Prospectus

Design and Construction of a Kinetic Art Weather Display
(Technical Topic)

Designing Sustainable Technology through Aesthetics
(STS Topic)

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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Introduction

Though often overlooked, engineering design is one of the most influential and powerful techniques in the field of engineering. Design is not only important for creating functional technologies, but it has the ability to shape human behavior and human interaction amidst expanding innovation. In shaping human interaction with technology, designers intend to create new products that may develop value beyond their individual functionality—that is, designers have the ability to invoke consumers to personalize their experience with technology in order to make it more meaningful and sustainable. Oftentimes consumers will keep a technology around beyond its technical lifespan due to the psychological value they have created—I argue that it is the designers who have the power to direct this type of behavior.

The technical portion of the Prospectus will describe my capstone project in which my team and I will be creating a kinetic art weather display to be mounted in the basement of the Mechanical Engineering (MEC) building at UVA. The intention of this project is to create a functional yet meaningful, aesthetically pleasing display, allowing students to easily see the time and weather conditions since there are no windows on this floor of the building. One of the challenges in coming up with this project is the fact that a display with mechanical motions is not the most practical way to achieve the goal of this project: the display could be much more efficiently and accurately represented through a completely digital display, rather than going through the trouble to develop somewhat outdated mechanisms for it. However, in creating a solely digital display, it is easy for the user to overlook the intricacies behind it, and aesthetic value is lost in excluding older design techniques.

Deciding to create a mechatronic weather display has inspired me to research how consumers' interaction with technology creates more value past the functionality of the technology itself. Even if technological advancements have surpassed the need to use old techniques for design, there is still beauty retained in old design practices that prevent them

from becoming obsolete. In considering this, engineering designers must be conscious of the balance between functionality and aesthetics, as both bring significant value to technology in, oftentimes, contradictory ways. For my STS topic, I will be researching how engineers are able to aesthetically design technologies with the intent to create a more sustainable user experience.

Technical Prospectus

The objective of the capstone project is to develop a functional piece of wall art that uses mechanical movements and electronics to display various outdoor/weather conditions. It will further be referred to as a kinetic art weather display or weather display. This idea was inspired by the conditions that students and researchers are under when they are working in the labs of the University of Virginia's Mechanical and Aerospace Engineering department, which are located in the basement of the Mechanical Engineering (MEC) Building at UVA. These labs have no windows and one can easily lose track of time, especially when personal protective equipment is being worn, making it difficult to check one's phone. Additionally, according to the Harvard Business Review, the absence of natural light and outdoor views has a statistically negative impact on productivity and work experience (Meister, 2018). Therefore, this is the group's alternative solution to natural light and outdoor views: in addition to creating a functional display which shows time and weather, the group hopes to improve work experience for students and researchers through a pleasing visual display.

Thus, the weather display will serve the purpose of informing users of the current conditions outdoors (rain, snow, clear, daytime, nighttime, etc) through pictorial means that are quick and easy to process with just a glance, while also being aesthetically pleasing. It will also demonstrate important engineering concepts such as the modern-day synthesis of electronics and mechanical devices, as well as advanced manufacturing techniques such as 3D-printing, CNC machining, and laser cutting that allow for the construction of complex products with relatively low monetary and time costs.

A literature review yielded one product that is of a similar concept to the one developed by the capstone group. The "Weather Clock" by Bramwell Brown is primarily an analog clock, but it has a small display in the bottom portion that depicts various weather conditions with moving parts and what weather condition is displayed is dependent upon the information from an internal barometric pressure sensor (Bramwell Brown, 2020). From the following description, it can be discerned that the capstone group's weather display will differ significantly.

The display will be a circular design fashioned from wood using a CNC Mill, where the top half is a visible window for weather and the bottom will be space to store the mechanics that operate the weather changing devices. It will feature two transparent, semicircular acrylic sheets that are engraved with rain and snow patterns. These sheets, when illuminated by strips of LED lights, provide an artistic simulation of the current weather pattern. The design will also involve sun and moon figures that rotate around the display to indicate the time of day through pictorial means. Smaller features that will be included are a backlight that can vary brightness within the window, a UVA-themed background, an LED matrix display indicating time, date, and temperature, as well as interactive buttons that will allow manual control of the settings. The goal is for all these movements and displays to be dictated by a Parallax Propeller microcontroller chip that is connected to a Raspberry Pi single-board computer that will relay weather and time data from an open-source application programming interface (API).

The capstone group's general plan is to prototype the various mechanical movements to see if they are viable. Then, the entire project will be modeled in a computer-aided design (CAD) software to determine the placement of all the components and overall size of the project. Once the modeling is complete, the weather display will be constructed with traditional techniques as well as new, advanced manufacturing techniques such as 3D-printing, wood CNC milling, and laser cutting acrylic. The project is set to be completed by the end of November 2020.

