The Social Construction of Space Technology and the Space Community

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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

The social imagination of space has drastically changed throughout history as a result of sociopolitical interactions between countries and companies. Space has been a focus of the U.S. ever since the extremely competitive Space Race to the Moon against the USSR (Jha, 2017). During the Space Race, interactions between the U.S. and the Soviet Union cause the social meaning of space to be competitive. Since the Space Race, the US has increased space cooperation with other nations to set up the International Space Station (ISS) ("History and Timeline of the ISS", n.d). In the present, space is seen for its commercial value and the private sector has emerged in space. Private space companies such as SpaceX and Blue Origin have been working on their goal of space tourism and colonization (Carson, 2018). On May 30 2020, SpaceX launched two NASA astronauts towards the ISS in Earth's orbit (Potter, 2020). A commercial spacecraft heading to a worldwide cooperative space project would have been unimaginable at the start of the Space Race in 1958 ("The Space Race", 2010).

Space technology will have a large impact on the world as there are so many actors involved. As the meaning of space has changed over time, so has the development of space technology. Understanding how the social imagination of space has changed over time will help us decide how we want the future of space to be and how to shape that future. This study explores how the interactions between the US government, other national governments, and private space companies affected space technology and society and how that has changed since 1958. Space technology benefits from an STS investigation because space is not a neutral zone for scientists to conduct research, but instead it is an area full of different opposing interests such as different countries, private companies, scientific researchers, and the public.

Research Question

This research topic can be broken down into three questions. First, how has the imagination of space and space technology changed from the 1950s to the present? Second, how has the change in the imagination of space affected the practice and purpose of space technology? The study's hypothesis was that space was initially viewed as a battleground during the Space Race, but this view has gradually changed to see space more for its scientific and commercial value. This study hypothesizes that this change in the imagination of space has led to more international cooperation and the rise of private space companies. The analysis of how the imagination of space has changed over time can help to predict how the future of space will change.

The third part of the research topic was to analyze the rise of private space companies in the United States. What has been the role of private companies in space exploration throughout American history and how have they affected the social construction of space?

Literature Review

Previous academic works have discussed how the United States and the Soviet Union viewed space during the Space Race. Previous articles have also analyzed current problems with space exploration and their potential policy solutions. While there has been STS analysis for space technology at different time periods, few papers have analyzed the change in space technology over time with a social framework.

In the Journal of American History's review of "Eisenhower's Sputnik Moment: The Race for Space and World Prestige" (2014), they mention that Yanek Mieczkowski, the author, shows that the Space Race was really a race for worldwide prestige. Mieczkowski uses correspondence with members of the media and Congress to point out that there was an

association between U.S. space exploration and national prestige. This source puts a lot of focus on Eisenhower and his pursuit of prestige, but doesn't emphasize other actors or future presidents enough. First (2017) gives an overview of the book "Soviet Space Mythologies: Public Images, Private Memories and the Making of a Cultural Identity" by Slava Gerovitich. In the book, Gerovitich explains the tension between Soviet engineers and cosmonauts and how that led to failures. Instead of autonomous rockets being products of Soviet totalitarian system, Gerovitich claims that they are products of the tension between engineers and cosmonauts and lack of clarity in their roles caused mission failures. This point of view may be attributing too much power to individuals in a Soviet system.

De Zewart and Stephens (2019) explore the relationship between space innovation and the military. They claim that military technology is embedded in space technology. For example, the launching of Sputnik was a military threat to the United States because of the power of the rocket used. De Zewart and Stephens also examine how the military has reacted to the change in space technology over the years. As more commercial space ventures have grown, the military has bought commercial products as well as started its own agencies such as the Space Force and the Space Development Agency.

Devezas et al. (2012) explores the magnitude of space activity over time by analyzing the number of satellites launched, budgets of space agencies, and other statistics. They claim that that space activity peaked during the Space Race, then declined, and is now increasing with China being a major player. This paper fails to credit this pattern to the decreased competition after the Space Race as a factor. Another work also analyzes the current space environment, calling it a new space race with multiple countries and private companies (Weeks & Faiyetole,

2014). They claim in order to follow the Outer Space Treaty, that promotes equality in space, that cooperation and space education needs to increase.

More academics such as Iliopoulos and Esteban (2020) focus on the emerging commercialization of space. They claim that policy must ensure a focus on environmental and financial sustainability for all space ventures. They also counter the Outer Space Treaty by stating that space treaties should allow for private property in space. Viadurri et al. (2020) agrees with the focus on sustainability by claiming that government policy needs to be proactive for planetary protection and ethics in space. The researchers disagree with Iliopoulos and Esteban by stating that imperialism should be avoided in space since colonial competition was the premise of the Outer Space Treaty. Brehm (2015) agrees with Iliopoulos and Esteban that private space property should be given because banning private property will hinder the development of space technology.

