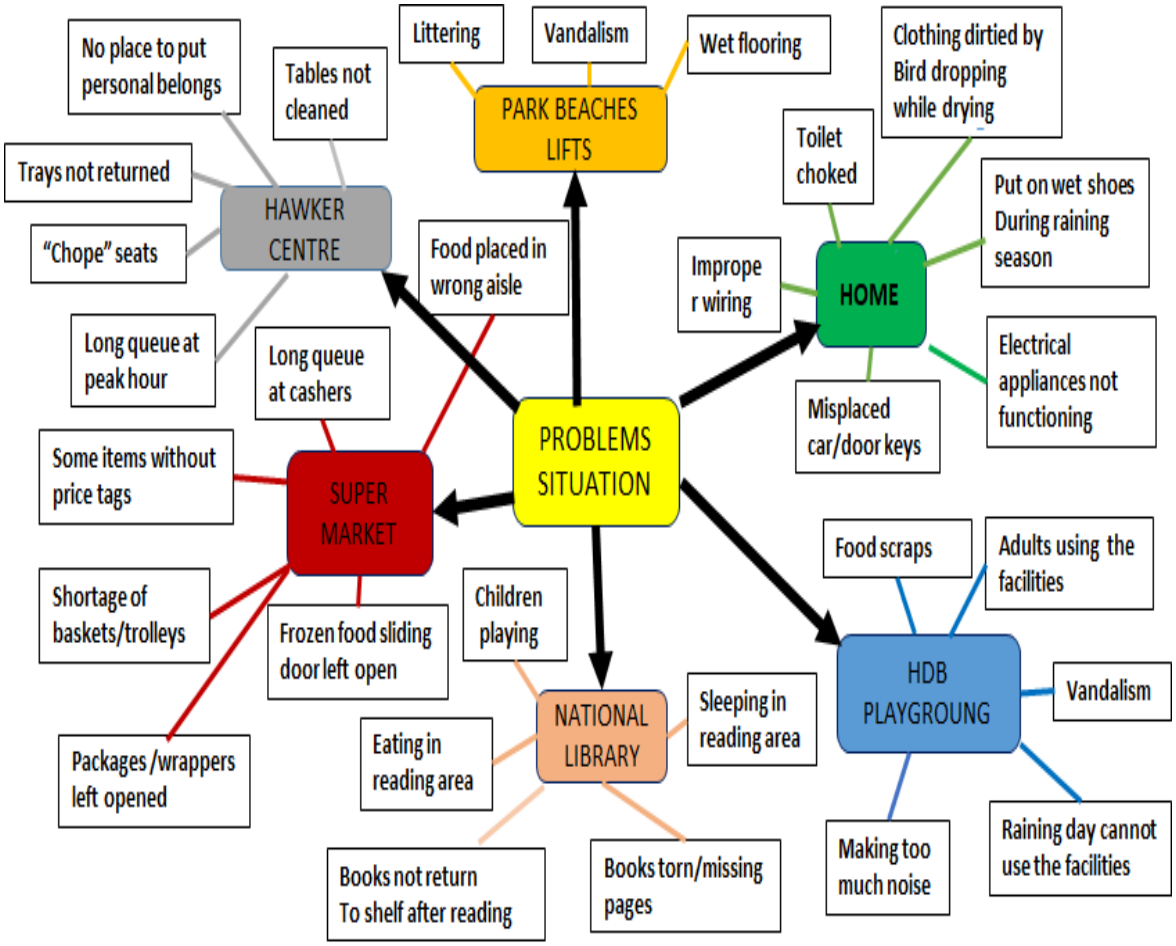
Hwa Chong Institution
Project Work
Category 3 Inventions Log Book

Title of Project: Superdry
Group Name: 3-48
Group Members: **1) Ryan Quek Kai En (1i1)** **2) Huang Yujie (1i1)**

1.Problem Finding

Our group went around the following areas and finalized some common issues as followed.



2.DefineThe Problem

After inspecting the problems thoroughly, we decided to solve the most annoying problems that happens to our children and most of time even adults.

The Problem is:

“Every family will face a problem during the monsoon season or rainy days, which is not uncommon for the people living in a tropical country, like us. During these rainy days, our shoes will definitely be drenched without a doubt and as long as the water stays in our shoes for about 15 minutes, harmful bacteria might start growing and our feet will feel uncomfortable, and it will be stinky as well when worn the next day.

