Social Construction of Spaceflight Technology

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Carsten Connolly

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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.

Advisor

S. Travis Elliott, Department of Engineering and Society

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Introduction

What is the motivation behind space exploration? Since prehistory, humans have been fascinated with space, wondering about "what's out there?" Humans of 30,000 years ago used the moon as a timekeeping device (Boyle 2019). In 2021, Jeff Bezos described his 10-minute spaceflight as "the best day ever!" (qtd. by Dunn, 2021). It is only human to lust about pushing the frontier of what is known. However, when it comes to exploring space, not everyone can agree on how, or why, if at all, we need to be spending our time and money venturing beyond the Blue Planet's atmosphere. In a 2019 survey conducted by the Associated Press, 38% of responders felt that the United States' space program expenditures were unwarranted (AP, 2019). Why do so many citizens feel that their money is being improperly allocated? There exist various reasons for this disapproval. In some cases, the criticism comes from policymakers who oppose space exploration because of the sheer cost and resource allocation that it requires (Smith, 2006). In other cases, public opinion of space missions is influenced by celebrities who deny the scientific findings of previous space expeditions for whatever reason.

This paper aims to further analyze and explain the justifications for opposition of space exploration held by each of the identified relevant social groups. Moreover, once the justifications are understood, the STS framework of Social Construction of Technology (SCOT) will be applied to analyze how these opinions influence the adoption and transformation of spaceflight technology and its intended purposes.

Framework of Social Construction of Technology

In order to use the STS framework of Social Construction of Technology (SCOT) as a tool for analysis, its main idea and tenets must first be laid out and understood. SCOT is an STS theory or framework that explains how technologies are defined and transformed based on their social context, rather than society itself being shaped by these technologies. The success, failure, or transformation of a technology over time can be analyzed using the SCOT methodology by first identifying the relevant social groups associated with the technology; understanding how each social group used, or adapted the technology for their specific needs, known as "interpretative flexibility"; and finally, finding how these groups applied their differences in opinions and agendas to bring the technology closure in its current use case.

When it comes to space exploration, especially in the U.S., the major social groups that arise are: the policymakers, that is, the government and elected officials who create the laws which dictate how the government sponsored form of this technology will be used; the taxpayers, who elect the policymakers and fund their proposed budgets; and, entrepreneurs who have commercial interest in space exploration technology.

Historically, policymakers have used space exploration technology as a way of bolstering national image. Many taxpayers, while aware of the political strings tied up in space exploration, understand and expect that space exploration technology deliver scientific results that will improve the lives of the individual. As of late, investors and entrepreneurs have entered the

scene in hopes of one day using space exploration technology as a means of capital extraction, and have interpreted this technology in a purely commercial context.

Social Attitudes Define Spaceflight Relevancy

Over time, public opinion of space exploration has oscillated based on the historical context. As outlined by SCOT, these social attitudes and interpretations of the technology ultimately define its relevancy and purpose in society.

From its inception, the United States space exploration program was more about national image than anything else. By the early 1960s, the Soviets had already successfully launched Sputnik into orbit, sent the first human, Yuri Gagarin into space, and were leading the pack in the Space Race. Immediately after, and in direct response to Gagarin's successful mission, President John F. Kennedy challenged our nation "to achieving the goal, before this decade is out, of landing a man on the Moon and returning him safely to Earth" (Kennedy, 1961). This rebuttal towards the Soviet's achievement signaled to American taxpayers that the nation's involvement in the space race was born out of the preservation of national image, and the advancement of science and the citizens would be secondary goals. Kennedy's agenda and the policy it ushered in marked the beginning of the policymakers' interpretation of space exploration technology as a diplomatic tool and symbol. From the onset of the space age, public opinion was generally favorable, and cultural excitement was high, as is evidenced by the popularity of space-themed pop culture such as shows and media like *Star Trek, The Jetsons, 2001: A Space Odyssey*, and even food items

like Tang, which was "chosen for the Gemini astronauts" according to a 1966 advertisement from LIFE magazine.

By 1969, Kennedy's goal for the nation was achieved, and American astronauts set foot on the moon and safely returned home. The objective was fulfilled, the space race was concluded, and the future for the American space program was now more uncertain. Moreover, Earthly conflicts began to hit closer to home as the Vietnam war raged on, and the Civil Rights movement was still wrapping up. Anti-war activist groups, like Students for a Democratic Society (SDS), organized anti-NASA demonstrations, alleging that NASA was a "weapon of the military establishment which is draining our resources" (Maher, 2019). Furthermore, the late Reverend Ralph Abernathy, leader of the Poor People's Campaign, accused the government of a "distorted sense of national priorities," and that he and his campaign wanted "NASA scientists and engineers and technicians to find ways to use their skills to tackle the problems we face in society," (Abernathy, qtd. by Maher, 2019). As a result, space exploration technology waned in popularity and relevance, as is evidenced by the nearly 40% NASA budget cut from 1965 – 1970 (Gawdiak & Fedor, 1993).

