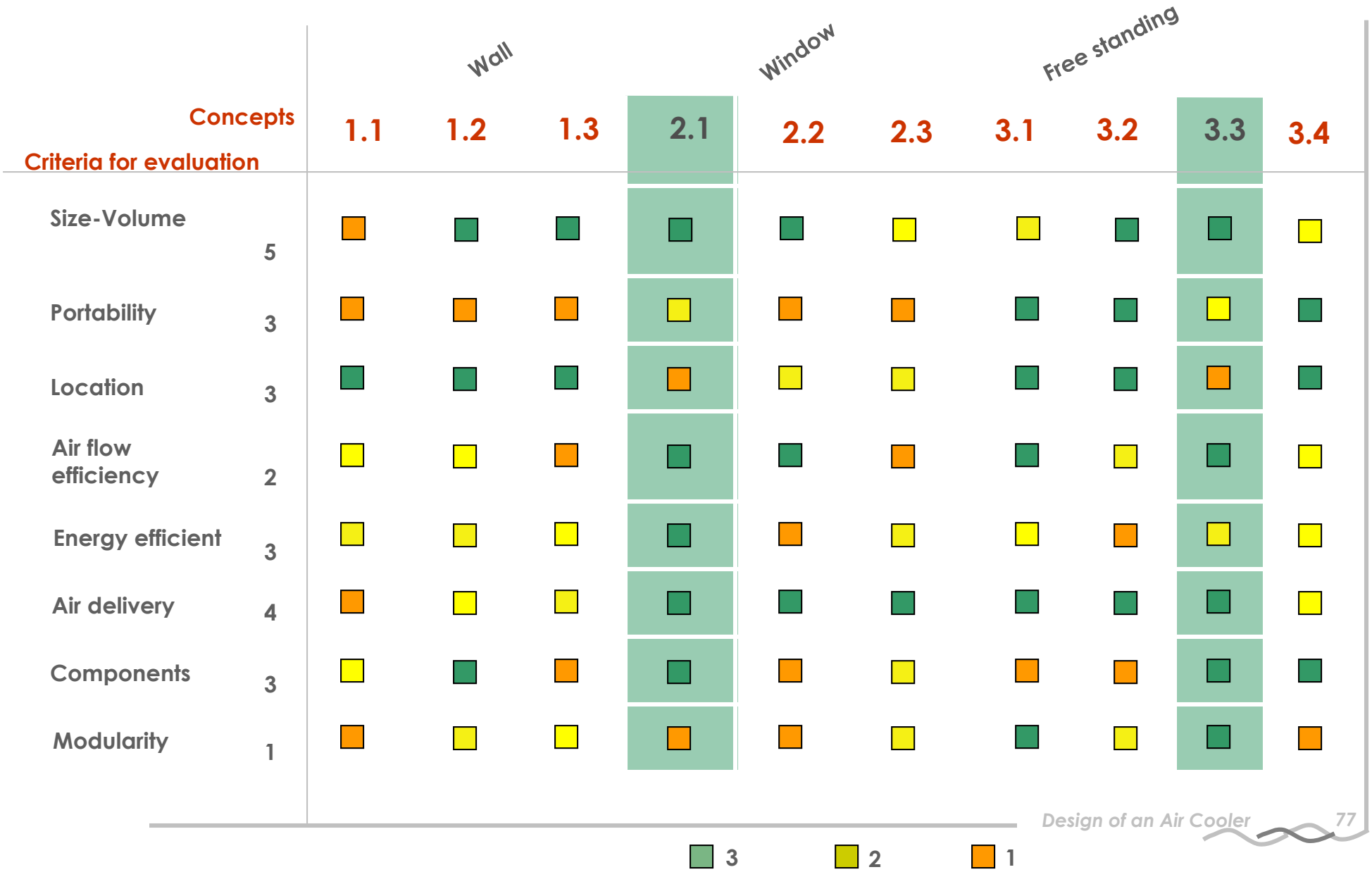
Combined tray



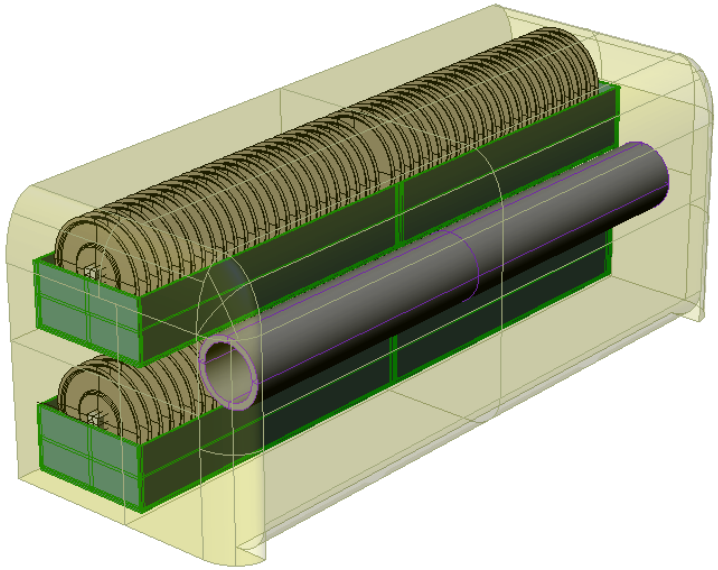


2 Water tanks can be
Combined with ice box
in the centre

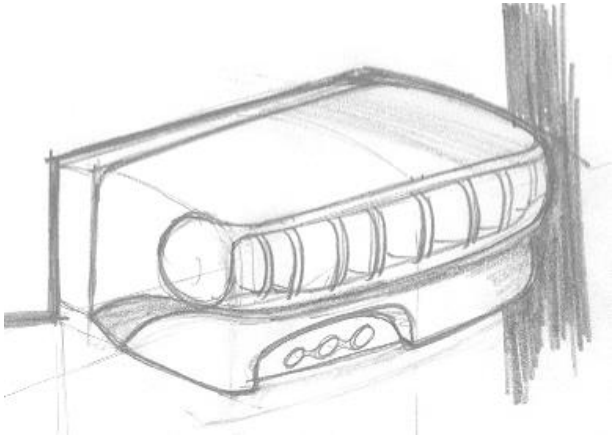
Evaluation of Concepts

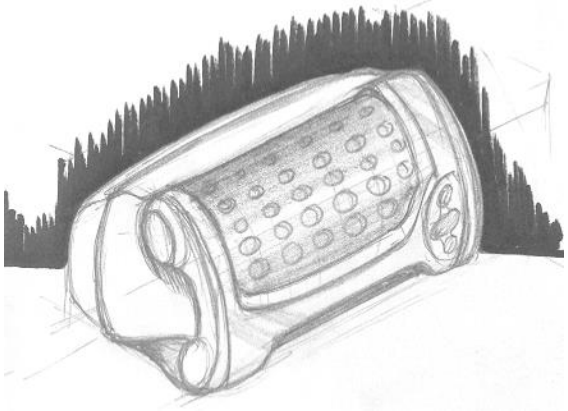


Advantages of finalizing this layout



Increasing the diameter of the discs to 200mm to restrict the length of the unit to 710 mm





Design Concepts

Concepts

Concepts based for unit to be compact

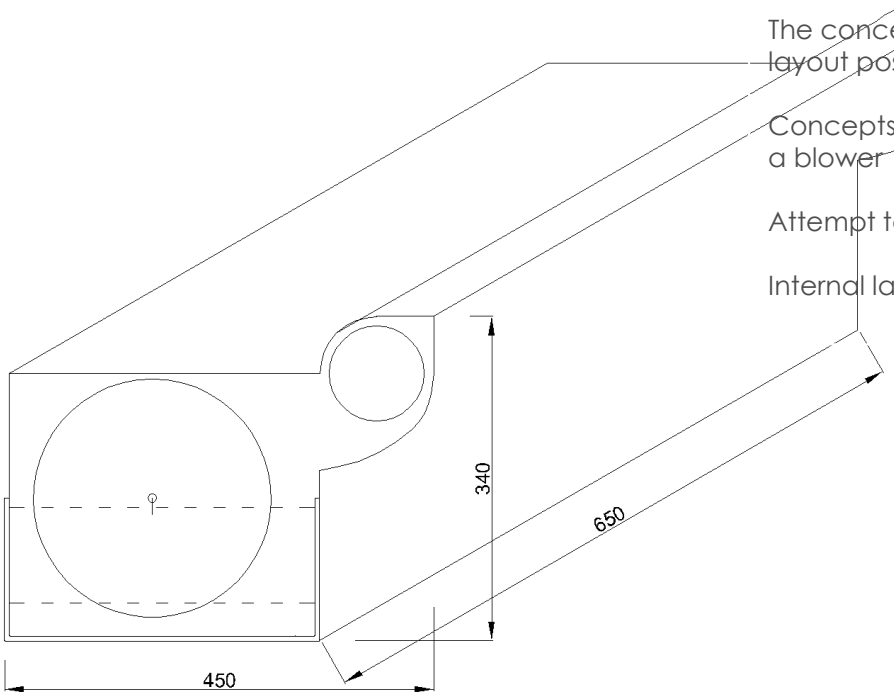
Essentially on lines of the existing air coolers of being portable

