Electrical Discharge Machining

(Technical Paper)

NASA's Necessary Role in the Future

(STS Paper)

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On my honor as a University of Virginia Student, I have neither given nor received unauthorized aid on this assignment as defined by the Honor Guidelines for Thesis-Related Assignments.

Introduction

According to NASA, the government agency generated almost $7.7 billion in federal, state, and local taxes throughout the United States and supported more than 339,600 jobs. There is no denying that space exploration over the past 60 plus years has been a crucial part of the American economy. Not to mention, the technology that has been developed by NASA and the space industry has largely benefitted society. Ultimately, it needs to be determined if the continued spending in the space industry is advantageous for our current society. This needs to be answered because a large portion of U.S. tax dollars are used to fund NASA. Alternate uses for the funds that are currently being used to finance the space industry, such as building the infrastructure, better health care, or social programs will be considered. This topic will be discussed using the Social Construction of Technology (SCOT) framework. SCOT is a theory that states that society shapes technology. This paper will look at how society has influenced the development of the space industry and why this industry is still needed.

One technology that has been developed for the space industry is called regenerative cooling and is used to keep rocket engines from getting too hot during take-off. My Technical topic will focus on building an EDM device that is capable of cutting holes through a block of metal to be used for regenerative cooling. My STS topic will focus on the space industry and how the space industry continues to drive many of the worlds scientific advancements.

Technical Topic: Electrical Discharge Machining (EDM)

Electrical discharge machining is the process in which a metal tool piece is brought within microns of another piece of metal that is intended to be machined, called the work piece. A large voltage is induced between the two pieces of metal which causes a spark to be generated that erodes the work piece very slightly. The spark is repeated several times a second and allows

for the tool piece to cut away parts of the metal work piece. The EDM process is not extremely well practiced and has the potential to be developed further.

Rocket Engines use regenerative cooling to keep the engine from overheating. This process works by flowing liquid fuel through channels inside of the rocket engine bell nozzle to keep the metal from melting. This allows for an opportunity to use EDM. Currently these channels inside the rocket engine are made from multiple pieces of metal that are welded together. EDM would allow for these rocket nozzles to be produced with one piece of metal. EDM is known to be better than typical machining processes when the metal being machined is very hard. Rocket engine nozzles need to withstand extremely high temperatures and therefore EDM is a clear candidate for making rocket engine nozzles that can withstand high temperatures without having to attach more than one piece of metal together. The goal of the project is to create an EDM device that is capable of drilling holes into pieces of metal that can be used as cooling channels for regenerative cooling.

The EDM device needs to be able to make relatively precise cuts in a relatively short amount of time. Typical EDM takes a lot of time, and if this process could be shortened, then this would be exceedingly beneficial to the manufacturing industry. To research this topic further, the articles Electrical Discharge Machining: Principle and Manufacturing Applications and Electrical Discharge Machining: Construction, Application, Pros And Cons will be very useful. These two articles discuss how EDM works, different types of EDM, and when it is best to use EDM. This project will take a lot of testing because there is still limited amount of information on the EDM process as it is not an extremely common practice. This also means that even deeper research of the practice needs to be conducted. Finding out precise values for voltages and currents in certain situations will help the group design the product.

STS Topic: The Impact of the Space Industry

The argument could be made that the money used to fund the space industry could be better used for other purposes, such as feeding impoverished people or helping third world countries. However, the indirect benefits of the space industry ultimately aid those third world countries far more than what they could do with the money that is being used to advance space exploration. The technology that has been developed by NASA has led to improvements in areas including health and medicine, transportation, public safety, consumer goods, energy and environment, information technology, and industrial productivity ("Benefits Stemming from Space Exploration", 2013). All these areas benefit developing countries in ways that they do not have the technology to do themselves.

The science and technology that has been developed from traveling to space has been used to propel the world into a fourth industrial revolution (Dooley & Signé, 2023). For example, lower launch costs have made it possible to put more satellites into space that make it possible to optimize broadband infrastructure, enhance earth observation capabilities, and increase national security (Dooley & Signé, 2023). Some companies are even considering implementing operations in low-orbit space to take advantage of the physical properties low gravity offers (Dooley & Signé, 2023). For instance, pharmaceutical companies are considering growing organs for transplant patients and producing drugs that target cancer cells in low orbit (Dooley & Signé, 2023).

