The Relationship between Science Consultants and the Film Industry

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Introduction:

"Today's science fiction is tomorrow's science fact." This quote from famous author Isaac Asimov embodies the idea that science fiction, if rooted in real science, could actually become reality. This genre has been a form of escapism for centuries, and many stories have been written that have changed the way people think about Earth and other worlds beyond our own. Books, movies, and even TV shows are still being made in the genre of science fiction, and they are becoming more and more popular. Due to this rise in popularity, more people are obviously watching science fiction movies. Many of these films have elements in them that are rooted in real science. This is where science consultants are brought in. Science consultants are typically scientists or engineers that are hired to provide their expertise on a particular scientific subject that a movie is based on. Most of the time, the goal of these consultants is to make the movie as scientifically realistic as possible for its viewers. This goal of being realistic, however, is not always met.

I will be analyzing several popular films throughout this paper, including *2001: A Space Odyssey, Gravity* and *Interstellar,* to provide specific examples of how a science consultant can affect the making of a film. These three movies are considered staples in the genre of science fiction space movies, and they all used cutting edge technology that was unprecedented for their times. I will be focusing mostly on the people who are working behind the scenes in these films, and I will gather information about how they go through the creative process of making a science fiction movie. One of my main focuses in my research will be the relationship between the head filmmakers and the science consultants. This relationship is a very interesting look at how people work behind the scenes in the world of Hollywood, and by analyzing this, I will be able to show the importance of accurate portrayal of science in blockbuster films.

Special Effects and Science Consultants:

Special effects are of huge importance when creating a science fiction film. Considering that these films can take viewers to outer space and beyond, it is very obvious that a lot of innovative technology must be created to do so. In her study on special effects, writer Stacey Abbott (2006) writes "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" (p. 89). One of the things that I focused on in my research was the technologies that are created for specific science fiction films. Abbott captures the idea that the creativity of the writers of the films can often inspire new technologies, and many different people often work to create them.

The writers and directors of these movies are not the only people who help in creating these films. A very important figure, the science consultant, is often used to provide insight on what they think the films should look like. Science consultants have been more and more in demand as science fiction becomes more popular in the film industry. "In the last decade alone, such consultations have increased by an order of magnitude: Kirby (2003) found 36 films utilizing science consultants from 1990 to 2001, while the SEE [Science Entertainment Exchange]—the largest facilitator of such consults—reported 550 in the 4 years from 2008 to 2012 (National Academy of Sciences, 2012)." (Szu, Osbourne, & Patterson, 2017, p. 597).

One major step in the evolution of using science consultants in movies was the creation of the Science & Entertainment Exchange in 2008. This organization was created by the National Academy of Sciences, and its purpose is to "create a sense of community by building a bridge between talented filmmakers and excellent communicators in science, engineering, and

medicine" (ElShafie, Gerbin, Loverd, Merchant, 2018, p. 14). The Science and Entertainment Exchange was a major step towards the creation of more science fiction films. "By not explicitly telling storytellers what to do, but instead showing them what's on the cutting edge and introducing them to incredibly interesting people, we (SEE) inspire writers to think differently" (ElShafie, 2018, p. 26). Inspiring filmmakers to put real science in films is perhaps one of the most important things a science consultant could do. They have no creative control of the actual story, so it is integral to the public understanding of science that the consultants do their best to enlighten filmmakers with the most intriguing things that could possibly be a part of their movies.

