CECIL, 1U Amateur Radio CubeSat (Technical Paper)

The Relationship Between Science Consultants and The Film Industry
(STS Paper)

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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

From 1902's *A Trip to the Moon* to 2014's *Gravity,* space has been a very large presence in the film industry. There were many factors that led to the production of all of these space movies, and this research plan will deal with how current and past ideas of actual space exploration have been changing the film industry. Innovative technologies have been emerging over the years that are meant to make moves set in outer space more realistic, including new green screens and new ways to mimic the effects of zero gravity space travel. A lot of the movies set in space that are currently being released are definitely very far-fetched, but there are bits and pieces of each film that are inspired by our current technology. My research will dive into the intricacies of the movie business, and I will also be analyzing the relationship between engineers and the people involved in making space movies. In addition, I will be looking into how all of the technologies used over the years have evolved to make space seem more realistic in films. This will not only include historical movies like *Apollo 13* and *First Man,* but I will also address science fiction movies like *The Martian* and *Interstellar.* Finally, I will be analyzing critical literature to gauge how public interest in space movies has changed over the past century.

The technical project that I will be conducting consists of planning a space mission for a small cube satellite. The goal of this capstone project is to connect the satellite with the ground station at the University of Virginia, which has never been done before. Both my technical project and my thesis topic are related to space, and they both have a large amount of public interest, making them great examples of mutual shaping in society. They both show how the work that engineers and filmmakers do to advance their respective industries has an effect on all of the groups involved, including actors, the audience, other engineers, scientists, and film crews. Since there is still so much knowledge that is unknown about space, the possibilities are endless.

More knowledge about space in general would expand the potential ideas that filmmakers have for making their movies. Both of these topics include technologies that have so much potential based on the findings of space exploration and research. Not only can space exploration inspire new ideas for film technology, but film science can inspire real world technologies, too.

Technical Topic: Connecting UVA's Ground Station to a Cube Satellite

My technical project as an Aerospace Engineering student at UVA is to design and launch a cube satellite into space. This satellite will be in the shape of a 10-centimeter cube that will have a radio on it. The purpose of this project is to send a student-built satellite into space that is able to autonomously communicate with the ground station here at UVA using that radio. Similar capstone projects, funded by NASA, have been completed in the past four years. One cube satellite, which was launched in the summer of 2019 is in space right now. This satellite is in a constellation of satellites from Old Dominion University and Virginia Tech. The goal of these missions is to collect data on the atmospheric drag, the position vectors, and velocity vectors of the satellites in space. We have not been able to contact any of these satellites from the ground station here in Charlottesville, so the motivation for my capstone project comes from the communication issues of the most recent UVA cube sat mission. Completing this project successfully will not only bring a sense of completion to the aerospace engineering department at UVA, but it will also prove that the university is a credible engineering institution that is capable of building and communicating with a satellite in space.

Throughout our work this past semester, my group has proposed a few different secondary objectives for the mission. One of these possible objectives is to add an amateur radio to the satellite, allowing amateur radio enthusiasts to send signals to and receive them from our satellite. Amateur radio (also known as ham radio) is a way that people can use radio signals to

communicate as a hobby. This way of communication does not require a phone or the internet. Another viable secondary objective that was mentioned in the team meetings recently was to add a camera onto the satellite, allowing us to take a photo of the Earth from a satellite in Low Earth Orbit (LEO). The motivation for adding a secondary objective to our mission is to make our capstone project more interesting and engaging. Also, including other groups like amateur radio and satellite imagery enthusiasts in our project would make our project have much more of a purpose.

My component group on this capstone team will be dealing with the orbital mechanics of the cube satellite. We will be determining the optimal orbit and attitude for the satellite. Two of the main requirements for our work are: 1) the satellite must pass over the ground station at UVA at least once per day, and 2) the satellite must be oriented in such a way that the radio antenna and the camera are always pointed at the Earth. My group also must determine many of the orbital elements of the satellite, including the shape of the orbit and the altitude that will give the best radio signal.