The announcement of the Space Shuttle program in the mid-1970s returned some public enthusiasm surrounding NASA. With globalization on the rise in the 1980s and into the 1990s, society had a craving for instant and convenient connectedness, bringing with it the opportunity for commercial enterprise in the realm of spacefaring. Satellites became an increasingly popular vehicle for TV, telecommunication, and radio communications. The needs of society had successfully industrialized space, changing the interpretation of spaceflight technology held by

many taxpayers and entrepreneurs. This interpretative flexibility was only further encouraged by the failures of the Space Shuttle program starting with the *Challenger* disaster in 1986, followed by the *Columbia* failure in 2003, and culminating in the cancellation of the program altogether in 2011.

Critics of Spaceflight Policy

It is evident that public opinion of space exploration has fluctuated significantly over time. However, there have always been groups that are steadfast in their criticisms and naysaying when it comes to venturing past our atmosphere. There exist three important social groups, more specific than those defined in the introduction of this paper, when it comes to criticisms surrounding space exploration: policymakers, specifically Congressmen; activist groups campaigning for human rights, as was briefly mentioned in the previous section; and finally, science-denying conspiracists. All have great influence over public opinions of spacefaring.

In 2004, when president Bush announced his Vision for Space Exploration, the main concern expressed by Congress was the sheer cost of the proposal (Smith 2006). The rhetoric surrounding space exploration in congressional debates clearly shows the policymakers' interpretation of spaceflight technology as a diplomatic tool. Phrases like "boots on the moon," "American leadership in space," and "American space dominance" are often flung around during subcommittee budget planning meetings (Waltz, Cartwright & Granger, qtd. by Foust, 2020). Thus, the congressmen who oppose, hold a different interpretation of how the technology should be used, and are also likely motivated by personal agendas, such as the allocation of the would-be space funds to their own districts. Since 1966, NASAs budget as a percentage of the federal

total has been steadily declining, signaling to the public that the use of this diplomatic tool is less and less important each year.

Social activist groups are often critical of the opportunity cost that arises from the resource allocation demanded by space exploration programs. In fact, civil rights activists have been critical of federal budgeting dating as far back as the early 1870s, engaging in what Shugerman (2014) calls, an "uphill battle," following the post-Reconstruction establishment of the U.S. Department of Justice. In an activist protest of the *Apollo 11* launch, some protesters held signs reading "$12 a day to feed an astronaut. We could feed a starving child for $8" (Niiler, 2019). Clearly, these groups understood the space program as none other than an exorbitant misappropriation of resources. They wanted equity and civil rights, not national glory in a global context.

Among the critics are those groups that deny the scientific discoveries of spacefaring. In 1963, in a condemnation of "anti-God, theoretical astronomy" and "early youth … indoctrination," Samuel Shenton, founder of the International Flat Earth Research Society (IFERS) contended that governments in the space age enforce ideology and suppress free-thinking (Shenton 1963). In fact, the anti-science sentiments seem to be the main draw for prospective members of IFERS. In a correspondence between hopeful member, Francis McGrath, and Samuel Shenton, McGrath explains that he "holds steadfastly to the well-known fact that the Earth is flat in spite of the brain washing of so-called scientists" (McGrath 1969). By no means do these sentiments cease to exist even after copious amounts of legitimately collected data confirm the original scientific findings. Even today, celebrities like rapper, B.o.B., and NBA point guard, Kyrie Irving are

openly skeptical of terrestrial roundness. B.o.B. famously took to twitter in early 2016 to criticize the conventional knowledge of a round Earth and, much like the Flat Earth Society of the 1960s, protest indoctrination and suppression of free thinking (Figure 1).

