Atmospheric Vapor Extraction Device

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Problem Definition and Project Plan Report

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Introduction

Our team wishes to put into practice an idea proposed by Chris Allender who is a biological sciences graduate student at NAU. Chris wishes to build a device that will help in the study of vapor extraction from the atmosphere. A constant supply of fresh water, coupled with an ever increasing human population has resulted an unprecedented fresh water shortage among developing nations as well as developed nations. Approximately two point five percent of the earth's water supplies are freshwater (time magazine or something 2015). While approximately one percent of these freshwater is easily accessible, the remaining one half percent remains an untapped potential which contributes to the global clean water crisis.

Over extraction of freshwater from the world's reserves has resulted in unprecedented constraints on the supply of fresh water. Despite the numerous advances in the technologies that signify our modern world, such as desalination plants, the overall constraints in the freshwater supply is still a recurring issue among nations. Couple this with non-conservative habits that are common for most households, institutions, and business organizations, the need a for new methods of mining freshwater. As such, innovative techniques like vapor extraction possesses the ability to counteract some of the rising needs for water

Problem Definition

The client, Mr. Christopher J Allender, is looking for a device that is capable of extracting water from the atmosphere. Mr. Allender would like the device to collect data in order to find the optimal condition for which a maximum amount of water can be extracted. Though water vapor extraction devices do exist, there has not been enough research to find the optimal conditions. This project will serve as a teaching tool for future devices, and will possibly be used to aid communities that lack a potable water supply. The team's goal is to create a working atmospheric vapor extraction device that will be tested in different conditions, including: pressure, temperature, elevation, humidity, etc.

Team Mission

The principle aim of the team is to condense water vapor into potable water that utilizing temperature and pressure differences. This device will be used to research optimal weather conditions for similar devices. The data that this device collects will be used to test if this idea is a plausible source of water when typical sources are unavailable, or insufficient.

Design Constraints

The design constraints that will be considered are shown in the following table.

Table 1 Design Constraints

Objective	Basis for Measurement	Criteria	Units
Power required	How much power is needed	Power used	Watts
Low Cost	How much does it cost	Dollars spent	$
Clean	Carbon Footprint	Must produce no pollutants	CO2 %
Quality	How long it works	Years in operation	Yrs. in operation
Safe	How hazardous it is	Number of incidents	# of incidents
Useable water	How clean it is	Number of bacteria	Bacteria %
Collect water	How much water is collected	Volume of the water	Liter

Project Timeline (Gantt Chart)

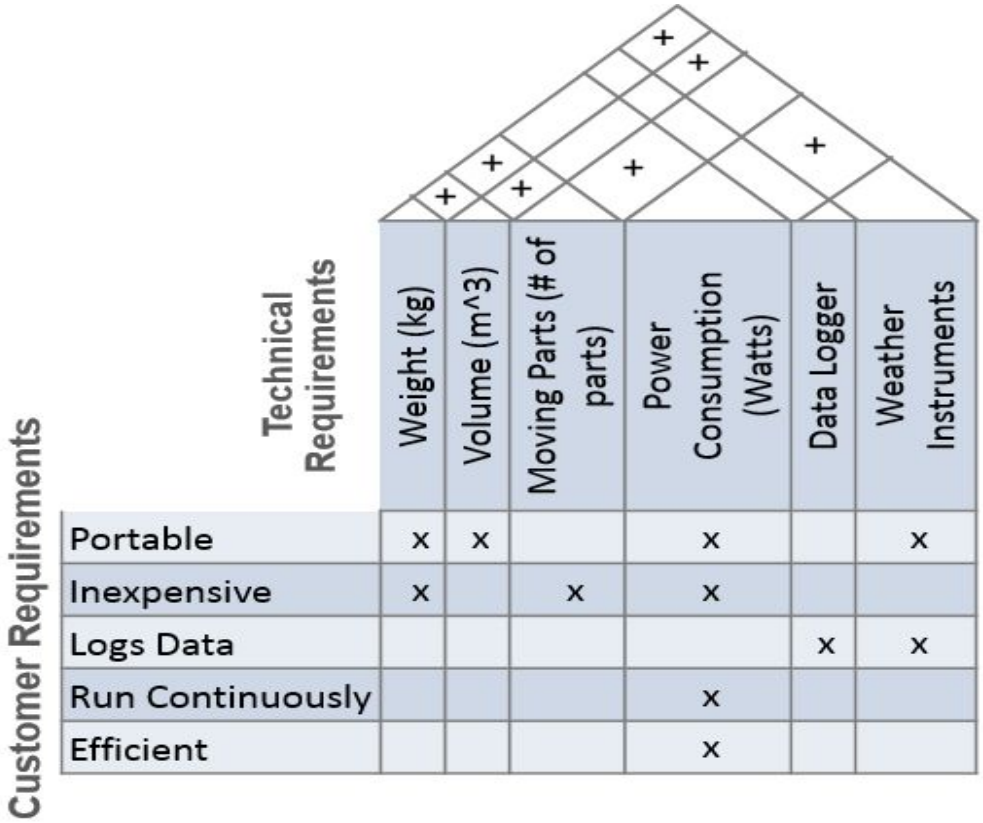
A Gantt chart is a tool that has a list of all the assignments that need to be done, and during what weeks they are to be done. The first three weeks of class primarily consists of the team meeting each other, meeting with the client, and overall planning. This first block concludes with the first set of deliverables. (This report and the corresponding presentation.) The next block consists of the actual design of the product. In this section, the team will look over the technical and economical aspects of the project, and will come up with a design. The third block will be prototyping, and the testing of the prototype. The final block consists of the project proposal.

