Water Filtration System

DeVILS Report

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FSE 100 Monday & Friday 10:10-12:00

Group 1

<u>Introduction:</u>

- <u>Problem Definition:</u> All around college campuses, underclassmen live in student housing. In these housing units, they often have to drink the water from their sinks. This water isn't filtered beyond EPA city water standards. This causes many students to complain about the taste of this water and they are reluctant to drink it.
- <u>POV Statement:</u> Dorm housing residents at ASU need a better water system because they complain about the current water system being too expensive, the sink water being unsanitary, and drinking fountains being very inconvenient.
- <u>Users:</u> ASU students living in the dorms
- <u>Payers:</u> ASU or colleges/companies
- <u>Requirements:</u>
    1. The water shall be filtered at least twice
    2. The water shall be available within a 2 minute walk or less from dorm room
    3. he water shall be more affordable for students (budget of $100) ($1500 for companies or schools)
    4. Shall be able to fill water bottles 32 oz
    5. The system shall be self cleaning and self reliant
- <u>Criteria:</u>
    1. doesn't taste bad
    2. Ice feature
    3. water pressure above 40 psi

4. cool water temperature
5. balanced pH

- The reasons for these criteria are as follows; the taste is what would satisfy the customer the most. College students want water that doesn't taste like gross tap water. An ice feature was part of the criteria because it would make our product more appealing to the customer. Having ice would help keep the water cool. Having a high water pressure would allow the water to be dispensed quickly and would be more satisfying for the customer. Waiting for the water to fill up larger gallons is annoying. Cool water temperature is optimal because usually people prefer their water at a lower temperature. Having a balanced pH is healthier for the human body and would therefore make the water the most optimal. If the water makes the customer feel better, they would most likely want more.

Customer Discovery:

In the creation of our solutions we outreached to many different members on campus. For instance we decided to do interviews of students about their experiences with the ASU water. Some examples of this is our interview of Maddy, a Tooker resident, and asked her various questions on the ASU water and her experience with it. Maddy's overall concern with the water was the cleanliness of the water and how often it gets checked for anything that could contaminate it. Another student that was interviewed was Zach Fantozzi. Zach gave the information that the water delivery systems were inconvenient and also said that buying water you know is clean is beyond expensive for a variety of reasons. For instance Zach gave information that students can get a water system in their rooms through ASU but it's a lot of money and he also stated that buying water bottles from stores can be very costly. Zach gave us the insight on how the water delivery systems are not convenient or even in working order and he also gave us insight into how expensive water can be. We also interviewed an individual named Jack. Jack told us that he was not a fan of the water. He stated that the water in his dorm is unusable so he is buying water from the grocery store which he said was expensive. The last individual that we interviewed was Johannas. Johannas gave us insight into his experiences with the ASU water and said it had a funky taste and that it overall was not a good source of water. He said that he would use a water filter to help him get the water up to his standard. Overall, the interviews gave us insight on the experiences of students with the water in their rooms and how they are using their money and resources to get water that suits their needs. Our customer archetypes are :

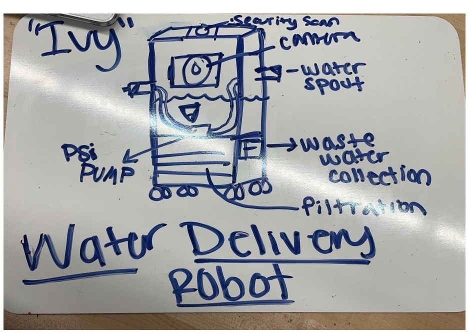
- Johannas: Tooker Resident, Germany, Male, Aerospace Engineering major
- Jack Timothy Rupert Nanna: Hassyampa Resident, White Male, Business Major
- Maddie: Tooker resident, White Female, Civil Engineering
- Zach: Tooker resident, White male, Computer science major, Gym user

Over our interviews we learned that many people are not fans of the ASU water and have many other means of getting water. Some of the people we interviewed have Brittas which are hand held water filters that you pour tap water into which will filter dirty water into clean water. Another solution on the market that we learned about from our interviews was pre-package water bottles. We learned that many college students are buying pre packed water for their clean water source and learned that it can become very costly to the student. So with all this research we learned that we need to have something that can allow students clean water access that wouldn't be out of reach to consumers or be a hassle to get to. We also want to allow them to filter their own water or allow them to be able to get water quickly and effectively. All of this research and customer opinions were taken into consideration and used in our requirements plus they were also used to incorporate in our design and solution to the issue.

