Postively Influencing Space Junk Policy by Utilizing Negative Emotions Toward Technology

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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

"If you can't clean up after yourself… There's no need for you to mess things up…

And expect another person to clean up behind you." (Peter, 1969, p. 143.)

The amount of space junk that has accumulated around Earth has exploded on an exponential scale since the beginning of the Space Race in 1955. As quoted from the National Aeronautics and Space Administration's (NASA) Global Exploration Strategy, "Space exploration enriches and strengthens humanity's future". The buildup of space junk can be accredited to the desire for mankind to explore the unknown, and the established benefits that space presents such as access to global communications, navigation, and meteorology (Thompson, 2005, p. 1).

Overpopulation of space due to the deployment of increasing amounts of space junk may lead to international dispute and competition while simultaneously cluttering up space. The current international governance that exists over space is slim to none. It is difficult to determine whether change will emerge from the government, industry leaders, or from an increase in public concern.

Throughout this paper, I highlight the importance of identifying stakeholder relationships and user attitudes when implementing a new technology into society. I utilize Gary Downey's PDS model to identify the stakeholders involved in space junk and to further evaluate the actor network that exists for the space technological revolution. Kerschner and Ehlers' Framework of Attitudes Toward Technology is also used to explain the importance of considering negative user feedback in order to implement government involvement towards this emerging technological issue. I focus on the lack of concern from top industry leaders and the need to raise public

awareness for space junk. I argue that before a project is deployed into space, the industry leaders that regulate those projects must develop a more skeptical approach that considers the already existing severe amounts of space junk.

Part I: Space Junk is Escalating at an Alarming Rate

More than 4,600 satellites are currently orbiting the Earth along with over 14,000 old rocket parts and pieces of space junk that are no longer in use (Kiersz & Mosher, 2017, p.1). Orbital debris, or remnants from previous space missions, is the number one threat to spacecraft, satellites, and astronauts (National Aeronautics and Space Administration, 2016, The Risks of Orbital Debris). The pieces of debris that are moving in space are accelerating at speeds far greater than a speeding bullet. These pieces of debris range in size from that of a school bus all the way down to the size of a grain of sand. If a collision were to occur, the result would be more pieces of debris flying around at extremely high uncontrolled velocities. Collisions create more debris creating a chain reaction of collisions and more debris known as the Kessler Syndrome (National Aeronautics and Space Administration, 2016, The Kessler Syndrome).

In addition to collisions in outer space, the high density of space debris that surrounds Earth could soon make it too dangerous for missions to leave Earth (Kiersz & Mosher, 2017, p.1). Once collisional cascading due the Kessler Syndrome begins, the risk to satellites and spacecraft will increase until the orbit is no longer usable (National Aeronautics and Space Administration, 2016, The Kessler Syndrome). The result is a man-made impenetrable barrier around our planet that we will not be able to travel through (Thompson, 2011, What can we do about the space junk problem?). If this were to happen, it may take hundreds or thousands of years for this space to clear before mankind can explore space again (Mosher, 2019, p.1).

Figure 1 offers a visual representation of the dense amount of junk that currently surrounds Earth.