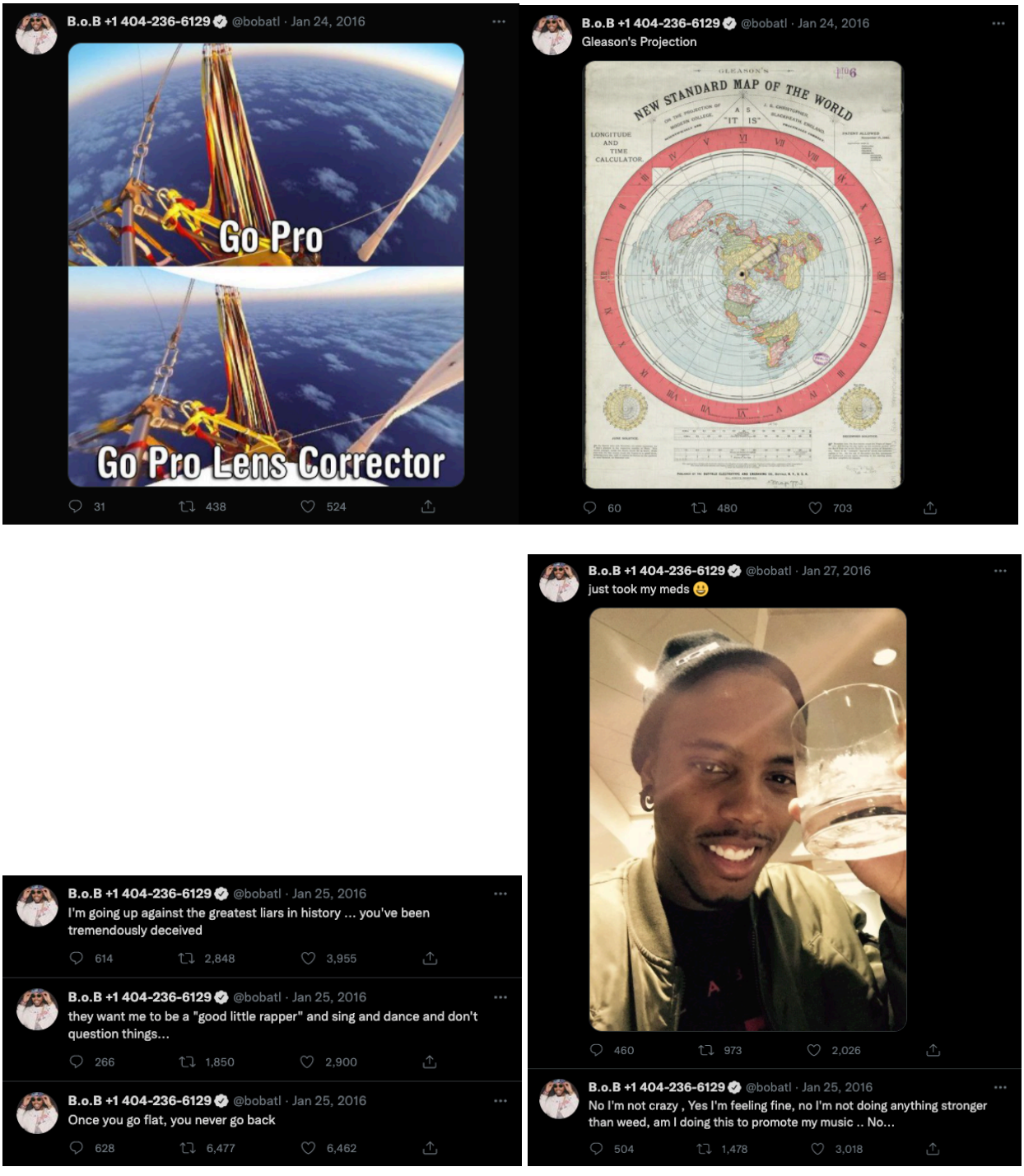

Figure 1: Selected tweets from rapper, B.o.B.'s infamous rant about how the Earth is flat.

NBA point guard Kyrie Irving has doubted terrestrial roundness, asking if "you can openly admit that you know the Earth is constitutionally round? … Like I don't know" (qtd. in Deb 2018). In a livestream on social media, Millie Bobby Brown, a Netflix star, stated: "I think I am … a flat-earther" (qtd. in Young Celebrity World, 2018). Anti-science rhetoric is not uncommon, even among U.S. politicians – especially in the Republican party (Hsu 2021). Hsu (2021) posits that "crusades against science can be appealing to voters that have little in common with scientists, perhaps materially much less than scientists, and perhaps have a poor understanding of science," linking anti-science rhetoric's ethos and pathos to efforts to promote it. Furthermore, the Trump Administration was known to criticize science. Trump frequently disparaged scientific findings that directly linked coal, mining, fossil fuels, and other chemical industries to the climate crisis (Hsu 2021). In tandem with his political pull, Trump used the "celebrity effect" to amplify his opposition to science. In a paper titled "The Influence of Celebrities in the Spread of Anti-Science Beliefs," Badrish (2016) explains that "by circulating anti-science ideas, and constantly forcing the media to talk about them, celebrities can potentially change individual opinions into believing these false statements." Through the celebrity effect, celebrities have a disproportionate influence on public opinion, and thus, according to SCOT, the eventual acceptance and formation of technologies.

