September 23, 2010

Dr. Andrew Rawicz
School of Engineering Science
Simon Fraser University
Burnaby, British Columbia
V5A 1S6

**Re: ENSC 440 Proposal for a Portable Filtering System**

Dear Dr. Rawicz,

The attached document outlines our project, *Portable Filtering System (PFS)*, for ENSC 440. Our attempt is to develop a product that is capable of filtering undrinkable water while it is being transported, thus saving the user time and energy which would traditionally be wasted on filtering the water once it had reached its final destination.

In this document, we further discuss the workings of our product while also giving you more details about its creators, the costs involved and the timeline we hope to follow in the development process.

Our team is comprised of four senior engineers who each, with their varied backgrounds, bring varied points of views and ideas to the table in order to tackle this project. If you have any follow up questions please free to contact me via phone or email listed below for clarifications.

Regards,

*Vaibhav Mal*

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AquaQuick Solutions

# Proposal for
# Portable Filtering System

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***Submitted to:*** Dr. Andrew Rawicz – ENSC 440
Michael Sjoerdsma – ENSC 305

***Issued Date:*** September 23rd, 2010

# Executive Summary

*"....Water water everywhere,*
*Nor any drop to drink…."* - Samuel Taylor Colridge

Those famous words, first written for mariners out at sea, can aptly sum up the plight of millions of people in rural areas of developing countries. People in these areas have to not only walk miles to get to a water source but also spend copious amounts of time filtering the water once they bring it home. Our Portable Filtering System (PFS) aims to help people in such situations by filtering the water while it is being transported, hence ensuring clean usable water for the user once he arrives at his destination.

The PFS itself will consist of a series of cylinders mounted on a frame with wheels. The movement of the wheels acts as the source of power that we will use to filter the water. This combined with the fine mesh on the mouth of each cylinder will replicate the process that is carried out in an average household to make the water safe for consumption while cutting the time and extra energy that would be wasted on this process.

We have estimated the budget of this prototype around 800$. Though this may seem steep for just one unit, we had to take into account replacement parts that we may require and also factor in a certain amount of money for a "Plan – B" in case something goes wrong closer to our deadline. Majority of this funding has already been secured through the Engineering Student Society Endowment Fund (ESSEF) and we also plan to apply to the Wighton Fund and contribute ourselves if such a need arises.

Our team is very excited at the possibility of producing a product with such far reaching and lasting effects on people's lives and while we would all like to be involved in all aspects of the development, we have very clearly laid out responsibilities and task according to the members strengths to streamline our process and make sure every aspect gets the care and attention it needs.
These delegations (discussed in more detail in the document) make us confident that we will be able to build a durable, cheap and reusable solution to the water-filtering problem once and for all.

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# Introduction

Every day in rural areas housewives, wake up before the wake of dawn and start their daily trek to the nearest water source, carrying with them as many containers as they can balance on their head and hands. Some enlist their children as extra carrying hands to save themselves an extra trip. After filling up the water they make the same trek back home and set about making the water suitable for consumption before setting about their other duties.

Immediately, it is obvious that there should be a way to help save time and energy during this tedious process that they undertake every day. We propose to make a Portable Filtering System (PFS) which not only makes the trek easier by putting the carrying containers on wheels and on a single cart, but also saves the time and energy spent in the filtering of the water once home by filtering it during the journey itself.

The presence of the wheels, while a great way to make the carrying easier, serves a much greater purpose. The rotation of the wheels powers up a generator/ charges a battery that are the main sources of power used to filter the water. Larger impurities are caught by a fine mesh fitted on the mouth of each cylinder starting the filtering process from the minute the water is poured into the cylinders. We have also fitted a gear system that amplifies the RPMs produced by the wheels so as to accommodate the walking speed of even the slowest person. The presence of the battery ensures continuous powers supply even if the person stops to take a break for any reason.

The advantages of our product are quite obvious and evident. It not only makes carrying the water easier, since you can drag a much heavier load than which you can carry, but it also saves time and energy spent on the filtering process since the energy is self produced by the motion of the wheels. We must also remember that in such rural areas the primary source of energy in most houses is burning fuel or wood and by cutting out a major energy consuming process it is also financially advantageous since lesser fuel is now consumed.

In this proposal we will outline our product, why we chose to implement it a certain way and our timeline of deadlines that we expect to maintain.

# System Overview

Our system is based on four major systems interacting with each other. The user is one of these and is key in our design. Without the user pulling the system there can be no generation of power. We can think of the user as a proxy power source.

