Pantastic
(Technical Topic)

Examination of Engineer Design Choices
(STS Topic)

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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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Introduction

According to the National Fire Protection Association, the leading cause of home fires was due to cooking. The leading cause of cooking fires was unattended equipment (31%) and unintentionally turned on or left-on equipment accounted for 8% of home cooking fires. The result of these fires is over $1 billion in property damage as well as thousands of injuries and hundreds of lives lost each year. Furthermore, cooking fires are the leading cause of injury and the second highest cause of death in US household fires.

Most college students live with roommates and have busy schedules. As a result, students often will multitask or can become forgetful. This can lead to food being left over cooked and unattended, or even stoves simply being left on. Due to this risk factor and the prevalence of cooking fires from unattended equipment, the technical portion of this project will aim to design a kitchen safety device that can reduce the risk of household fires. The technical portion will be undertaken as a group capstone project. The focus on college students is due to the fact that students often do not have a structured schedule with the same routine every day. This can contribute to the absent mindedness that increases the risk of fires; however, this device is designed to be helpful to any who choose to use it.

The loosely coupled STS research will examine Social Technical Systems and design choices to examine the effect of designer bias and designer decisions. I will examine three design instances and discuss how the end user was or was not affected by these decisions. I will also discuss the importance of engineers examining the impact of design decisions in the products they design.

The reason the STS research is loosely coupled is because the research does not examine any topic related to fire, but it does specifically examine the potential effect of decisions made during the design process of the Pantastic. This STS research was chosen because I find the examination of engineering design choices and the effect and ethics of these choices to be a thought-provoking topic. I also find the style of thinking to be important for all engineers.

Technical Topic

The technical project will be centered around the design of a device which aims to decrease the number of household cooking fires and thus increase safety—The Pantastic. It works by using an IR device to measure the heat of the zone it is measuring and broadcast the information to a local app via Wi-Fi.

The device will be relatively easy to manufacture. The system will require a printed circuit board (PCB) and a plastic case to protect the microcontroller which will hook up to the sensory modules. Only slight complexity is introduced by designing a case which will allow the IR sensor to be aimed at a specific zone.

The part availability should not be a major issue besides the given issue of the chip shortage at the time (IEEE Spectrum). The majority of the components that would be used aren't particularly specialized and many alternatives have been found. One ongoing cost for the system will be the batteries. Because Pantastic will be battery powered, batteries will need to be replaced throughout the product's lifespan. The largest expense for the project will be the non-contact infrared temperature sensor, which will cost approximately $45.

Due to the inherent electrical nature of our product, byproduct and battery disposal will always be a major concern (Rapier, 2020). In addition to batteries, the PCB may also have a negative impact on the environment if not recycled properly. However, while using the product, there should not be any significant byproduct (besides batteries) that could possibly cause a significant environmental impact.

In regards to some sustainability constraints, the most important thing to consider is the use and safe disposal of batteries. Specifically, for the testing phase, it is likely that many batteries will be used and it is crucial for the team to make sure that the batteries are properly disposed of safely.

According to the Consumer Product Safety Commission, having some sort of reminding device with regards to unattended cooking can be instrumental in decreasing the number of annual cooking fires. However, the main ethical issue stems from the user misunderstanding their role in exiting-the-loop of supervision of appliances in the household kitchen. Pantastic is not a cooking companion which instructs the user when to remove or modify the state of cookware, but rather a safety device that serves as an extra backup when humans accidentally reveal their forgetful habits. Pantastic works in a similar capacity to a smoke alarm which senses a potential danger but is not equipped with the means to stop that danger. Humans are required to assess the danger or rather leave the handling of the situation to a professional with proper equipment if the situation becomes too severe. That being said, Pantastic is generally limited to the health and safety concerns of a normal IoT device.

This project was designed as part of a group project. My specific responsibilities include designing the embedded software program to run the Pantastic, writing the drivers to interface

the physical components to the software, researching and choosing an IR sensor, designing electrical circuitry for the IR sensor, push buttons, buzzer alarms, and IR laser diode aiming device, and finally 3D printing the case for the device.