There are many reasons that a filmmaker might use a science consultant, depending on the genre of the film, but there is one main reason that is universal across all genres. "The motivation for filmmakers to utilize science consultants is clear. Scientific knowledge holds a place of privilege in society, and the scientific expert is often used to legitimate one's own views. By using scientists as consultants, filmmakers can claim legitimacy for their visions of science" (Kirby, 2011, p. 264). Public perception of science can often be altered due to some science fiction movies, so hiring a science consultant that is knowledgeable about the particular subject of a film is often pivotal to the production of certain films if filmmakers have the goal of making their projects scientifically accurate. A major problem in today's world of movies is that some films do not portray science correctly, as they give audiences false information about technical topics. All filmmakers obviously want their films to be popular, so they have to make their stories accessible to a wide array of viewers. "Popularization involves the simplification of genuine scientific knowledge for a public audience, which usually results in the distortion of that

knowledge" (Green, 2018, p. 307). The motivation for using science consultants is clear, but this does not always work out the way it is planned.

As the film industry gained more traction in the early 1900s, many science fiction movies were developed, the first one ever being George Melies's *A Trip to the Moon.* This movie, released in 1902, was extremely influential in the creation of many science fiction 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, 2018). At the time, fantastical movies were not very popular, partially because the technology to make realistic effects in movies were not readily available. Melies's film 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, 2019). Although this film was not scientifically accurate at all, it still provided viewers with a new form of entertainment and it is still inspiring films today. There are many movies that are supposed to make the scientific aspects within as accurate as possible, but the demands of the story are not always supportive of this goal.

Scott Frank, in his scholarly article titled "Reel Rejects," wrote about different types of "realities" that films can portray to audiences, referential and perceptual reality. Referential reality is when a film depicts a scene that actually occurred, giving the audience a sense of familiarity. Perceptual reality is when a scene in a film seems like it is "realistic" even though it cannot happen in real life. If a fictional film is not perceptually realistic, audiences may see it as more fantastical, pulling them out of the story. Science consultants working on many films walk this fine line, and try to make their films as referentially and perceptually realistic as possible (Frank, 2003). Frank's terms all depend on the assumption that the public knows basic

knowledge about science, and that any new scientific knowledge that could be presented to someone in a film would be scientifically accurate. In most science fiction films, creators want to bring as much perceptual reality into their stories as possible, making it believable. For people who do not know the science behind a film before going to see it, which I would assume would be a majority of people, it is very important that filmmakers make their films as accurate as they can. For example, if someone was seeing a space movie for the first time without having studied the subject, they would not know much about it. What they perceive in the film would probably be the first time they had ever experienced anything like it. It is a filmmakers duty to accurately portray the aspects of space that are important to his or her movie so that this specific viewer's perceptual reality is formed correctly.

Science consultants and engineers work closely with the behind the scenes crews on the set designs and new technologies for many films. My thesis includes a lot of insight into why these technologies were made, and what films would have been like if they did not exist. Film technology has a great impact on the public perception of science through film, and this idea is explored in depth. My thesis also deals specifically with space movies, rather than the genre of science fiction as a whole.

Methods:

For gathering my own research, I collected interviews, behind the scenes videos, and other primary sources from each of the films that I studied. To find these interviews, I read articles, watched videos, and found first-hand accounts of what it was like to be a science consultant in Hollywood. I also read through some interviews with directors and actors that were involved in the making of some films. In addition to these primary sources, I looked into specific technologies that were used to create a realistic set or aspect of a science fiction film, and

included figures of these inventions. Then, I analyzed these sources and information to explain how they fit into my framework. By doing this, I was able to show that by using science consultants to make films, audiences are more immersed in the fictional realities that are made in these space movies.

2001: A Space Odyssey

Perhaps one of the most iconic space films of all time, Stanley Kubrick's 1961 science fiction epic, titled *2001: A Space Odyssey*, paved the way for many science fiction films to come. It has a rather simple plot, and is about an astronaut who must travel to the far reaches of our solar system with the help from an artificial intelligence named H.A.L. This film took many years to make, and inspired many people to become scientists. In an interview about the making of the movie, visual effects supervisor Douglas Trumbull said, "If anybody had known how difficult it was going to be, it would probably never have been approved…" (Hoad, 2018). It was a real challenge for Kubrick to accomplish his goal. "Kubrick wanted his film to explore "the reasons for believing in the existence of intelligent extraterrestrial life, and what it would mean if we discovered it" (Chiasson, 2018). Public perception of extraterrestrial life has not really changed since the release of this movie, as it is still just a hypothesis that aliens could exist. The director, however, knew that it was only a hypothesis, so he wanted to give audiences a look at what would happen if humans did find evidence of life beyond Earth. Kubrick, in addition to portraying the existence of alien life, wanted to accurately portray space travel and other scientific aspects of the film. He hired famous science fiction author Arthur C. Clarke to help him with his goal. Together, they wrote a book with the same plot of the movie and adapted that (Chiasson, 2018).