Lal (2016) has a different perspective on the government's relationship with private space companies. They propose that the government adapt to become a catalyst for the private space industry. One way to accomplish this is for the U.S. government to partner and fund private ventures in order to attract the best space talent. Christensen et al. (2019) agrees that the U.S. government needs to position itself to grow the space industry. They also claim that any regulations should be incremental and reactive since challenges in space exploration are not fully understood.

These academic works make interesting points about the interaction between space technology, the government, and society at different periods of time. The literature confirms that space is not a neutral cooperative playground, but full of national, social, and economic interests. This research provides a systematic approach to understand the evolution of all of these interests

through the SCOT framework. This is important to understand the meaning of space and its impact on technological and societal development.

STS Framework and Method

In order to understand the change in the imagination of space over time this study uses the social construction of technology (SCOT) framework to compare and contrast three important periods in space. The time periods analyzed were the Space Race , the creation of the International Space Station (ISS) , and the current commercial space landscape. The SCOT framework recognizes different social groups, such as the U.S. and Soviet Union, who are involved with developing space technology. Each group, either a country or an organization, interacts with other groups in different power dynamics to determine the meaning of space. All of these groups negotiate to have a social construction of space, and the meaning of space affects how space technology is developed.

In order to examine the change in social imagination of space over time this study analyzed United States government policy documents and space news sources from 1957 to the present. Document analysis is the research method that suited this project the best because this topic analyzes history. Government documents from NASA's archive such as the Outer Space Treaty of 1967 and President Trump's directive to allow for space commercialization provided insight to how the government's attitude toward space exploration, international cooperation and space commercialization has changed. These documents were slightly biased with the United States government's point of view in space, so historical space news was also analyzed. Space media from the ProQuest Historical Newspaper database provided sources to show the American public's view of space and the rise of private space industry.

Data Analysis

The first big moment that shaped the development of space technology was the Space Race. The Space Race was a period of intense competition between the United States and the Soviet Union where they raced to explore space. The Space Race started during the Cold War between the United States and the Soviet Union when the Soviet Union launched the Sputnik satellite ("The Space Race", 2010). During this time, space was seen as another battleground for the Cold War.

When the Soviet Union launched Sputnik, the world's first artificial satellite, the Soviet Union was proud to be a step head of the U.S. in space exploration. The United States interpreted Sputnik as a military threat as it showed that the Soviet Union had ballistic missile technology ("The Space Race", 2010). When Sputnik launched, Americans had mixed responses. A newspaper surveyed Chicagoans about what actions to take after Sputnik. Some Americans believed that the U.S. needed to catch up to Russia's space program at any cost and other Americans predicted disaster if the U.S. did not improve its defense (SPUTNIK CONGRESS, 1958). In the eyes of many Americans, space exploration was a point of national defense and national pride. The U.S. government created NASA with the National Aeronautics and Space Act of 1958. This act stated that the objectives of NASA were scientific research, human exploration, and preservation of the U.S. as a leader in space technology and in peaceful applications. Additionally, the act directed NASA to give discoveries of military value to the proper departments and established a civilian-military liaison committee. In 1961, John F. Kennedy summarized the U.S. interpretation of Cold War space technology during a message to Congress. He says "Finally, if we are to win the battle that is now going on around the world between freedom and tyranny, the dramatic achievements in space which occurred in recent

weeks … The impact of this adventure on the minds of men everywhere." (Kennedy, 1961) This statement highlighted the animosity between the U.S. and the Soviet Union. Additionally during this speech, President Kennedy set the national goal to land a man on the moon. This speech spurred the United States to start the Apollo program and the Soviet Union to their own competing lunar program.

The international community interpreted the Cold War space rivalry between the U.S. and Soviet Union as a quest for space domination that could hurt countries who had not started space agencies or had smaller space agencies. The international community used their influence in the U.N to push for cooperation. Their influence shifted some thinking within the U.S. In a 1963 address to the U.N, President Kennedy proposed a joint space mission with the Soviet Union and stated "Why should space be a matter of national competition?" (Kennedy, 1963) The biggest influence the international community had during the Space Race was the Outer Space Treaty of 1967. This treaty, signed by U.N countries, agreed to set space as free to be explored by any country. Every country agreed to use space for peace and to leave space as an independent area that cannot be claimed by any person or country.