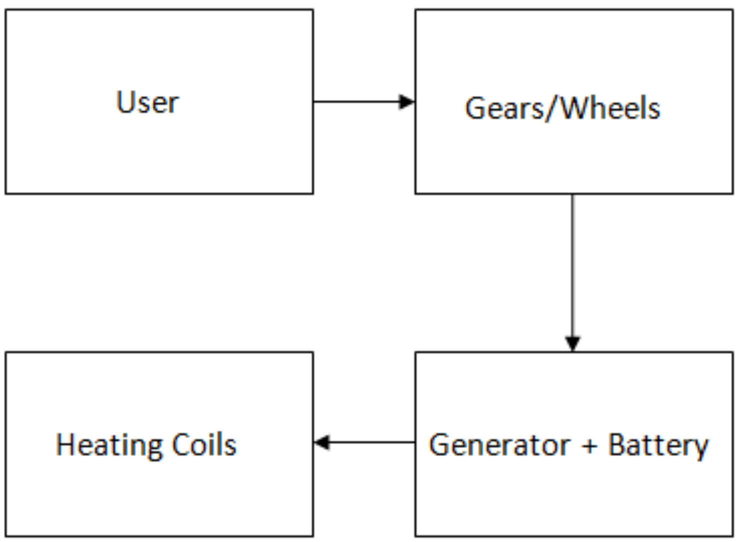


**Figure 1:** System Interaction Overview

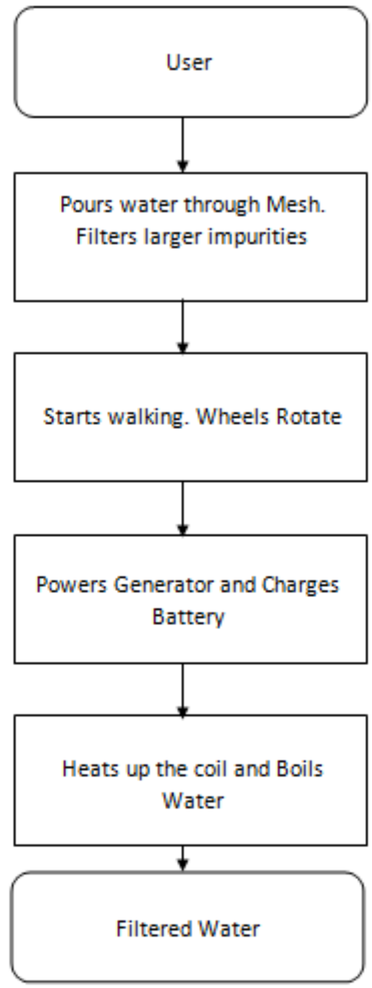


**Figure 2:** Water Filtering Flowchart

The other systems are the Wheels/Gear system, Generator + Battery and the Heating Coils. Once the user starts pulling the cart, the wheels start rotating. The axle of these wheels is connected via a system of gears to the generator, which is then brought to life due to the rotation. The power generated by this process is first captured in a battery, which acts as a buffer, providing continuous power supply even in case the user stops moving for a brief amount of time. The power supply is used to heat up coils of wire that run across the length of the cylinders causing the water inside to be boiled, which is the main process involved in filtration.

# Possible Design Solutions

## ➢ Solutions to filter water

Though there are many ways to filter water, they can be classed into three main categories: physical barrier, chemical process and biological process. Usually, natural water includes bacteria, slit, clay, polymers and other insoluble substance, such as suspended particles and the following are the few methods used to remove those.

### Physical barrier

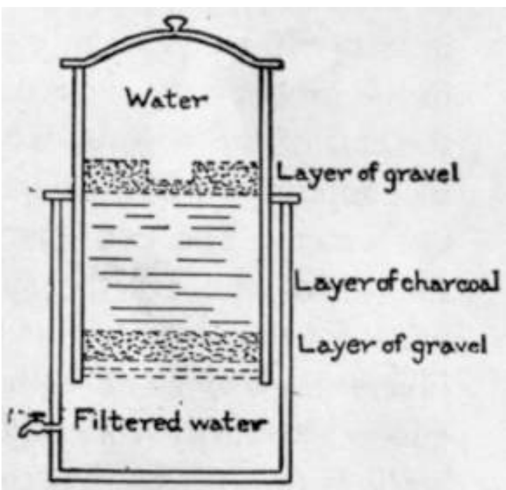


**Figure 3:** Physical barrier Filtration

The basic idea of an interception filter is that if the water follows a fixed path through the layers it will be pure once it has gone through all the layers.

