

Undergraduate Thesis Prospectus

**Water Bottle Cooling Station**

(technical research project in Computer Engineering)

**Fighting for the Right to Clean Drinking Water**

(STS research project)

by

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On my honor as a University student, I have neither given nor received unauthorized aid on this assignment as defined by the Honor Guidelines for Thesis-Related Assignments.

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## **General Research Problem**

*How do we better secure reliable access to safe water in the United States?* There are two parts to this problem: there are places in the United States that do not have complete plumbing facilities and there are places that have infrastructure that is old and needs to be replaced. A house with complete plumbing facilities has hot and cold running water, a flush toilet, and a bathtub or shower (Raglin, 2015). In the 2019 State of the Water Industry Report conducted by the American Water Works Association (AWWA), “Renewal and replacement of aging water and wastewater infrastructure” was stated as the #1 issue facing the water sector while water rights is stated as #25 (AWWA, 2019). Replacement is being prioritized by the AWWA.

According to the 2018 American Community Survey, published by the United States Census Bureau (USCB), roughly 3.8% of 121,520,180 households, or 465,211 households, do not have complete plumbing facilities (USCB, 2018a). On the other hand, a report from the American Society of Civil Engineers (ASCE) states that “the amount of clean drinking water lost every day could support 15 million households,” due to old, leaky pipes (ASCE, 2017). Old pipes contaminate the water supply and contribute to water waste.

At an average household size of 2.63 (USCB, 2018b), roughly 1.2 million people do not have either hot and cold running water, a flush toilet, or a bathtub or shower. It is not enough to provide water if it is not being checked and maintained to ensure it is safe and clean.

## **Water Bottle Cooling Station**

*How can we reduce individuals' water waste?* My capstone advisor is Professor Harry Powell of the Department of Computer and Electrical Engineering. I am working on a team

project with Mac Baskin, Micah Harris, and Everett Patterson. The goal of this project is to reduce water waste by preventing people from dumping water they find too warm to drink.

There are water bottles that try to maintain the temperature of the water in the bottle, but there are none that actively cool the water. Given this, there is no way to cool the water once it is in the bottle, save for putting the water bottle into a refrigerator or having the air outside of the bottle be significantly colder than the water inside of the bottle, due to the insulating nature of the bottle. Over time, the water heats up until the drinker no longer wants to drink it, so the choices are to wait until you can put it into a refrigerator or dump it and get colder water. Dumping the water is very appealing compared to waiting to get to a fridge, then waiting for the water to cool down.

We are using a thermoelectric cooler to actively cool water that is already in a bottle. The cooler consists primarily of a Peltier module, heat sink, fan, and aluminum plate. The Peltier module is what actually does all of the cooling using the Peltier effect which is achieved by applying an electrical current at the seam of two materials creating a temperature differential on either side of the module. The heat sink and fan are used to help disperse heat while the aluminum plate is used to place the water bottle on.

Although this device will need to be plugged into a wall outlet, it will be small and light enough to be easily portable. This device provides a middle ground for what to do with too-warm water and makes the option of dumping water not as appealing. The wait time for cool water is significantly decreased as the odds of finding a wall outlet are greater than the odds of finding a refrigerator when you are out. We will conduct experiments to find out how cold the water will get in a specified amount of time. We will use temperature probes to monitor the cooling of the water and the state of the heat sink.

At the end of the project, we will have a portable water bottle cooling station that will cool water in a bottle without the need for a refrigerator or ice. This allows people to not have to sacrifice as much when it comes to not wasting water. If the choices are to wait a few hours until you can get home to your refrigerator or getting new, cold water, the former seems to be a pretty big sacrifice. People will only have to sacrifice a fraction of that time.

### **Fighting for the Right to Clean Drinking Water**

*How are social groups seeking to compel state governments to provide clean drinking water?* In the United States, local drinking water quality varies widely. Because water is essential, one would expect state governments to guarantee safe access. The World Health Organization (WHO) produced guidelines for water quality, but it does not have the means to enforce them (WHO, 2017). The Environmental Protection Agency (EPA) leaves most regulation and enforcement to the states (EPA, n.d.). Local governments must follow regulations, but some lower-income areas lack the resources necessary to provide safe water to everyone or to enforce regulations. Given this, it should be up to the state government to allocate resources to make sure that everyone has access to clean drinking water.

Many groups are fighting to achieve equal access to clean water or to help the public to do so. DIGDEEP is a nonprofit organization that promotes access to safe water (DIGDEEP, n.d.). The Coca-Cola Company claims it supports universal access to clean water (Perez & Koch, 2015). The American Civil Liberties Union of Michigan is fighting for safe water for Flint (ACLU, n.d.). One of the Virginia Tech Research Team's aims is "To summarize findings from [aims] a and b to inform decision making and policy considerations, if necessary, on the part of both citizens and government agencies in the city" (TVTRT, n.d.). Potomac Conservancy is

“holding local leaders accountable for keeping clean water a top priority” primarily around the Potomac River (Potomac Conservancy, 2019). The Newark Water Coalition “has declared the Newark water contamination crisis a Public Health Emergency” and “are calling on our government stakeholders, healthcare providers, faith and community based organizations to make this public health crisis a priority” (Newark Water Coalition, n.d.).

Some residents of Flint took part in four sampling campaigns evaluating water from their homes during Flint’s water crisis. The results can be used to evaluate the state government’s efforts to end the water emergency. The researchers found a decline in contamination, but with contamination spikes (Pieper et al., 2018). Washington, D.C., had a similar contamination problem. Researchers found a correlation between blood lead levels and drinking water lead levels in children aged  $\leq 1.3$  years (Edwards, Triantafyllidou, & Best, 2009).

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