Design Alternatives:

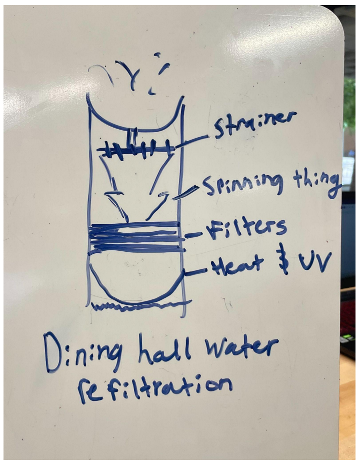
For brainstorming, we used multiple strategies. First we just went through and talked about different ideas that we had starting out. After that we used the design heuristics and random stimulus as strategies to think of some ideas that were more creative and outside of the box. For the random stimulus our TA gave us a heat lamp as our random object. We got lots of ideas from this object for our problem including, "have a self-cleaning features by using the process of heat and condensation to filter the water" and "have a very small opening so we can engineer the water pressure to be optimal". For design heuristics, we used the "Layer" Card. This card gave us the idea to have multiple filtering layers in our design to make the water more satisfying for the dorm students. We also used the "Recycle" card to come up with the idea to Reduce water waste by finding a way to recycle water. Take dirty water and filter it back to being drinkable. Filter beer to water, wine to water, alcohol to water. After all of this we came up with three solid ideas for a solution.

Solution 1: "Ivy" The water delivery robot



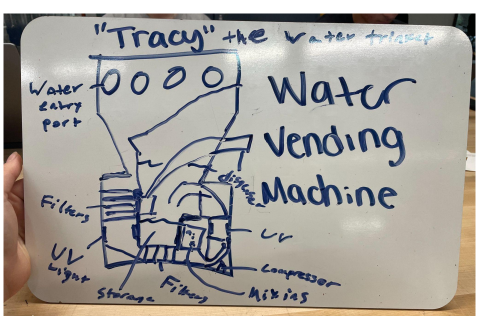
This solution relayed an idea that robots would live in the college dorms and deliver water to the students living there. This water would be clean and filtered so the students wouldn't have to drink the tap water. The robot would be connected to the students via an app where the students could summon the robots to their door with drinking water.

Solution 2: "Charlie" Dining Hall Water Refiltration System



This solution would provide students with an alternative to drinking their dorm tap water by having clean filtered water available at the convenience of the dining hall. It would recycle waste water in the dining halls (dish water, unfinished drinks, etc) and turn it into satisfying drinking water for the dorm students. It would be able to fill a gallon of water per student per day to be enough for them to last a while. This water would be available to everyone.

Solution 3: "Tracy" The Water Vending Machine



This solution is similar to the previous. It takes waste water from around campus and re-filters it into satisfying water that is distributed around campus and in dorms. This water would be available to buy at a cheap price so that it's affordable. These machines would be everywhere so that they would be convenient for students and they would sell up to a gallon in size.

Design Evaluations:

AHP analysis for determining the winner between the designs.

Criteria	Weights (%)	Design 1		Design 2		Design 3	
		Rating Factor	Weighted R.F.	Rating Factor	Weighted R.F.	Rating Factor	Weighted R.F.
Taste	40.9%	4	16.36%	3	12.27%	5	20.45%
Ice	8.4%	0	0%	0	0%	0	0%
Pressure	12.5%	5	62.5%	3	37.5%	5	62.5%
Cold Water	29.4%	4	11.76%	2	58.8%	4	11.76%
pH	8.8%	5	44%	5	44%	5	44%
Total	100%	134.62		152.57		138.71	

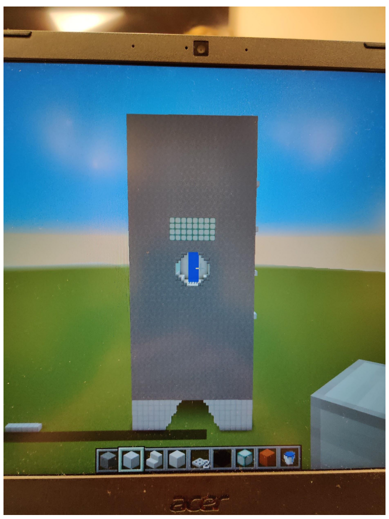
The given criteria were chosen based on the customer needs found in the research. In each interview, students were asked what they were looking for when it came to the quality of the water and the given needs were taste, ice, pressure, cold water, and pH. The taste was the top priority according to the weight because that was the major concern for students. Next was how cool the water was. Cool water can create a huge difference when it comes to the overall quality and freshness of the water. In addition, having the system carry cool water attracts more customers. To follow up, the pressure of the water was a required criterion because the system needs to be time efficient when many students will be in use of the system. Then, the pH level came as the fourth most important as it is necessary to have a balanced pH of 7 to create water that is high in value. Lastly, ice was added because it is a plus to have a system that can generate ice but it is not essential compared to the others listed. Three designs were created and compared to determine the most fit model that goes with the requirements needed. The scale of rating was from 0-5. For Taste, 5 refers to having specialized tastes added in, or just tasting very good, and 0 referring to having an awful taste that leaves a bad taste. For Ice, 0 refers to not even being present, and a 5 refers to having that super good restaurant-style ice that is perfectly clear and does not melt for hours. For pressure, 5 refers to having a quick and steady stream of water with no breaks, and 0 refers to having an inconsistent stream of water that breaks and splatters. For Cold Water, a 5 refers to a cold and refreshing water temperature of about 40 degrees Fahrenheit, while a 0 refers to an uncomfortable hot water temperature of about 80 degrees Fahrenheit. For pH, a 5 refers to a balanced water pH of 7. The water is also clean and free of contaminants, while a zero refers to dirty water that is either too acidic or too basic and bitter. The score for each design was based on the overall efficiency of each system which came down to how well the system can create the best product. The robot, for example, is small compared to the other designs which can affect how well it can create quality water which is a reason for how low it scored.

