Construction of an Automated Solar Panel Cleaner

Creating a Nuclear Navy - A Social Analysis

A Thesis Prospectus
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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:

For any modern society, a chief concern is the creation, and distribution of power. From the Industrial, to the Computer Age, fossil fuels have been a most versatile source of energy, being abundant, portable, and energy dense. This, however, has led to pollution, and climate change, and to combat this, alternate means are being pursued. Thus, I will examine these sources of energy, paying attention to their societal impacts.

The technical project then is the *creation of a domestic, automated solar panel cleaner*. As the cost of photovoltaics decreases, the ability of the average household to acquire single-family solar panels increases. Therefore, creating a cost-effective, and easy-to-operate system that allows the average homeowner to clean their solar panels without the expense of traditional cleaning crews is desirable.

The STS project will examine the societal impacts of implementing the Naval Nuclear Propulsion Program (NNPP), alternatively known as the Naval Reactor (NR) program by the US Navy. Commonly referred to as the creation of a "nuclear navy", this was an effort to introduce nuclear propulsion to naval vessels. Occurring during the middle of the Cold War era, this represented a departure from diesel boats as a means of gaining a technological edge, allowing submarines to stay submerged longer during the arms race versus the USSR. Specifically this thesis hopes to answer the question of "*How did social attitudes allow for the creation of a nuclear navy in the United States?*".

These two projects are important as they define differing attempts at reducing reliance on fossil fuels. For the technical project, one finds a modern approach to the issue. Photovoltaics are a way for the average consumer to eliminate fossil-fuels in household consumption, being championed due to a combination of cost, desired localization from the energy grid (Winner, 1980, p. 130), and environmental concerns. The STS project then is a historical approach to the issue, where the concern is the tactical

advantages of having independent power supplies that allow for long periods underway in light of technological competition with the USSR.

These two projects relate, as both are a devolution of energy production from a larger-scale energy infrastructure. Domestic solar panels entail adopting single-unit, non-fossil fuel sources of energy, allowing for a decentralization of infrastructure from regional utilities. Nuclear propulsion on ships then, represents the adoption of single-unit, non-fossil fuel sources of energy, allowing for a decentralization of energy from port refuelings. Though diesel ships were by all means self-sufficient underway, they could not maintain the same level of independence from ship tenders, and port calls as could their nuclear counterparts. Thus, each is an example of the devolution of power generation from reliance on larger aggregated fossil-fuel utilities, into the single-home and single-ship scale.

This prospectus will outline how I will undertake the technical, and STS projects. I will describe the technical project, followed by the STS project. I will then list the texts to be consulted, accompanying them with descriptions of their primary arguments, and how I will use them during research. Finally, I will provide a reference list for cited sources.

Technical Project: Construction of an Automated Solar-Panel Cleaner

Problem Statement and Significance

Currently, photovoltaic (PV) cells are a common way of producing electricity for the homeowner. These absorb light energy from the sun and need a cleaning system to keep absorption rates consistent. To help the domestic homeowner maintain these panels, our capstone group will develop an automated solar-panel cleaner.

The creation of such a system is important since energy production using PV is highly dependent on having a clean, unobstructed surface. Losses from debris on panels amount to up to 7% of energy production in the US (*Scientists*, 2021). Current methods of cleaning PV cells are labor intensive, and are hassles for individual homeowners, making the creation of a wholly automated system minimizing human input all the more appealing.

Problem Approach

To create this solar-panel cleaner, we will create an electro-mechanical system. This system employs motors to actuate motion and uses electronic controls to ensure properly timed action. Physical mechanisms provide the range of motion needed to accomplish all required tasks. This system will use off-the-shelf motors and components, and several custom-made ones and we will design it around a scale model of a solar panel, mounted atop a scaled roof-truss. We will build this system on a skeleton of linear guide rails made from commercial square tubing. The rails allow motion across the surface of the panel by an attached squeegee wiper. Drip irrigation provides cleaning fluid during operation, rinsing off any initial debris before wiping. Controls restrict the motion of the wiper, and a single DC-brush motor will power the apparatus. This servo motor is attached to a spindle shaft which acts as a windlass for a cable, hoisting the wiper up and down across the surface of the panel, much as a winch might. Tension springs act as a return mechanism and bring the wiper back down the panel. We will mount the rails on either a custom aluminum mounting plate, or else screw it directly into the roof. Figures A, and B show a

preliminary sketch of the system. Given that the design process is ongoing, many of the components that are needed are not yet shown in the figure.

