2020-2021 MESA USA
National Engineering Design Competition

Design Brief Template

School: Skyline High School

State: Utah

Division: High School

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Problem Statement: Briefly describe the people who will benefit from the project and the challenges they face. Include any inequity that the project hopes to address.

- Our project will help people all over the world, but our target audience is those living in states that get their water from sources that violate the Environmental Protection Agency's (EPA's) Safe Drinking Water Act. They currently don't have proper access to reliable clean water and providing them with our device will allow them to check their water purity while also bringing attention to the issue at hand. The goal of our project is to solve inequality in water purity awareness by allowing everyone to be informed about their water quality and bring awareness to the disparity.

User Research: Discuss key information about the users gathered through your research, interviews, and ongoing discussion with the users throughout the project.

- Through our research, we learned that the main problem that many people face in determining water purity is that they believe that their water is pure since it runs clear. This causes a sense of false security in many homeowners and they fail to realize that there are large amounts of solutes dissolved in the water that can cause illnesses if ingested for long periods of time. We found that the main culprits of contaminated water are invisible to the naked eye (Heavy Metals, Chlorine, MTBE), and we decided to focus on detecting them. One of our team members previously had traces of copper in his water system and when we interviewed his parents to learn more, they stated that they didn't notice for a long time because they thought that they just had hard water. They only realized the gravity of the situation after having a water filtration system expert check the quality of the water. We realize that most people can't do that and that's why the goal of our project is to allow individuals to easily test their water and inform them of contaminated water before they get sick.

User Insight: Discuss your team's understanding of the experiences, emotions, and motivations of the users.

- Water is something that affects your pipes, your water heater, your laundry, your shower pressure, and even your health. A study by the CDC found that more than 19 million Americans get sick every year from drinking contaminated water. The individuals who are most impacted by this problem live in rural and marginalized communities and the core issue is that they don't have access or the money to pay for these services. According to Anthropologist Sera Young, 40% of adults and 63% of children don't drink the tap water of their homes due to this fear. Taking this into account our motivations are shown through the need to help these states that don't have access or are just unaware of their unsafe water conditions. Especially in regards to those individuals in less advantageous monetary situations, a solution that would allow for a lower barrier of entry would be beneficial to help them feel safer knowing more about their water situation.

User Needs: A specific list of user needs produced from the user Insight is provided.

Affordable - Our clients' biggest concern was about the cost. They wanted our product to be affordable while still collecting correct data.
Reusable - Our clients want the ability to check their water purity regularly to ensure that the quality hasn't changed and their filters are working properly.
Ease of Use - Another major concern for our clients was usability. They wanted a device that was easy to use and presents the data in a simple model.
Peace of Mind - Our clients want to know for sure if there's anything wrong with their water and the confidence to drink it without concerns about safety.

Project Goals: Goals selected are linked to and will adequately meet the users' needs.

- Our goal with this design was to provide an affordable alternative to expensive single-use water testers. Market-priced water testers are around $100 while our's is a low $42 multi-use tester. This brings down the barrier of lower-income families that want to be safe while also allowing these individuals to easily access information about their water quality to determine whether or not to take action. Furthermore, a simple interface and usability is a requirement to allow for more users to be able to pick up the device and use it easily, without having to learn anything new.

Key Features of Design: The list of the key features illustrates that design will adequately meet project goals.

- **Sensors**: Our design has all the necessary sensors that measure pH, Electrical Conductivity, Temperature, and Turbidity which account for the most common water contaminants and will give us a good representation of water quality.
- **Logging** - We also included an SD card module so that if the user wants to record data over a period of time, the data can be logged to a portable SD card and accessed on a computer. This would allow for long-term data collection of one source, or multiple sources of water.
- **Accessibility to Everyone** - The simplicity and easy setup of the design allow anyone to operate the device with little instruction. Our companion app, which no other device on the market has, allows for a visual representation of the data collected on a scale of safety levels so that individuals without traditional education can use the device.
- **Affordable and Portable** - Our design also incorporates affordable parts that can be easily replaced which keeps the overall cost of the device relatively small.

Status of Project: Adequately examines the progress of the project and discusses potential next steps.

- At its current stage, the device can record the data from the probes and adequately compile it together for use in our desktop application along with regular spreadsheet applications. Further steps to improve the project is the production of printed circuit boards to simplify the layout, along with improving the simplicity of production. Along with that, a custom waterproof case can be developed to allow for easier production and durability. 3D printing can be used to prototype before full production units are chosen and produced.
- One of the users gave some feedback to improve, suggesting more accessibility to the data through a mobile app that could connect wirelessly, instead of using a desktop application. We have developed the structure to implement this and could be used in a future prototype.
- Another improvement that could be made is a more sustainable way of charging, such as the implementation of a solar panel to allow the device to function in more remote areas. This would help with water quality monitoring in more locations around the world, such as in third world countries without reliable access to electricity, or in natural disaster locations, allowing individuals to know the water quality around them.