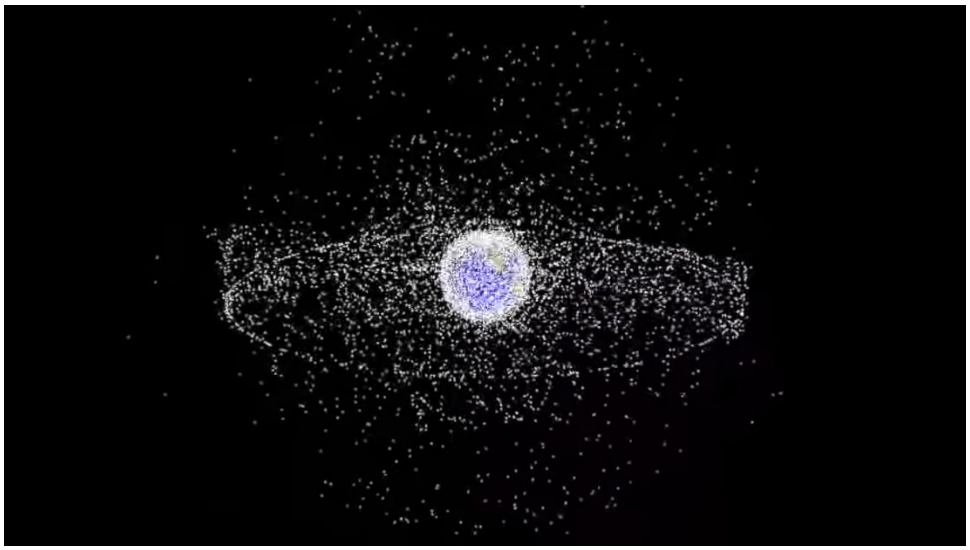

Figure 1: A visual representation of the amount of space junk that currently surrounds Earth. Overpopulation of space is a major issue closer to Earth in low Earth orbit, but extends into orbits that are further from Earth. Space junk is categorized as satellites that are currently in use and old rocket parts that are no longer in use. Image received from Wenz & Rand, 2015, Gallery.

So how did the environment that surrounds our Earth get to this point? The Space Race that began during the Cold War era introduced desire and national pressures to explore space. Since then, space exploration has remained a fundamental characteristic of the relentless curiosity that drives humans to investigate the unknown (NASA, 2007, p. 2). So instead of ending the quest towards outer space after the first lunar landing in 1969, the world wanted to know more about the environment that surrounds our Earth. Lunar missions were replaced with satellite technologies to expand scientific knowledge, economic expansion, and information sharing, to create industries, and to foster a connection between nations (NASA, 2007, p. 25). Space exploration between the Earth, Moon, and Mars only continues to increase as the aerospace industry continues to grow in success on a global spectrum.

The United States is currently the most responsible for the amount of debris in space, followed by Russia and China (Kiersz & Mosher, 2017, p.1). Figure 2 below offers a visualization of the amount of space debris that each country contributes. As of 2019, American companies SpaceX, Amazon, and Apple have all announced plans to collectively launch tens of thousands of internet satellites over the next decade (Mosher, 2019, p.1). With approval from the United States government, Elon Musk, founder of SpaceX, plans to launch nearly 12,000 Starlink satellites to provide easily accessible global internet access. If 12,000 satellites were not enough to raise concern, Musk is still waiting for approval to launch a total of 42,000 new satellites into orbit for his Starlink internet initiative. This example alone is proof that space junk is a problem that was created together by both the public and private sectors.

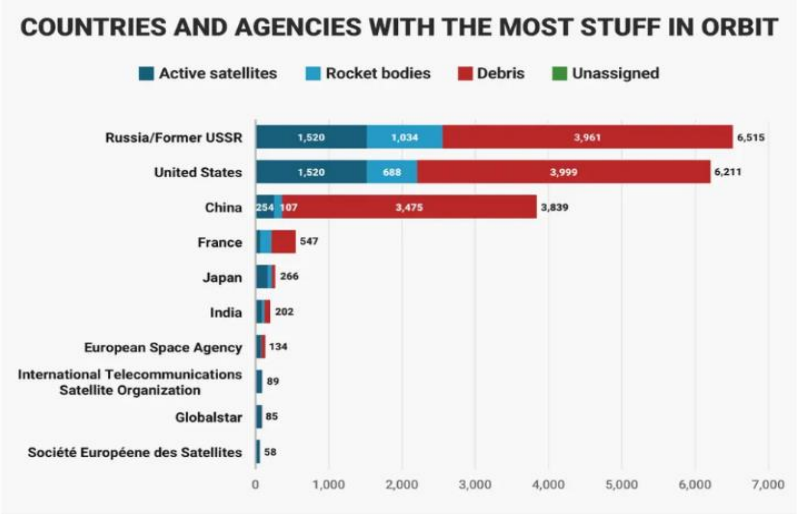

Figure 2: A visualization of the top ten entities with the most trackable objects around Earth. These objects include active satellites, rocket bodies, and debris. Data collected from SpaceTrack.org, Image received from Kiersz & Mosher, 2017, p.1.