This project will be done under the direction of Professor Momot in a team of 5 members, each assigned a team role. We will spend the fall semester developing a mechanism concept, sketching preliminary part drafts and researching components. We will begin construction, and testing of the mechanism during the spring semester.

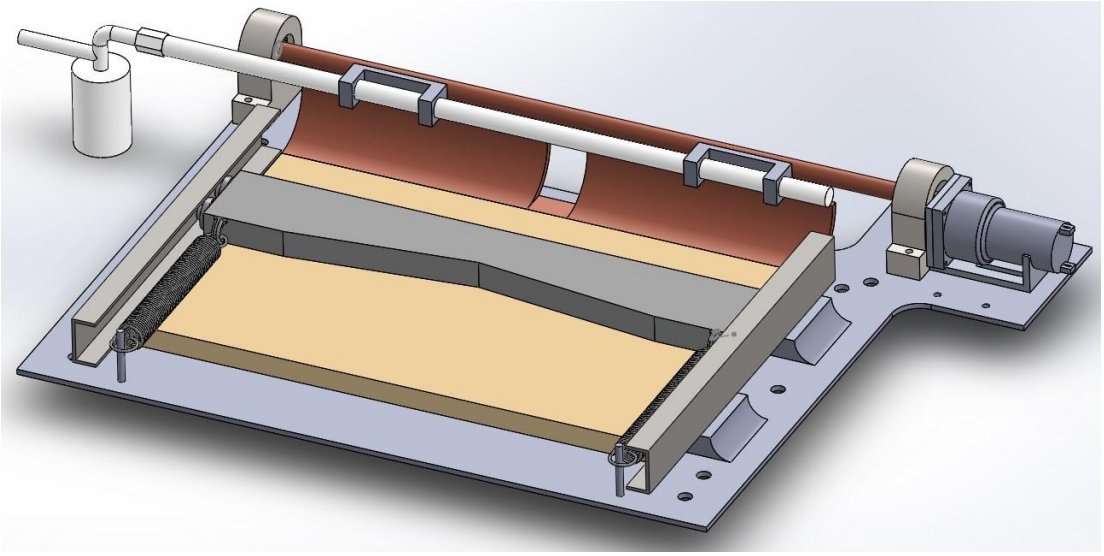

Figure A: Solar Panel Cleaner Model

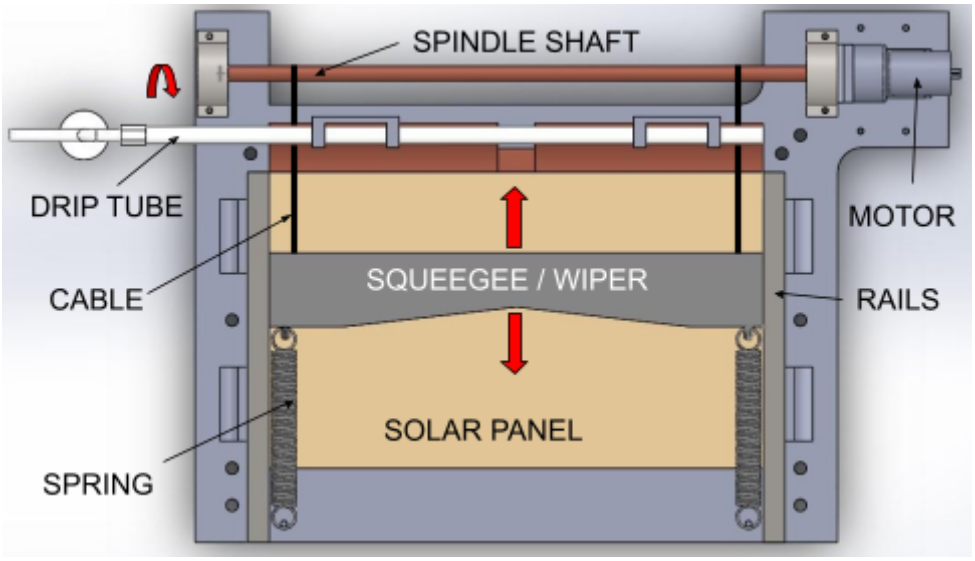

Figure B: Solar Panel Cleaner Model Components

Resources Used

To produce this device, the Department of Mechanical and Aerospace Engineering (MAE) has allocated a budget for purchases of off-the-shelf components, and raw resources. We will use the MAE Machine shop to create any custom components, and if need be, make use of the Makerspaces around Grounds.

