A New Solution to Offer More Affordable Hypersonic Glider Flight Research

Analyzing the Impact of Desiring Low-Cost Alternatives on the Production of New Technology Through the Lens of Social Construction of Technology Theory

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STS Background

A CubeSat is a “square-shaped miniature satellite” that is “roughly the size of a Rubik’s cube” [13]. The advantage of CubeSats over traditional satellites is that they “provide a cost effective platform for science investigations, new technology demonstrations, and advanced mission concepts using constellations” [12]. The Iridium Satellite Network “consists of 75 satellites that are cross-linked in space just 780 kilometers above Earth” [11]. Through this cross linked constellation architecture, Iridium is “the only network that covers 100% of the planet” with satellites that provide “reliable, low-latency, weather-resilient connections that enable communication anywhere in the world” [10]. The advantage of the Iridium Satellite Network for CubeSats is that its low-earth orbiting network “enables the use of smaller omni-directional antennas, resulting in devices with a compact, lightweight and streamlined form factor and shorter network registration times” [11].

STS Introduction

As technology advances, expenses at times can increase expeditiously. This cost increase expands the barriers to entry which can limit stakeholders who can benefit from such projects. Therefore, the objective of the technical team is to send a CubeSat into space to orbit for a week to mimic space flight for research. When it falls back into the atmosphere, thermocouple sensors and pressure transducers will measure the temperature and pressure of the CubeSat and send this data through the Iridium satellite network back to earth. This will determine if a CubeSat can be used as a cheaper alternative to fostering advanced hypersonic glider flight research by obtaining vital flight measurements and sensor readings without needing to build a hypersonic glider. In providing a new, more affordable research mechanism, this project can limit these barriers and enable increased access to technology garnered information. However, striving for a low-cost alternative to this research can prove complicated. Desiring lower cost alternatives to technology inspires the creation of new technology that is lesser in quality and performance. As human action to lower cost shapes the development of new technology, this economic incentive was brought about through the Social Construction of Technology (SCOT) framework.

Social Construction of Technology (SCOT)

SCOT argues that “technology does not determine human action, but rather human action shapes technology” [9]. It is the needs of stakeholders within the social community that lead to developments in technological fields. This theory assists researchers in giving detailed and insightful accounts of the development of technology in society through discussion of relevant social groups. While these could be engineers, companies, contractors, politicians, mundane citizens, these social groups all have some form of “equal expertise” [7], with no one group having special priority. Each stakeholder has their own concerns and experiences that are no more important than the other, despite the scale of importance being typically favored towards engineers. Additionally, SCOT offers a conceptual framework for politicizing a technological culture, opening technological issues for political debate. SCOT argues that “the ways a technology is used cannot be understood without understanding how that technology is embedded in its social context” [9]. This brings new technology being developed into the social spotlight, with the impacts and purpose being weighed in a public sphere. Through SCOT, engineers and companies do not have full power and custody over what specifically gets developed as this is driven through the needs of society and their stakeholders. SCOT claims that the adoption and acceptance of a new technology rests not only on the effectiveness of the product, but more so on its effect on the social world. Technological developers “must look at how the criteria of being the best is defined and what groups and stakeholders participate in defining it” [33]. Relevant social users, those indirectly affected by the technology, and bystanders all determine the feasibility of a product in the current social realm.

SCOT and CubeSats

When creating new, more affordable technology for flight research, relevant stakeholders can weigh both the pros and cons of a cheaper alternative. For flight scientists, past aeronautical missions conducted by companies were costly, with researchers deducing that these actions are not as beneficial or efficient as they could be. This progress led scientists to believe that new, low-cost technology should be shaped to combat this issue. Pilots and glider developers, however, may fear that this cheaper alternative will provide insubstantial, weaker results and lead to unsatisfactory testing plans. Bystanders may have negative viewpoints towards CubeSat flight research, as there is a chance the satellite could not burn up in the atmosphere as intended and hit the earth, spelling environmental and safety concerns. Lastly, as the CubeSat will launch into space within the payload of a rocket, launch sites and companies will be wary of the risk this cheaply made product poses to their rocket and other payloads in the event of an explosion. Hypersonic gliders and CubeSats provide varying levels of contemptment between different stakeholders. While government contractors may value CubeSats more for their affordability, everyday citizens might prioritize the safety, security, and quality of data gathering hypersonic glider testing provides. This opinion differential can be explained by SCOT’s first theory of interpretive flexibility. SCOT in this case “stands for a group-dependent lens of analysis” [8] where “each technological artifact has different meanings and interpretations for various groups” [31]. In terms of this example, the idea of a CubeSat that can provide a cheaper flight research alternative is viewed differently by varying stakeholders. Introducing cheaper alternatives to existing quality options is often met with discontent from bystanders. SCOT’s second theory of closure and stabilization argues that “over time, as technologies are developed, the interpretative and design flexibility collapse through closure mechanisms” [31]. The first example of a closure mechanism within this theory is rhetorical closure, “when social groups see the problem as being solved, the need for alternative designs diminishes” [31]. The second example in this theory is a redefinition of the problem, where conflicts reside by using the technology "to solve a different, new problem, which ends up being solved by this very design". This idea of redefining the problem is more likely to happen with the new CubeSat implementation. While CubeSats may not end up providing enough quality data to be a more affordable alternative to hypersonic gliders, they might end up solving a different problem regarding avionics or space research. By following these two theories, this discussion falls within the realm of SCOTs framework.