With all the positive benefits that the space industry offers, more private companies are now looking to expand their presence into the space industry. Private space companies have been growing rapidly with goals of building reusable rockets, commercial space stations, hotels in space, and even visits to the moon and Mars (Ludwig, 2023). The article The Commercial Space

Age is Here will be a great resource to discuss private companies in the space industry. According to Weinzierl and Sarang, in 2020, a private company transported people into space for the first time. This is important because it allows for opportunities to build an economy that is in space and made for space (Weinzierl & Sarang, 2021). Another useful article for this section will be The Rise of Private Actors in the Space Sector by the European Space Policy Institute. According to the European Space Policy Institute, traditionally, global space activity has been driven by governments, but now private actors are playing an important role in a market of space-based products. New projects of commercial industry have affirmed the intention of private companies to implement new methods to develop and produce space systems aimed at cutting down costs and disrupting existing markets (European Space Policy Institute, 2017). All this information points to the change from the traditional way of governments running the space industry, to the new way in which so many private companies are beginning to make their own rules. This means that even more advancements, lessons, and motivation will happen because of the competition between companies.

The space industry has provided people with jobs ever since it became relevant in the Apollo era and continues to do so today. NASA alone sustains approximately 339,645 jobs across the county (Zelalem, 2022). “At the national level, NASA supports labor income of $25.7 billion per year and an estimated economic output of $71.2 billion annually” (Zelalem, 2022). With such a large budget and an economic output of about 2.77 times that, it seems obvious that the space industry is producing more than it is spending. However, what is the extra money that is being generated going toward? The question that ultimately needs to be verified is, are these jobs and the money that is being spent on the space industry truly necessary? The answer seems to be very straightforward, but it needs to be confirmed in the STS thesis. The Economic Impact

Study done by Zelalem, Y., Drucker, J., & Sonmez, Z. will be a great resource for researching this question. The article Advantages & Disadvantages of Space Exploration will also be a useful resource when comparing pros and cons of the space industry. A limiting factor of this project will be fully encompassing all the societal factors that are impacted, positively or negatively, by the aerospace industry.

The importance of the space industry should be studied because such a large amount of money from tax dollars goes to funding space exploration. The accomplishments of America within the space industry have been nothing short of incredible. However, it needs to be made certain that tax dollars are being used in the best possible way. Thus, a thorough study should be done to prove the importance of the space industry.

STS Framework: Social Construction of Technology

Social construction of technology (SCOT) states that human actions shape technologies instead of technology determining human action (Klett, 2018). People who believe in SCOT, or social constructivists, also believe that the way in which a technology is embedded in its social context must be understood first before being able to understand the ways a technology is used (Klett, 2018). Since society is working so hard to reach goals in the space industry, this allows a way to study social construction of technology. The actions of people wanting to go to the moon developed new technologies that were used to get humans to the moon. Technologies did not just appear and then humans thought to go to the moon, the people apart of the Apollo missions had to work very hard to develop the technologies that enabled the first man to walk on the moon. SCOT will provide a way to look at the STS research topic in a way that highlights the importance of the actions of people developing technology. The argument will be made that, according to SCOT, people need to act so that society does not remain idle. If people do not work

toward a specific goal, such as getting humans to Mars, then technology will not advance. NASA is aiming to put people on Mars by 2039, the technology to do that does not fully exist currently, but the engineers and scientists at NASA will develop the technologies necessary to do so. Society has always been the driving factor in the advancement of technology. People are faced with a problem and then find a way to solve that problem. This has been the case since the beginning of time, and this will always be true. Mankind has a remarkable way of problem solving in challenging situations and this is confined in the SCOT framework.

Conclusion

Researching the reasons as to why the continued advancement into the space industry is important because it will provide the public with reasons as to why so much time and money is spent toward something that feels far away to some people. This is specifically relevant for my technical project. With more funding being put into aerospace sciences, it should make it more possible to continue researching applications for EDM to produce regenerative cooling channels. This specific technical project does not affect the everyday person, but many aerospace projects produce technologies that will benefit far more people than those directly involved in the space sciences.

In conclusion, NASA has provided society with technology that has made significant impacts for mankind in the past. There are no indications that NASA or the private aerospace companies will slow down its development of technology, if anything, technology development will only advance based on the current relevance of the private space science companies. As talked about in the discussion of SCOT, NASA is working to go to Mars in the 2030s and a lot of technology still needs to be developed for that to happen. This will lead to technological benefits

for all of society. SCOT also shows that technology does not drive human actions, and therefore, people cannot wait around for the technology to appear. People must strive for a goal in order to continue to advance.

Questions to consider when writing the thesis include, do most Americans believe that taxpayer dollars should be spent on the space industry, what profits are being generated from current research, and what are the risks of space exploration? In the STS thesis, more data and statistics should be presented to support the claims made in this prospectus. The STS research thesis could either prove that governments should continue funding space engineering or prove that the budget is too high.

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