Design and Construction of a Ferrofluid Kinetic Art Clock

(Technical Paper)

An Analysis of the Viability of Adoption of Renewable Energy Sources

(STS Paper)

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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

Introduction

Kinetic art is a term used to describe any piece of artwork that moves as part of its design (Tate, n.d.). Kinetic art is often viewed as extremely mesmerizing and beautiful, despite working off of simple mechanical principles. Some kinetic art also serves a particular function in addition to being an art piece. Thusly, from a desire to create something both beautiful and functional came the conception of the idea to create a functional clock that doubled as a piece of kinetic artwork. One of the first decisions made during the design process was how the clock should be powered, which led to some deep reflection on the state of energy production in the world.

Our world is dying. Anyone in the fields of science and technology must admit that given the current data, climate change is real and is largely due to traditional methods of energy production, specifically the combustion of fossil fuels ("Climate Change," n.d.). In order to solve this monumental problem, the first step must be to stop making the problem worse. Therefore the top priority of world leaders in regards to climate change must be to reduce, or ideally eliminate the use of fossil fuels. There are two options to reduce the use of fossil fuels: stop using electricity, or find alternative sources of power. Of course the former isn't possible in today's modern society, so the best course of action to begin combating climate change is to find viable and efficient sources of clean and renewable energy. This research paper will explore various forms of renewable energy as case studies, and investigate the technical, social, and even political factors that have inhibited their mainstream large-scale adoption.

Technical Topic

Kinetic art is any form of art that moves, often lending itself to having a helpful function through this motion. The core idea of this capstone project was to create a piece of kinetic art

that also functioned as a digital clock through the deployment of magnets to cause ball bearings to display the time. The clock should have the same functions as any other digital clock, such as the ability to have the time reset in case of Daylight Savings Time or a power loss. The constraint of keeping the clock reasonably quiet was artificially applied so that the clock could be displayed on the second floor of the Mechanical and Aerospace Engineering building without disturbing regular academic operations. The clock should be able to be powered by a standard 120V AC wall outlet. The aesthetic concept was decided to be that the magnets would attract the bearings through a thin front face, obscured from the sight of the viewer. This will create the illusion that the bearings are being held "by magic." Additionally, as much of the mechanism not involved in the actuation of the magnets should be visible to add visual interest to the piece.

In order to control whether or not a section of a digit will be displayed, two options were presented: electromagnets or actuated permanent magnets. Electromagnets could be kept in a fixed position and either be turned off or on depending on the numeral to be displayed. Alternatively, permanent magnets could be actuated closer or further ("on" and "off" positions, respectively) to the front face of the clock. Ultimately, the option of using actuated permanent magnets was chosen due to concerns with the amount of power electromagnets would consume in holding the bearings.

The clock will be controlled using a Parallax propeller microcontroller chip ("Propeller | Parallax Inc," n.d.). Utilizing its features of parallel processing and an internal clock, the propeller chip will prove invaluable in managing the operations of the clock. The propeller chip will be used in conjunction with I2C protocol to allow the many motors controlling the clock to be run using only one propeller chip.

The original strategy devised by the group was to make iteratively larger and more complex prototypes. First, a prototype of a single section of a digit would be made, followed by a prototype of a full digit, then all 4 digits, then finally the finished product. Key to success in this project will be the utilization of Computer Aided Design (CAD), advanced manufacturing techniques such as 3D-printing and laser cutting for the purpose of rapid prototyping, and the use of iterative design techniques to overcome challenges as they appear.

This project will add value to both the Mechanical and Aerospace Engineering department as well as the educational development of team members. The department will have a functional and beautiful art installation that will hopefully service students and faculty for years to come. Group members will gain skills and knowledge in the additive manufacturing and other advanced manufacturing techniques, the design process, and working as part of an engineering team and the organizational skills and tools there involved.

STS Topic

It is no secret that the way in which humans currently live is unsustainable. We consume the Earth's natural resources at far too great of a rate, the way in which we live further mars the natural environment, and after we're done using these squandered resources, we unceremoniously return them to the environment in the form of pollution and litter. One of our greatest environmental sins, however, is our use of fossil fuels to provide us with energy. These nonrenewable sources of power pollute our atmosphere with greenhouse gasses and contribute to global climate change. As climate change is the root cause of many other issues such as rising sea levels and an increased frequency of extreme weather events, preventing any further change in the global climate is a necessary first step in writing society's collective ecological wrongs.

