Hwa Chong Institution
Project Work
Category 3
Inventions Log Book
(Revised for 2020)

Title of Project: Eco-Taps
Group Name: Eco-Taps
Group Members: 1) Tan Myn Jae 2) Tan Jing Yi

1. Problem Finding

(The beginning...)

Identify a problem you would like to solve. You may want brainstorm for problems using different approaches eg thematic, survey or general brainstorming etc.

1 A Document a list of problems you have identified. Your documentation should show clearly how your group came up with the problems.

- Carbon emissions: CO2 concentrations in the atmosphere are now well over 400ppm – their highest levels in over 800,000 years.
- Land Contamination: Much of the waste we produced is either incinerated - causing potential air pollution issues - or buried in landfills, causing soil pollution problems.
- Healthcare for ageing population: By 2035, it is estimated that around 32 percent of Singaporeans will be aged 65 and above, while the median age was also expected to rise from 39.7 in 2015 to 53.4 in 2050.
- Deforestation: Deforestation not just removes vegetation that is important for removing carbon dioxide from the air, but the act of clearing the forests also produces greenhouse gas emissions.
- Water Shortage: <Explained below>
- Trawling nets destroying corals: Bottom trawls and other kinds of unselective fishing gear cause harm to other fisheries and to the marine environment by catching juvenile fish, damaging the seafloor, and leading to overfishing
- Excessive use of Plastic: Plastic pollutes many areas, such as land, oceans, etc. Animals tend to mistake plastic as food, and when they consume it, the plastic contaminates and kills them.

1 B You should have selected a problem based on some considerations. Identify and justify these considerations.

In order to choose the most promising problems out of the problems that we came up with, we had to take note of the considerations listed below:

- Magnitude of problem
- Practicality of the problem
- Difficulty of the problem

Using the above considerations, we shortlisted 3 problems that we could possibly work on:

1. Water Shortage in Singapore
2. Excessive use of Plastic Bags
3. Destruction of corals by Trawler Nets

1 C List some problems your group would like to solve. List also the considerations for selection of problem in the evaluation grid below. Score the considerations, against the problems, with points 1 (least significant) to 4 (most significant). Sum up the total points for each problem. Identify that problem you would like to solve.

Problem Evaluation Grid

*add more columns and rows where necessary

Considerations for Selection	Problems		
	#1 Water Shortage in Singapore	#2 Excessive use of Plastic Bags	#3 Destruction of corals by Trawler Nets
Magnitude	2	3	2
Practicality	3	2	1
Difficulty	2	1	3
Total Score	7	6	6

2. Define the Problem

(This is one…)

Now that the problem has been identified. It is important to gather information on the extent of the problem and/or evaluate the usefulness of existing solutions based on *some criteria*. You may need to conduct surveys and research on existing solutions.

2 A Extent of problem (Research and discuss the problem and write down the problem statement)

Problem Statement: "How can we create a product that will help us to obtain and reuse water through renewable water sources?"

Target users: The general Singaporean community.

Although Singapore is a city island surrounded by water, it is densely populated and the seawater around it is not enough to supply the water needs of the citizens. Water demand in Singapore is currently about 430 million gallons a day (mgd) that is enough to fill 782 Olympic-sized swimming pools, with homes consuming 45% and the non-domestic sector taking up the rest. By 2060, Singapore's total water demand could almost double, with the non-domestic sector accounting for about 70%. To solve this problem, the government has set up the 4 National Taps: Desalinated Water, Local Catchment Water, Imported Water and NEWater. However, as Singapore's population increases over the years, NEWater and desalination will have to meet up to 85% of Singapore's future water demand.

We also conducted a survey to test how aware people were of their water consumption. We conducted a survey to see how aware Singaporeans are about the current problem. We put the following questions into the survey, and part of it was a quiz.

1. How important do you think conserving water is?
2. Do you think it is important to raise awareness about conserving water?
3. How well do you know about Singapore's water shortage?
4. What is Singapore's current water demand? (2m)
5. How much water does the typical Singaporean use per day? (2m)

6. Which are Singapore's National Taps? (4m)
7. Which method does not save water? (2m)

The results of this survey can be found in Figs. 1 to 7. The results showed that the Singaporean community did not know much about their water consumption and how to reduce their water consumption. This highlights the need for an invention to ensure a continuous and sustainable water supply for the Singaporean community.