Table 2: Gantt Chart

A	Tasks/weeks	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1	**Problem Definition and Project Plan**																
1.1	Need Statement																
1.2	Project Goals																
1.2.1	Objectives																
1.2.2	Constraints																
1.2.3	Quality Function Deployment																
1.2.3.1	Engineering Requirements																
1.2.3.2	Customer Requirements																
1.3	State Of The Art																
2	**Concept Generation and Selection**																
2.1	Engineering and economic analysis/ concepts																
2.1.1	Filter through the possible designs																
2.2	Research power requirements																
2.3	Design concepts assembly																
2.4	Material selection																
2.5	Assembly planning																
2.6	Location selection																
3	**Proof of Concept Demonstrations**																
3.1	Prototype assembly																
3.1.1	Test 1 design analysis data																
4	**Project Proposal**																
4.1	Economic analysis																
4.2	Proposal																
	Tasks Due Date																
	Problem Definition and Project Plan Presentations				21-Sep												
	Concept Generation and Selection Presentations								19-Oct								
	Proof of Concept Demonstrations												16-Nov				
	Project Proposal Presentations																7-Dec
	Final Report																7-Dec
		completed	in progress	coming													

Quality Function Deployment

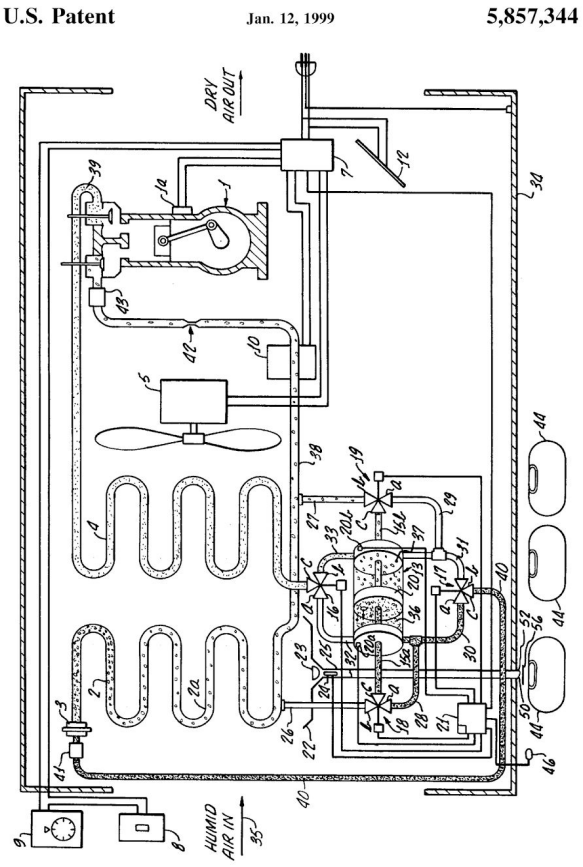
The team created a Quality Function Deployment graph in order to better connect the client requirements, with the technical requirements that are needed to make the product. Our client desires a product that can extract water from the atmosphere, while collecting data on the weather conditions. Taking this need, the team created requirements to make this happen and found the correlations between the two. The "hat" on the top shows the positive correlations between the technical requirements.



State of the Art Research

The beginnings of our research started by finding a US patent that uses the same idea that we were presented with. Patent number 5,857,344 was issued in 1999 to inventor Richard A. Rosenthal from San Jose, CA. This device first compresses air, then cools it which allows the water to condense and be collected. Since its issue date, just under forty patents have referenced this one, proving the validity of this general design.

Most of these designs admit that water is relatively unlimited in typical municipal situations, yet there are still areas that may need additional water. The most notable of these situations are in the aftermath of natural disasters. In these situations, water can be scarce or unobtainable via conventional means, leading many in need water from unconventional sources.



Extracting water from the air can be done on a personal or commercial scale. A company called Aqua Sciences, has taken over the commercial market. Aqua Sciences main target for its commercial products is for emergency relief efforts. For emergency efforts tha t have an Emergency Water Station that comes in varying sizes and water outputs. The 40 ft Emergency Water Station can make up to 2,600 gallons of water a day which is enough to hydrate 5,200 people a day.

This water plant can sustain this amount of water production for up to one week using just the two generators on board. This technology is perfect for short term relief efforts including disasters, contaminated water systems, drought, military applications, and drinking water for mass market applications. Aqua Sciences technology uses a highly concentrated brine solution to attract water molecules out of the air and into the brine solution. Once the water has been extracted from the air into the brine solution, the water then goes through a proprietary hygroscopic water extraction process. Once this process is complete the water is ready to drink (Aqua Sciences Inc, 2015).

Conclusion

As the human population continues to grow, the need for freshwater will continue to rise across the globe. Coupled with the increasing environmental degradation, over mining of freshwater from the world's water reserve continues to affect the environment negatively. Particularly, the atmosphere remains an untapped water source that can counteract some of the negative impacts on the environment. However, a need for more research to establish suitable operating conditions is necessary. Notably, variants of this technology exist. As such, the main objective of the project is in the creation of a portable device to test the optimal atmospheric conditions necessary in the extraction of water vapor from the atmosphere.

References

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Clean Water Crisis, Water Crisis Facts, Water Crisis Resources - National Geographic." National Geographic. Web. 21Sept. 2015.

"Aqua Sciences Inc - Making Water Virtually Anywhere on the Planet. Make Potable Water from the Air, Atmospheric Water Generators." *Aqua Sciences Inc - Making Water Virtually Anywhere on the Planet. Make Potable Water from the Air, Atmospheric Water Generators.* Web. 18 Sept. 2015.