The concepts are developed based on the internal layout possibilities

Concepts considering use of both fan and a blower

Attempt to optimize the volume of the unit

Internal layout considering air efficiency



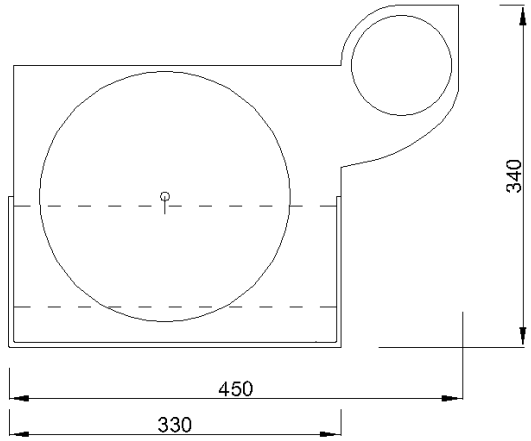


Fig 1

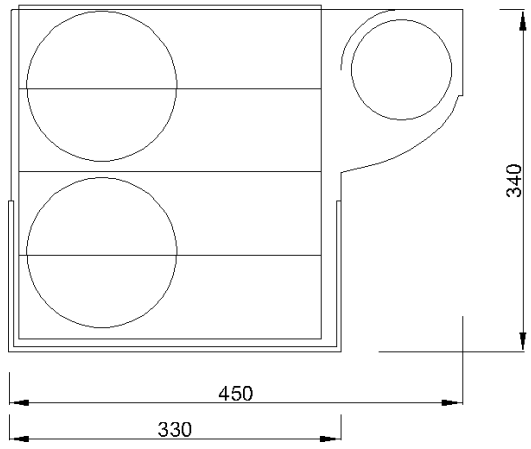


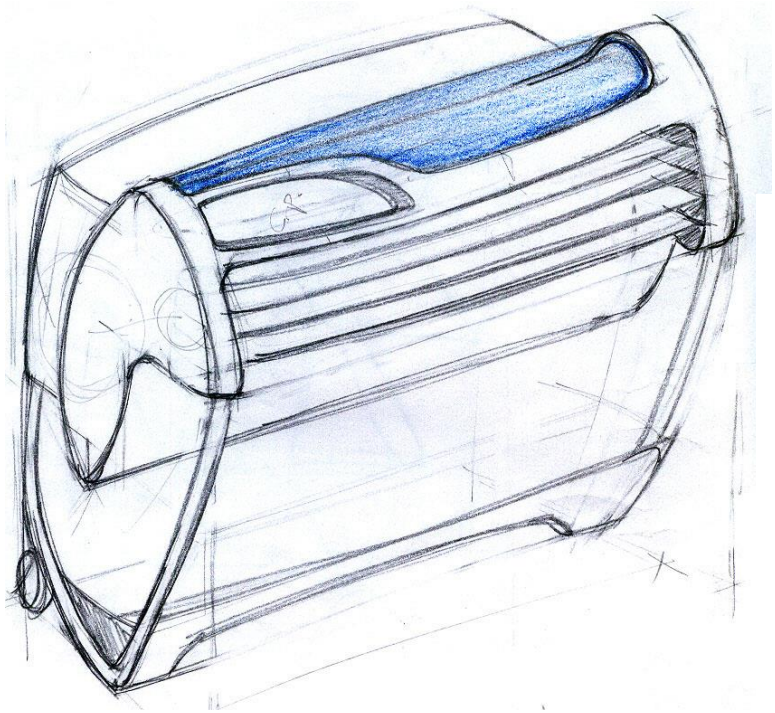
Fig 2

It was found that for 6 inch diameter discs, two trays would be required to a room of about 250sq.ft. in this case the ideal situation would be to use a fan.

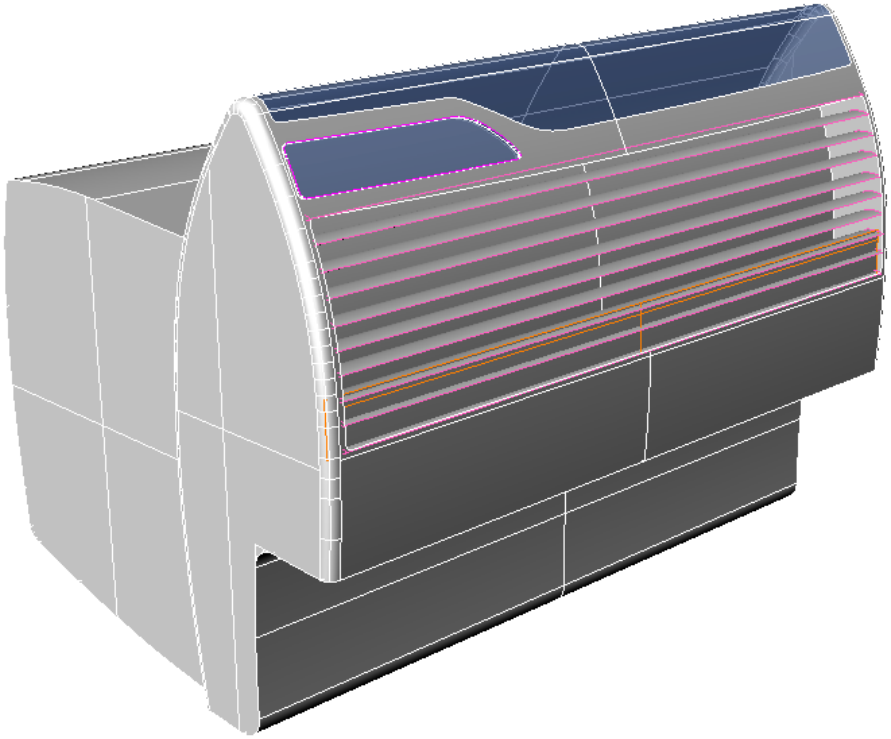
Also by increasing the diameter of the disc, the possibility of two trays is eliminates and only one water tank can be used.
This has an advantage in terms of cost reduction due to one tank.
Instead of using two rows of discs of 6inch diameter, one row of discs with 10 inch diameter is used.

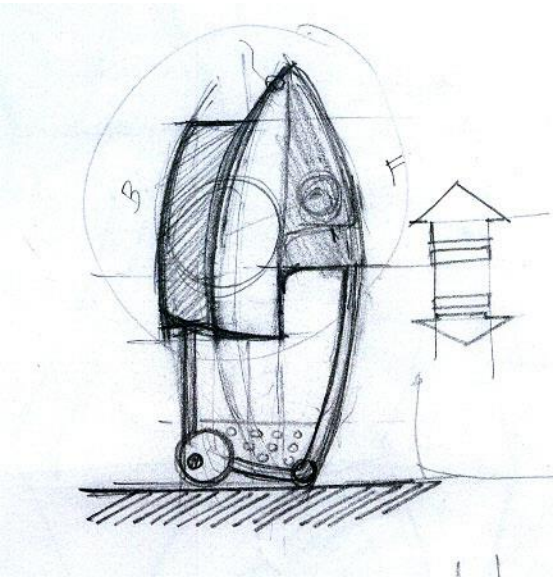
But in this case the column of air passing through is not wide enough to fit a fan, since half of the fan blade diameter will be blocked in the processes. Therefore the ideal situation is to use a blower.

The concepts hence are based on figure one as an internal layout.