In terms of tracking pieces of debris in order to try and prevent collisions, the United States government and some of its partners have the Space Surveillance Network (SSN) that currently tracks up to 23,000 human made objects that are floating around in space. The problem,

though, is that only objects larger than a softball can be accurately tracked to prevent collisions (Mosher, 2019, p.1). The millions of smaller pieces of debris still offer a huge threat to the Kessler syndrome.

There is no easy or cheap solution to the space debris problem. The most straightforward solution to reduce space junk is to stop leaving objects in orbit once they are no longer useful. However, the governance that currently exists between nations in terms of space exploration is slim to none. There are some international guidelines in place through the Inter-Agency Space Debris Coordination, but these rules are not strictly followed when missions are being considered for launch (The Aerospace Corporation, 2020, What can we do to keep the problem from getting worse?). It is difficult and very expensive to eliminate old spacecraft from orbit, so for the sake of budget, the consequences of space junk are not being prioritized as much as they should be.

Along with the physically difficult and expensive maneuvers that would need to be performed to remove space junk, there is also the issue of property rights. A nation that does not own a specific satellite cannot remove a satellite or rocket from orbit that belongs to another country without their permission. Ailor from the Aerospace Corporation stated, “No other nation has permission to touch a US satellite. And if we went after a satellite, if could be deemed an act of war.” (Kiersz & Mosher, 2017, p.1). Plans for space exploration and the consequences of evolving exploration must be considered especially in the effects that they may have in cross-cultural differences between nations.

Debris presents the same risk to a country’s own systems as it does to everyone else. This could lead to international dispute and frustration over the introduction of new missions into surrounding Earth space. Understanding the severity of the increasing quantity of space junk will

be necessary in order to create new political, economic, and legal frameworks that tackle the technical and social issues that space junk presents.

Part II: Utilizing Actor Network Theory and Kerschner and Ehler's Framework of Attitudes Toward Technology Creates a Strong Understanding of Stakeholder Perspectives

Kerschner and Ehlers investigate the diversifying number of attitudes that citizens of the European Union (EU) are developing in response to new technologies. Enthusiasm towards technology is being overridden by feelings of ambivalence and doubt. In the past, any aversion towards a new technology was seen as a bad sign, but as society has progressed, feelings of doubt have allowed the public to express more emancipation. This article notes that, "After decades of ambitions of governments and science advocates to streamline public attitudes toward science and technology into one dominating voice of cheer and consent, skepticism and divergent views all seem desirable for some." (Kerschner & Ehlers, 2016, p. 140). The trends in public opinion regarding technology are important to consider if policies are to be implemented in order to change the unhealthy progression of a toxic technology.

Kerschner and Ehlers draw on social and philosophical studies of technology from Ecological Economics and related areas to develop a framework of attitudes toward technology that consist of four categories. Although originally derived from the evolution of economies, Kerschner and Ehlers' attitudes can be applied to the evolution of any other engineering technology. The categories of their framework include enthusiasm, determinism, romanticism, and skepticism.

For technological enthusiasts, technology is considered inherently good and its misuses accidental. Enthusiasts have a fascination with technology and believe that technology should be

used and improved whenever possible. From a different perspective, deterministic technological change implies that social and political forces are co-existent with new technologies in the role that they play in the progression and success of a new technology. This summarizes the idea that technology shapes the social landscape just as much as the social landscape shapes technology. Varying very differently from technological enthusiasm, technological romanticism reflects "romantic uneasiness" or the view that technology is seen as questionable, doubtful, and associated with feelings of ambiguity. This belief expresses the idea that technology is not always reasonable in its intentions or applications. Somewhat similarly, modern skepticism is concerned about the negative social, environmental, and economic impacts of technology. More specifically, skepticism can be rooted in religious fears. Figure 3 describes the four attitudes of attitudes towards technology (ATT) in more depth.