As this technology requires no mechanical power and due to its simple design, it matches our main purpose perfectly. However, because of the slow filtration rate, it is not a viable solution given what we are trying to accomplish. We will, however, simplify this filter and use its basic principle as the first step of our filtration process to intercept larger particles.

### Chemical Process

**Figure 4:** Chemical Process Filtration

Aluminum Sulphate ($Al_2(SO_4)_3$) is widely used for water treatment around the world. As a coagulant, it will cause the following chemical reaction: $\mathbf{Al_2(SO_4)_3 + 6H_2O = 2Al(OH)_3 + 3H_2SO_4}$. The resulting Aluminium Hydroxide ($Al(OH)_3$) is in the form of large crystals which can be easily filtered out. However, acquiring Aluminium Sulphate on a regular basis is neither a cheap or a reusable solution, which is our main goal.

## Boiling

Boiling is the best way to kill bacteria and virus. From the graph we can see that the activity of most virus and bacteria will decrease as temperature increases. When the temperature is higher than 115 degrees, activity will be lower than 1.

According to scientific research, boiling water for more than five minutes at a temperature of 100 degrees or higher results in the killing of more than 95% of bacteria and virus.

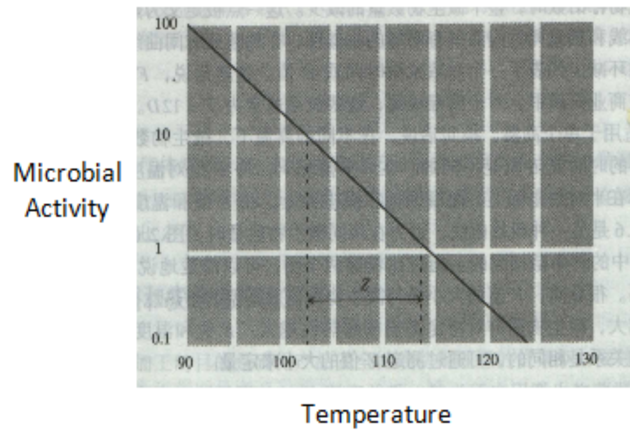


**Figure 5:** Filtration through Boiling

# ➢ Solutions to energy supply

## Electromagnetic induction generator

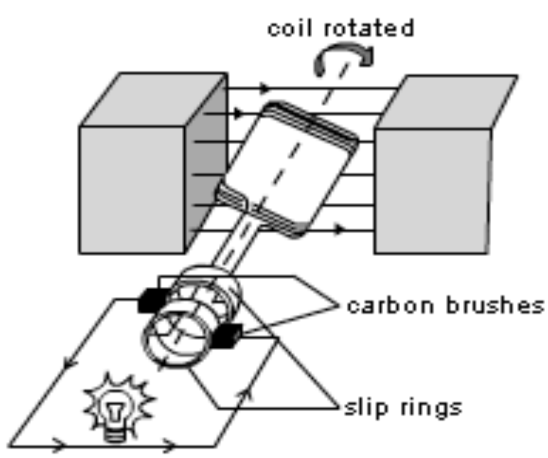


**Figure 6:** Electromagnetic Induction Generator

Using the theory of electromagnetic induction, we can change mechanical energy to electric energy by rotating a coil inside a magnetic field or rotating a magnetic field around the coil. We prefer this idea for our power source since the wheels of the cart already provide us with a rotational motion which we can capitalize upon and use for this purpose.