Analysis of Stakeholders

Currently, the testing of hypersonic flight research is expensive, with CubeSats potentially offering a cheaper alternative. This new landscape, however, poses risks to various stakeholders within the social world. Scientists who administer and test flights have a moderate amount of power in determining the new technological platform for research as they will be conducting it and receiving the necessary funding. The researchers have to adhere to the contract standards and regulations which limits their power in this decision. With funds more often than not coming from the government or a government contract, companies must compete and bid with a competitive market and often underbid for their project. In a study by American Progress, it was found that companies "win contracts with unrealistic bids that undercut standards" [29]. It is part of the researcher's job to conduct research within a low spending budget to meet these low-funding contracts. One way of doing this is by using CubeSats since they offer nearly as good data at a fraction of the cost. The government and commercial companies who send out the contracts and are ultimately launching and/or flying these aircraft have the most amount of power as they provide the funding and the contracts. Their main goal is to advance their hypersonic gliders to promote their own military/political agenda. For the government specifically, this is due to the glider's "responsive, long-range, strike options against distant, defended, and/or time-critical threats when other forces are unavailable, denied access, or not preferred" [6]. If the government or private company doesn't like the results that were given through CubeSat research, they have the power to withhold future contracts. Their stake in the research development is that potentially suboptimal data gathering techniques could lead to reduced performance in gliders. Bystanders have the least amount of power over this decision as they are indirectly affected by potential negative impacts. Stakeholder groups who are affected the most negatively typically have the least amount of decision power. Homeowners and environmentalists may have negative viewpoints towards CubeSat flight research with fear of harm to residences or communities. For homeowners, this could cause safety concerns as their property could be damaged from fallen debris. They, unfortunately, have no internal stake in the companies running this CubeSat platform and cannot intervene. Personal environmentalists as well as groups might decline this form of testing as burning up in the atmosphere could be negative for the atmosphere. Additionally, CubeSats colliding with objects in space "leads to a growth in space debris" [4]. This space debris could pose a risk for future space missions or harm the earth. The CubeSat will launch into space within the payload of a rocket. Launch sites and companies will be wary of the risk this cheaply made product poses to their rocket and other payloads in the event of an explosion. Thus, companies such as NASA and SpaceX launch rockets with hundreds of payloads on board, with schools and private companies buying space on the payload. CubeSats are not as robust as other satellite counterparts, and if they were to catch fire or explode on the payload this would endanger the other equipment on board as well as the rocket itself. NASA, SpaceX, or another launching company has a lot of power over this as they can choose which equipment to allow on their spacecraft.

Discussion

Through analysis of stakeholders within adopting CubeSats as a cheaper alternative, it is evident that promoting a cheaper solution can cause unseen consequences. SCOT helps reveal that desiring for lower cost alternatives to old technology encourages the creation of new technology that is of less quality, and potentially produces inadequate research/results. This is seen not only in Hypersonic flight research, but generally as well. An example of this is in the rise of plastic. Plastic has been used more frequently as of late for it is a lot cheaper to produce than metal, and is a lot lighter. Computers used to be very durable, although today, a computer is typically 40 percent steel, 30 to 40 percent plastic, 10 percent aluminum, and 10 percent other metals [3]. The added raise in plastic has lowered the overall quality of the new technology. An HP computer salesman states that before the rise in plastic you used to be able to "take that $4,000 HP LaserJet that you'd have in your office, drop it off the back of a truck, and plug it in. It would still work" [1]. HP computers cannot withstand the same amount of mistreatment as when they were made with more expensive materials. Clothing is another kind of technology that has taken a dip in quality over the last few years. Fashion retailers strive for lower-cost alternatives to material technology to obtain more profit in a booming industry of fast fashion. Heavy cotton has been replaced majorly with thin fabrics that are more vulnerable to breaking and ripping and provide less warmth and comfort. This lower quality technology being produced stemmed from companies' desire to lower production costs in parallel with a social desire for more affordable clothing. The last example of this is through technological parts being made outside of the US. The desire to find a lower-cost production alternative lends manufacturing to places where "the quality of goods produced overseas is often lower than those produced domestically" [2]. A dip in manufacturing quality of new technology can be attributed to the underlying desire to lower expenses for social and personal benefit. In both technology and clothing manufacturing, SCOT argues that the trend toward cheaper design and production stems from a social desire for cheaper products that lends to a change in technology.

Counter Arguments

Creating low-cost new technology can be seen as beneficial because it enables high-end production without outrageous expenses. This, theoretically, will allow for more innovation given the higher budget. Lowering costs, however, can undercut the government contract market and force other companies to utilize cheaper alternatives that may prove not as effective in production [5]. This could drive the competition to cut corners, leading the resultant product to be missing in quality, manufacturing, or successability. Another observed benefit of cheaper technology development is a lessened risk factor. Launching a $50,000 CubeSat into space and having it malfunction is less of an impact than having a $1,000,000+ hypersonic glider launch combustion. The data quality offered from the CubeSat, however, would not be as robust as an actual glider. While there is less short term risk in testing and research conducting, ultimately the glider will provide more accurate information which can be used to improve the safety, efficiency, and functionality of all hypersonic gliders. This will ensure more durability and performance overall which in turn will save more money in production.

Conclusion

CubeSats could prove to be a unique, low-cost option to replace traditional hypersonic glider flight research. There however needs to first be an analysis of stakeholders, as discussion regarding the potential impacts of CubeSats could prove valuable in ensuring the impact is net positive. A discussion of SCOT observes that promoting lower cost alternatives to technology and research can lend to inferior technology. Through discourse within social communities, research methods can be analyzed to their extent of cost-cutting and the impacts it can have on technological production and towards the wider social sphere.

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