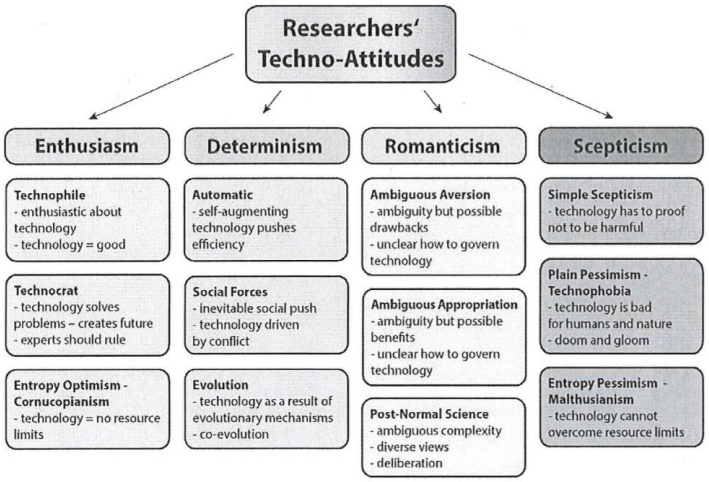

Figure 3: The four attitudes that form the attitudes toward technology (ATT) framework. Image received from Ehlers and Kerschner, 2016, p. 143.

When evaluating a technological system, it is important to understand the perspectives that each stakeholder may have. Ehler and Kerschner mostly focus on the user's feedback and how this may affect the development of a technological system. By applying Downey's theory of

engineering problem definition to Ehler and Kerschner's attitudes towards technology, a full point of view can be developed from each stakeholder. Downey's "Are Engineers Losing Control of Technology? From 'Problem Solving' to 'Problem Definition and Solution' in engineering education" (2005), discusses Actor Network Theory (ANT) and the importance of defining stakeholder relationships. ANT identifies contributors to a technology that may be human or non-human. Each actor has a relationship to the technological system that is important for its development and success or failure.

Framing Stakeholder Relationships and Attitudes Toward Technology Regarding Space Junk

According to Downey, "In the PDS model, engineers have to make difficult trade-offs among alternative stakeholders, alternative definitions of the problem, and alternative perspectives about what is taking place, including their own." (Downey, 2005, p, 591). This model can be applied to any technological system, but for the purpose of this paper will be used to analyze space junk. Identifying the important stakeholders relevant to space junk applies Downey's problem definition model and creates an actor network of people who are contributing to the technological issue.

From the four attitudes toward technology that were discussed by Kershner and Ehler, romanticism and the category of Post-Normal Science that branches underneath it are the most applicable attitude to develop in order to create policies for space junk. Post-Normal Science emphasizes the idea that if decisions need to be made about "if" or "how" to apply or support a new technology and if the system uncertainties are very high, then so are the decision stakes and an extended peer review should therefore be initiated on the technology. Post-Normal Science

acknowledges the plurality of perspectives (Kerschner & Ehlers, 2014, p. 141) which then can be extended towards the multiple stakeholders that exist within the issues of space junk. It is important for the stakeholders involved to gain a negative attitude toward the accumulating quantity of space junk in order to initiate and create international policy change for space exploration.

Part III will focus on the incorporation of Downey's problem definition model and Kershner and Ehler's framework of attitudes toward technology to develop an understanding of stakeholder emotions toward space technology.

Part III: Utilizing Negative Public Feedback Towards Space Junk to Create Policy Change

When evaluating the Actor Network that space junk presents, it is difficult to determine where exactly policy change for space junk will emerge from. Because outer space is a space that is not necessarily regulated or owned by one particular country, it is hard to predict which nation will be the first to implement policies toward space junk. It is important to understand the relationships that nations have with each other and the relationships that top industry leaders have with the public.

As stated in Part I, the public and private sectors are not as concerned as they should be about the amount of space junk that exists. Removing space junk poses large financial risks that are not attractive to public and private stakeholders. There is also the political risk of damaging another nation's space project. The major issue behind space junk is that the top industry stakeholders who are in charge of the development of space technologies are not motivated to

make change. Where then should this change be coming from? A bottom up democratic approach from the public may be the answer.

A quote from *The Case for Mars* says, “I feel very strongly that something as exciting and vital to the human feature as the real issues involved in opening a new planet to humanity should not be the property of the technical elite, but must be open to consideration by everybody.” Although this quote is referring to Mars exploration, it can also be applied to space junk. The issues that space junk presents aren’t something that should only be considered by the industry leaders that understand the technical components of it. The public has as fair of a say in technological development as industry leaders do.