Due to the geographical location and maritime exposure, rainfall in Singapore is mostly consistent throughout the year. Singapore experiences the wettest mouths during the monsoon season between November and January.

Precipitation Table

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Average Precipitation mm (in)	198 (7.8)	154 (6.1)	171 (6.7)	141 (5.6)	158 (6.2)	140 (5.5)	145 (5.7)	143 (5.6)	177 (7)	167 (6.6)	252 (9.9)	304 (12)	2150 (84.6)
Precipitation Litres/m² (Gallons/ft²)	198 (4.86)	154 (3.78)	171 (4.19)	141 (3.46)	158 (3.88)	140 (3.43)	145 (3.56)	143 (3.51)	177 (4.34)	167 (4.1)	252 (6.18)	304 (7.46)	2150 (52.73)
Number of Wet Days (probability of rain on a day)	17 (55%)	11 (39%)	14 (45%)	15 (50%)	15 (48%)	13 (43%)	13 (42%)	14 (45%)	14 (47%)	16 (52%)	18 (60%)	19 (61%)	179 (49%)
Percentage of Sunny (Cloudy) Daylight Hours	43 (57)	49 (51)	51 (49)	47 (53)	49 (51)	50 (50)	51 (49)	50 (50)	45 (55)	44 (56)	37 (63)	38 (62)	47 (53)

The average humidity in Singapore is always above 80% because it rains frequently, close to sea and due to proximity to the equator. It is very difficult to dry out any wet items in the house without sufficient sunlight.

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Relative Humidity (%)	*821*	*79*	*79*	*81*	*81*	*79*	*80*	*80*	*80*	*80*	*82*	*82*	*80.4*
Average Dew Point Temperature °C (°F)	22.5 (72.5)	22.5 (72.4)	22.9 (73.1)	23.7 (74.6)	23.9 (75.1)	23.4 (74.2)	23.4 (74)	23.3 (73.9)	23.1 (73.5)	23.1 (73.5)	23 (73.4)	22.4 (72.3)	23.1 (73.5)
Interpretation	Very humid	Very humid	Very humid	Very humid	Very humid	Very humid	Very humid	Very humid	Very humid	Very humid	Very humid	Very humid	Very humid

According to the statistics published by Ministry of Education in 2019, the enrolment for primary school was 227,466 and for secondary school was 146,703 in 2018.

<u>Existing solutions to solve this problem:</u>

We have found out many already existing solutions such as

1) Buying extra pairs of shoes.
2) Soaking up wet shoes with newspaper.
3) Use a hairdryer to dry up.
4) Put the shoes in an oven to heat up and dry.
5) hang the shoes in front of the portable fan.
6) buy a shoe drying device to dry up the shoes.

Disadvantages

If you put newspapers into the wet shoes or hang the shoes in front of the fan, the drying period will be greatly extended as the environment during the raining season the humidity is very high. The air is almost fully saturated with water vapour. Thus, it is very difficult to dry anything without sufficient heat.

If you put the shoes in the oven, your shoes have a high chance of getting burnt

If you use a hair dryer to dry your shoes, it will require constant observation and attention as you have to let the hot air travel around the wet areas of the shoes and it will take a lot of time. The hair dryer may also get damaged as the heating coil may be overheated.

If you buy a shoe dryer device you may not solve the problem also as most shoe dryers are designed to dry the internal portion of the shoe and the outer part may remain wet. If you have more than one kid studying in school you may have to buy more shoe dryers

3.My Big Idea

Our proposed solution:

To design and make a special enclosed shoe rack to dry up wet shoes fast, efficiently and safely.

In the future you will no longer have to worry about wearing wet shoes to school and it will also benefit your parents by saving time instead of worrying about the wet shoes.

If your shoes are dried constantly it will last longer

Your feet will not be smelly when you take off the shoes

You will not get Trench Foot which is a fungal disease

Our invention is user-friendly and child-friendly.

It must be simple and easy to construct.

It will be safe and not costly.

It will be able to turn off by itself, so you do not need to monitor it.

It can be used to dry more than one pair of shoes.