## Solar powered generator

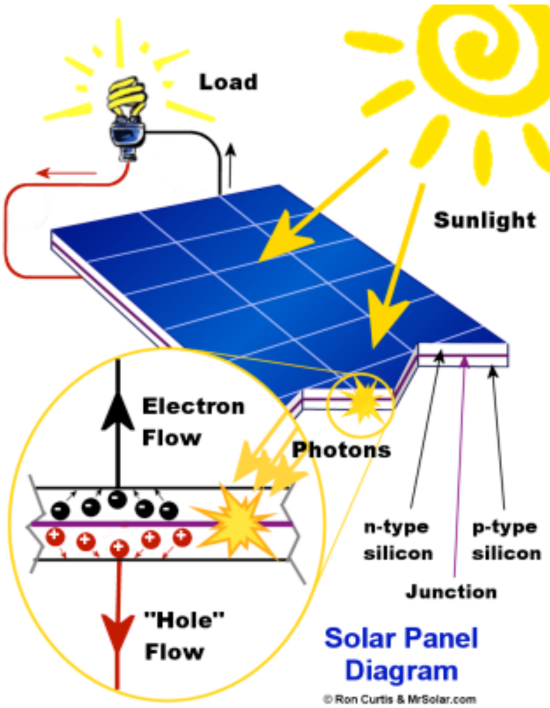


**Figure 7:** Solar Powered Generator

A Solar panel system is the most green source of power but at the same time is the most expensive source of power. Given our need to make the product as cheap as possible we cannot justify the use of solar panels. Additionally, solar panels are extremely fragile and would most likely break given the terrain over which the filter would be dragged.

# Our Prototype

Our main goal is to build something that is not only reusable and durable, but given the demographic we are trying to help, cheap and easy to use. The user should be able to operate it with minimal instructions and should not be expected to maintain it or be responsible for its up-keep. Keeping these requirements in mind we chose certain specifics because we feel they fit the need perfectly.

- *Boiling*: We chose boiling as our main method of filtering over other methods since this is not only one of the more effective methods but it is also the simplest and easiest to implement. We do not need to worry about chemicals running out or any other malfunctioning. As long as the wires and generators last pure water is guaranteed.

- *Power Supply*: We chose to power our PFS with the self-generating power of the wheels because, again, this is the cheapest way to implement this solution. Also in case of a break down of wheels, they are easily available and replaceable. If we were to use something like solar panels, which are the next most obvious candidate, the price would not only be much higher but the durability of the product will suffer since the panels are extremely fragile.

At this point, we are unable to provide you with a design of our prototype since we are experimenting with various designs to maximize water capacity and minimize the difficulties faced by the user while interacting with the PFS.

# Budget and Funding

The project proposed budget comprises of equipment costs. The estimated cost for the prototype is broken down in the following table.

| Equipment List | Estimated Unit Cost |
|---|---|
| 2 Large Magnets | $50 |
| 2 Pulleys (40cm and 5cm) + Weddings | $25 |
| Wheel (4) and generator (2) bearings | $50 |
| 4 Metal Bars + 4 Wheels (50 cm diameter each) | $110 |
| 4 Plastic containers (4L each) | $50 |
| Large Coil + 5 m heating wires | $150 |
| 2 planes of wood 0.5 X 1 meter each | $20 |
| Cylindrical Metal case for the generator | $70 |
| Belt 150cm circumference (similar to ones used for alternator in the car) | $40 |
| Screws, nuts and metal joints | $30 |
| Plastic tubes 4cm diameter and 3 m long | $30 |
| Rechargeable Battery 15-20 Volts | $25 |
| Regulator 15 Volts | $25 |
| Total Cost | $675 + Shipping + Tax |

**Table 1:** Equipment cost breakdown

The initial cost of research and design of a prototype is much higher than what we expect of the production cost. Once the design is finalized, the parts will be bought in bulk thus bringing down the expenses.
We plan to apply funding through both ESS Endowment Fund as well as Wighton Development Fund.
In addition, we may be able to obtain some of the components as free samples from their manufactures. Development costs will be much less as we will make use of the open labs provided by Simon Fraser University.

# Project Schedule

In order to meet our goal of project completion by December 2010, we have created a project schedule (Figure 8) and technical development (Figure 9) outlined in the Gantt charts. The first Gantt chart shows the project management tasks and the second Gantt chart shows technical milestones, assuming we have the parts by the end of September.