Kubrick hired many other consultants, and talked to almost 65 private companies, government agencies, and universities. This movie involved more science consulting than any other film that came before or after it (Kirby, 2003, p. 2). Many different technologies were created by Kubrick and his team of scientists in order to portray the desired images on screen to the audience. These new innovations include the rotating movie set, slit-scan photography, and a visual technique called front projection (Vulture, 2018). Perhaps the most influential of these inventions was the rotating set, which was created by Vickers-Armstrong Engineering at a cost of $750,000.

Shown in *Figure 1*, this was a giant, centrifugal set created by engineers to mimic artificial gravity on a space ship. The interior of the set was equipped with all of the parts of the interior of the spacecraft that Kubrick was portraying. The actors could walk on the frame inside

Figure 1: Rotating Set From *2001* (Fox, 2018)

of the centrifuge, and it rotated at a maximum speed of 3 miles per hour to give the perception that the astronaut was in a spaceship with artificial gravity. The artificial gravity comes from the centripetal force that the spacecraft was creating as it was rotating (DeMet, 1999).

The science behind the artificial gravity is very accurate, and the consultants working with Kubrick definitely gave him the right advice. This technology would not have been possible without the many scientists and engineers that worked to make it as realistic as possible. Audiences who watched this movie were mesmerized by the visuals that were pulled off by the effects team using this centrifugal set. Also, normal people who saw this movie likely had no clue that they were being tricked by the camera, or that the movie set itself was actually rotating in a circle. This trickery is often essential to keeping an audience fully engaged in a film. The artificial gravity in the film, created by the rotating set in real life, gave the audience a sense of perceptual reality. Although the technology of a rotating space ship has not been invented yet, the idea of it is rooted in real science, making it believable. The rotating movie set was very influential, and inspired many future films, including Christopher Nolan's *Inception.*

In addition to the technologies created for *2001,* Kubrick also played with sound while editing his film. Many of the scenes in this movie are silent, and that is because in space, sound does not travel like it does on Earth. Once again, Stanley Kubrick and his team of engineers successfully portrayed another scientific aspect of their story with great accuracy. Overall, there was a great amount of work put into creating *2001: A Space Odyssey,* and it definitely paid off for Stanley Kubrick and his team. Other films that were made after *2001* were most certainly inspired by Stanley Kubrick, as he is one of the first filmmakers to show that working closely with scientists and engineers, although it can be tedious, really pays off in the end. There are

many more examples of real science influencing this film, but I think it would be beneficial to look at more modern films and how filmmakers try to portray accurate science in those, too.

Gravity

Like Stanley Kubrick's sci-fi epic, Alfonso Cuaron's 2013 space thriller, *Gravity*, was another groundbreaking film, and it won many awards for its achievements in special effects and editing. Cuaron won the Academy Award for best director, and the movie also won for best visual effects, best cinematography, and best sound editing. The story of *Gravity* is about a female astronaut named Ryan Stone, played by Sandra Bullock, who gets caught in a storm of space debris. She is eventually left alone in space, and has to find her way back home to Earth. Cuaron used many different camera techniques to make the story more engaging, and did a lot of research on the science of his film. This film, however, had many small parts of it that were not scientifically accurate, and it received a lot of criticism for that.