The United States ended up succeeding with their Apollo program which effectively ended the Space Race (Space Task Group Report, 1969). The meaning of space during the Space Race was heavily affected by the rivalry between the United States and the Soviet Union. Their fierce competition turned space into a battleground to display their dominance. This interpretation of space concerned the international community which is why they used their influence to develop the Outer Space Treaty. The meaning of space during this time period affected the development of technology. Both the United States and the Soviet Union put a lot of money into their space programs during this time because of the competition. The Soviet Union

spent more than 4 billion dollars on manned missions and the United States spent 23 billion dollars on manned missions from 1961-1969 (Race to the Moon, n.d.). The technology developed during this time contributed to artificial limb technology, insulin pumps, and heat-resistant suits for firefighters (Green, 2019).

The next significant moment of space technology was the conception and development of the ISS, one of the largest peacetime international engineering projects in history (Warren, 1998). The creation of the ISS signaled a paradigm shift in the meaning of space as many countries joined the field. The meaning changed to see space as an area where countries could come together and perform scientific research. Additionally, the United States still wanted to be a leader in space and started to see the value of private space companies.

The Space Race propelled the United States to be a leader in space, but their power had slightly eroded by the 1980s. A report by President Reagan's transition team noted that US leadership and preeminence were threatened and eroded. The Soviet Union had established a permanent manned presence in space and Japan were broadcasting directly from space to homes and businesses. The report recommended that President Reagan recognize the importance of a space program for military and economic benefits as well as national pride (Report Transition, 1980). Additionally, the NASA Space Policy in 1982 stressed the importance of maintaining US space leadership, promoting international cooperation, exploring outer space for peaceful purposes, and encouraging commercial exploration of space technologies (NSDD-42, 1982). In President Reagan's State of the Union address in 1984, he summarized the United States' interpretation of space. He stated that the next frontier was space and nowhere else did the U.S. so strongly demonstrate their technological leadership. In this speech he directed NASA to develop a permanently manned space station within the decade and invite other countries to

participate. This station would allow for research in science, communications, and medicine. President Reagan also mentioned that space activities would multiply jobs and opportunities and NASA would promote private sector investment in space (Reagan, 1984).

While planning the space station, the United States started to explore the use of the private sector in space. In 1997, a study on Space Travel and Tourism examined the popularity of space tourism and recommended national attention to enable private space tourism to be safe, comfortable, and at an acceptable price (O'Neil, 1997). NASA also realized that the biggest factor in reducing space costs would be the long-term involvement of the private sector, specifically for private reusable launch vehicles (Analysis, 1998). NASA developed a plan whose short term goal was to begin the transition to private space investment and whose long term goal was to establish a marketplace for space products and services dominated by the private sector (Commercial Development Plan, 1998). These plans to incorporate the private sector were steps for the U.S to ensure that it would be a leader in space and was the start of the commercialization of space.

The space station mentioned in Reagan's speech ended up being the ISS which was a collaborative effort by the United States, Russia, Japan, and 14 other nations (Warren, 1998). The cooperative development of the station was a big departure from the Space Race competition. When the first part of the ISS was launching in 1998, Russia's economy was collapsing. To resolve this conflict, NASA cooperated with Russia and announced a bailout plan to help Russia pay for their section of the ISS (Warren, 1998). Smaller space programs from Europe and Japan also joined the ISS. Cooperation is necessary for these countries to pursue space exploration because of how much space travel costs (Broniatowski et. al, 2006). In 2007, China requested to join the ISS (Person, 2007). However, the U.S distrusted China and blocked them from joining

the ISS. The United States were worried that China joining the ISS would cause an increase in China's military power, which would be dangerous for the U.S. The Wolf amendment in 2011 prevented any cooperation between NASA and China due to these concerns (Whitford, 2019).

The power dynamics between countries helped define the meaning of space during the ISS period. The United States worked with many countries to create a space station that was used for international scientific research. NASA even helped bail out Russia in the name of space cooperation (Warren, 1998). This cooperative view of space led to scientific discoveries from the ISS such as water purification technology, improvement in eye surgery, ultrasound technology, and protein research (Rainey, 2015).

However, the United States still wanted to be seen as a leader in space and their view of space wasn't completely cooperative. While planning the ISS, the United States also started to explore options for the commercialization of space to set themselves up as an economic space powerhouse. Additionally, the United States wielded power over the smaller countries that joined the ISS. The United States and Russia controlled the critical components of the ISS, while Europe and Japan provided auxiliary modules. This meant that decisions were effectively made by the large nations, as the United States pulling out of the ISS would mean its demise (Broniatowski et. al, 2006). The United States wielded its power over the ISS by blocking China from joining the station. The blockage of China shows that although the space had changed to be a cooperative landscape, the United States still partially viewed space as a battleground. Because of this view, they barred China from the ISS, citing military concerns (Whitford, 2019).