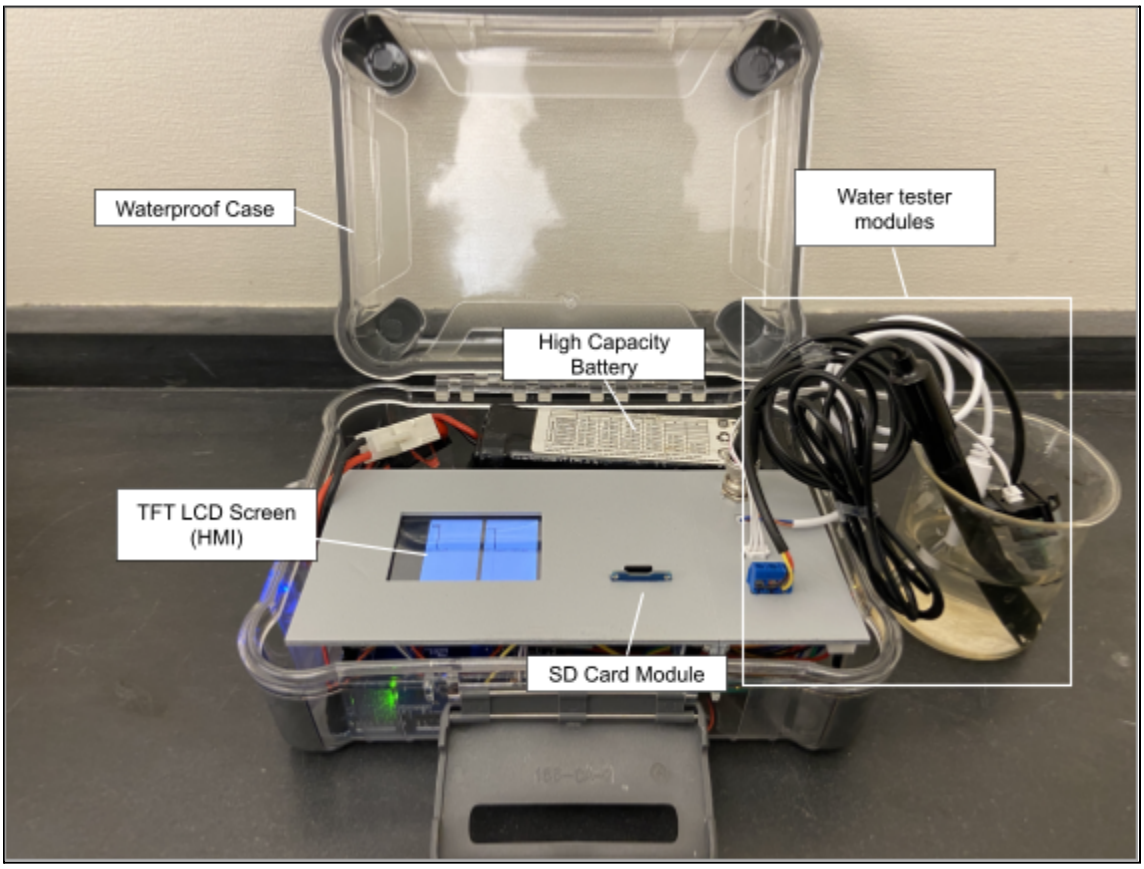
Impact: Discussion adequately describes how design may improve inequity for the user and/or remove barriers.

- The design reduces barriers for users across the globe. Currently, developing countries do not have efficient systems that can detect water quality which we can help with by using our project to increase the efficiency of water quality testing systems. The design also removes the barrier for people who are not as tech-literate, as it is a simple system that requires minimal instruction to use. Most of the functionality is done by the system itself without the need for interference from the user. The design overall greatly increases the ability for users all around the world to get access to quality water monitoring because we attempted to use the lowest cost for the control system for monitoring. We found the lowest cost materials possible and used those to create the device.
- Some of the user feedback that we got back about the device was that its reusability was very useful for them, as they owned multiple houses, and they were able to test multiple households with a single, comprehensive device, without the need for multiple more expensive single-use sensors. They supported our endeavor and were supportive of the device's abilities.

Reflection: Demonstrates an increased understanding of Human Centered Design. Discusses personal growth and insights about designing for others and helping them overcome challenges.

- Overall, we worked well as a team to solve the problems with the project. We took into consideration the multiple perspectives of each of our group members on multiple facets of the project, which allowed us to work with more efficiency. This also allowed us to better figure out what users would want out of our design. We focused on creating a design that's convenient, easily understandable, and highly operational. Specific feedback from our users added to its usability, as different outside perspectives of the device provided useful insight into development. Our design was portable and reusable, and other features were added that were targeted to make the consumer experience as enjoyable as possible. The challenges consumers may have with normal quality monitoring systems may include not being able to understand technical aspects of them, which is an issue we aimed to reduce by making our control system easy to understand and navigate around. By taking these factors into account, we gained more insight into human centered design rather than simply designing based on a given problem. Personally, we grew as well, as we increased our knowledge of some of the issues consumers may face, and we attempted to solve them.