We hope that by the end of the spring semester, we will have made a fully-functional prototype. This will then be tested on a scale model of a roof, complete with a plywood-model solar panel.

STS Project: Creating a Nuclear Navy - A Social Analysis

Problem Statement

The technology at the center of this STS project is nuclear power in the form of naval nuclear propulsion used aboard ships in lieu of diesel. I will answer the question of "*How did social attitudes allow for the creation of a nuclear navy in the United States?*". To do so, I will track the progress of social views on nuclear energy in the society at-large, and among key actors in the adoption of this technology, and find out how their interplay allowed for the successful creation of a "nuclear navy".

This answer is important to understanding modern pursuits of cleaner forms of energy. As the disastrous effects of climate change are being felt, and the use of the fossil fuels which have wrought such calamity are scrutinized, the social changes which must occur to sever reliance on fossil fuels must be understood. On a smaller scale, but still one where fossil fuels ruled as status quo for energy needs, the adoption of nuclear propulsion was a fundamental shift in the understanding of energy needs, with "society" accepting that technology as one that could supplant traditional fuels. Thus, examining this case reveals how society might one day come to accept new renewable energy technologies.

Figure B: The USS Nautilus, the first nuclear submarine (UnionLeader.com, 2022)

Affected Groups

To pursue this question, I will consider the social groups which factor into naval nuclear propulsion. First, are the sailors who operate the ships. They are the ones who must train, and live aboard these ships. They will feel the effects of both the need for new technical knowledge of nuclear systems, and the effects of longer periods underway using nuclear fuel. I will also consider those higher in the command structure, particularly, the admirals. While ostensibly politically neutral due to their military affiliation, they nevertheless exert considerable political power, their desires and whims often serving as later political policy. This then leads to another group of actors: the politicians. These are the larger figures in the governmental landscape who hold clout in either legislation, or executive power, and allocate, or divest funds from any large-scale project. Finally, I will consider the general tax-paying Americans. These form the constituents of the political actors and thus, gauging their general attitudes, even at a basic level gives insight into what political actors must consider when making political decisions.

In particular, I can also consider individuals who had considerable sway over the development of the NNPP. Canonically, the Navy has lionized the figure of Hyman Rickover, an electrical engineer who

would turn Navy Admiral and spearhead the implementation of nuclear-produced electricity for ship propulsion (*The Nuclear*, 2021). An examination of his personal relationships within the Navy, and the overall government yields further understanding of the situation, giving particular insights in how members of the previous groups interacted on a personal basis.

This leaves out certain groups. First, it does not account for governmental figures in the judiciary, assuming them to be too insular in their powers, therefore not interjecting into the rapidly changing politics that define program allocation. I am also not accounting for marginalized groups in their own right, instead, considering sailors, and taxpayers as a monolithic bloc. I can of course, break this down, with potential for doing a more in-depth analysis through a racial, or gender critique. I am also leaving out other branches of the armed forces; this may prove very well to be important as they also contend for funding, and vie with the Navy for large expenditures. I might later consider this. Further, by not adopting a racial or gender critique, I may abandon a valuable perspective from which to view NNPP. That, however, would be enough material for an entire thesis, and may be pursued by someone in the future.

Social Frameworks

Alongside identifying pertinent social groups, studying the interaction of these groups is also important. To do so, I will employ several STS methodologies, studying the interplay between these social groups, and find a societal meaning within this topic.

First, in this thesis, I seek to find out how societal values and influences impacted the development of the NNPP. I can therefore analyze the topic using the social construction of technology (SCOT) framework. This SCOT analysis requires that I view the development of a technology, as a series of multidirectional stages, where design decisions are made *not* as simply improvements of previous iterations. Rather they are but only ones made amongst many possible paths. Any decision made is the one that fulfills technological, *and* social desires (Bjiker, 2012, p. 22). In the case of NNPP, alternative technologies, or limited adoption of nuclear propulsion are examples of different paths not taken for reasons that I will examine. Further, SCOT can also be used to look at the social patterns that might affect

each design choice. For instance, how do prevailing attitudes towards nuclear energy cause certain variations of nuclear propulsion to be adopted, and how might that have influenced the eventual adoption of the technology wholesale? How might cultural contexts impact the adoption of NNPP, and similarly, how does NNPP affect culture itself?

