DIGITAL COMMUNICATION AND ITS INFLUENCE ON NUCLEAR ENERGY

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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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NUCLEAR POWER AS THE FUTURE OF ENERGY PRODUCTION

As humanity develops more advanced technologies, power has become a critical component of daily life. Hydrocarbon fuels such as coal and oil have long been primary source of energy production globally, but their use has become a topic of contention (Peter, 2018, p. 1557). Their usage has continued to pollute the environment through the propagation of harmful emission of sulfates and other heavy metals like mercury. These particulates are harmful to human respiratory systems, poison wildlife, and acidify bodies of water. The need for an energy source whose environmental effects are less severe is necessary to prevent irreversible damage to the planet (Union of Concerned Scientists, 2017). Alternatives such as solar and wind power have been explored, but cannot yet match the power demands of the general public (U.S. Energy Information Administration, n.d.). One promising plan of attack is the development of nuclear energy. Nuclear energy has a number of benefits; it has markedly high effiencies that allow it to reach energy production rates comparable to traditional carbon sources. Today, the 57 power plants in the United States generate 20% of the electricity demand of the country (U.S. Energy Information Administration, 2020, para 1-2). Additionally, research and innovation surrounding nuclear technology has yet to reach a plateau. More advanced fuels and plant designs are constantly being devised that further safety, efficiency, and reliability. These benefits clearly indicate that nuclear technology may likely be a critical component of addressing the energy crisis in the near future.

Unfortunately, the past few decades have been tumultuous for nuclear technology. The 1940s saw the rise of nuclear weaponry and the bombing of Hiroshima and Nagasaki, which had both physical and social consequences on the global scale. Disasters such as the failures of the Chernobyl Nuclear Power Plant in 1986 and the Fukushima Daiichi Nuclear Power Plant in 2011

highlight the grim consequences when technology fails. These reactors both encountered failures during operation, which resulted in the release of radioactive elements into the surrounding areas. While the Fukushima plant managed to employ fail-safes to mitigate the extent of failure, the Chernobyl plant underwent an explosive meltdown that rendered the surrounding area inhospitable. Despite improvements to safety and the numerous policies present to mitigate the chances of failure since these events, American polling on the public opinion of nuclear power done by researchers such as Baron and Herzog (2020) have shown a downward trend of support, with sharp drops after these disasters (p. 2). The need to better understand the relationship nuclear technology has with society and various interconnected social groups is critical to improving public understanding and facilitating the implementation of nuclear energy.

NUCLEAR TECHNOLOGY AND ITS COVERAGE THROUGH HISTORY

The big question of this research paper is to determine how to improve the status and standing of nuclear power. To this end, my STS project will help better understand the most prominent methods of information dissemination, especially with regard to digital communication. Understanding these methods will help establish the best courses of action to take with regards to spreading information about the benefits of nuclear power. Additionally, this research will also focus on the propagation and mitigation of disinformation surrounding nuclear power, with efforts made to understand why these rumors became popular and how to avoid these developments in the future. The loosely coupled technical project will address some concerns with the longevity and safety of uranium nuclear fuels by looking into the mass production and refinement of thorium. The project provides a detailed overview of a thorium refinement plant from monazite sands, complete with economic and social analysis. This plant aims to produce over 30,000 kg of thorium fuel per year, a scale magnitudes higher than any

previous work. Both these projects will culminate with relevant reports and conclusions about the feasibility and future of nuclear technology with respect to these topics.

NUCLEAR ENERGY WITHIN THE FRAMEWORK OF SCOT

Ensuring that all social groups affected by nuclear technology are appeased is challenging due to their size and standings, shown below in Figure 1, which is a depiction of the Social Construction of Technology (SCOT) framework devised by Pinch and Bijker in 1984.