STS Prospectus

Design is one of the most powerful techniques in engineering because of its ability to create lasting impacts on user behavior. In general, the impacts of design must be carefully considered in order to achieve a desired reaction when creating new technologies (Atzmon & Boradkar, 2017). Designing the most advanced technology isn't always the most sustainable solution—if the intent is to develop a sustained lifespan for a technology, it is important to consider the relationship that will ultimately form between the human and object itself. This relationship may be strengthened through psychological value as opposed to the purely functional value of a technology. For my STS research, I will be analyzing different techniques and examples in which engineers have considered aesthetics in the design process as well as anticipated the relationship between technology and its users in order to develop a more sustainable user experience.

Human-Object Interaction

Before discussing the impact of designers on human behavior and interaction with technology, it is important to establish the fundamentally dependent relationship between humans and objects which is required to make technology functional. This interdependency is best described through Actor-Network theory and the idea that both humans and non-humans possess agency. As Sergio Sismondo writes, humans and non-humans form linkages between one another, which causes the formation of large networks; these networks "might make machines function, when their components are made to act together to achieve a consistent effect. Or, they might turn beliefs into taken-for-granted facts, when their components are made to act as if they are in agreement" (Sismondo, 2010). It is important to note that this applies to technoscience, which cannot be effectively driven without human/non-human associations and dependencies.

Prasad Boradkar continues with this reasoning to point out the interdependencies between "people and things" as well as how both entities shape one another. He describes this as a symbiotic relationship: "As things themselves have agency, they afford specific

kinds of action, they encourage certain types of behavior and they can elicit particular forms of emotions. Therefore, in addition to being designed by us, things in turn design us" (Boradkar, 2010). The relationship Boradkar describes is important in considering the impact of design not just on non-human objects, but humans themselves. Not only do humans have the ability to design functional technologies, but in turn, these technologies have the ability to equally shape humans in their behavior, emotions, and society.

Design Techniques to Control Human Behavior

The relationship between humans and technology is important to note because the interaction between the two is what creates function and therefore value. Technology requires human interaction in order to fulfill its purpose. In many instances, technologies may be designed in order to stimulate or even require human interaction through the use of aesthetics (Verbeek, 2006). This is one design technique used to control the user experience with technology. As advancements in technology continue, it is much easier to take progress for granted: the less humans interact with a technology, the less likely they are to appreciate the purpose it achieves. Aesthetics, in this case, are a tactic to continually draw the user to the technology. Thus, it is possible that designers deliberately create technology with the purpose of developing consistent interaction with humans, even though it may cause the technology to not be as relatively advanced as others.

Another design technique described by Kristine Harper is in designing a "temporal object" in order to create more sustainable technology and allow users to create emotional bonds with said objects. She mentions that it is difficult to control the recipient's experience with an object, but it is possible to analyze features which trigger an emotional reaction from the recipients—this allows for insight to how to deliberately provoke those connections through intentional design choices. This could be as simple as material choices during the design process. Furthermore, Harper emphasizes the need to create objects as "carriers of time" to promote sustainability (Harper, 2017). This may be possible by establishing the decay of an object as a deliberate tactic to enhance an aesthetic experience—as the object

is decaying and becoming more imperfect, it is additionally becoming more *beautiful*. These design techniques anticipate the long-term impacts of technology in how psychological value may arise overtime through a personalized experience for the user.

Future Study

A few design techniques involving aesthetics are described above which create a more sustainable user experience with technology. In my STS research I will be continuing this discovery as well as analyzing the design techniques in the context of various examples of technology. I plan to analyze what design aspects cause users to keep technologies around past their technical lifespan along with which aspects strengthen the psychological lifespan of technology for users (Verbeek, 2006). It will be interesting to investigate how aesthetic considerations in design have evolved as advancements in technology have progressed.

Conclusion and Next Steps

Through my STS research topic, I plan to analyze how engineers consider aesthetics in designing new technologies in order to create a more sustainable user experience through various techniques and examples. Designing with the intention of creating a functional product is not always the best solution—it is important to consider how humans and technology will interact with one another, and how this interaction may produce value beyond the technical functionality of the object itself. Researching aesthetics for designing sustainable technology stems from my technical project in which newer, more efficient and accurate design solutions are excluded in order to enhance aesthetic value.

The technical research is set to be completed by the end of November 2020, around the same time that the capstone project will be completed. The STS research will be ongoing throughout the next few months and will be completed by May 2021. Below is a detailed timeline of work to be expected through May 2021.

Date	*Technical Item Completed*	*STS Item Completed*
November 2020	• Finish final deliverable for capstone project • Complete technical research report by the end of the month	• Submit the Prospectus to technical advisor and STS advisor • Receive sign-off for the Prospectus
December 2020		• Refine Prospectus as needed
February 2021		• Continue research for more design techniques and examples of implementation • Create first draft of research paper
March 2021		• Refine thesis and make improvements of research paper
May 2021		• Submit final portfolio at the beginning of the month

References

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