I will first write about the accurate parts of the film, and what Cuaron did with his science consultants to create innovative technology. The main science consultant on this film was Kevin Grazier. He was a scientist at NASA's JPL Laboratory in California, and the Cuaron brothers contacted him in hopes that he would help them with the science behind their film. When asked in an interview about the director's goal for creating the film, Grazier said "Alfonso had seen the 3-D IMAX film about the final Hubble servicing mission, and he was so inspired by that film that he wanted to create a movie that gave audiences a real "You Are There" feel about space exploration" (Brotherton, 2013). Alfonso Cuaron also did an interview with Collider, and was asked how he would be portraying the physics of space realistically. He responded with, "It was a big learning curve with experts coming to explain the physics of Zero G and what would happen" (Radish, 2013). Sandra Bullock, the main actress, had to use her background in dancing

to portray an astronaut in freefall accurately, and it really paid off. She had to sync her movements to the cameras and the contraption that she was attached to in order to portray an astronaut in freefall accurately. Her movements throughout the scenes in space looked extremely real, and she should be applauded for that. Had she not had a background in dancing, her movements would most likely have looked forced, and would have taken away from the gripping nature of the film. This is a prime example of how an actor works with new technologies that are created for their films, and Bullock did it flawlessly.

Another technological aspect of the film that was a new invention was the Light Box. This contraption, shown in *Figure 2*, was used "in order to realistically portray the brightness and speed of light in space. Both the technology and what it achieved are stunning" (Gravity, n.d.). This box was equipped with a bunch of panels that would light the actor inside of it the way that the Earth and the Sun would light them. This is meant to replicate way that the light would hit them if they were actually in outer space. When Bullock was inside of the light box, the lights would spin around her to mimic her spinning in space. The fact that she wasn't actually spinning, and that the lights were spinning around her, is astonishing. This gave audiences a very striking spectacle to look at, and only enhanced the impact of the film.

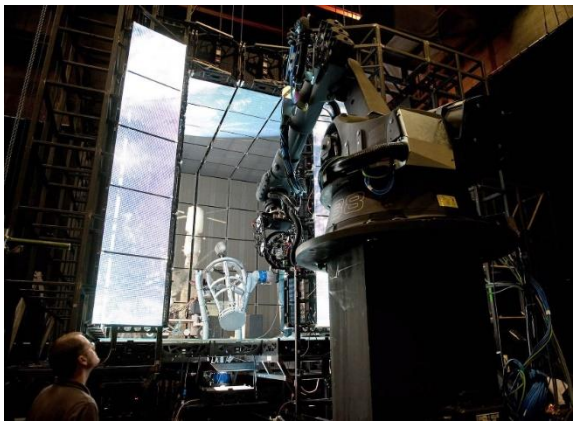

Figure 2: Light Box used in the making of *Gravity*
(Light, n.d.)

In addition to all of the technological achievements in this film, however, there are also a lot of inaccuracies. In his interview that was cited above, Kevin Grazier stated, "Perhaps the most common class of science or technical inaccuracy in TV and film involves the rates at which phenomena progress – where the rate is either decreased or (more often) increased to dramatic effect" (Brotherton, 2013). Everything in this movie happens so fast, and that is just a tool that the director uses to progress the plot forward. Although the other inaccuracies are very miniscule, they definitely have the potential to pull a lot of people out of the story of the movie. For example, in the beginning of the film, a tear rolls down Bullock's face, which should not happen in space due to the lack of gravity. The tear should have floated out of her eyeball, and created a floating sphere of liquid. Also, the incident in the beginning of the film, when Russia fires a missile to destroy one of their satellites, however gripping it is, does not have scientifically accurate fallout. Russian satellites usually have a completely different orbit from American satellites, because they want their satellites to pass over their homeland. Therefore, if the Russians fired a missile at one of their satellites, the debris field would have almost no chance of coming into contact with the ISS, let alone orbit back around to it every 90 minutes (Kluger, 2013). Most people likely did not know about the Russian satellite situation before going into the film, so it could have given them the wrong idea about what really happens in space. The consequences of feeding the audience this inaccurate information are miniscule, but science fiction film directors should try to come up with better ways of integrating their proposed story with real science.