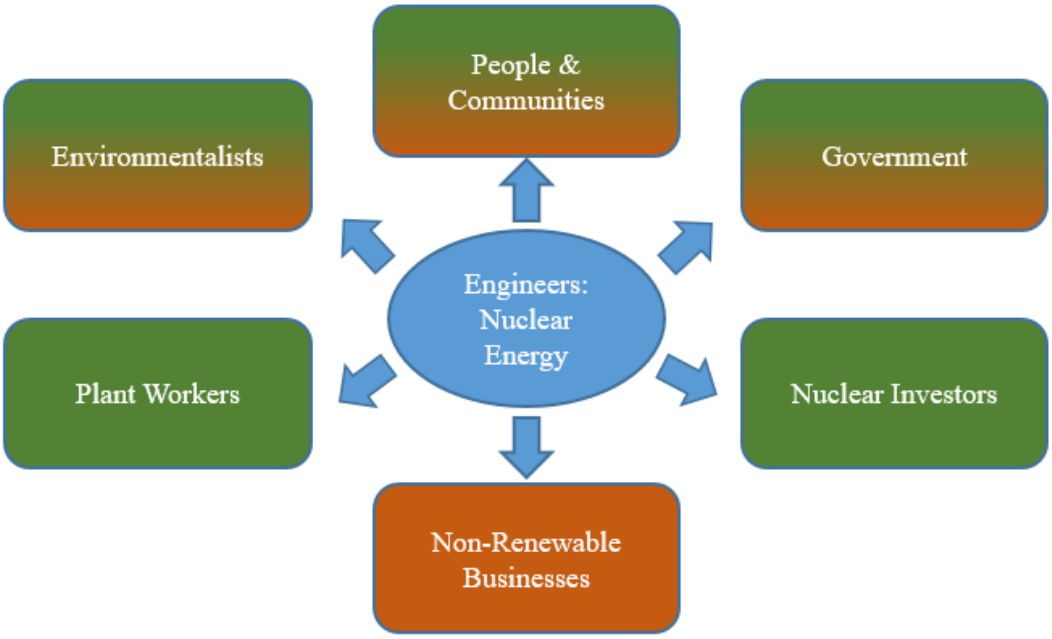

Figure 1: Nuclear energy SCOT model. The implementation of nuclear energy, headed by engineers, must appease the interests of all social groups involved (Adapted by Samuel Ong (2020) from Pinch and Bijker, 1984).

This framework shows that various social groups are dependent on nuclear energy as an artifact, and their collective interests must be kept in mind. This model also signifies that engineers are soley responsible for the proper implementation and distribution of nuclear technology. As such, they must interface with all relevant social groups and ensure that their goals and interests are met or alleviated to some degree. For each social group, nuclear energy has a different purpose; for some, such as the investors in the technology and the workers at the

plant, it is an opportunity for profit and growth, while other groups, such as the corporations who manage traditional energy production, see the rise of nuclear energy as a threat to their current standing. Each group brings something unique to the table that is necessary for the artifact to succeed, and often acts independently to achieve their goals. Like any other technology, public acceptance is highly reliant on available information. With the advent of the global inter-connected network, it is easier than ever to distribute knowledge, and this has continued to steer the course of this technology.

It is clear that some of the social groups depicted in Figure 1 have more social standing and power than others, and may be able to influence the opinions of other groups through various means. Understanding the primary methods of communication between social groups is crucial to determining how information is effectively distributed. The formation of public opinion relies on this flow of information, and so the groups and actors who distribute this information hold significant power. To this end, this report will focus on the media as a significant actor in this field. Its historical actions will be evaluated, and how it has evolved over the years will be explored as a potential solution.

THREE MILE ISLAND, CHERNOBYL, AND THE LACK OF TRUTH

The 1979 Three Mile Island incident in Pennsylvania was the first time a nuclear power plant experienced a major breakdown. A significant amount of nuclear material was released into the surrounding area due to a failure in the cooling systems of the plant, but operators on site were able to stop the disaster from spiraling out of control. Regardless, this event caused many to question the safety and efficacy of nuclear power. During the time of this incident, now-common methods of digital communication were non-existent. The public primarily got information through newspapers and other media with more restricted influences. The social groups that were

able to influence this flow of information were few, and so were able to essentially control the narrative to benefit their own interests. There was a clear hostility towardnuclear power with regards to media coverage regarding the matter; reactors across the world were put under heavy scrutiny, and once minute incidents were blown up and sensationalized. Friedman et al. (1992) emphasize the propagation of a documentary on the major U.S. network ABC titled 'The Fire Unleashed,' which was found to employ numerous subliminal techniques to promote an anti-nuclear opinion (p. 306). Referendums in Europe after this incident displayed widely negative views, and nuclear programs in prominent countries such as Austria and Sweden were halted or cancelled (Freidman et al., p. 305). With the nuclear industury still reeling from the social impacts of Three Mile Island, Chernobyl further rallied the public against them.