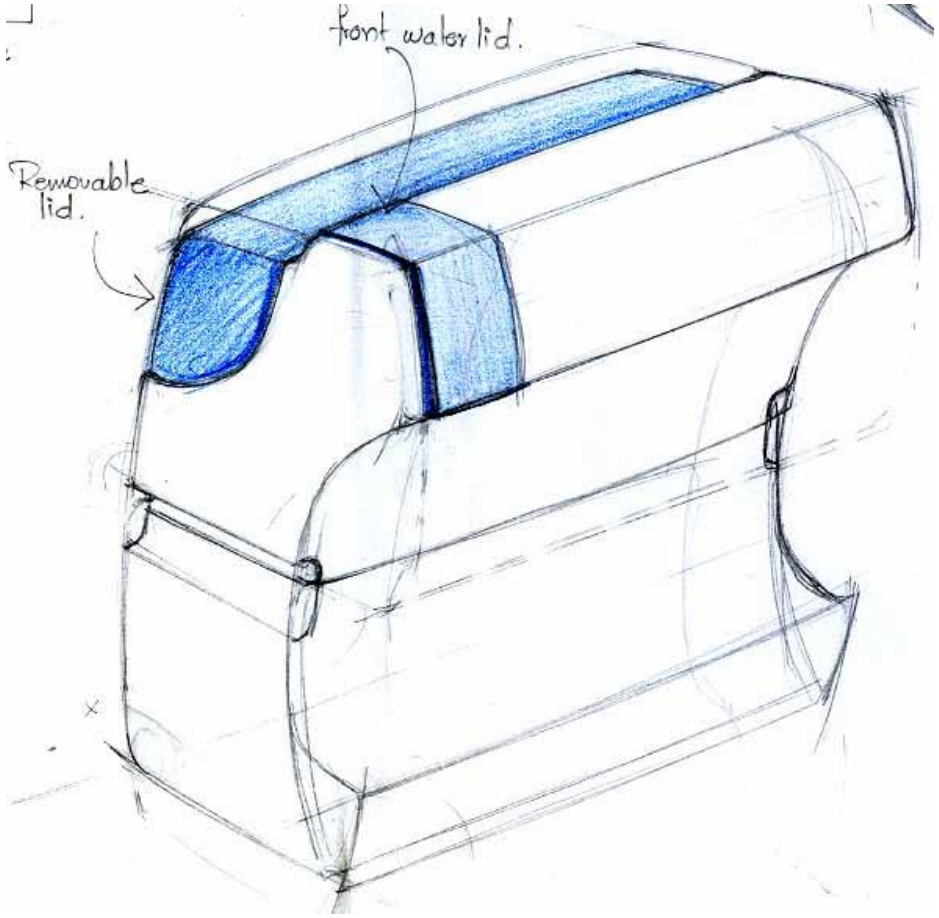


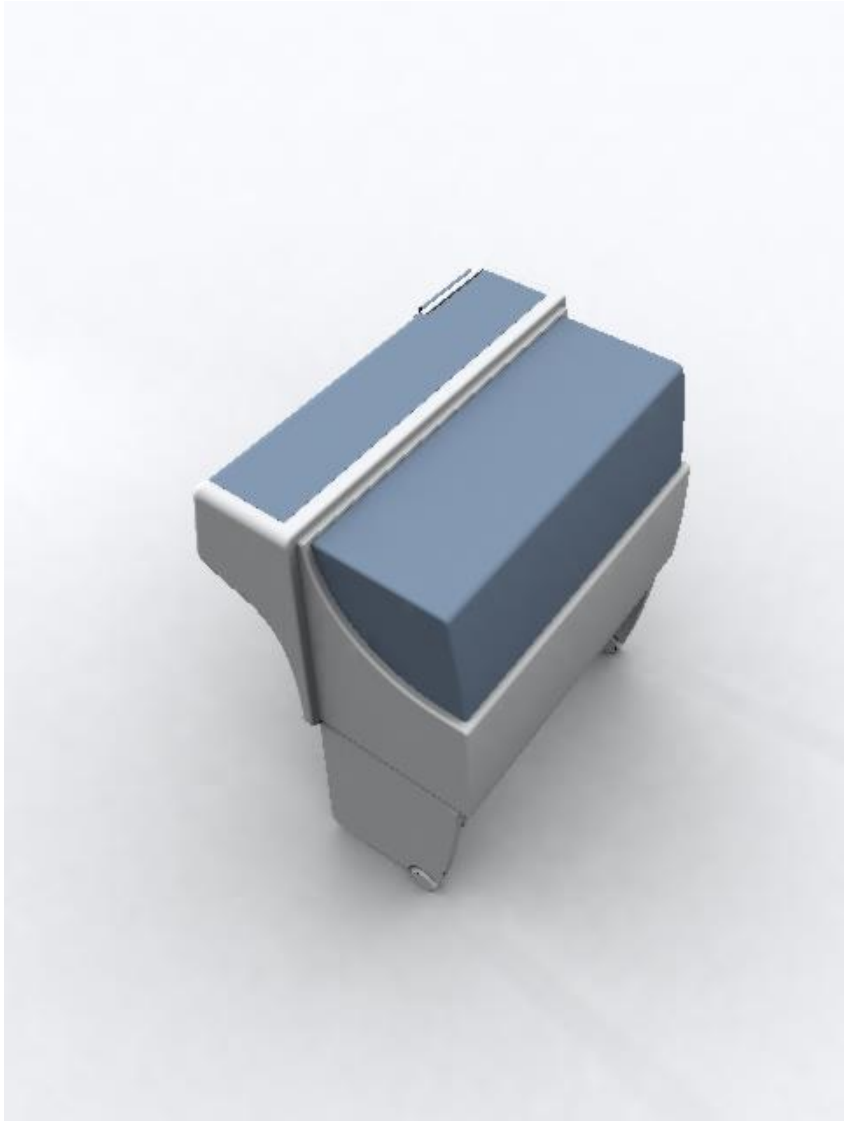
Concept 1

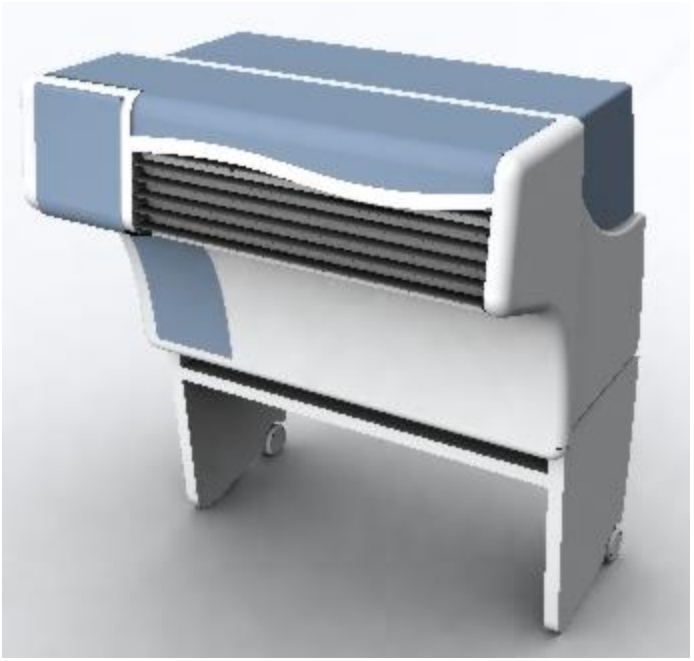


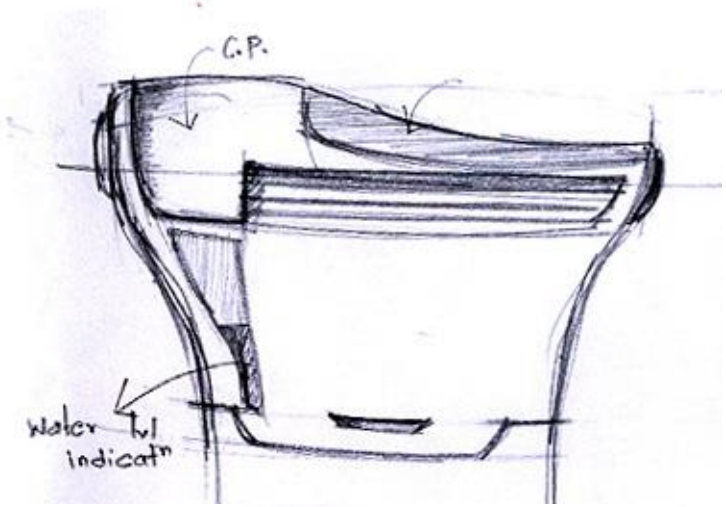


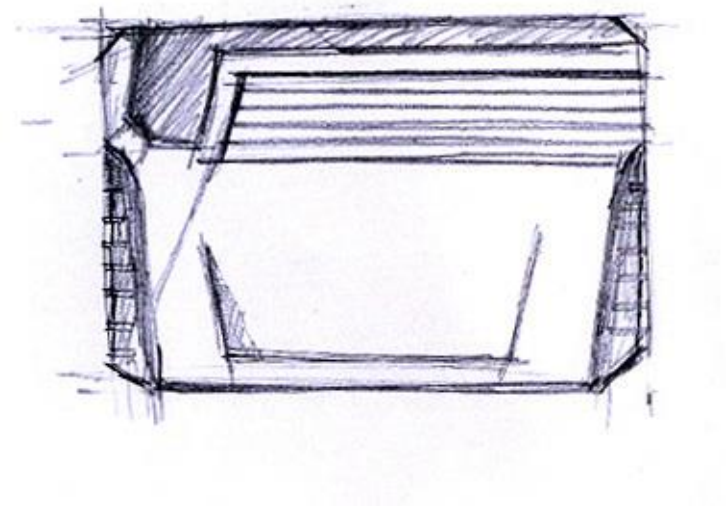
Concept 2









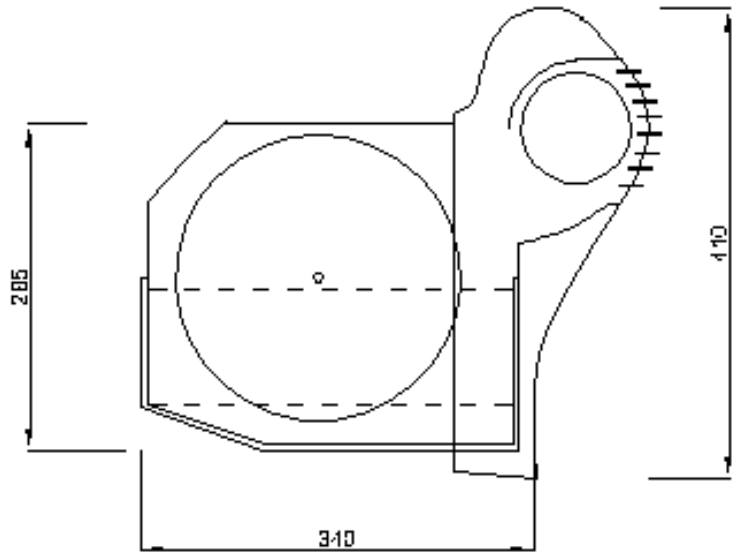


Concept 3

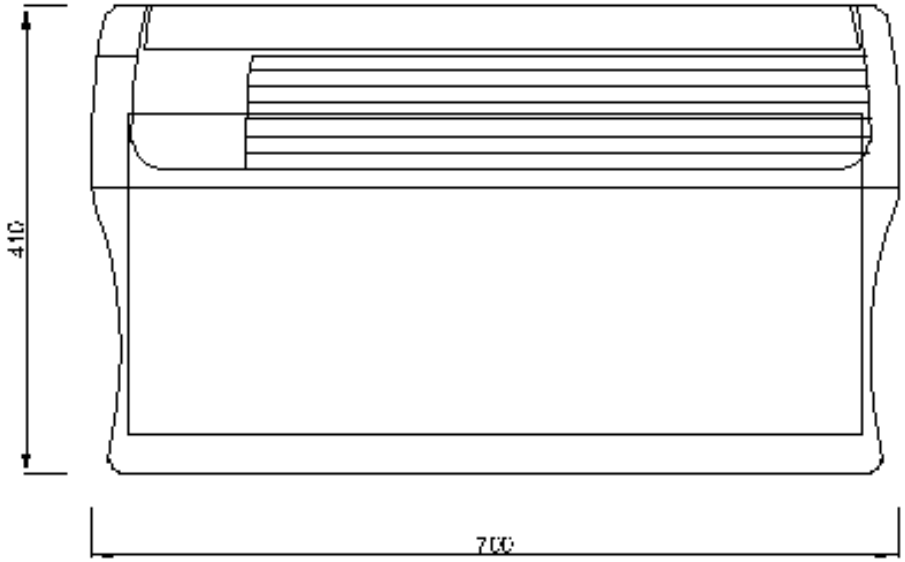
This concept is based on transparency.

The body of the cooler as shown on the next page is seperated from the front panel. The front panel is a translucent plastic with a mix of thermochromatic material.
When the cooler is OFF, the front panel is translucent white in colour and the rear container can be somewhat seen. As the cooler starts decreasing the temperature, the fascia of the cooler changes colour due to the thermochromatic material.
It also acts as a temperature indicator.

The front panels as shown in the sketches can be varied like more dynamic front or more formal appearance.

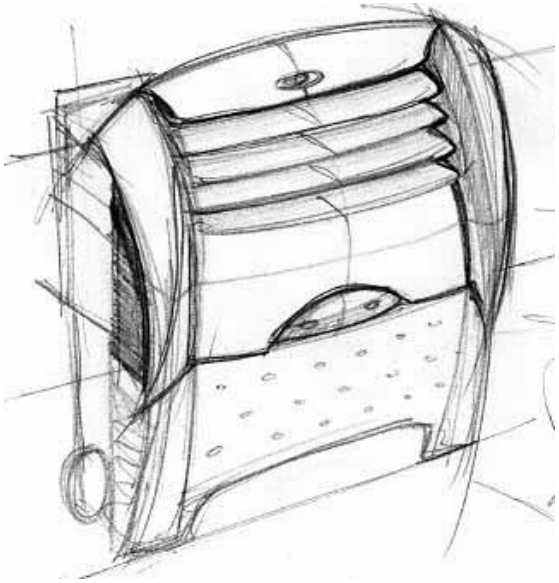


Section



Elevation

Concept 4



The final concept is a free standing unit. It attains portability with the help of four castors. The unit is split into two parts; the actual air cooling unit and the lower trolley.

Design:
The unit is designed as a free standing unit and no longer a window mounted. There are two main parts; the unit and the trolley. The trolley has to be provided since the height of the unit independently is much lower.

Unit: the unit contains the water tank, the front air propulsion system and the rear air intake system. A blower of four inch diameter propels the air at a distance of ten meters. The upper front shell holds the blower, the motor, the control panel and the ice box.
The rear shell is hinged at the top. It is mainly used to pour water inside the tank and for air intake. The tank,front and the rear are clearly demarcated with a strong groove line also to break monotony of the mass. It also forms the separation visually.

Trolley: the trolley unit holds the air cooler unit. It is also used for portability of the air cooler. The trolley compliments the air cooling unit. It also acts as a base and at the same time, its like a rack to hold the wire when unplugged and also for keeping accessories related to the cooler.

Form: the for m of the cooler is derived out of mobility and movement, since air cooling is a process which is like movement of air and also a pleasant feeling, the form leans forward to add dynamism to it.

The volume of the unit is divided into a white block and a blue mass intersecting it. This is also done to break the volume of the whole unit and to make it look lighter. The wave form of the white part at the bottom also compliments the colour of the castors and their position either forward or backward. The front doesn't touch the floor but is slightly off the ground because of the front castors.

The front blue also looks like a large grill. But the actual grill is only in front of the blower.