There are many more inaccuracies in this movie, many of them the audience did not even catch, but they all gave the wrong information to viewers. They were implemented in order to forward the story, and the filmmakers obviously did not heed the science consultant's advice.

This shows how science consultants do not always get their ideas onto the screen, and that they are often overlooked in order to forward the story. Scott Frank's idea of perceptual reality can be applied here. Most people probably did not know a lot about space before going into this film, so some of the inaccuracies could have given them the wrong idea when it comes to space debris disasters. This new perceptual reality that is formed in the audience's mind can alter their perception of space science for a long time, and can affect the way that they experience space movies in the future. To sum it all up, abandoning science for the sake of story can pull viewers out of the experience.

Gravity is a great example of how many different groups worked together to make this film. The relationships between these groups are constantly shifting, and there is a lot of back and forth when making a decision on what will actually be in the movie. These shifting relationships between filmmakers, science consultants, actors, and audiences are what helps make the best movie possible. Although some of *Gravity* included inaccurate science, it was still very pleasing to look at, mostly because of the innovative technology that was invented to create it.

Interstellar

Interstellar is one of the most famous science fiction films of all time, and it only came out six years ago. It was directed by Christopher Nolan, and has received a lot of praise since its release. This movie is about an Earth in the future where the world is covered in dust, and our home planet is becoming unable to sustain life. In this futuristic world, NASA has been working secretly to find other planets for humans to live on. They recruit a former astronaut named Cooper to go into deep space with a team to find a place to live, while his daughter and the other NASA employees work to find a way to get all humans off of Earth. The characters go through a

journey in which they encounter a plethora of different obstacles, including black holes, worm holes, and gravitational anomalies. This plot seems simple at the surface, but the scientific aspects of it get extremely complicated.

Interstellar took many years to make, and most of the creative process was taken up by lead science consultant, Kip Throne, understanding the science of 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, 2014, p. 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. In an interview, Kip Thorne said, "But the spirit of it, the goal of having a movie in which science is embedded in the fabric from the beginning—and it's great science—that was preserved" (Rogers, n.d.). The story was mostly the creation of the Nolan brothers as writers, but their collaboration with the science consultants made it even more intriguing given the fact that the science inside of the story is all plausible. 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, or else it would not work. 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.

A very interesting scientific aspect of the film was the actual mechanics of space travel that NASA used in the story. *Interstellar* was not meant to be too far in the near future, so Nolan wanted to make everything as believable as possible. Visual effects supervisor Paul Franklin said about space travel in an interview, "We wanted to ground the cinematography in the language of

the Apollo and Gemini missions, a very reality-based look of space exploration" (Pyle, 2014). In fact, the launch vehicle that Cooper and his team of astronauts use to get into space is the all too familiar Saturn V rocket that was used for the moon missions. This is an example of referential reality because the audience was familiar with this type of technology. The use of this rocket made the idea of getting into space entirely believable, and portrayed a scientifically proven way of travelling to space.

Perhaps one of the most intriguing scientific aspects of *Interstellar* was the black hole called Gargantua. Kip Thorne did a lot of research surrounding black holes and it all led to the depiction of the massive, terrifying anomaly in space. This black hole can be seen in *Figure 3,* and it is truly astonishing. Thorne did a lot of research with Paul Franklin, and wrote many equations that involved the Gargantua that we see in the movie. As you can see in the picture, the light around the black hole is not travelling in a straight line, and this is because it is warped by the hole itself. Gargantua is supposedly spinning at the speed of light, so it would make sense that it would be warped like this (Rogers, n.d.).