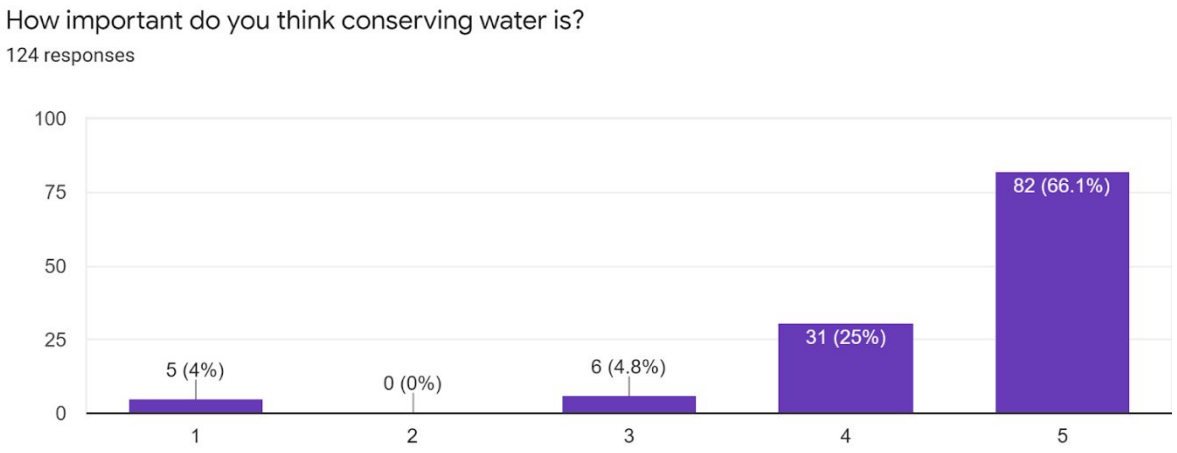


Figure 1: How important do people think conserving water is?

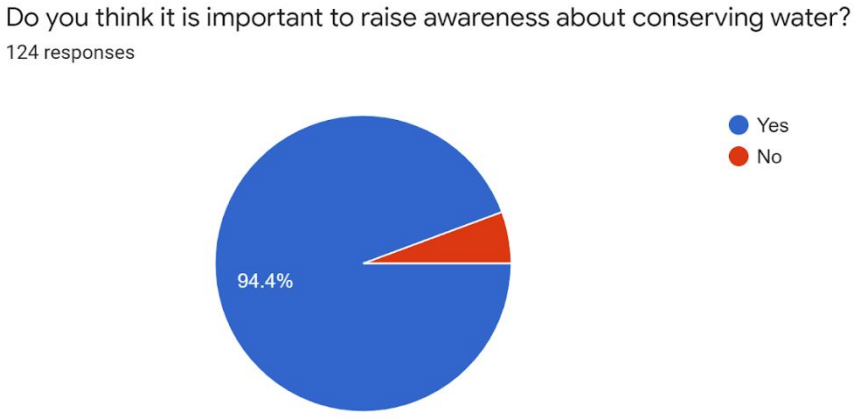


Figure 2: How important do people think raising awareness about conserving water is?

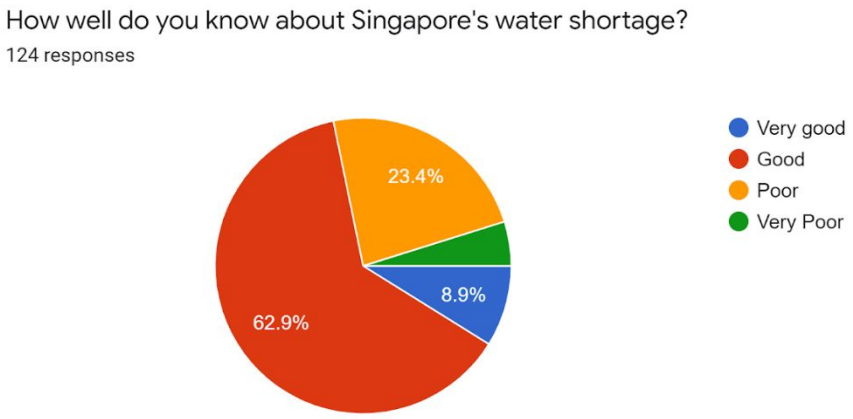


Figure 3: How well do people think they know about water shortage?