The Chernobyl incident in 1986 was the first major failure surrounding nuclear power. Operators attempted to perform a routine test to determine the effectiveness of the plant's auxiliary power systems, and shut down the reactor. The reactor was at an unstable state at the time of this process due to irregularities in the fuel rods, and created a power surge that damaged numerous tanks and pipes. The workers lacked the necessary procedures to halt a breach of this size, resulting in multiple explosions, fatalities, and ultimately the completely meltdown of the plant. The surrounding area was evacuated due to the release of radioactive material, resulting in paranoia and fear surrouding the event as a whole. Numerous investigations have been done on the Chernobyl incident to determine its shortcomings and to develop safer nuclear technology (World Nuclear Association, 2020). However, all of them were done years after the event occurred.

The media found after the Three Mile Island incident that the public were highly invested in these events. Friedman et al. (1987) found that "'Chernobyl gave journalists a fresh excuse to

continue glamorizing the anti-nuclear power people and their misleading views-as long as the anti-nuke people remain good for sensational copy. Given the journalistic mind-set against nuclear power, that should be a long time' (p. 306)." It was clear this was the case; a majority of coverage of the incident was not focused on the nuclear industry or nuclear power, but rather the event and its negative impacts (Freidman et al., p. 309-310). This was not only the fault of the media. With tensions high between the Soviet Union and a majority of the Western world, the Chernobyl failure was a chance to prey upon the faults of the communist regime and expose their weaknesses. The Soviet Union was aware of this and surrounded the accident with a wide degree of secrecy, refusing to divulge information on the matter to the media. The stunning lack of information allowed rumors and misconceptions to take their place. Despite the fact that the United Nations Scientific Committee on the Effects of Atomic Radiation (UNSCEAR) found no correlation between the accident and major health defects, Rahu (2003) documents a number of commonly-accepted rumors including "15,000 nuclear victims… into mass graves" and "as a result of radiation, over 300,000 persons have died by now (in 2000)" (p. 296-297). These accounts make it clear that communication techniques and methods of information distribution hold major power over the opinion of the general public. In turn, the general public is able to influence decision making surrounding the technology, as shown by the fact that nuclear reactor implementation slowed down dramatically. Now, years after the events, people still associate nuclear power with the fear of failure, and it is critical to dispel the ever-present misinformation surrounding the topic.

THE RISE OF DIGITAL COMMUNICATION: COVERAGE OF FUKUSHIMA

The formation and development of the global network as a result of digital communication has greatly altered the methodologies by which public and societal opinions

develop. Methods such as social media, forums, and news sites are the primary methods of information consumption in the Digital Era, all of which are reliant on the internet and its interconnectivity. A critical difference between these passageways and those prior is its freedom and accessibility. Information is freely distributed by any groups, regardless of its truthfulness or accuracy. However, these communication methods are still the primary way of influencing public opinion on various matters. As shown in Figure 2 on page 7, this creates a feedback loop of sorts; social groups can popularize their views and opinions on the internet, which in turn is able to influence the viewpoint of the general public (Kim, 2014, p. 373).

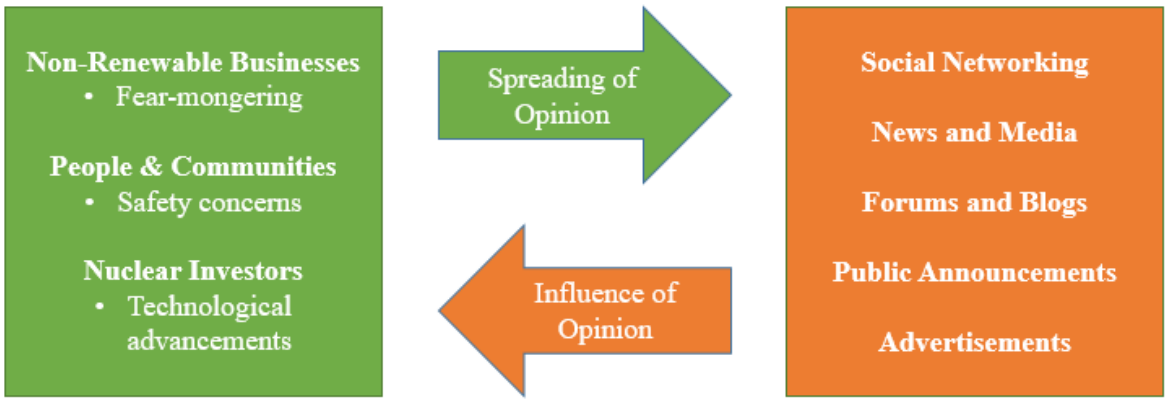

Figure 2: Representation of the effect of digital communication on opinion. Social groups spread their opinions through digital communication, which influences the opinions of others and converts them to their viewpoint (Ong, 2020).