Material:

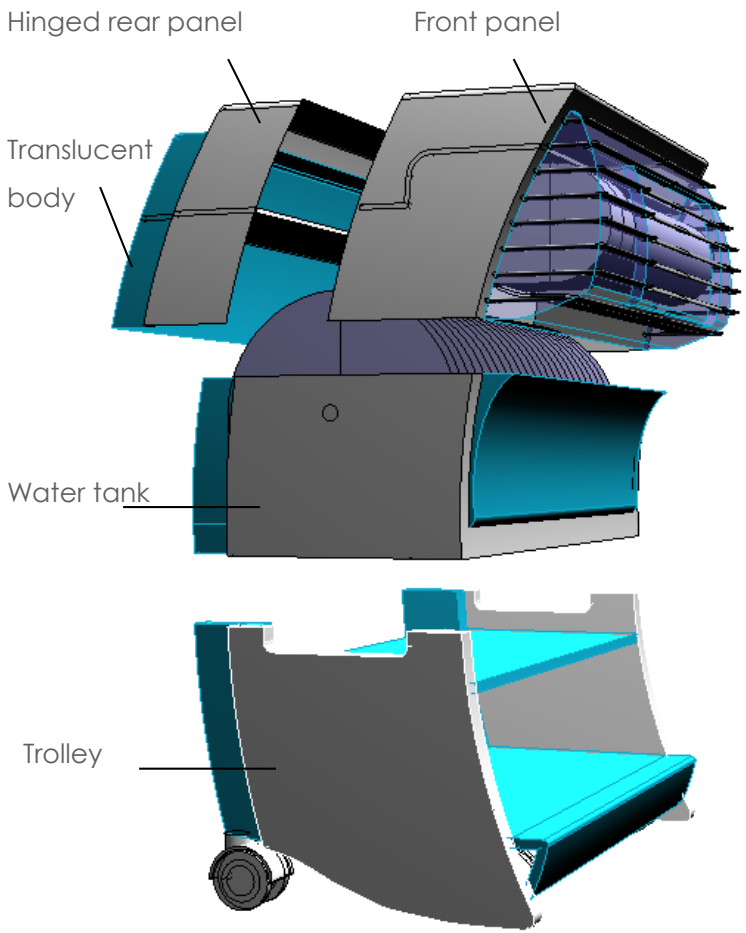
The main unit and the lower trolley are of different materials.

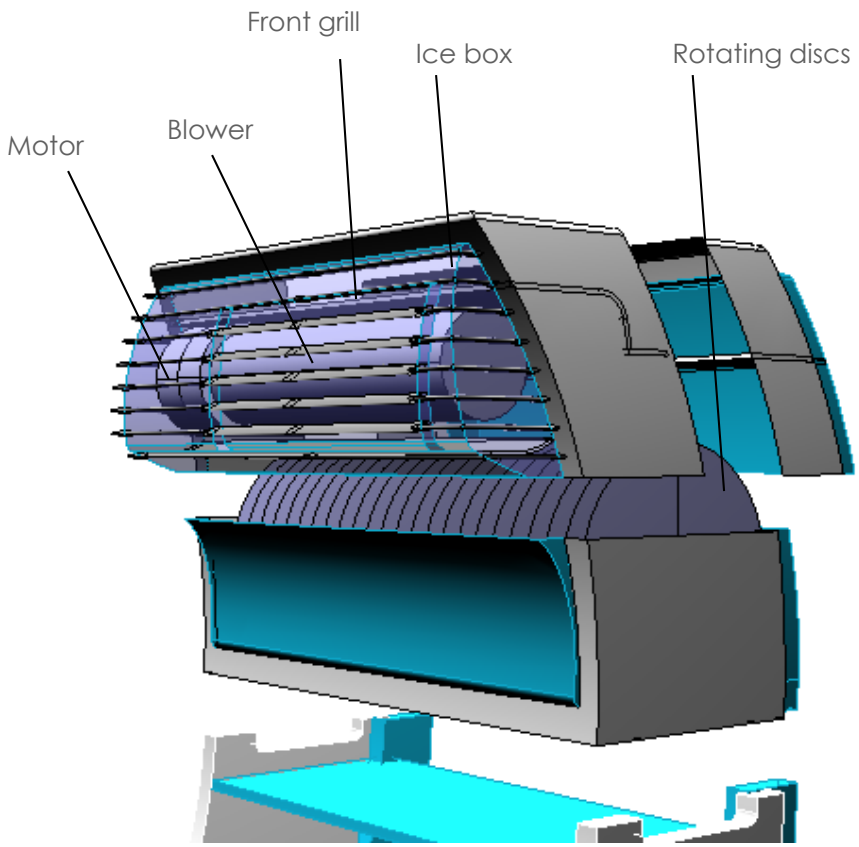
Unit: the whole body of the unit is proposed to be made in ABS. That is the front part and the tank only. The part I.e. the air intake is proposed to me manufactured in PP since the blue area as shown in the model has to be translucent.

So the half white part will be painted in the same colour as the main body. The front and the tank are also of two colours.

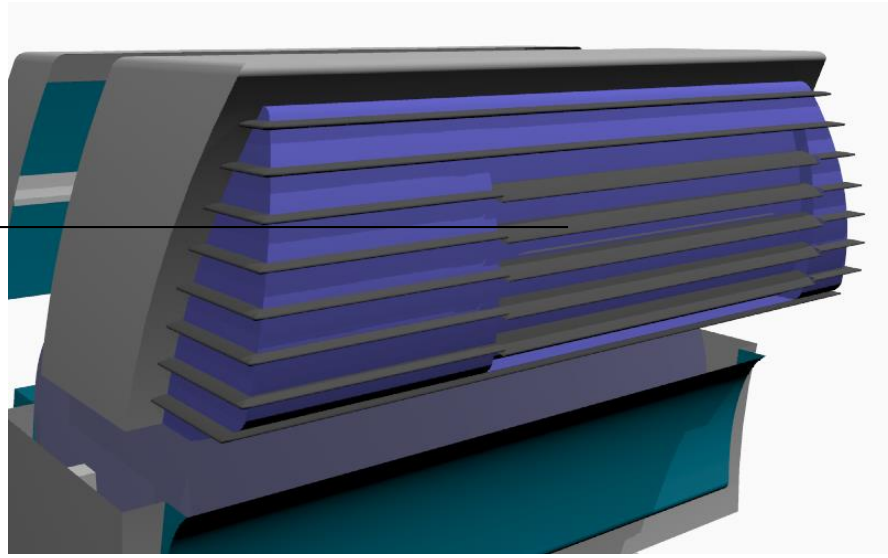
The trolley is proposed to be manufactured in Medium Density Fibres board. The whole unit is collapsible for transportation. The MDF board gets the colour with the PVC vacuum forming over the board. The castors are hen attached to the trolley.