Currently, the space landscape is very different from the time period where the ISS was being assembled. Space is now being seen more and more for its commercial value. Set off by

NASA priorities in the 1980s (NSDD-42, 1982)(Reagan, 1984), private space companies have grown. Currently, the relevant social groups in space activities are the United States government, private space companies, and the international community.

While the United States has been trying to increase private space investment, more space companies have started. Blue Origin is a company started by Jeff Bezos around 2001 as a hobby. Their goal is to have millions of people living and working in space, where spaceflight companies are like commercial airlines (Kang, 2017). Another large private company is SpaceX, which was founded by Elon Musk from his PayPal fortune. Their goal is to make space launches more affordable (Private rocket, 2008). NASA and the U.S government have been working to help private space companies through legislation and partnerships. In 2014, NASA supported the ISEE-3 Reboot Project to command a defunct probe and become the first private group to command a spacecraft in space (Chang, 2014). The international community who support the Outer Space Treaty of 1967 poses some problems to the development of the private space sector. This treaty still stands and it states that space can not be claimed by any person or country, exploitation of space resources should benefit all countries, and that countries are responsible for activities done by their private space companies. This treaty disincentivizes some private mining companies, like Moon Express, as it seems that they cannot profit from obtaining space resources. However, in 2015, the United States created the U.S. Commercial Space Launch Competitiveness Act which seemed to sidestep the Outer Space Treaty and allow for private companies to use space resources for commercial purposes (De Selding, 2015). This law shows that the U.S. really values the commercial benefit of space and wants to be an economic space leader at the cost of cooperation and past treaties.

The U.S. support of private space companies has had some success. Blue Origin has

developed rapidly and got their first paying customer, Eutelsat, in 2017 (Kang, 2017). They also got an investment as a part of NASA's "Moon to Mars" initiative (Sheetz, 2019). SpaceX won a contract from NASA to ship supplies to the ISS and also got the opportunity to fly two astronauts to the ISS in 2020 (Pae, 2008) (Potter, 2020). While the U.S. wants to limit regulation on private enterprises to promote growth, they have stated that regulations would be adopted in space commerce to align with national security and foreign policy interests (President Donald, 2018). This shows that the U.S is still looking to cooperate a little bit in space.

During this current space era, there has been a departure from the cooperation of the ISS era. Instead, the U.S. has focused inwards on incubating a strong private sector in space. This focus on commercializing space even caused the U.S. to sidestep the Outer Space Treaty. This will cause international tension, but it is needed in order to develop private space technology. Because the United States has put such a prioritization on the private sector, the meaning of space has again shifted. Space is now seen as a place for an abundance of commercial opportunity. Due to this new meaning of space, new technologies have been developed. SpaceX has been able to build reusable rockets and have started planning for Mars colonization. Blue Origin is building vehicles for space tourism and Moon Express wants to profit from exploring and mining the Moon. Additionally, companies like Capella Space have greatly improved satellite imagery.

Conclusion

As seen in these three periods of space history, different social groups have shifted in and out of the picture and the meaning of space has changed. Space was initially viewed as a battleground for the Cold War, but eventually changed to a cooperative platform. This change in

the meaning of space changed the technology that was produced. During the Space Race, the competitive environment drove the U.S. and the Soviet Union to build separate lunar programs. As cooperation increased and more countries joined space research, cooperative technologies such as the ISS were created. The U.S. still maintained leadership in space by developing the critical portions of the ISS. The U.S. started to think about the private sector during the ISS era, and private space companies have risen to prominence during the current landscape. Aided by government policies, private companies such as SpaceX were able to build their own private rockets. The rise of private companies have also created concerns about creating an equitable and fair space environment as described by the Outer Space Treaty.

By analyzing the landscape of space with the SCOT framework, this study shows that space has never been a solely American endeavor, but an international landscape with shifting priorities. When crafting policy for growing its private sector, the U.S. needs to consider the international community if they wish to continue cooperating in space. On the other hand, the international community may need to update the Outer Space Treaty to account for the private sector which can advance space technology far past any government efforts. This study predicts that the U.S. and the rest of the globe will prioritize private space endeavors over the Outer Space Treaty and new international space agreements will need to be made. This will cause a quantum leap in space technology, because the private sector's efficiency, at the cost of inequality in space.

Some limitations of this study was that it mainly focused on NASA documents from the United States and news articles about American space companies. A future investigation in this topic could focus more on international endeavors such as China's growing space program. China is currently developing their space program and it would be interesting to see a SCOT

framework analyzing China and America's current relationship in space as it is more competitive than cooperative. Also, a study comparing the beginning of the Space Race competition between the U.S. and the Soviet Union with the current climate between China and America would be able to make some insightful predictions on the future of space technology.

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