It is important to note that the three distinct groups surveyed in this section may seem wildly different on the surface level, however, they all have a common position: that the government has failed to serve them adequately. For the congressmen and social activists, the opportunity cost that arises from the space programs is a failure to allocate resources correctly and equitably here on Earth. The conspiracists feel failed by the government in that they believe to have been deliberately delivered false information in an attempt to indoctrinate and control its constituents.

Discussion

The trend since the cancellation of the Space Shuttle program has been towards more and more commercialization of space. With Earth's limited resources dwindling, and human consumption growing it is likely, if not guaranteed, that societal attitudes and demands will mold space flight technology into capital extraction methods, waste removal services, even transportation of goods, and perhaps people. The entirety of the asteroid belt has already been valued at 700 quintillion dollars, due to its rich content of minerals and precious metals. One can only imagine how the likes of entrepreneurs such as Elon Musk are probably drooling over this prospect. Precious metals found in these asteroids are the same materials that go into the phones, computers, tablets, cars, and nearly every electrical device used by consumers every day, and it is no secret that harvesting these minerals is one of the most harmful practices to the planet still in use today. Moreover, the consumption culture of modern times generates massive amounts of waste that eventually ends up in our oceans, food chains, and ultimately back into our bodies through a process known as bioaccumulation. These dire situations beg the question not of "if" we will commercialize space for these needs, but rather, "when?"

Jevons' paradox states that in doubling the efficiency of a technology, the consumption of the related resource is also doubled, rather than halved. The paradox was formalized after the invention of the coal-powered steam engine in Great Britain. It quickly became clear that the coal reserves of the U.K. would soon be depleted if consumption at the rate at that time were to continue. Thus, the engineers set out to double the efficiency of the steam engine design. To their dismay, as they improved the efficiency of their technology, they noticed that the coal reserves were depleting at a quicker rate than before. British economist, William Jevons

explained that now that the efficiency of the steam engines was increased, its users were incentivized to travel further and use the engines even more, because, "hey, it's more efficient!" It is easy to see how a similar crisis may arise in an era of capital extraction from space. The seemingly infinite stock of resources beyond our atmosphere may actually exacerbate the crises brought on by consumption culture. Sure, precious metals and materials would now be harvested from space, externalizing the would-be mining damage done to Earth. But what about manufacturing of the space tech that would fly to space to harvest these materials? They will certainly require extensive mining and manufacturing here on Earth. Will we have a truly environmentally friendly fuel source by then, or will the space mining fleet continue to pollute Earth's atmosphere during takeoff and landing? And how about the refining and processing of metals? Current processes generate large amounts of toxic byproducts that pose a serious threat to the environment, so who's to say that refineries will be "cleaner" by the time space mining rolls out? Not only does the wealth of space pose a threat to sustainability, it also could bring about economic problems and inequality. A saturation of precious metals and minerals in the market would deflate their value, which means entrepreneurs would be motivated to monopolize the asteroid mining business to control the supply keep and profits high, increasing the divide between the haves and have-nots.

The promise of capital extraction from space is certainly exciting, and could offer a solution to various problems on Earth, but should be approached with caution and restraint. From its outset, both national and international policy need to be in place to ensure that net good can be achieved. In any burgeoning industry, externalities (both positive and negative) are abound. We don't know what we don't know.

Conclusion

As laid out in the SCOT framework, one of the major tenets is how the relevant social groups seek to bring the technology in question to closure. As it stands with space exploration, the technology is still relatively destabilized, with only loose closure being achieved by the relevant social groups. Sure, American policymakers still practice diplomacy in space, but it is now much more a collaborative practice, than it is a statement of power and national standing. Taxpayers and entrepreneurs are still unsure of the main role that spacefaring will serve in the years to come. Will the constituent components of iPhone 20 be sourced from space? Surely, Elon Musk doesn't have a definite answer, let alone the average American taxpayer. Space technology is still so new that there hasn't been enough time and application of the technology for society to really understand how it will be used to satisfy their needs.

Social attitudes are the guiding forces in defining the role of a technology. This paper set out to identify and analyze the ways in which these forces gave meaning to space exploration technology throughout history. The future of spaceflight is still up in the air, but understanding its past is paramount for society to be able to define its future.

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