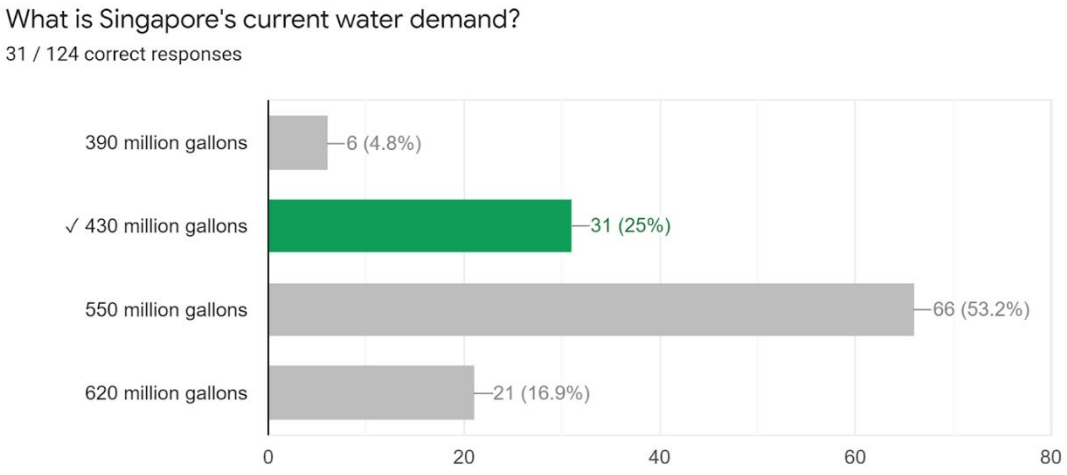


Figure 4: How well do people know Singapore’s water demand?

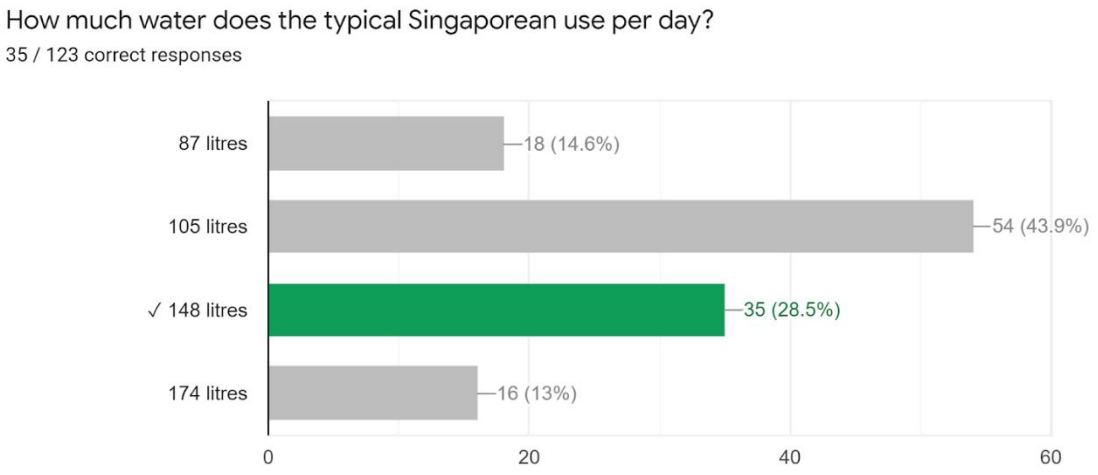


Figure 5: How well do people know about the average Singaporean's water consumption per day?