It is much more efficient and faster than current methods.

Our project will make use of the concept of Heat and Wind to carry out the drying process of wet shoes or socks. We might make use a fan and light bulb.

The project timeline:

1) Carry out an experiment first when we make a prototype of the shoe rack and test out if it works.
2) Refine and improve the idea all together.
3) Make the final product.
4)Test the product to double check that it works

4. Construction or modelling process

Choose of materials for the prototype or project:

The enclosed box

The purpose of this enclosed box is to make sure that the temperature inside the box maintains at a constant reading so that the water in the wet shoes will evaporate faster. The most important thing to consider is that the material used to make the enclosed box has to be a good insulator of heat, secondarily, it has to be easily cut and shaped by using common cutting tools and can be purchased in Singapore.

The following was the study of materials for the enclosed box. We leave out metals (as metal are good conductors of heat)
and only study wood and plastics.

Materials suitable for making the enclosed box

Material	Property	Method of cutting and construction	Is it easily available? (Yes/No)
Wood	Hard, tough and strong but mostly heavy. They are good insulators of heat and electricity.	Can be cut using normal tools or a wood cutting machine. Can be joined using nails, screws and wood glue.	Yes

Plastics	They are made of different types of plastics, all man-made materials. They are colourful, light, waterproof and relatively strong. They are good insulators of heat but when the temperature is too high, they may deform or even melt.	Can be cut using normal hand tools. Shape Can be changed by using injection moldings or parts can be joined by using plastic glue or the normal fastening method.	Yes

After careful consideration we have decided to choose plastics for our enclosed box as the majority of the plastics are light, fairly strong and easy to cut and shape. As compared to wood they are better insulators of heat than wood. Our project does not need to withstand very high temperature (only range from room temperature 25c to 65c only) so the plastics will not be deformed or melt

After further research, we found out the most suitable plastics material for our enclosed box is expanded polystyrene or Styrofoam. This plastic is very buoyant-light weight, very good sound and heat insulator of heat as air can be trapped inside the material. The Styrofoam box is commonly used to keep frozen food, vegetables or worm food for transportation as the temperature inside the box will stay constant for long periods of time. Furthermore, the Styrofoam box is easily obtainable from supermarket or any market place.

We decided to use the Styrofoam box with the size (47x35x38) cm so that we can put maximum three pairs of shoes for drying at the same time. The length of the shoes for secondary students normally not longer than 32cm.

Discarded Styrofoam box

(47x35x38) cm

Our choice

The heat sources

The toaster or electric oven normally use heating coils as the source of heat to heat up the device. The heat that the coils produced is usually too high, ranging from 80º c to 250º c, they are not suitable for our project as the shoes may get burn or damage at this temperature. The other option is to get the heat from the filament lighting bulb. The bulb has a filament that when electricity passes through, the filament will be heated up and transform the heat energy into light energy but some of the heat energy also will make the temperature of the surrounding area increase gradually. We decided to used filament lighting bulb as our source of heat for our project.

The following is the study and research done for the lighting bulbs:

Light and heat energy produced by some of the bulb used at home

Type of bulb	How it works	Percentage of energy converted to heat	Can be purchase from local supplier.
LED	Passing electricity through a semi-conductor which then emits light.	Only 10% of the energy wasted in heat and 90% converted to light	Yes
Incandescent bulb	Passing electricity through the filament and give out light.	90% of the energy wasted in heat and only 10% converted to light.	Yes
Halogen bulb	Passing electricity through the tungsten filament and generate heat and bright white light. More efficient than incandescent bulb and longer life span.	90% of the energy wasted in heat and only 10% converted to light.	Yes

So finally, we decided to use the halogen bulb as our choice of heat source as 90% 0f the energy is converted to heat energy.

Halogen bulb

Mini-fan

The purpose of the mini-fan is to keep the hot air in the enclosed box circulating so that the water vapour from the wet shoes can easily escape through the air outlet holes. At the same time, we must make sure that the temperature in the box stays constant. We managed to get the mini-fan from the dismantled CPU box. The fan worked on 12V D.C. supply by an adaptor. It is the right choice as the fan just good enough to keep the hot air circulating but not too strong to greatly affect the temperature in the box

Mini fan 12V Dc

Other materials and accessories used

We need an electric wire, bulb holder, power plug and power socket and fastening accessories for assembly of the project for testing. We also need a hygrometer cum thermometer to test and monitor our project.