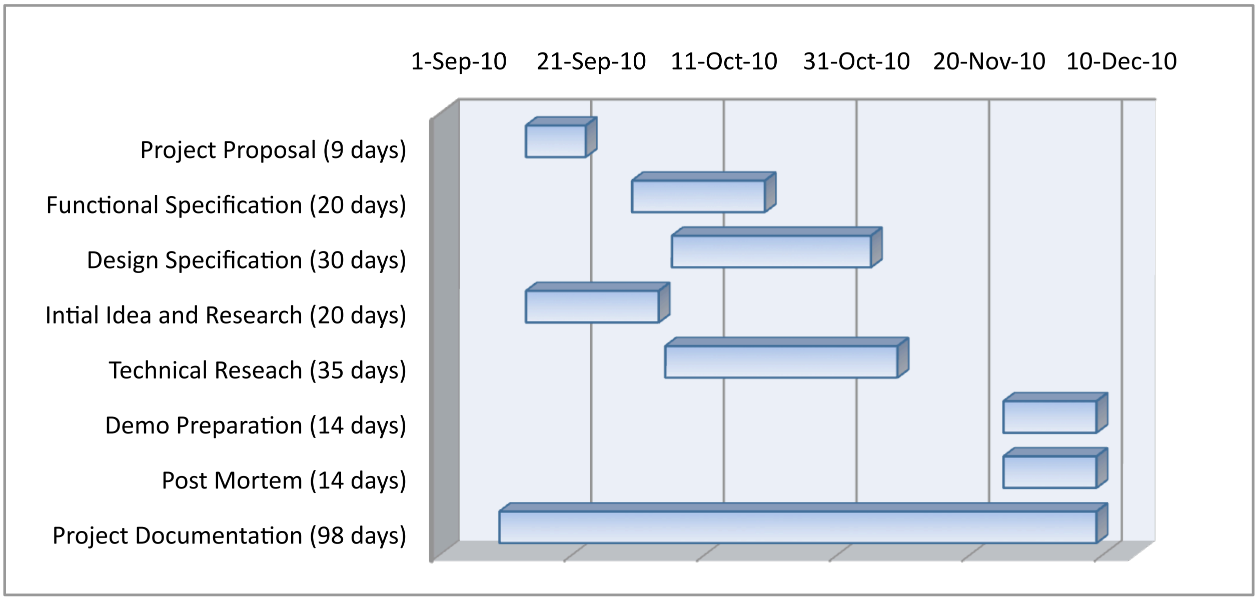


**Figure 8:** Project Gantt Chart

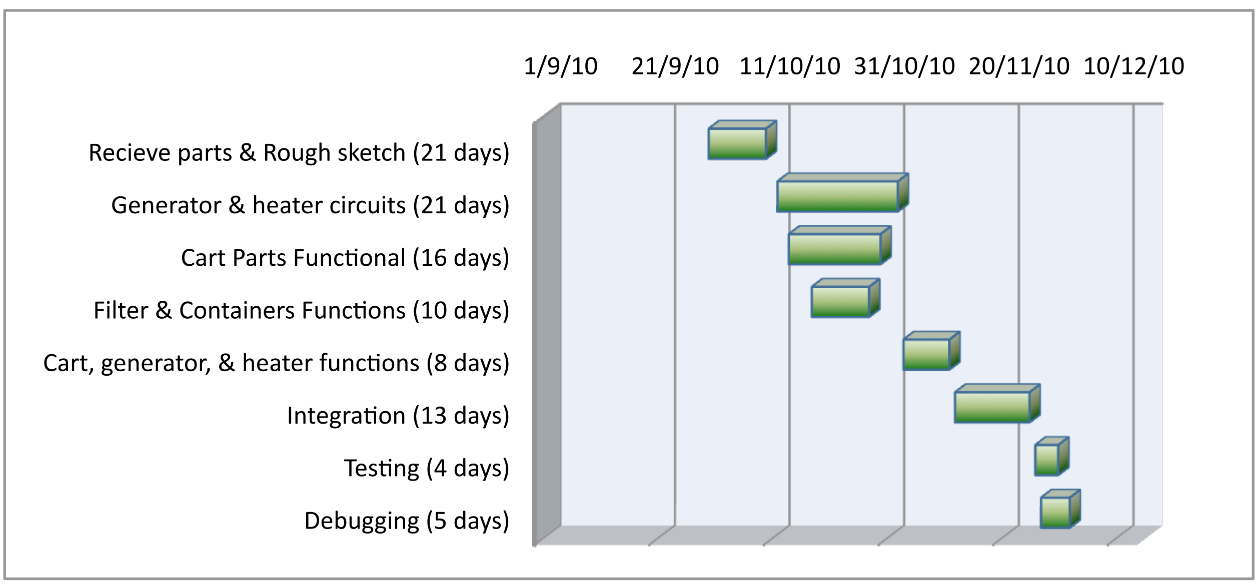


**Figure 9:** Technical Development Gantt Chart

T he following Figure 10 shows our project milestones and deadlines we expect to meet. The approximate start date is September 15th and we expect to have a working prototype as well as all other supporting documents by mid December.

