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Exploring the Influence of Science-Fiction: How Are Sci-Fi Novels an Agent in the Construction of Reality?

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Abstract:
This paper examines the impact of science fiction literature on reality. The different roles of science fiction in technological innovation and social change are explored through a review of existing studies, an online survey targeted towards young scientists, and expert interviews in scientific and psychological research. Science fiction has played a significant role in shaping our current reality by serving as a guidebook for virtual world construction and inspiring technological innovations. Additionally, science fiction has had a strong influence on society, inspiring impactful communities and contributing to the improvement of social issues such as race relations. The mutual relationship between science fiction and reality is also noted, with the evolution of science fiction reflecting societal changes and technological advancements. The findings suggest that science fiction can be a valuable tool for inspiring innovation and promoting positive social change. Further research is needed to investigate the statistics of building projects utilizing science fiction ideas and to gather more diverse perspectives on the influence of science fiction on reality.

Keywords: *Science fiction, science technology & society, social change*

1. Introduction

6 February, 2018, leaving thunderous applause on Earth, SpaceX's newest rocket, the 23-storey Falcon Heavy, took off, a cherry red Tesla Roadster as its payload. Humanity's dream of exploring the universe just became a bit closer to reality. The technology on this rocket represents the highest level of human intelligence and capacity. However, interestingly, in the car's glove box was a towel and a science-fiction novel called: 'Don't Panic! The Hitchhiker's Guide to the Galaxy.' After the launch, Elon Musk, CEO of Tesla and funder of the rocket initiative, explained that while growing up, the book motivated him to pursue the dreams of exploring the universe and making humans a multi-planetary species. In the novel, a towel is carried around the universe, as "it can be used as a protection from the weather, it can double as a blanket, a bag, clothes, and anything you can think of. The towel is your friend, and its benefits are endless." The story of the towel becoming reality marks that reality is one step closer to the adventurous and futuristic world people imagined in science fiction novels.

Science fiction plays an important role in many children's childhood. With the help of science fiction literature, numerous children have lived in a submarine, and driven it for 20,000 miles underwater, witnessed the legendary life of Hari Seldon, who forever changed the destiny of the imaginary galactic empire, joined our future battle with aliens and became friends with them afterward. These novels did not just make people dream about the imagined world; they motivated people to be a part of it, to shape reality into the better world sci-fi novels wrote about. Over 87.3% of the US population read science fiction novels when they were below 15 years old, and over 88% of these readers continued to read more than 10 sci-fi novels afterward (Menadue & Jacups, 2018). As supported by the statistics, sci-fi novels do have a very large audience group, and the people in that audience group are very likely to be interested in reading more novels of a similar kind.

Science fiction's value was not recognized for a long time. The word 'fiction' was originally a Latin word 'fingere,' which literally means to fake, to pretend. On the other hand, the word 'science,' according to STS and philosophy professor Sergio Sismondo (Sismondo, S. 2007), is "a formal activity that creates and accumulates knowledge by directly confronting the natural world." In other words, science directly questions the world to find the truth. Originally scientists believed that science should not be related to the word 'fiction' at all, such as Isaac Newton, who expressed his refusal of 'fiction' through the sentence he wrote, "I stick to the facts" (Newton, I. 1687). Disconnecting science and fiction seems to help people identify the facts against the interference of their uncontrolled imagination. However, can people really make significant scientific progress when an important way of expressing their imagination is disconnected?

When people from ancient China first looked up to the sky, they regarded the stars as flames from heaven and made fictional stories to explain the nightfall. These stories played an important role in encouraging people from ancient times to explore and develop scientific knowledge about the sky at night. These stories were not technically sci-fi stories as there was no scientific knowledge that acted as the basis of these stories. However, they were like sci-fi novels and acted as incentives for people to construct their perception of the world.

The etymological exploration: The Latin word 'fingere' had a different meaning initially: to model, to sculpt. It is, in fact, very concrete and factual. Together with science, science-fiction novels aim to depict, to model an imagined world to the very detail, based on true scientific knowledge. Novelists such as Jules Verne, Arthur C. Clarke, and Isaac Asimov have not only succeeded in using science fiction novels as incentives for people to explore the world, but they also successfully predicted and even shaped our reality. Jules Verne is famous for predicting the invention of submarines 55 years before they were invented. Arthur C. Clarke predicted the invention of communication satellites and the internet revolution that would come with it. Isaac Asimov wrote about the three laws of robotics, which became three important principles of developing artificial intelligence along with developing moral codes of the robots.