Second, I can also use actor-network theory (ANT) since I know the identities of the groups, and individuals pertinent to naval nuclearization. This is where technologies, their artifacts, and relevant human actors exist in an ever-shifting relationship with one another, forming networks of "action" upon each other that can be examined. I will then study the technology itself, looking at how its attributes may be considered advantageous to some actors, but disastrous to others. This can be coupled with the technology's own development, with certain ships such the *USS Nautilus* and the *USS Thresher* — respectively examples of success and failure of nuclear powered ships — being usable as particular actors which influenced public perception of the technology (*The Navy*, 2003).

The ANT and SCOT analysis then work together to provide a comprehensive look at the social conditions which allowed for the adoption of NNPP. While SCOT looks at how attitudes towards aspects of the technology might bolster, or diminish enthusiasm for NNPP, ANT then contextualizes these attitudes. It assigns them towards specific groups and individuals, considering them not only as instrumental towards individual steps in the development process, but also considers them as being in a continual relationship with NNPP.

Research

To conduct this research, I will use texts provided in the bibliography along with other texts that are still undetermined. The technical research will use public-access, and institutionally accessible journal articles found through the UVA library catalog, and sites like *Web of Science*. I will find relevant humanities scholarship, and sociological commentaries using UVA's *Virgo*, and sites such as JSTOR. Finally, I will use in-class readings, particularly Winner and Bjiker, to inform STS-analyses.

I have provided some key texts alongside how I will use them in the following section.

Key Texts:

My thesis will first scrutinize the canonical interpretation of the development of NNPP. A prevailing perspective amongst many military historians, this considers primarily the work of a single man, Admiral Rickover, and his personal ambitions for the passage of NNPP. To do so, biographies of him can be consulted, one such book being *Rickover and the nuclear navy: the discipline of technology*. This will provide technical details on the events immediately surrounding the NNPP, and also gives some background on a particular actor, Hyman Rickover. This of course must be used with caution, given the danger of falling into a "Great-Man theory" interpretation of the past. While a popular mode of historiography in prior centuries, this invites the folly of ignoring wider socio-political, and economic factors that contribute to any historical event. While Rickover was indeed integral to NNPP, I would need to not unduly give credit to him at the expense of larger societal processes.

Having assessed Rickover's contributions, I will then examine the social groups which informed the decision to adopt nuclear propulsion. To do so I will access the Navy Institute's archives. With myriad accounts written by former sailors, and compiled for open access, the words of individual sailors are available. In particular, I will use the memoir of Richard Claytor, a sailor who worked extensively with Admiral Rickover (Claytor, 2007). From this, I will gain an understanding from sailors of the period, finding their attitudes towards both the technology, as well as the admiral. This fleshes them out for both an ANT analysis, where Claytor is representative of "sailors" and for SCOT, where I will consider the attitudes of that particular group of people in society.

To consider how the mechanisms of government were manipulated to allow for the continuation of NNPP, I will scrutinize various government correspondences. For example, Executive Order 12344, the executive order which created the NNPP provides the purported reasoning for the technology's allowance. This shows what concerns were priorities for the government, and more importantly, how the current administration *wished* to be perceived through the issuance of this order. This reveals a good deal about both prevailing attitudes amongst government officials on nuclear posture, and the role of nuclearizing

conventional weapons. Alongside this order, I can also pull from bureaucratic artifacts, such as the spending authorizations for the program, including the Defense Authorization Act of 1985. This shows not only the input of the administration, but also legislative actors.

To understand the changing social perceptions of atomic events, I can use various scientific studies. One source is the paper *Public opinion on nuclear energy and nuclear weapons: The attitudinal nexus in the United States*, offering polling data of attitudes amongst Americans on nuclear weapons throughout several decades, including during the NNPP. This gives perspective on broader views of nuclear weapons, and proliferation, providing the societal context in which the other sources exist.

I will use various other sources too, however they will be adjuncts to these main ones.

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