Exploded views

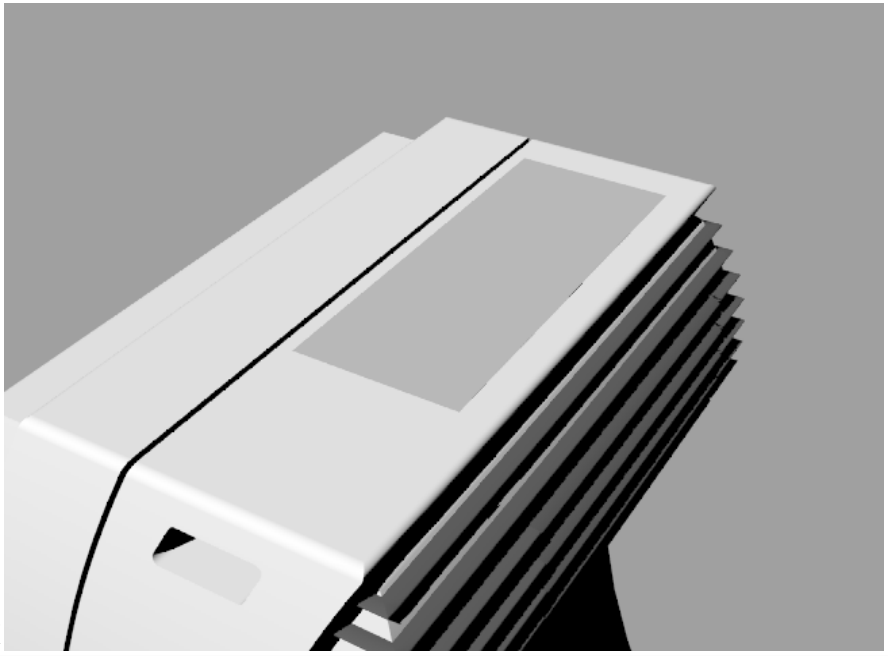




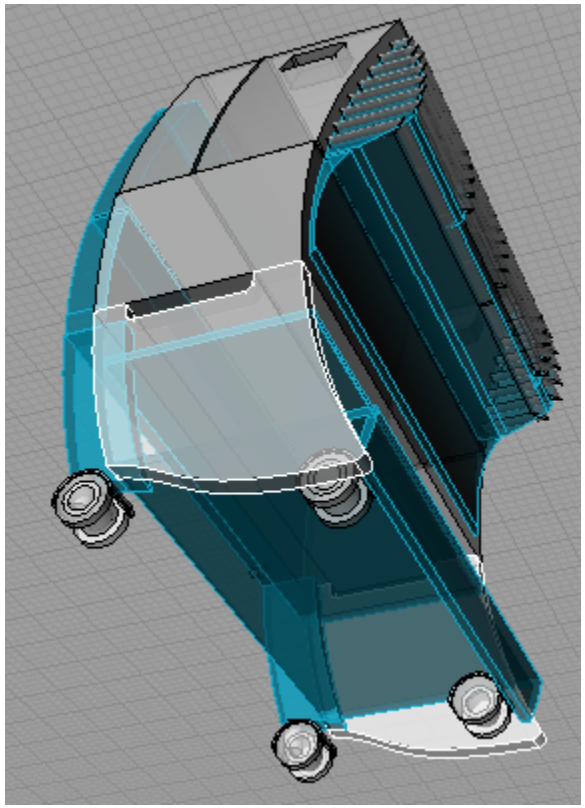
Oscillating louvers



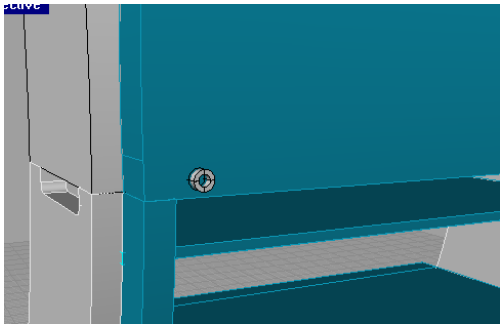
FRONT GRILL



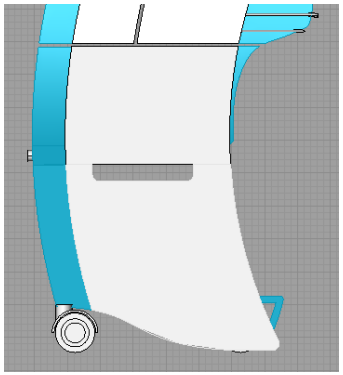
ICE BOX

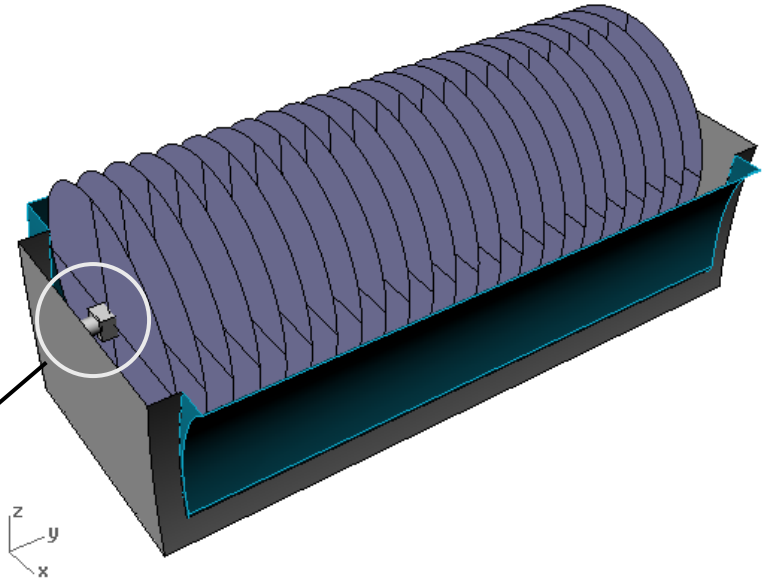


Position of the castors under the trolley

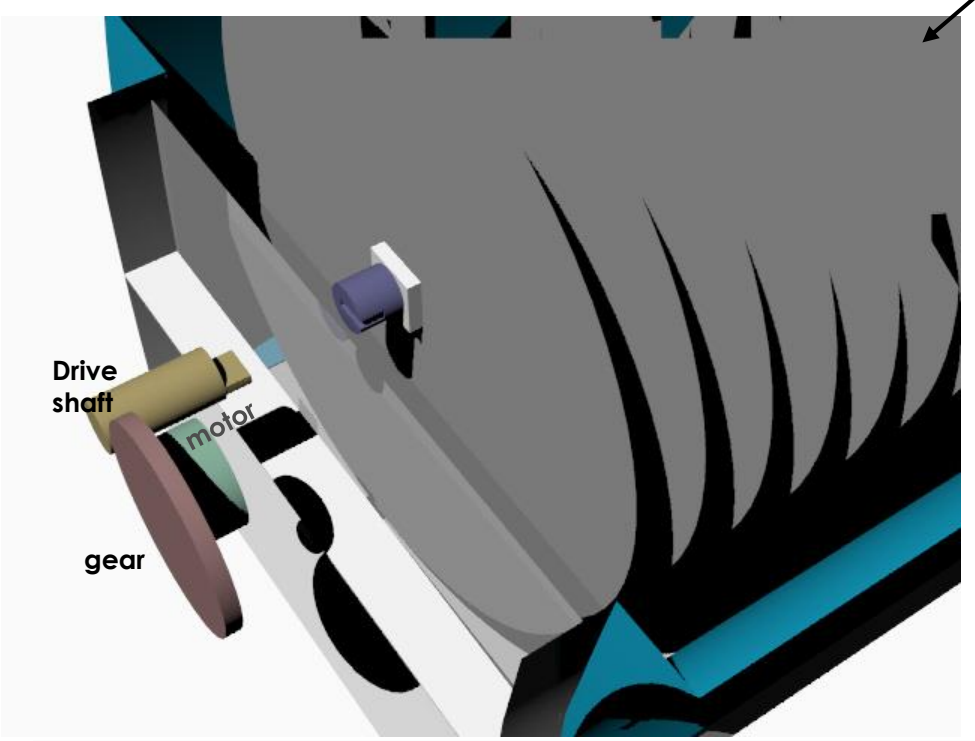


Drain pipe position



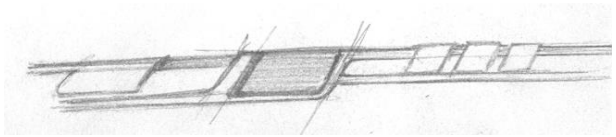


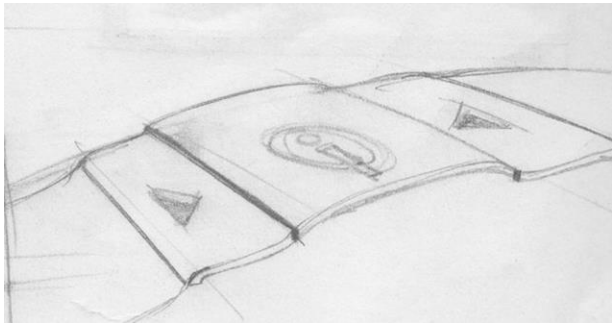
Tray containing the discs and the shaft

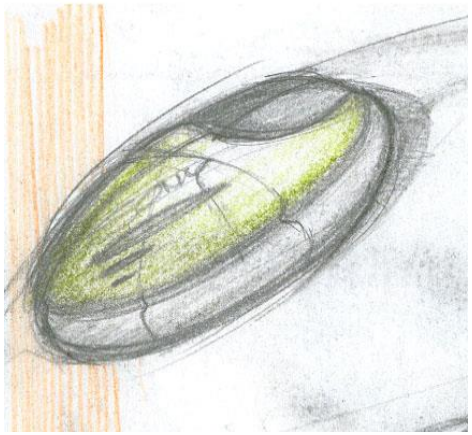


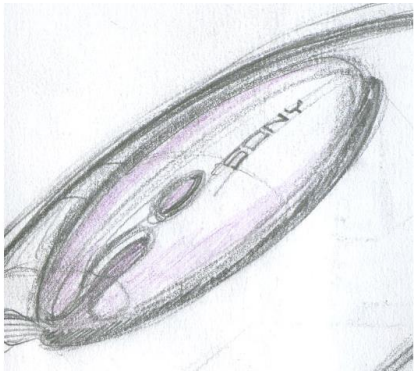
Enlarged view of the detail at the motor end