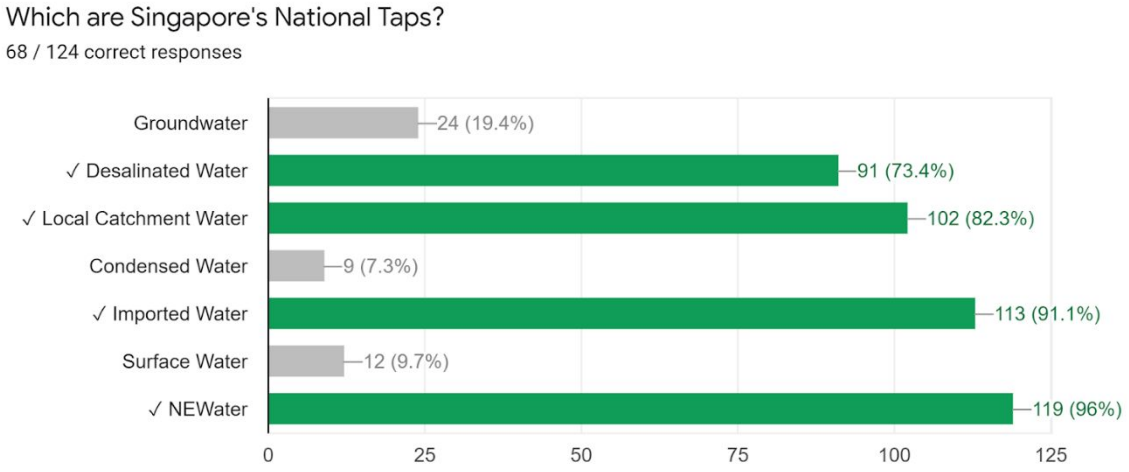


Figure 6: How well do people know Singapore's water demand?

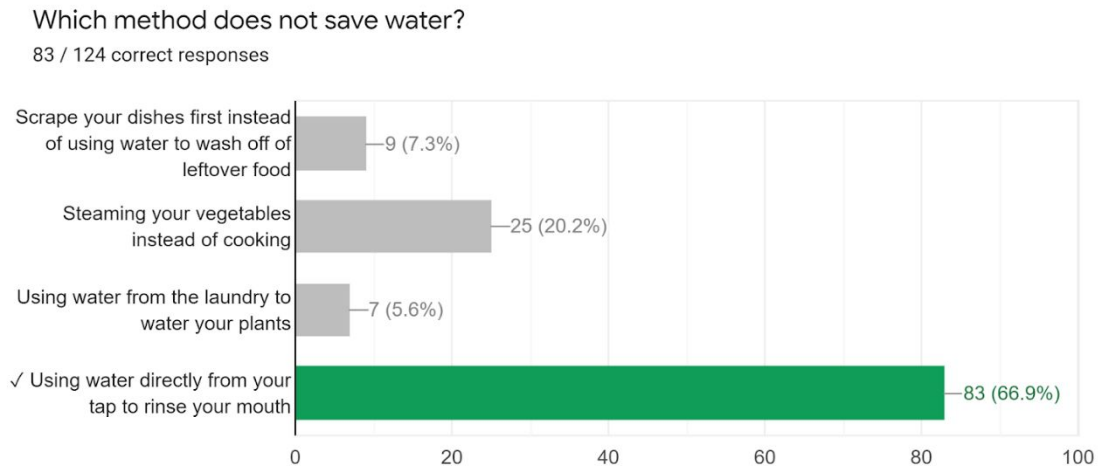


Figure 7: How well do people know about methods that can save water?

2 B Compare and contrast the existing or similar solutions.

Existing Solution 1: LifeStraw

LifeStraw is a special type of straw which contains filters inside it. The filters help to clean the water, making the water suitable for drinking (Fig. 8).

Advantages	Disadvantage
- Removes bacteria, parasites and microplastics - Durable and ultralight: weighs only 2 ounces (0.10 lbs)	- Cannot filter out waterborne viruses - Cannot filter heavy metal contamination in water sources - Not a good development tool as it lacks sustainability

- Long-lasting: filters 1,000 gallons (4,000 litres), enough drinking water for an individual for over 5 years - Easy to clean	- Should not be shared - Cannot be used by children

Existing Solution 2: SunSpring

SunSpring is a system that uses GE nanotube filtration technology (Fig. 9). It helps to provide clean water to people living in poverty all over the world.

Advantages	**Disadvantage**
- Very efficient - Removes 99% of particulate matter, turbidity, bacteria, viruses, and cysts - Can filter up to 5,000 gallons of clean water per day for 10 years and beyond	- Needs electricity to work - No storage tank option - Not effective on muddy water

Existing Solution 3: Carbon Fibre Aerogel

The Carbon Fibre Aerogel (Fig. 10) is made of a special type of material that helps to absorb oily things and other waste. As such, it is very useful in industries like the oil industry.

Advantages	Disadvantage
- Cheap Easy-to-manufacture - Can clean huge amounts of waste water at a large scale - Absorbs 190 times its weight in waste, contaminant and microplastics	- Water may not be safe for drinking because of other unknown particles inside the water - Oily water is not usually produced during the daily lifestyle (Product will not be so usable)

Existing Solution 4: WaterRoam Filtration System

The WaterRoam Filtration System is a portable device (Fig. 11) that allows the poor people to extract water, purify it and make it suitable for consumption.