Prototype Graphic: Graphic is easy to understand and adequately labels key features



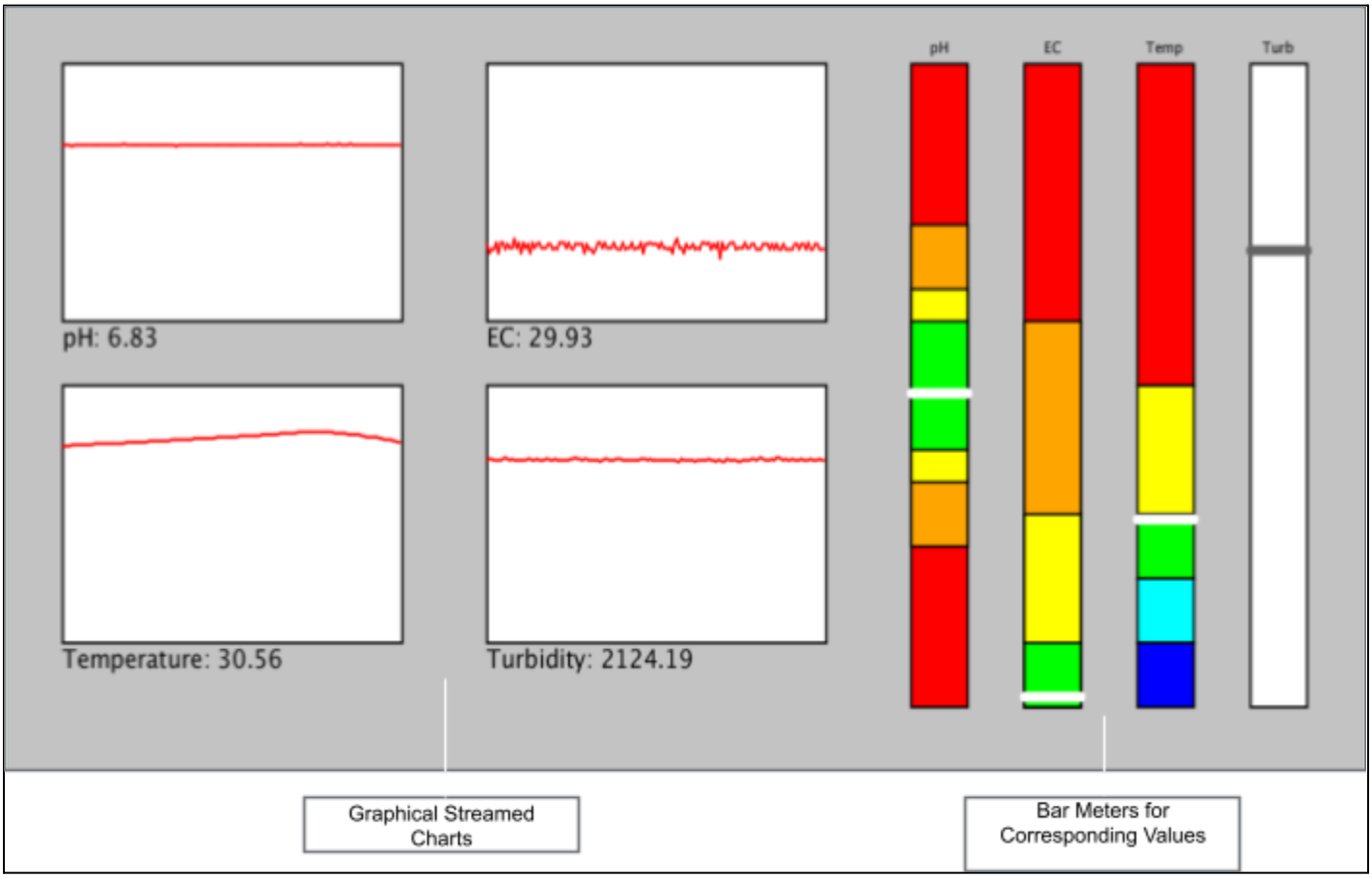
Waterproof Case: Used to protect the internal circuitry from damage during transportation or during use. Allows for ease of portability and storage as well.

TFT LCD Screen: A graphical interface that can be used by the user in order to interact with the device, including the creation of data sets on the removable SD card.

Water Tester Modules: A set of probes that are used to determine the TDS, pH, turbidity, and temperature of the sample water.

SD Card Module: The interface where an external SD card can be inserted in order to begin data logging. Multiple samples over different time periods can be logged automatically.

High Capacity Battery: The main power source of the device, with a high capacity in order to allow for long durations of operation.



Graphical Streamed Charts: These charts are created from the data that is directly transferred from the device, and allow for a greater visual representation of the recorded data.

Bar Meters for Corresponding Values: These bar meters are used to provide better insight into the significance of the values collected by the device, assisting in the understanding of uses who do not understand the finer technicalities of water quality metrics.