Luckily, the one cube satellite that has been launched by the university in the past year is the exact same size that we are planning to make ours. This means that there are many resources that previous groups have created that we can look at to guide us through the process of engineering this mission. We do, however, have to take into account that the previous mission is not yet a success, so we may have to make some changes to the processes and parameters that were used in designing the first satellite.

This project is important in the UVA community because we want to establish our Aerospace Engineering program as one of the top programs in the country. Also, it will give all the students good experience in designing space missions. If we were to add either an additional

amateur radio or a small camera, it would definitely expand the project's influence past the university. By adding a new amateur radio, the people who like to use ham radio as a hobby would have one more satellite that will allow them to do what they love. Additionally, taking a photograph of the Earth from outer space by a satellite is something that is not often done by students. By adding this secondary objective and successfully completing it, we as students will be able to prove that UVA is capable of more complex space missions. This could lead to more funding for future projects or new sponsorships. Since there is so much that we still do not know about outer space, the possibilities of new findings that can be obtained from any given space mission are endless.

How are scientists and engineers working in space exploration changing the film industry?

Science Fiction movies have been a very large presence in the entertainment industry since the very early 1900s. Over the past century, movies set in an alternate world have provided viewers with a way to escape their reality and enjoy film for pure entertainment. Although it is very easy to sit down and watch a movie, so much is going on behind the scenes, especially with the genre of science fiction. Hundreds of people work on special effects for any given science fiction movie, and their goal is to make their work look as real as possible. The idea of what a "real" setting is has been constantly changing as the technologies used to create space movies has become more and more advanced. In my research, I will be looking at the relationship between filmmakers and engineers, and will be analyzing the ways that they have changed the film industry over the years.

The first science fiction film to ever be created was a silent film called *A Trip to the Moon,* which was a loose adaptation of one of Jules Verne's novels. This movie, released in

1902, was extremely influential in the creation of many science fiction space movies that we know and love today. It had unprecedented technology for the time, and eventually it became an international phenomenon. Shocking technologies that were used in this film include time-lapse photography, hand painted special effects, actual explosions, and new theatrical machinery (Wilkinson). The director for *A Trip to the Moon,* Georges Melies, created the many different techniques mentioned before to portray a fantasy setting to his audience. At the time, fantastical movies were not very popular, and this is known by many as the very first science fiction film that had the goal of providing viewers with a way to escape reality (Campbell).

The research that I will be conducting is largely focused on how today's engineers are helping movie studios in making films set in outer space. I will then lead into a discussion of how the technologies to create these films has evolved over the years. Finally, I will discuss the effect that space movies have on audiences and film critics. There are many engineers that serve as consultants in Hollywood today, which may be something that not many people know. Very popular movies today, including many superhero movies that take place in space, have science consultants who talk to the director and movie producers to make the new worlds they produce more believable. In fact, movies that involve complicated physics and math are often much harder to make, because it is sometimes difficult to find people who are willing to help (Adams, 2019). Being a science consultant in Hollywood is often an unpaid job, and many scientists and engineers just have to do it based on their own good will.

Movies also hire engineers that can assist in the set design of the movies. One relevant example that I will dive deeper into in my research is the set design of *2001: A Space Odyssey.* Not only is this film one of the most influential space movies of all time, it also had unprecedented technology for the time it was made. The engineers working on this movie

created a centrifugal set, which spun around and used centrifugal force to mimic the effects of gravity (Miller). It is very clear that engineers had a major role in making *2001: A Space Odyssey* extremely realistic, and they paved the way for engineers working on space movies today.