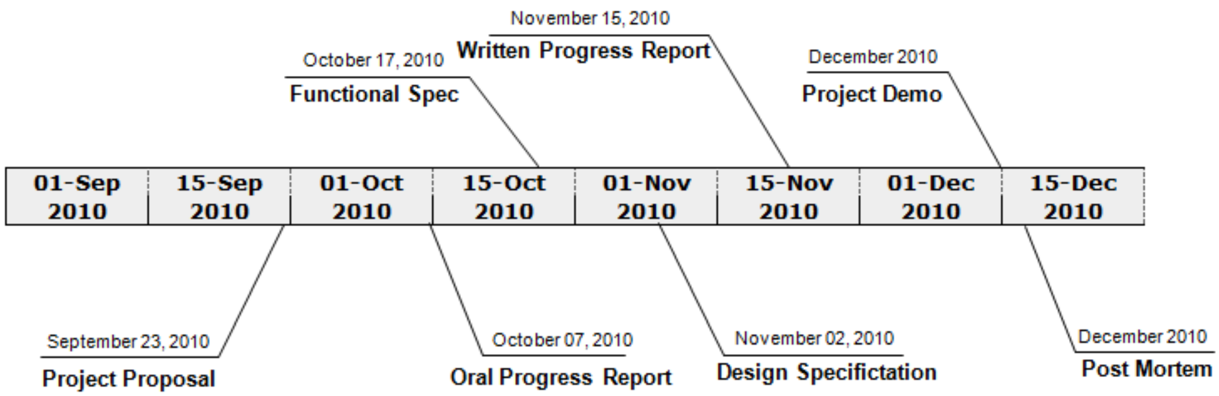


**Figure 10:** Project Milestones

# Our Company

## ➢ Company Profile

### Vaibhav Mal

Vaibhav is currently in his final year in the Electronics Engineering at SFU. Having worked extensively with people in rural parts of India, he is able to not only understand their problems very well, but also able to use the analytical and problem solving skills developed during his tenure at SFU to approach the problems in a realistic and practical manner. Additionally, his experience in reliability testing and usability are extremely useful in developing a product that we can be extremely confident in.

### Shivam Mathur

Shivam is a fifth year Systems Engineering student at Simon Fraser University. He has completed co-op term at Research in Motion where he worked a Software Developer. He has extensive experience in programming languages such as Java, C++ and C#. In addition, he has experience in product testing and knows reliability and usability issues that may arise in any product cycle. Through his courses, Shivam has developed a solid understanding of mechanics of a physical product. His experience with sensors/actuators and control theory will be an asset during our project. In addition to Shivam's technical experiences, his involvement in the Engineering Science Student Society has given him organization and financial management skills.

### Jie Gu

Jie is currently a fifth year engineering student at SFU. His last co-op position as a Systems Engineer entailed designing, manufacturing and testing Automatic Teller Machines for multinational customers and also communicating with business, research & design departments. During his time at SFU he has earned lots of experience in software programming, testing and network technology and has done collaborative work with Mechanical and Electronics Engineers and is a definite asset to have on the team.

### Adam Tanbouz

Adam is in his final year of Electronic Engineering program at Simon Fraser University. Before joining SFU, he had been working for 16 years in power generation and water distillation plants as a senior electronic technician, responsible for maintaining the data logging monitoring systems and distributed control systems. He also worked for repairing Electronic appliances. He is familiar with using the electronic measurement tools and electronic components. From electronic courses, he has gained the knowledge in electronic circuits, electronic control, and electronic design by using software programs and microcontrollers.

## ➢ Team Organization

AquaQuick was formed by Four Engineering students, Vaibhav Mal, Adam Tanbouz, Jie Gu, and Shivam Mathur, each with different experiences and backgrounds.

All members contribute solutions and ideas to the various design and implementation problems that arise, but to ensure that the work is organized and the steps are completed on time, we have assigned certain majors task for each member.

Vaibhav is responsible for the main design of the PFS. Additionally, he is tasked with following up with other members to ensure that each member meet the deadlines asked of him while also overseeing the general progress of the project and resolving any conflicts that may occur.

Shivam's background in systems makes him the perfect candidate for designing the mechanical part of the product. In addition, he is also responsible for the finances of the project, making sure that we have a well planned budget that we do not exceed.

Adam and Jie will manage the hardware design and the implementation of the electric and heat generating components used to filter the water. They are in charge of finding solutions to most of the technical problems that may arise, the main one being the generation of adequate energy to boil the water. Additionally, Jie is also in charge of the general marketing of the PFS.

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