Figure 3: Black Hole Gargantua as seen in *Interstellar* (Wall, 2015). ©Paramount Pictures

Black holes are something that had never been accurately depicted before this film, so giving audiences a chance to see what one would actually look like up close was a huge incentive for the filmmakers. This is an example of how perceptual reality, mentioned in the

literature review, can come into play. Even though the visual creation of this black hole was mostly based on theory, it was still rooted in science. The filmmakers and special effects team created something that had never before been seen by the human eye, but still made it extremely realistic, keeping the whole audience engaged.

Interstellar, although it was very scientifically accurate, took a major turn at the end that confused many viewers. Cooper ends up travelling into the black hole, and enters some sort of fifth dimension, gaining the ability to see time as a physical manifestation. This part of the movie was actually all based on one of Einstein's theories, and was extremely difficult to visualize (Pyle, 2014). Interestingly, the film crew used slit scan photography for this sequence, which was also used in *2001.* Although it was definitely not believable that someone could see time as a physical property, the rest of the movie leading up to it was so gripping that people had to see how it ended. Originally, the ending of the film was meant to be extremely sad, having Cooper die while trying to save humanity. Since the whole film was somewhat depressing, Nolan wanted to end it on a glimmer of hope. This is another example of sacrificing scientific accuracy for story.

The inclusion of all of the scientific elements earlier in the film was necessary for keeping the audience as invested as possible. The effective collaboration between the Nolan brothers and all of the scientists involved in making this film was what made it so believable. The public understanding of science from *Interstellar* was forever changed because of the striking visuals used, and it is definitely a movie that will inspire other films for years to come.

Synthesis:

2001, Gravity, and *Interstellar* are three of the most influential science fiction films of all time, and they all have very similar methods of production. All three of these movies obviously

used science consultants, and they all used new technologies to achieve their goals. The behind the scenes details about *2001: A Space Odyssey* show that movies released over fifty years ago can still have very similar styles of production as more recent films. The use of science consultants in all of these movies was not pointless, and the films would not be as highly regarded if they were not used. In *Interstellar,* Christopher Nolan worked extremely closely with his main science consultant Kip Thorne, and that film would be completely different if he had not used a scientist to guide him through the physics of his story. *Gravity* made very good use of its science consultants, and the scenes portraying astronauts "floating" in space would not be so gripping if the light box had not been created.

One large theme in my research has been the needs of the story. It is extremely important that filmmakers not only have accurate science, but also that they have a great story to tell. The fictional plots and characters in science fiction films can affect the portrayal of science in films, as well. This is why the relationships between all of the behind the scenes workers is very complicated. All of the elements of filmmaking—the story, special effects, characters, actors, directors, and even the audience—have an effect on the final product. One of the most interesting things about science fiction films in general is that even the fictional parts of the process can affect the relationships between the crewmembers. There are many obstacles that must be overcome on the journey of making a science fiction film, and the science consultant is one person who can unite everyone under the same goal.

Conclusion:

On the surface, it may seem like the main players in science fiction films are the actors and the directors—the faces of the movies—but there are many more people who are involved. These people, especially the special effects crews and the science consultants, are as important as

the people who are recognized the most. By looking at *2001*, *Gravity* and *Interstellar*, three of the most influential films in the science fiction genre, the importance of accurate portrayal of science was brought to light. These are not the only films that have the complicated goal of portraying accurate science, and other films that were not mentioned have very similar relationships between all of the workers. I picked the three movies because I felt that they captured the potential and importance of science consultants the best. They also all had great examples of technology that is used to create special effects. Behind the scenes crews are not just isolated groups that work in their departments of expertise. They all collaborate together to make their vision possible. Without science consultants, the movie industry would be much different, and the public understanding of science would be skewed. As space movies become more and more popular, the need for science consultants is dramatically increasing. New technologies are constantly being developed for space movies, and these technologies are inspiring many future films. With the development and growing popularity of the science fiction film industry, there are endless possibilities for what can come in the future.

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