There are many examples of science fiction literature becoming a reality, from Jules Verne's prediction of the submarine to SpaceX's rackets. Is it really that many SF novel writers are such excellent predictors of the future? Or perhaps their works not only just entertained the readers but also influenced generations over generations of people? This research takes science fiction novels as a separate STS research object and aims to contribute to understanding the impacts of SF literature on the real world. In this research, I will first give a definition of SF literature. Then try to understand the historical context of this object and review the previous research to investigate the impact of SF on the world. After that, I will break down the impact of SF into two parts: the technical level and the societal level, subsequently investigate them by conducting online surveys, interviewing experts in scientific and psychological research, and analyzing different cases of SF to reality.

2. Literature Review

2.1. Terminologies

To investigate and relate science fiction novels to social practices, we need to use knowledge from the interdisciplinary field of study that we call science, technology, and society (STS). STS relates objects to their practices in social circumstances.

This paper researches science fiction novels in our society. There are numerous definitions given for this object. Here we take the newest definition - Science fiction is a genre (of literature, film, etc.) in which the setting differs from our own world (e.g., by the invention of new technology, through contact with aliens, by having a different history, etc.), and in which the difference is based on extrapolations made from one or more changes or suppositions; hence, it is such a genre in which the difference is explained in scientific or rational, as opposed to supernatural, terms ((Prucher. 2006). This is the definition we will be using in our research.

Due to the exponentially increasing amount of SF works after 1950, there seem to be clear traits of two different groups of SF novels (Akhmedov, 2020). It has become clear to us in the 21st century that science fiction has genres: it can be categorized as hard SF and soft SF.

Hard SF refers to science fiction focused on developing the details of the technology context. Research done by Gulistan State University (Akhmedov, 2020) defines it as the following:

While both hard and soft sci-fi often deals with technology and futuristic elements, hard sci-fi leans more into realism and attempts to base the 'science' part of its science fiction in as much fact as possible. Even if the technology or science itself does not exist in our world, it has to be plausible and described with as much accuracy as possible in order to be considered hard sci-fi.

Soft SF, on the other hand, deals with soft sciences such as psychology, anthropology, sociology, etc. It is defined as (Akhmedov, 2020): If hard sci-fi likes to discuss science itself, soft sci-fi likes to examine the societal implications of that technology or science and how it affects people. Soft sci-fi will still have those scientific and technological elements that hard sci-fi deals with, but it does not need to explain the science behind it or base it in as much technical realism.

2.2. Historical Background of Science Fiction Literature

Science fiction literature was first introduced and became hugely popular among people who understood science at a high level and were intrigued by engineering and technology due to its creativity based on real scientific extrapolation (Gerlach & Hamilton, 2003). To understand how SF literature may be able to impact or 'shape' reality, we need to look at the brief historical background of SF literature. In this section, we will divide its history due to its development timeline into 3 parts (Arthur B. Evans, 1999): before the 1900s (the early era), 1900 to 1950 (First step into social and political criticism), and 1950 onwards (the formation of soft and hard science fiction).

The first science fiction novel appeared in 1634, published in Johannes Kepler's Somnium, called 'The Dream,' which is referred to by both Isaac Asimov and Carl Sagan as "the earliest work of science fiction" (Asimov, 1987). In 1726, 'Gulliver's Travels' was published. The book was filled with irony about world politics and discussed the form and possibility of utopian societies. It contributed significantly to the future development of the dystopian idea, such as in George Orwell's 1984, Yevgeny Zamyatin's We, and how authors express their thinking to the public through a science-based, fictional story. In the late 1870s, Jules Verne arrived with 65 novels. As the second-highest translated author, he pushed SF literature to a popular genre of literature (Marguerite, 1956). Jules Verne was a pioneer of his era. For instance, Simon Lake, one of the inventors of the submarine, referred to Jules Verne as the source of inspiration for designing the submarine (Submarine: The Autobiography Of Simon Lake, 1938).

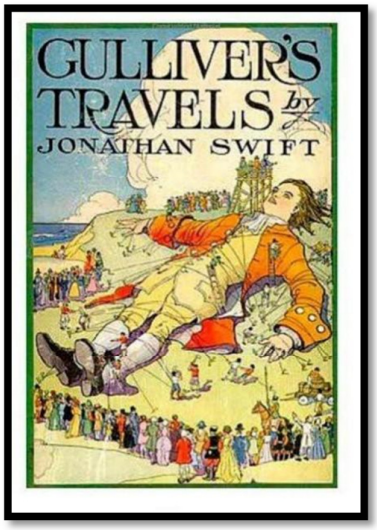

Figure 1: Gulliver's Travels
Taken from: https://beforeikick.wordpress.com

From 1900 to 1950, science fiction literature started to take shape (Gerlach & Hamilton, 2003). The world was experiencing world wars at that time. SF literature was also experiencing a brand-new change (Gerlach & Hamilton, 2003). Many SF novels published during that time, along with their descriptions of futuristic technologies, were filled with social and political criticism, such as using narratives from an alien (Arthur C. Clarke, 1947). Totalitarianism and communism started to take over Europe. Different tragedies happen every day at an increasing pace (Somasundaram, 2006). Even though the stories were taking place in the future, people could still find them touching and resonating with some of their own experiences.