Advantages	Disadvantage
- Lightweight Portable (It is no bigger than a bicycle pump) - Can provide clean water to villages of 100 people for up to two years - Has provided clean drinking water to more than 75,000 people across Southeast Asia.	- Requires complementary solutions to remove chemicals and heavy metals

3. Your BIG IDEA[#]

(Developing the idea....)

Write down your proposed invention and why you want to do it. State also how you think your proposed invention is better.

3 A Describe your proposed invention.

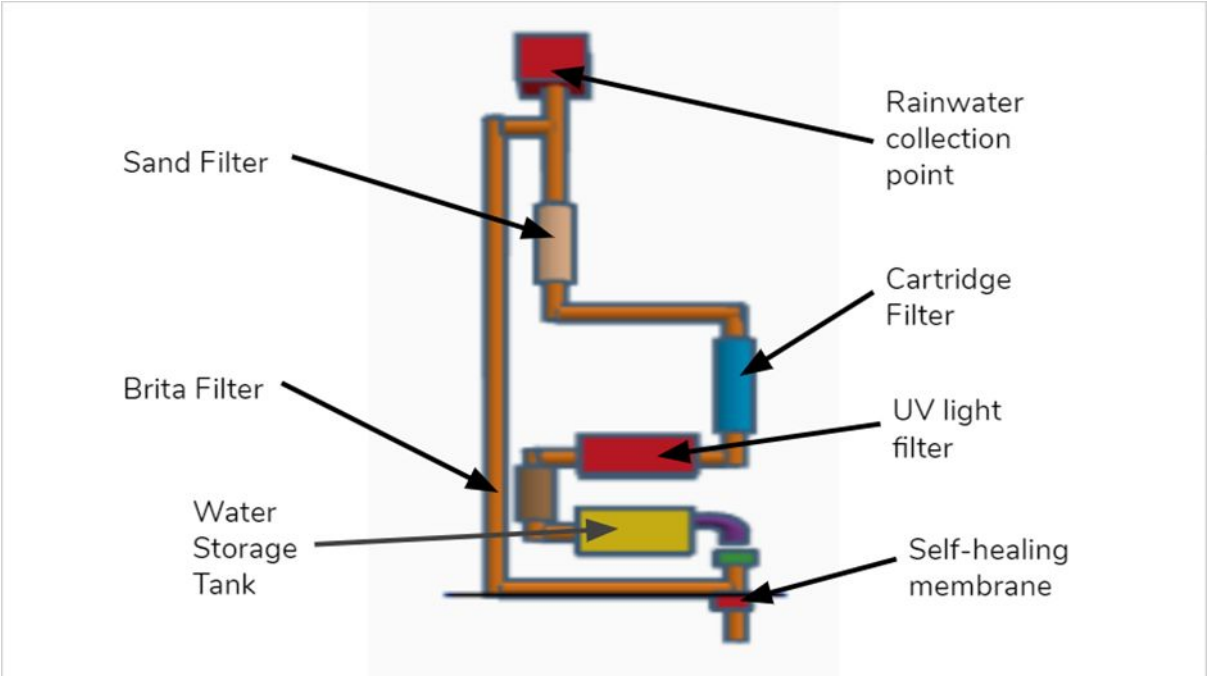
The proposed invention is basically a NEWater system that can be operated on a smaller scale as compared to a national scale (Fig. 12). The design of the pipes allows water to be reused, so that the user will have a constant supply of water.

The proposed invention consists of 5 different filters:

1. Wire mesh (sieve)
2. Sand filter
3. Cartridge filter
4. UV light system

5. Brita filter

The filters have different filter efficiencies which are in descending order (Fig. 13) in order to ensure that no one filter will clog up. The smallest particles that are filtered out from the water in this system is 0.2 microns. As the size of a water molecule is only 0.000282 microns, water molecules will be able to pass through the filters. On the other hand, bacteria range from 5 – 50 microns, which means that bacteria cannot pass through this system.



Sand filter: Sand Filters are generally the most compact and affordable option to filter an in-ground or above ground pool. Sand Filters use specially designed Pool Filter Sand that removes the dirt and debris

Cartridge filter: Cartridge filters can remove sediment, metals and some microorganisms from the water. They can filter around 10 to 15 microns.