Informing the public about the growing severity of space junk may increase negative attitudes toward the massive amount of space missions that are being deployed. If negative attitudes toward space junk exist, this may make it more difficult for more space missions to be put into space. The Royal Society of London published a 1985 report suggesting a trend towards negative or ambiguous view on science and technology, which would make funding for research increasingly difficult to defend politically. To clarify, this negative opinion doesn’t mean that the public won’t want to stop learning from new space projects. The intention is that a negative public opinion would create a more skeptical approach from industry leaders toward space technology. In this way, there would be more public involvement as to how much space junk will be left behind and the associated risks that a specific mission presents. The solution of an emerging negative public opinion may cause policy makers to take a stand against this growing technological issue and work together internationally to establish space exploration policies that industry leaders must adhere to.

Negative emotions from the public can be raised by utilizing Mesthene's idea of observing the negative sides of a technology (Mesthene, 1970, p. 12). By referring back to Figure 1, the public may become more concerned about space junk by being exposed to shocking images that explain the amount of clutter that currently exists. Technical components of the issue do not need to necessarily be understood by the public in order to raise awareness. By viewing understandable images similar to Figure 1 and recognizing that space exploration offers a competitive national advantage and more job openings in an emerging field, the public may become concerned that space junk presents restraints on the future of success for their nation. The public relies on satellites more than they may realize for global communications, navigation, and meteorology. By destroying those, the public will lose systems that have become integral parts of society (Thompson, 2005, Space junk problem reaches 'tipping point'). This approach does not introduce physical concern to the public, but rather a burden on the future success of the public. Therefore, there is great reason for the public to care about this issue.

Shocking images such as that presented in Figure 1, have had a way of persuading the public to feel a certain type of way in the past. A way to gain public exposure of images similar to Figure 1 may need to be through public service announcements. A public service announcement (PSA) is defined as "information set about to change public opinion and raise awareness on important issues while disseminating information quickly and efficiently" (Suggett, 2019, p.1). PSAs usually address social issues such as smoking, alcohol use, safe sex, texting and driving, or drinking and driving. There is no reason to argue that the way in which PSAs are utilized for social issues such as these cannot be applied to political issues such as space junk.

Consider graphic public service announcements (PSAs) about cigarettes for example. After being exposed to shocking images of the effects that cigarettes have on human lungs, there was a dramatic change in the amount of young adult smokers in the United States (Leshner, Vultee, Bolls, & Moore, 2010, p. 502). According to a study done on the effects that cigarette ads have on public perception of the product, when campaign producers choose an appeal that doesn't directly focus on the threat of dying from using tobacco, it is a good idea to include disturbing images in public service announcements (Leshner et al., 2010, p. 504). By applying this PSA strategy to space junk, understanding that space junk does not pose a large threat towards dying, disturbing and shocking images could be presented to the public in order to effectively produce a negative emotion toward space junk.

An emphasis on the loss of potential for progression as a global leader in technology would be necessary in order for the public to care about the severity of such images. The goal is that this negative emotion becomes so extreme that a bottom up approach will be effective in creating policy change for space junk. Industry leaders will be forced to listen to the public's backlash of the way space junk has been previously handled, and a more skeptical approach towards space exploration will be developed as a result.

Conclusion

Since the Cold War, participation in space exploration has expanded on a global scale as curiosity continues to drive humans to investigate the unknown. Individual nations have completed their own space missions in hopes to expand their country's global navigation, communications, and meteorology technologies. While in the midst of exploration, countries failed to recognize the tradeoffs that introducing so many new missions into space presents. Space junk has become an increasingly large issue that top industry leaders do not want to address due to high cost, energy, and potential for international conflict.

Like many democratic systems, policy may need to be formed from the bottom up. If top industry leaders do not want to aid in reducing the amount of space junk that currently exists, it may take negative attitudes from the public for industry leaders to act on the severity of the issue. A negative attitude toward space junk can be developed by exposing the public to shocking and controversial images of the space junk that surrounds Earth. Similar to public reactions to PSAs about health and social issues, the public may be able to develop a strong enough negative emotion towards a political issue like space junk so that policy will need to be implemented as a result. The influence of negative public emotion will cause industry leaders to develop a more skeptical approach to space technology which will enable the amount of space junk that surrounds Earth to be significantly reduced.

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