Final Prototype Specifications:

The final prototype stands 64”x30”x30”. The fountain will stand by itself on the floor. The fountain will be made of stainless steel. The front will have a 13.71” circular hole that houses the water dispensing nozzle. Above the dispensing hole, is a touch screen that is 4.57” x 13.71”. The left and right side of the fountain both are flat stainless steel panels with blue streak decals. On the rear of the fountain are stainless steel handles to remove the filters for replacement and cleaning. On the top of the fountain is a stainless steel collection tray leading into the machine.

The fountain will allow a user to select a quantity of water using a touch screen. The touch screen displays 4 options to be dispensed. The user can either choose between 8 oz, 16 oz, 32, or 64oz. Once the option is selected, the system detects if a container is placed within the filling compartment. If the system detects a container, it will release a protective plastic shield and begin to dispense the selected amount of water at 80 psi. If there is no container entered, the system will flash a message informing the user to enter a container in order to receive the water. Once the water container is filled, the plastic protective shield will retract back into the fountain. The user is then free to take their water.

The water source comes from the water recycling system built into the fountain. Users could dispose of any unwanted liquid such as leftover drinks from the dining hall, expired drinks, unwanted drinks, etc. The filtering system would then filter the entered liquids into clean, purified water to be consumed. The system uses a number of filters to ensure the water consumed is clean and drinkable. The first layer the liquid flows through is a large catch net. This will catch the large debris such as ice or garbage. The next layer is a smaller catch net to catch smaller sediment. The next layer is a ceramic filter which will filter out pathogens and small sediments. The next layer is a carbon filter that will suck out remaining contaminants. The next layer is a water softener that will remove hard molecules such as calcium and magnesium. The softener will then replace the hard molecules with softer molecules such as potassium and sodium. The last and final layer is a UV filter which will kill and destroy any remaining bacteria and pathogens.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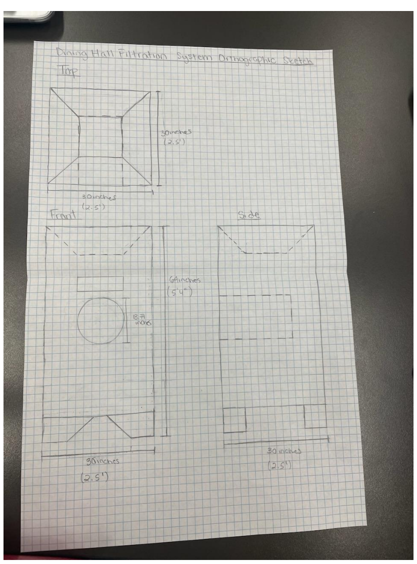
Dining Hall Filtration System Orthographic Sketch
Top
30inches
(2.5')
30inches
(2.5')
Front
Side
64inches
(5'4")
13.71
inches
30inches
(2.5')
30 inches
(2.5')

Conclusion:

The finalization of the prototype was done by first doing background research to learn more about the problem and to interview students to get a better understanding of the needs and requirements of the customers. Then, team brainstorming was done to create a wide variety of designs. After, the top three design options were evaluated on how well they met the criteria. The design matrix was then used to determine the most absolute design which then became the official prototype. The final prototype met the requirements by having the features needed for customer satisfaction. However, potential risks with the system are non-recyclable liquids entering, confusion about the functionality, and abuse from students. This prototype creates value because it delivers drinkable water to students in the most efficient way. For the end product, there were a couple of things that could have been improved. For instance, the use of the wastewater was not clear enough. Also, the filtration system needed more research because the best way to actually filter the water was still not understood enough. As a team, much success was achieved since each individual contributed equally which made each step run smoothly.