One really important aspect of my research will be the special effects used to make outer space realistic. “Every few years — and sometimes every couple of months — a movie comes along that pushes the boundaries of what we believe is possible on screen” (Anderson). The technology that is used in the film industry is constantly evolving, and the science fiction genre of movies would most certainly not exist without special effects. In her study on special effects, Stacey Abbott wrote “the relationship between science fiction and special effects is often mutually dependent since the genre needs special effects to showcase its future worlds and technologies while the imaginative demands of the stories themselves have spearheaded new developments of FX technologies” (89). Not only have special effects methods inspired new stories to be written, but the stories themselves can also inspire filmmakers to create a new technology to accomplish their goal of bringing their story to life. Abbott also states that the computer-effects artists are the real heroes of the genre, because their research and dedication to their work can bring about new innovations that revolutionize the genre. These workers are one major group that I will focus on in my research, because they shape the way that many filmmakers plan and create their movies.

Another movie that had many engineers and scientists involved in its creation is *Interstellar,* directed by Christopher Nolan. This film is a space adventure that takes the characters all across the galaxy to find a new home for Earth’s dwindling human population. Although the story takes place very far in the future, many scientific aspects of the film are

rooted in real physics. The characters go through a journey in which they encounter a plethora of different obstacles, including black holes, worm holes, and gravitational anomalies. Kip Thorne, who was the lead science consultant on the Nolan film, wrote a book called *The Science of Interstellar* that explains all of the actual physics involved in making the movie. In his book, Thorne also goes into great detail about the collaborations that he had with the writers, directors, and even the actors in the film. When meeting with screenwriter and director Christopher Nolan, Thorne laid out his two main guidelines for the science in the movie: "Nothing will violate firmly established laws of physics…[and] speculations will all spring from science" (Thorne 8). The main challenge of meeting these guidelines was that Nolan had to make a movie that would be accessible to normal people who were not well-versed in the physics of outer space. This means that Thorne had to make sure that the director, writers, producers, actors, and even the special effects crews understood the science behind the film in depth. Otherwise, the film would not be a success. Christopher Nolan and some of the actors, including Matthew McConaughey and Anne Hathaway, also had some major input that Thorne used to create the world of the movie. This shows that Kip Thorne was not the only one that came up with ideas based on the science of *Interstellar*. He was the expert, but the rest of the film crew also used their knowledge to make a compelling world and story. By collaborating with Thorne and finally understanding all of the science behind the film, the entire crew of *Interstellar* was able to make it into a spectacle that audiences around the world were awed by.

There are many primary resources out there that may help with this research. Web articles, interviews, and the movies themselves will serve as the main sources for my thesis paper. The web articles that I am going to use will be found on entertainment sites and engineering company sites. They will be helpful to give an overview of how engineers are

involved in the space movie industry, and can also enlighten me about new technologies that are emerging in Hollywood. Articles that discuss the reception of space movies by audiences and critics will be very helpful in my research, too. Many articles also give a list of the "most realistic" movies set in outer space. This will give me an idea of what movies to focus on in my STS research. In addition to *2001: A Space Odyssey* and *Interstellar,* some of the movies that I will address are *Gravity, The Martian, Hidden Figures, Star Wars,* and *Apollo 13* (Lang). Interviews are also a great resource because they give a first-hand account on what it is like to be a consultant for space movies. By watching the actual movies, I can get a first-hand look at how the technologies have changed over the years. Like I mentioned before, Stacey Abbott's scholarly article about special effects sums my research up very well. What I will be focusing on is not only the networks of relationships between different groups in the science and film industries, but also how technologies are pushing each other beyond the limits that were thought possible. New technology in the actual industry is inspiring new stories, and new stories are inspiring new technology to be made.

Conclusion

My research will answer all of the questions posed in the sections above, and it will address more examples of mutual shaping between actual engineering in the space industry and the production of movies set in outer space. By examining different movies and the technology used to make them, I can provide a framework for the relationship between scientists, audiences, and the film crews involved. As more knowledge is gained about space, more possibilities for what can be seen in film will arise. In addition, as I go through the process of design reviews in my technical project, I will gain more knowledge about space in general and the technology used to collect data there. Overall, space is becoming more and more prominent in all aspects of

society, and my research will prove that the engineering and entertainment industries will be forever changed because of it.

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