Both hard SF and soft SF were developed throughout the second half of the 20th century. The most influential soft SF writers in human history were: Isaac Asimov, Frank Herbert, Robert Heinlein, Douglas Adams, Neil Gaiman, Philip K. Dick, Anne McCaffrey, and many more. Their works together focused on the impacts of different kinds of technologies on the cultural, psychological, and emotional well-being of the human race (Menadue & Cheer, 2017). Hard SF writers such as Arthur C. Clarke, Cixin Liu, Michael Crichton, Kim Stanley Robinson, and Robert Heinlein contributed significantly to the insights and the depiction of details of developing future science and technology (Menadue & Cheer, 2017).

2.3. Technical Impacts of Science Fiction Literature

According to *Manadue and Jacups's research* based on an online survey about the audience group of science fiction, the social groups which are directly influenced by SF, such as the audience, producers, policymakers, and scientists, are characterized by optimism and belief in science, very high-volume of reading, and a very high level of education. These people appear to have a high-interest level in the future development of technology and science and are capable of influencing the direction of the industry directly or indirectly (Menadue & Jacups, 2018). Thus, researchers consider science fiction and fantasy as essential sources of insights to discover public interests, inspire public policy, and affect future science in public engagement, lobbying, and education (Menadue, Giselsson & Guez, 2020).

Past research investigating the relationship between science fiction and innovation focused on drawing parallels between the past descriptions of similar technologies the authors imagined and the existing technologies the human race actually developed nowadays. The idea of Mars terraforming, heavily invested by NASA, appeared to have a popular hit in 2015, but the actual concept was proposed long ago. In his 1951 short tale 'Seetee Ship,' science fiction author Jack Williamson coined the term 'terraforming,' which is the process of changing a planet's environment to make it more conducive to life. The science-fiction novelist Poul Anderson really foresaw the existence of a planet in orbit around a neutron star in a 1958 novel, contrary to what the astrophysicists reported (Galvez, 2013). Since the conservation of angular momentum during the collapse of a stellar core, Anderson contended that a neutron star must have a powerful magnetic field because the field strength should be proportional to the neutron star's rotational velocity. In general, Anderson's physics is accurate. These are examples of how SF works influence the research timeline of a real technology organization. Another example with exactly the reverse relationship would be the space elevator. In The Fountains of Paradise, Arthur C. Clarke described the space elevator, which was first proposed by Russian physicist Konstantin Tsiolkovsky in 1895 and revisited 60 years later. The space elevator, described by NASA as "an economical way to get up to geostationary orbit," may actually be built in around 50 years. The material for the cable of such a lift should be 100 times more resistant than steel and is likely to be constructed of nanotubes (Galvez, 2013).

2.4. Societal Impacts of Science Fiction Literature

SF literature has a role as the cultural wallpaper (Menadue, 2020). In social science, there is a concept called social emergence. In five mutually constituting ontological layers or 'frames' of analysis—individual level, interaction level, ephemeral emergents, stable emergents, and social structure—social emergence states that phenomena arise through

unplanned individual interactions (Goldspink & Kay, 2007). Our society, analyzing from the appearance of our behaviours, is a significantly complex mixture of numerous unplanned interactions, just like the ants' society, where every ant performs seemingly chaotic individual behaviors but together they form order and efficiency. The ants achieve their order and their agreement on the direction of where the society is heading through their scents carried naturally with them as signals of change (Lenoir, Fresneau, Errard & Hefetz, 1999). Our human society is similar to the ants' society in terms of the social emergence concept but a much more complicated version (Hilbert, 2017). One 'scent signa' in our society may be played by SF novels, which we call 'the cultural wallpaper' (Menadue, 2020).

SF literature helps us reflect on our society. When there emerged an increasing number of science fiction authors, they tended to form social groups of science fiction writers. These people had one thing in common, their persevering habit of thinking wildly with a wider range of topics. According to research based on an online survey (Menadue & Jacups, 2018), writers and readers of science fiction novels in the US tend to have a longer time to be alone and read more books than the rest 87.3% of people in the US. One explanation is that people who immerse themselves in a broader background in the universe and in a longer timeline start asking big 'questions' such as "What Exists Out There?" (Douglas Adams, The Hitchhiker's Guide to the Galaxy, 1979), "What Happens When 'They' Come to Earth?" (Arthur C. Clarke, Childhood's End, 1953), "What Makes Us Human?" (Isaac Asimov, Bicentennial Man, 1977), and the most controversial topic during the 1930s, "Is utopian society feasible?" (George Orwell, 1984, 1949).