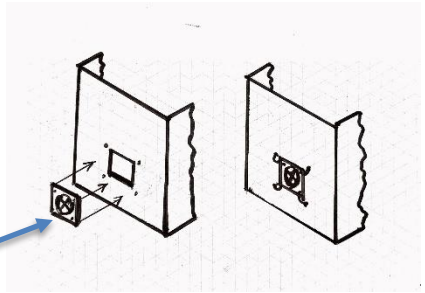
Plug

Bulb holder

Hygrometer cum Thermometer

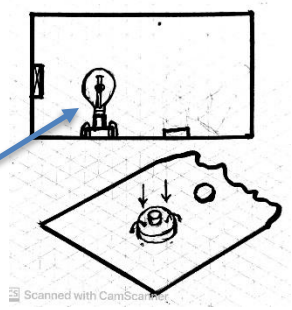
Nylon cable ties

Construction of the prototype or invention

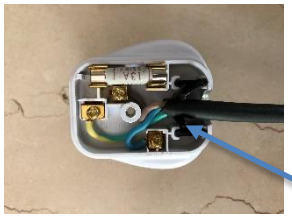


Use a penknife to cut a square hole on the side of the Styrofoam box. The position has to be the same as the height of the halogen bulb with holder.
Insert the mini-fan into the hole and use wire ties to fasten it to the box by punching four holes at each corner.

Use a hole puncher to punch two holes for the lamp holder at the base of the box about 1/3 distance from the left side. Then use nylon cable ties to fasten the lamp holder to The base.



Connect the lamp holder to the 3-core wire with live, neutral and earth connecting points, connect the end of the wire to the power plug. Connect the adapter to the 12V DC mini-fan with red to the positive and black to the negative wire.

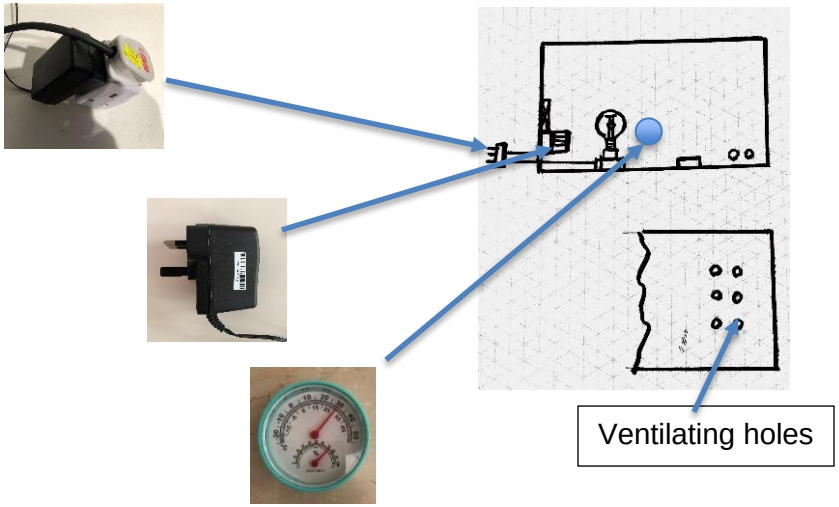


L-Live wire
N-neutral wire
E-Earth wire

3-core wire connection

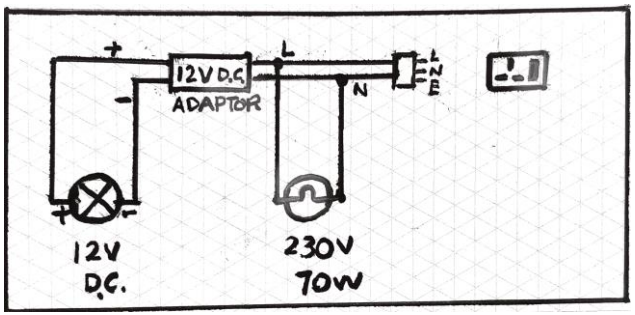
Use a hole puncher to punch ventilating holes on the top cover at the right end side and also at the front and back vertical sides.