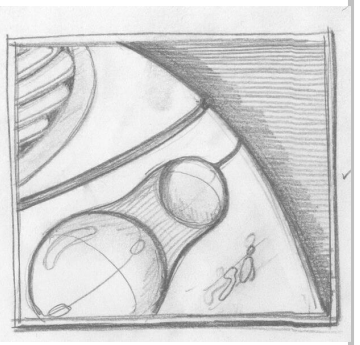
Explorations for Control Panel

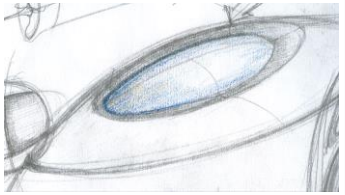


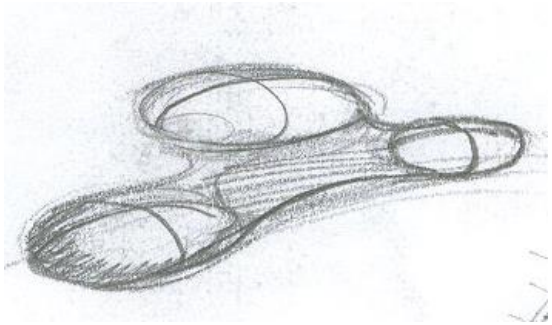


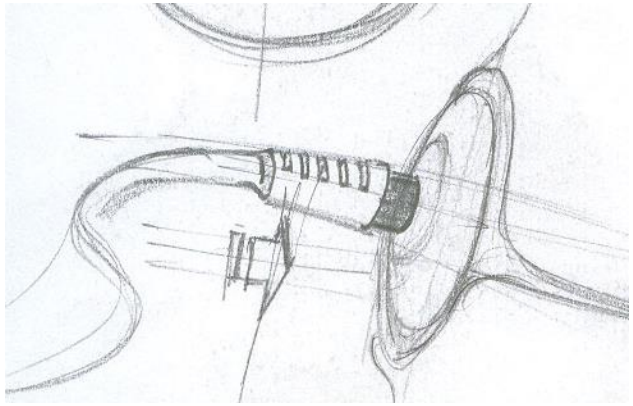


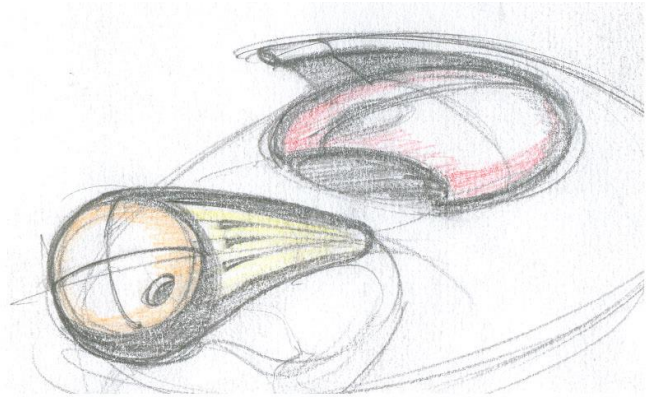


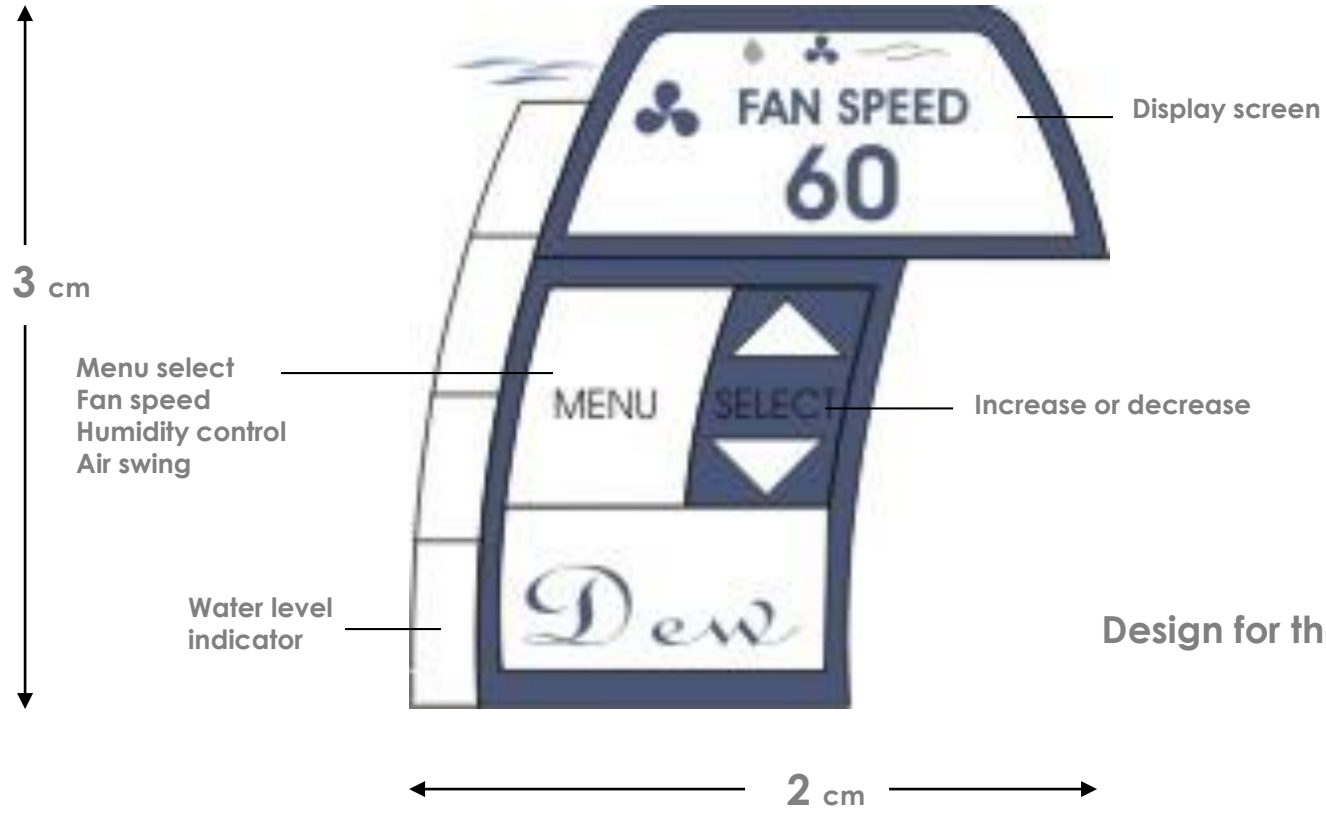






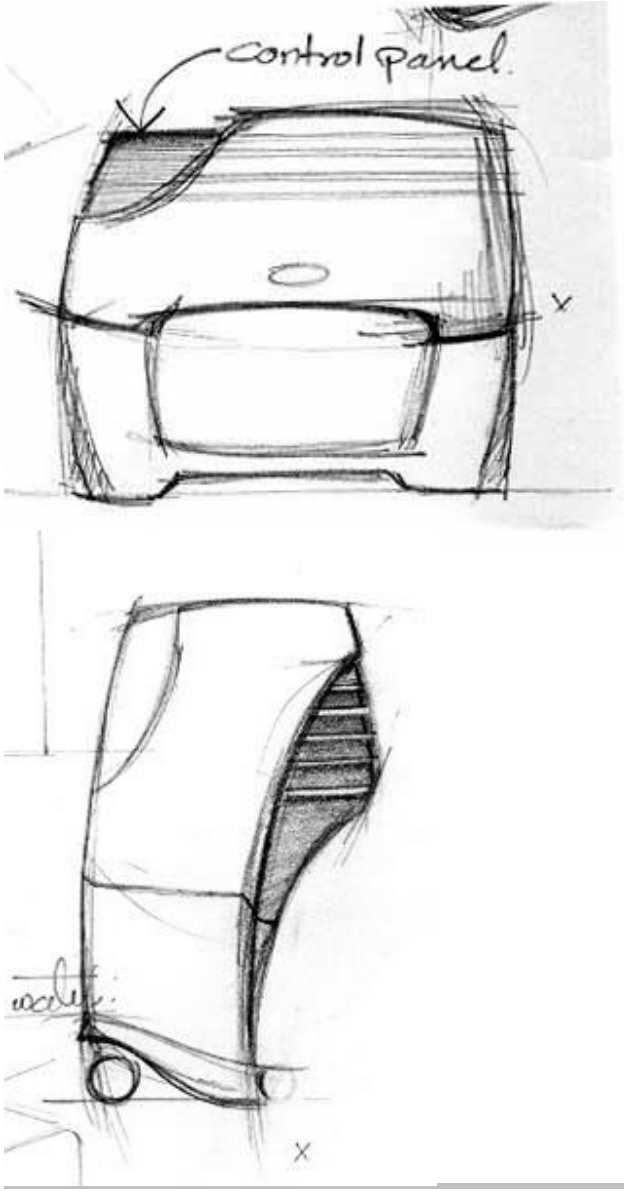




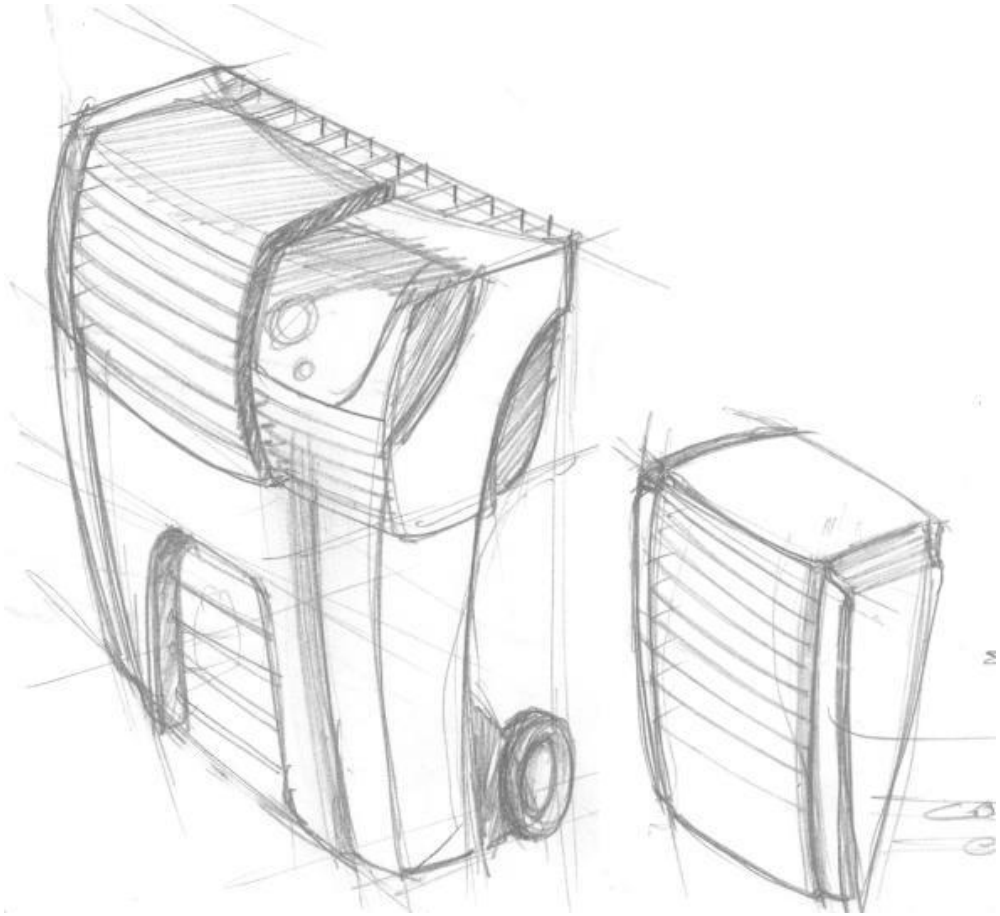


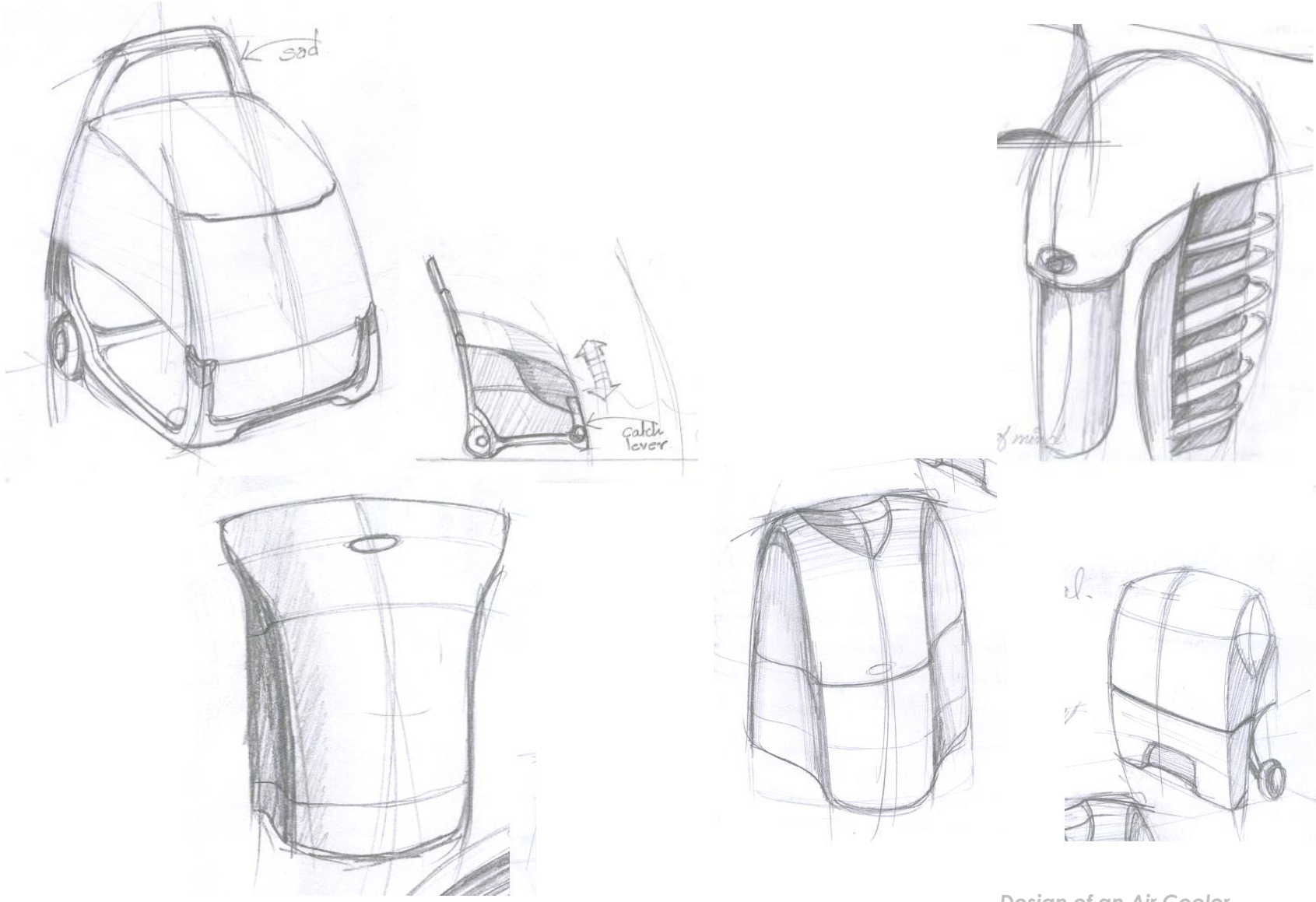
Design for the Control panel

Final Model



Other Explorations




sad
catch lever

Bibliography

Books

U.A Athavankar, **Product Semantics and Beyond**, An Alternative viewpoint, (IDC library)
Anand Rajhans, **Design of Desert Cooler** (IDC library)
Garrat James, **Design and Technology** (Central Library, IIT)
Innovation, IDSA(1994) , Central Library

Websites

http://www.brilliantstore.com/air/coolers.htm
http://www.kaitousa.com/roomconditioner.htm
http://www.bajajelectricals.com/appliance/intraapkp/ac.htm
http://www.symphonycomfort.com/
http://www.kenstar-appliances.com/cooler.htm
http://www.ebmnadi.com/
http://www.electrolux.co.in/index.asp
http://www.air-n-water.com/