The failure surrounding the Fukushima Daiichi Nuclear Power Station in 2011 is a prime example of the effectiveness of communication in the Digital Era. A major tsunami and earthquake that hit the region had caused the reactors to rely on emergency power. However, the emergency power generation units were critically damaged following the tsunami, resulting in the meltdown of the reactor's core due to a lack of cooling. A considerably amount of radioactive material was released into the surrounding communities and the Pacific Ocean, which the plant bordered. This disaster was the first incident that was classified as severely as the

Chernobyl disaster due to its aftermath, and became an international scandal. The Digital Era's newfound mass media quickly descended on the incident, flooding the internet with copious amounts of information and articles.

News surrounding the Fukushima incident spread exponentially faster than the Three Mile Island and Chernobyl accidents thanks to the presence of the internet. Studies done on the spread of information by papers such as Kim (2013) found that news about the disaster spread immediately and on an unprecedented scale, forcing immediate political and corporate changes with respect to future nuclear development (p. 822-823). Coverage of the incident was fed to the public in real-time, and countless articles were published regarding everything even remotely related to the matter. Official media sources, with experts knowledgeable on the matter, were not the only source of information available. Many information sources were highly biased and lacked credibility, but were able to gain a foothold due to the preexisting concerns surrounding nuclear technology (Friedman, 2011, p. 59-62). Social media sites such as Facebook and Twitter were breeding grounds for rumors and misinformation, infecting the general public with paranoia. Again, a large majority of these articles failed to discuss nuclear power and safety, and instead focused on the 'hot topics' such as the radiation leaks and damages. The lack of credible science in these reports hurt public opinion on nuclear power significantly, and the results could be seen in international policies around the world. The International Atomic Energy Agency (IAEA) cut its planned nuclear generating capaicty by half, and countries such as Germany announced plans to remove themselves from nuclear energy entirely (UPI, 2011, para. 3-4). Ever since Three Mile Island, the anti-nuclear movement continued to gain support worldwide. With Fukushima and more robust means of communication, their cause was only amplified and

popularized further. Nuclear technology remains a delicate and controversial topic in numerous countries.

DIGITAL COMMUNICATION AS A SOAPBOX FOR NUCLEAR ENERGY

While historically being used by anti-nuclear groups to spread propaganada, digital communication can be utilized to help dispel disinformation and emphasize the benefits of nuclear power. The rise of anonymity and sensationalism as a way to help news stand out has made disinformation and falsification a common occurrence. As said by D. Kim (2014), "there are some drawbacks on online public opinion on social media such as fraudulent and biased messages, with hunting… and information distortion on social issues" (p. 373). With regard to nuclear energy, unsubstantiated rumors and lies about the extent of nuclear incidents have continued to contribute to negative bias about the technology as a whole (Rahu, 2003, p.295). Yet, this goes both ways. Digital communication can also help distribute information of the benefits of nuclear energy, and could be key to currying favor for its future (Kwok, Yeung, & Xu, 2017, p. 56-57).

SURVEYING PUBLIC OPINION ON NUCLEAR POWER

Before working toward altering public opinion, it is important to have effective methods of polling and suveying to have a better idea of demographics and perspectives that influence public decision. One of the most effective ways of evaluating the public opinion of a certain matter is to evaluate its presence on social media. Work done by D. Kim (2014) aimed to quantify this using information from the social media platform Twitter, where users are able to freely express their opinions on any variety of topics. After categorizing comments on nuclear power as positive or negative depending on their verbiage, they were able to determine that the general view was widely negative, with a significant drop after Fukushima that has yet to recover

(Kim, p. 381). Historically, surveys like this could have easily taken considerable amounts of time to achieve similar sample sizes; digital commuication has made these processes considerably easier due to its accessibility and open-ended network. However, it sacrifices personality for the anonymity of the internet, obscuring important variables to the situation such as the person's background. Therefore, it is critical to use online polling in conjunction with more traditional methods that allow for surveyers to obtain a more complete picture of the people they are evaluating. Kwok et al. (2017) tried to determine the Hong Kong public's opinion of nuclear energy by interviewing them in public areas. This study aimed to determine the effect of the presence of pro-nuclear and anti-nuclear information in their questionnaire, and found that up to 37% of the public changed their opinion within these biased framings (p. 6). Despite there being a significant number of people who were resolute in their opinion despite the information being presented to them, the portion of people that were influenced by the information could prove to be critical. From these studies it is concluded that despite current views towards nuclear energy being negative, it is entirely possible to remedy the issue by changing the global perspective.