Use a marker to mark out the size of the Hygrometer cum thermometer and then use a penknife to cut the outline of the shape and use a wood file to file the final shape of the hole. Insert the meter into the hole to get a tight fit.



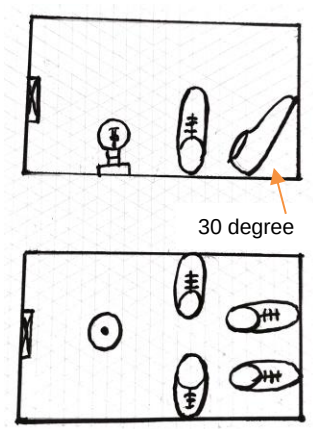
The circuit diagram of the invention

The wet shoe drying invention is connected to the 230V AC power supply for the halogen lighting bulb and also connected to an adaptor to convert the supply to 12V DC for the mini-fan.



Testing the prototype or project

After checking all the connection, parts and accessories are properly installed now we can conduct the testing. Firstly, we put the wet shoes into the box that slant and rest at about 30º to the side as shown in the figure, then we cover the box and switch on the power supply.



Record of testing

Table 1 using halogen bulb 46 Watts (Testing using one pair of shoes)

Time interval (Hour)	Temperature (ºc) In the box	Humidity In the box (%)	Shoes condition Wet/Moderately dry/very dry
0	28	80	Wet
0.5	41	44	Wet
1.0	42	42	Wet
1.5	42	40	Moderately dry
2.0	42	40	Moderately dry
2.5	44	38	dry

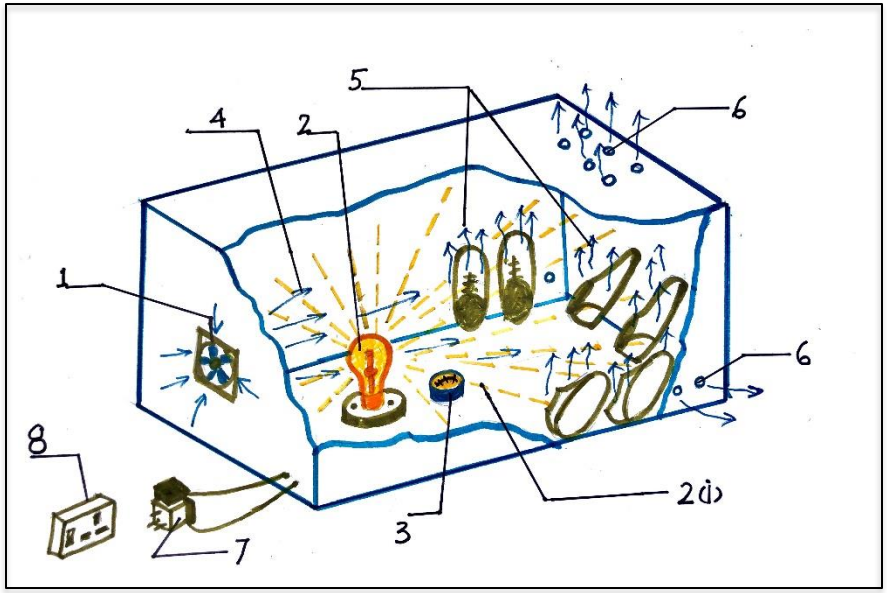
Table 2 using halogen bulb 70 Watts (Testing using one pairs of shoes)

Time interval (Hour)	Temperature (ºC) In the box	Humidity (%) In the box	Shoes condition Wet/Moderately dry/very dry
0	28	80	Wet
0.5	49	30	Wet
1.0	50	28	Moderately dry
1.5	52	26	Dry
2.0	53	22	Very dry
2.5	53	22	Very dry

We decided to use the 70 Watts bulb as it took only about 1 ½ hour to dry the shoes. The temperature in the enclosed box was about 52 degrees and the humidity reading were less than 30%. The air in the box is very dry and the shoes was totally dry.
The pictures below shown that the box can be used to dry up to three pairs of shoes.