STS Topic

Everything ever designed required design choices that had to be made. To what extent can implicit and explicit engineering decisions affect the end user or the availability of the product to the end user? How much does the designer need to think about the impact of design choices? These questions are of importance for two reasons. First, engineers should be conscious of the end user and ensure products meet the need. Second, engineers should be conscious of how design choices may affect a user's ability to use a product. The STS research will examine two academic papers to form a basis for research; then three different cases involving implicit/explicit design decisions and the effect of those decisions will be discussed. Two are widely known design issues revolving around racism, and the last relates to the Pantastic and incidental design choices.

The first paper to be discussed is Goldstein's paper on Green Capitalism. This paper specifically relates to the hyper focus on how to take an issue that the end user has and sell a product that has a supposedly massive net green effect on the world. This paper is covered because Green Capitalism is a combination of combining altruistic motives with financial motives and targeting a niche need of a user to deliver a product to help the end user solve a problem and save the world. Although design choices are not the central focus of the paper, the paper does show the importance of design choices. Specifically, by targeting a problem of the end user and solving it in a green and economically advantageous way, the user benefits.

The importance of understanding the effect of design choices is illustrated by TallBear in Tribal Housing, Codesign, and Cultural Sovereignty. The paper is based around the redesign of Native American housing sponsored by the US Department of Housing and Urban Development. The original housing designs were modeled after a generic suburban American house and did not adhere to specific culture needs of the community it was serving. Essentially, this explicit design choice caused the housing to not suit the needs of the consumer and revealed the implicit desire to force assimilation to American culture. The solution revolved around placing the end user into the design process to ensure the product met the needs of the end user. By placing the end user into the design process, the product was tailored to their specific needs and the bias of the designers was mitigated. The difference in the original product and the co designed product revealed the engineering decisions had a large impact on the usability of the product to the community it was supposed to serve. The original product did not respect the cultural sovereignty of the Native American community and was a poor product.

Now, the first example to be examined is how Thomas Jefferson designed his home, Monticello, with the intention of hiding the institution of slavery by using tunnels and secrete passageways. In the Dark Side of Thomas Jefferson, Wiencek describes how Monticello had multiple tunnels to allow enslaved laborers to carry out daily tasks or tasks related to hosting events without being seen. This design choice reveals who the end user was and how the product is used. The end user was Jefferson and colonial high-class society. The product, Monticello, was designed to hide the institution of slavery and make visits to Monticello mystic for guests who saw food, drink, and laborers appear out of the walls to serve guests. What were the effect of these design choices? The first effect was to hide the institution of slavery. The second effect is

the revelation that Jefferson, a supposed emancipationist, never had intentions of freeing the enslaved laborers, as they were almost "built in" to Monticello.

Next, Robert Moses intentionally altered New York City designs to make life more difficult to low-income residents (Powell, 2007). Powell discusses how Moses intentionally would attack mass transit to affect poor New Yorkers. Moses would try to enact different designs and policies to divert funding away from public transportation. He would also design bridges on the way to the beaches that were too low for busses to pass under, effectively forcing the beaches to a haven for affluent car owners only. These design decisions show how Moses manipulated New York Sociotechnical systems to exclude low-income residents and the effect was the exclusion of a group of people based on socio-economic status.

Finally, design choices for components of the Pantastic cause it to be priced out of an affordable pricing range which unintentionally limits who can access it. In order to achieve a great enough level of accuracy, an expensive sensor had to be used. Even in mass production the cost of the sensor would not go down a significant amount. This is an example of an intentional design choice that will price some consumers out of the market for the product, but for a justified reason. Further, the original design for the onboard LED heat visualizer would have excluded color blind persons from fully utilizing the product as well. The heat visualizer was originally going to use RGB LEDS and changing colors to indicate heat. A color-blind person would be unable to differentiate all of the colors and thus would be unable to fully use to function of the product. The design was changed to use a matrix of single-color LEDs to be more inclusive. These design choices show the effect engineers can have on the end user and the importance of thoughtfully considering how decisions can affect others.

Next Steps

My responsibilities on the team have been centered around IR sensor research and circuit design for the first portion of the project. In the next portion of the project, I will be responsible for the embedded development which will include designing the state machine for the controller and writing the drivers to interface the physical components with the software. I will also be responsible for 3D printing the case for the device. So far, the team has reached 95% completion of all electrical designs and will finalize schematics and place an order for the second prototype PCB in one week. The cloud engineer has configured the MCU to send data over the network and has designed the UI. The next steps will be to order, test, and redesign the prototype PCB and begin writing the embedded software. The goal is to have a fully functioning prototype and place the order for the final design before Thanksgiving.

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