UV light water filter: UV water filters use the electromagnetic energy of the light to offer protection against harmful substances in water by attacking them at their DNA. The UV energy destroys illness-causing microorganisms by altering their DNA and eliminating their ability to reproduce. UV light water filters can filter around 5 to 10 microns

Brita filter: Brita filters remove elements such as calcium, magnesium, chlorine and lead. Brita filters contain activated carbon pearls which are used to purify liquids and gases. Resin beads used in ion exchange water treatment. Ion exchange is a water treatment process commonly used for water softening (removal of calcium, magnesium, and certain other metal cations in hard water) or demineralization, but it also is used to remove other substances from the water. They can filter around 0.2 microns.

Filter	Filter Efficiency
Sieve made of wire mesh	Large objects like leaves
Sand filter	20 - 40 microns
Cartridge filter	10 - 20 microns
UV light system	5 - 10 microns
Brita filter	0.2 microns

Filter	Filter Cost
Sieve made of wire mesh	$0
Sand filter	$600
Cartridge filter	$20
UV light system	$600
Brita filter	$450
Pipes	$1,067
Reverse Filter	N/A
GRAND TOTAL	**$2737**

3 B Explain the purpose of your proposed invention and the potential benefits to users.

Our invention is purposed to benefit users that would like to recycle water so they do not need to waste money on monthly water bills. Our invention suits the kitchen where much water is used to clean vegetables or meat. Despite the expensive initial price of the product, in the long run saving money from water bills will be more worth it. This product also helps the environment as it recycles water and makes sure waste water does not flow to pollute water sources like rivers and seas.

3 C In what ways would your proposed invention be different and/or better than existing solutions, if any?

The proposed invention is self-sustainable as it relies on reused water to produce clean water. This proposed invention also maximises the use of water as the water can be reused many times. The water is also not affected by external conditions, as it relies on reused water to work. Even if there is a lack of water in the system, there is a water storage tank to store access water and a rainwater collection point to collect rainwater. Recycling water prevents pollution by decreasing the amount of wastewater that must be discharged. The filters of this system can also keep themselves working and do not require frequent maintenance.

3 D What are some problems you expect in the course of your proposed invention?

The water may not be balanced in terms of pH value. To solve this, we can add a pH adjuster to the system. However, we have not tested the water, so we do not know if the pH adjuster is required.

This proposed invention is also expensive (Fig. 14), and we feel that we could have made it cheaper by removing some of the filters. However, as we were unable to physically create and test the prototype, we did not know which filter worked and which filter did not work.

The power required to power this system may also be a lot. However, this could be partially solved by adding turbines along the pipes to harvest electricity from the flowing water. This would generate electricity which could be used to power the system.

3 E What and when are the major milestone (project timeline) in your invention?

February: We came up with an idea to generate electricity through flowing water.

March: We decided against that as the magnitude of the problem was too small and came up with the idea of recycling and reusing water.

April: We added our first initial filters: cartridge filter and UV light water filter.

June: We started building our first prototype.

July: We finalised our ideas and added more filters (Sand filter, Brita filter) to ensure cleaner water.

August: We finished the logbook and presentations.

#***must be able to be constructed based on current / emerging technologies, must not violate the laws of Science or go against the laws of nature.***

4. Proposed Construction <u>or</u> Modelling Process*

(This first... then that...)

You are now onto the fabrication of your prototype/ product. You need to select material and understand how to put them together so that your prototype/ product can perform its function.

4 A Explain how and why the materials were chosen for the prototype/ product of your invention

4 B Explore these considerations that may guide the construction of your prototype/ product.

4 C Propose how the prototype/ product will be constructed or developed. You may use drawings and photographs.

<u>OR</u>

If construction of the prototype is not possible, then you have to create an animation / as a proof of concept that it can be applied in a bigger scale.

4A Explain why construction of a prototype is not possible and the proof of concept is needed in your case.

For this project, we were unable to make a full working prototype or a simulation. Due to cost restrictions, we were unable to obtain the materials required to build a fully workable prototype. Due to lack of video/animation tools to customise the content in the

video/animation, we were also unable to create a video/animation. However, we have a picture with explanation and evidence from sources to prove that the prototype will work.

4B **Briefly explain how the video / animation can effectively show how your invention will work and the different considerations.**

For obvious reasons, the invention will be too large and expensive to build it out, and partly because we do not have the money to do so. In the end, we built a prototype online with components. We did a 3d model online and we labelled it.

5. References

Read http://www.bibme.org/citation-guide/apa/ on how to cite references.

5 A **Cite the references you have used for your project work. Your source of reference should come from different types (eg books, magazine, websites, journal articles, interview, photographs, product brochure, reviews etc.)**

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