Parts of the completed prototype

1 Mini-fan
2 Halogen bulb with holder
2(i) heat waves generated by the bulb
3 Thermometer cum hygrometer
4 air circulating in the box
5 water evaporated from the wet shoes
6 Ventilating holes for water vapour and air to escape
7 power plugs for the bulb and fan
8 Main power supply 230V AC



Working principles of the prototype or invention

When the halogen bulb and the mini-fan are switched on, the air in the box will be heated up from about 30ºc to 55ºc. At the same time the mini-fan will keep the hot air circulating in the box. Thus, the temperature of the air will maintain at about 55ºc throughout the whole drying process. The water in the wet shoes will evaporate and the water vapour will escape through the ventilating holes. The humidity level in the box will decrease from the initial stage of 80% to about 23% as the water vapour escapes through the ventilating holes. The whole drying process should take about 1-3 hours

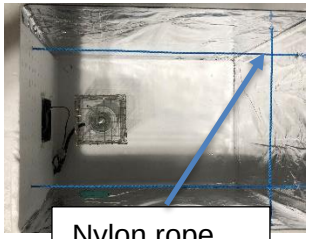
Improvement and modification

After our testing we are quite happy with our invention as the project can dry out the shoes in a short period of time. It is ideal to dry out the wet shoes during the raining season. But we find the invention can be further improve by adding some modification and improvement to make it work even better.

1.We found that if the shoes were not properly placed in the box they might fall down especially when three pairs of shoes were drying at the same time. So, we decided to use the nylon string to hold the shoes in place.

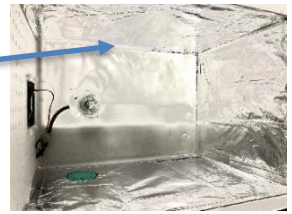
2. We decided to make a metal enclosed cover to cover the bulb to prevent the shoes or our fingers from touching the hot bulb glass surface.

3. When the fan was switched on and if something touching the blade of the fan it might cause the blade to break. We decided to add a metal cover to protect the fan.



4. We used the aluminum foil to cover the inner wall of the box so that when the heat wave reached the wall of the box it would reflect back to the box and less heat will be wasted.

Aluminum foil



5. As the box was made of Styrofoam and we got it free from the market place, it did not look very nice and presentable. We decided to paint the box with enamel paint.

Final testing of the modified and improved invention

Table using halogen bulb 70 Watts (Testing using one pairs of shoes)

Time interval (Hour)	Temperature © In the box	Humidity In the box	Shoes condition Wet/Moderately dry/very dry
0	28	80	Wet
0.5	52	29	Wet
1.0	55	26	Moderately dry
1.5	55+	23	Dry
2.0	55+	22	Very dry
2.5	55+	22	Very dry

Conclusion

1. From the testing results we can see that the air temperature in the enclosed box reaches about 55ºc within the shorter time as compare to the original design and the nylon rope also can hold the shoes in place properly. We also no need to worry the hot bulb glass surface.

2.The invention is best to dry out one to two pairs of shoes at the same time. The time used to dry out the shoes is about 1 ½ hours. if you need to dry out three pairs of shoes you may need to take another half an hour more.

Maximum can dry three pair of shoes

3. You can buy a timer plug to set the time so when you use this invention to dry out the shoes you do not need to monitor it, the power supply will turn off by itself automatically.

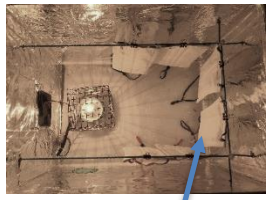
4. We find out our invention not only can be used to dry out wet shoes, during the COVID-19 we can also use this invention to dry out our washable facemasks.

Our invention can also use to dry out our socks during raining season. In conclusion we can say that our invention is a multi-purpose drying box.

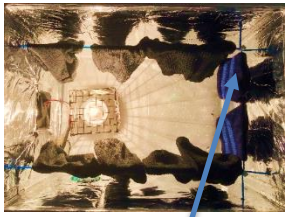
24h timer plug

5.The constraint of this invention is very difficult to buy the halogen bulbs as the filament bulb is replaced by the high efficiency LED bulb for lighting. It is quite difficult to buy halogen bulb from retail shop.

6. While the bulb is switched on the filament is very fragile, if you move the box at this time the filament of the bulb may break and you have to buy a new bulb



facemasks



school socks

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Some pictures taken while we constructed our invention.