When determining why nuclear energy has historically been negative, multiple factors come into play. As a technology, it is important to view nuclear power as a function of risk and benefit. Scientifically it can be determined that the benefit of the technology is high, but these studies and values are not easily accessible by the general public. A majority of news surrounding nuclear power is focused on accidents and failures, leading to a stunning lack of trust. These events, as explained by Shirley et al. (2019), have led to people's mistrust of 'the government's credibility, competency to safeguard their welfare, and transparency of nuclear

operators' (p. 466). It is critical that nuclear technology be popularized both through technical and social perspectives to emphasize its benefits while addressing fears about its risks.

NUCLEAR TECHNOLOGY AS A TECHNICAL ISSUE

Despite advancements in nuclear safety, a majority of the public is not privy to this information due to its lack of dispersion. Currently, many studies into the effects and innovations of nuclear power are often gated to the general public through the form of memberships and other high-level restrictions (Albert, 2006, p. 254). Efforts for the open access publication of scholarly articles may allow a more steady flow of scientific information to the general public, allowing them to be better informed about the matter and make more informed decisions (Sengupta, 2021, p. 203). Similarly, nuclear energy as a political issue needs to be better addressed. Government officials often demonstrate a greater propensity to pursue risks that the general public might be concerned with, leading to fear and lack of trust in authority (Geng, 2018, p. 92). More concrete lines of communication need to be established between the government and public to allow for greater transparency. Digital communication is an excellent tool for this, and can help better clarify agendas and the logic behind certain decisions (Geng, p. 92). Through proper risk communication and policy agendas, the public may be able to rebuild trust with government nuclear plans.

NUCLEAR TECHNOLOGY AS A SOCIAL ISSUE

It is clear that public opinion is not centered wholly around facts and rational thinking. It is important that the technology be treated subjectively and through more social frameworks to appeal to a greater audience. An example of this can be seen through TerraPower, a nuclear power company founded by Bill Gates in 2006. They have continued to popularize their goal and innovative reactor designs through social media and news coverage (TerraPower, 2021, p. 1).

Efforts like this show the influence that digital presences can have on the furthering of technologies and innovation. Instead of using complex engineering jargon in their documents, they instead focus on the pathos of their message, toting the "vision to be a world leader in… technologies that bring the world sustainable, afforadable, and safe energy" (TerraPower, p 1). It is these messages of positivity that, while idealistic, will win over a greater audience and help further the development of nuclear technology as a whole. Highways of digital communication should be utilized by corporations, engineers, and governments alike to popularize the many social benefits of nuclear energy. Through this, historical inaccuracies can be remedied and the public will have channels of pro-nuclear information to influence them.

NUCLEAR POWER'S LONG ROAD AHEAD

Despite numerous efforts to improve nuclear technology, the historically negative view that society holds towards the matter will not easily be swayed. Pre-existing policies and other popular rumors will continue to restrict the development of nuclear power until some form of quorum can be reached. For some regions, it may be too late. Administrative bodies such as the German government and mega-corporation Seimens have announced their complete withdrawal from nuclear energy within their plans, both representing a major loss for the nuclear industry. However, these developments are not immutable. Efforts to popularize the technology and paint its designs in a better light can slowly help improve its public relations. Continual innovation will further increase viability and favor, as there is still much to be understood about the process and its various techniques. Acting upon the information in this report about the influence of digital communication and allowing more open lines of information distribution between nuclear engineers and the public will help many better understand the technology and science. Additionally, many social groups are still hopeful about the benefits of nuclear power. Countries

such as China, India, and Russia have gone on record in support of nuclear power, and have continued to increase the breadth of their nuclear programs.

Through it all, it is critical to remember why nuclear energy is so important. The looming environmental consequences of the energy crisis worsen with every passing day. A solution must be found that is able to replace hydrocarbon fuels in their entirety. Nuclear power has proven itself as a possible solution, but failures surrounding its technology have shown to be devastating. Old scars can heal with time, but it is critical that efforts are made to move the process along. It is the responsibility of engineers to ensure that the technology is there when the world needs and accepts it.

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