Alternative sources of energy have thankfully already been created. While many forms of renewable energy have been invented, the most viable for large scale energy production are solar power, wind power, and nuclear power. Solar power uses photovoltaic cells on solar panels to convert sunlight into electricity ("About Solar Energy," n.d.). Wind power is generated when a turbine is spun, powering a generator ("The Basics of Wind Energy | AWEA," n.d.). Nuclear energy is produced by the fission of large atoms, producing a massive amount of heat which can be used to power steam turbines ("What Is Nuclear Energy?," n.d.). Other sources of alternative energy such as geothermal exist, but are not suitable replacements to fossil fuels due to their geographic restrictions ("Geothermal Energy Pros and Cons," n.d.).

Of course, these alternative energy sources are not perfect. The main drawbacks to wind and solar energy are their reliance on environmental conditions to generate power, and their lack of efficiency ("What Factors Determine Solar Panel Efficiency?," n.d.). Naturally, solar panels only work when the sun is out, meaning that during cloudy times and nighttime, the generate no electricity. Similarly, wind turbines only produce power when the wind is blowing. Comparatively, any time that power is needed, more coal or natural gas can be burned to exactly meet the demand for power. Nuclear reactors avoid this issue, with the ability to be run whenever needed, but the face the potentially greater issue of creating radioactive waste as a byproduct. This creates a new problem to be solved of how to properly and ethically dispose of this toxic waste ("Nuclear Waste: Last Week Tonight with John Oliver (HBO)—YouTube," n.d.). Thus, technology needs to advance to solve these technical problems before any of these sources of power can be seriously considered to usurp fossil fuels.

Social factors also have prevented the wide scale adoption of renewable energy sources. Nuclear energy has been particularly difficult given its public perception. Disasters such as those

of Three Mile Island, Chernobyl, and Fukushima Daiichi have tainted nuclear power's reputation ("Chernobyl | Chernobyl Accident | Chernobyl Disaster—World Nuclear Association," n.d.; "Fukushima Daiichi Accident—World Nuclear Association," n.d.; "NRC: Backgrounder on the Three Mile Island Accident," n.d.). Society rightly values their safety more than the use of renewable energy over fossil fuels. However, this has caused an attitude of risk aversion, and the widespread belief that any form of nuclear power is too dangerous, despite technological advances. Other less controversial forms of alternative power must face a different form of societal opposition in lobbying. The fossil fuel industries are deeply entrenched in the political system, with a massive lobbying presence to ensure their interests are protected ("Lobbying Spending Database Coal mining, 2019 | OpenSecrets," n.d.). This has made progress slow for policy benefitting alternative energy sources. Almost certainly, the way to drive innovation will be by making it economically advantageous. Should the technology behind alternative energy prove itself more profitable than the fossil fuel industries, hopefully the tide will turn in favor of renewable energy.

The research of alternative energy sources is important because if successful, it will provide a roadmap to accomplishing the first step in saving our environment. Holistic approaches to problems viewed through STS lenses offer the most comprehensive analyses of problems, and when a problem contains as many different factors as climate change does, an STS analysis will prove invaluable.

Research Question and Methods

The primary question to be investigated is: What factors limit the widespread adoption of solar, wind, and nuclear power production? These factors will be explored in two categories of technical and non-technical. Technical will explore the current inherent properties of each

method and explore whether technological advances could possibly curtail any problems with the technology currently. Non-technical will explore social, political, and other non-technical reasons why each technology hasn't been adopted. These reasons could be compounded with the technical factors, and following an investigation of the factors, a holistic analysis will be conducted. The primary methods of research will be those of documentary research methods and historical case studies. Particularly in the case of nuclear energy, historical events such as the Chernobyl disaster of 1986 and the Fukushima Daiichi disaster of 2011 have greatly impacted public perception of nuclear energy. Documentary research methods will be crucial to understanding the technical hurdles associated with each of the chosen forms of renewable energy, such as issues of efficiency and waste byproducts.

Conclusions

In a world as complex as that of 2019, care must be taken whenever possible. Questions as simple as "how should a clock be powered?" can have vast implications, reaching into issues as diverse as climate change and corporate lobbying. Thus it should be with scrutiny that consumers make their decisions. Technology such as 3D printing exists to reduce the amount of waste in the manufacturing process, as well as enabling the full customization of components in a project. Hopefully this ability of consumer choice will more viably extend to the power we consume. Ideally, 100% of the electricity produced will someday be from clean sources, but it is important to be realistic in one's expectations. However, it is not without grand dreams that great accomplishments can be achieved.

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