3. Roles of Science Fiction Literature in Reality

3.1. Research Methodology

To investigate the technical and societal impact of SF literature, I will use three different methods:

- Firstly, I create an SF reader survey towards a specific social group in which the members should be, according to previous research about SF audience groups, very much interested in SF novels.
- Secondly, I conduct a 90 min interview with my mentor Dr. Kenneth Y. T. Lim, who is a professor at Nanyang Technological University and operates at the intersection of data science, artificial intelligence, cultural anthropology, and cognitive psychology. We discuss the impact of SF literature on his field of research – engineering and social science.
- Thirdly, I conduct a secondary analysis of the existing cases of SF literature influencing society, such as criticism or breaking social norms.

3.2. Science Fiction Literature and Technology

3.2.1. Guidebook for Constructing Virtual Reality

"That you know what life is not enough. I need to find other expressions of what I'm capable of. Building worlds like 'Second Life,' they do give people these opportunities. What I do is I go into the landscape to design landscapes. And then, I work with people who are architects to populate the space. So basically, I consider myself a custodian of environments within 'Second Life.' Moreover, that is something that I am good at."

'Second Life' is a multimedia platform that enables users to build their own avatars and live a second life in an online virtual environment, with over 1 million regular users back in 2013. During the interview with Dr. Lim, he told me how he was inspired by SF novels, especially the idea of space elevators mentioned in SF novels (Clarke, The Fountains of Paradise, 1979), and decided to build it into reality with his team of friends from different academic fields on an online platform called the 'Second Life.'

Question:

"How does science fiction affect your personal work as a professor who operates in both social science and engineering?"

Dr. Kenneth Lim:

"So, here's the connection between science fiction and my personal world (as a builder in 'Second Life'). For example, in a virtual world, they are laws of physics, but the laws of physics are not necessarily identical to the laws of physics in the real world. So, you can have an architecture that might not be able to be built in the real world. One of the things that I like to do is to have my imagined landscapes, which would not be possible in real life but are possible in a virtual world, like 'Second Life.' An example would be something you may have seen in science fiction movies - A space elevator. It is basically a carbon nanotube, which is a planet-to-space transportation system. In 'Second Life,' you can have a space elevator to see. Because in real life, engineering is not there yet. But you can have it in 'Second Life.' In fact, I worked with one of my former team members in real life and my university team. He's an excellent builder with a diploma in architecture from one of the Singapore Polytechnic (universities), so we actually built and scripted a working space elevator in 'Second Life.' That's cool. That's an example of how the two worlds kind of collide."

The idea of the space elevator was first proposed by Russian physicist Konstantin Tsiolkovsky in 1895 and revisited 60 years later due to the publication of Arthur C. Clarke's hard SF novel, The Fountains of Paradise (Boucher, 2003). In the novel, Arthur C. Clarke described it as "the enormous 'orbital tower' that rises from the earth and connects to a satellite in geostationary orbit at the height of almost 36,000 kilometers. With such a device, cargoes may be raised into orbit without spending money on rockets." However, such a cost-efficient method of transporting supplies into space is still not available with our current technology in the 21st century due to a few reasons described by physicists and in the SF novel itself. Firstly, the material of the space elevator needs to have sufficient strength to hold the gravitational force

and its weight. Fortunately, when the height increases, the distance between the space elevator and the center of Earth increases. According to Newton's inverse square law, the gravitational force the cable has to endure will be less. Based on calculations, instead of a cable strong enough to hang 36000km under normal gravity, we need a cable strong enough to hang 5000km under normal gravity. Our current technology only allows us to manufacture a steel wire of 50 km under such circumstances (Boucher, 2003). Secondly, the location of the space elevator is limited to a few desirable places due to the consideration of catastrophes, humidity, inequalities in the distribution of the earth's gravitational force, etc. (Clarke, The Fountains Of Paradise, pg 204). Thirdly, the fuel of the space elevator must only have the negligible physical weight due to the fragility of such an infrastructure (Boucher, 2003). The above reasons have turned many people away from building space elevators in reality.

Due to the popularity of the multimedia platform, 'Second Life' rose in the first ten years of the 21st century. Dr. Lim, his university team, and his friends had put the idea mentioned in the science fiction novel into 'reality.' In 'Second Life,' the law of physics is different. We can 'set' the tension of the materials to be higher than what our engineering technology can build under the law of physics in the real world. Variables such as random catastrophes no longer exist, or if people want, they are no longer unpredictable. The space elevator was presented to people for the first time in human history. People got to know what space elevator would look like if one day our engineering is sufficient to build it. After collecting information on the official websites of popular platforms which simulate an environment less strict in terms of engineering requirements than the real world, such as 'Second Life,' 'Minecraft,' 'Roblox,' many more cases of science fiction novels were used as a discrete description for the building projects on these online platforms. The spaceport from Ender's Game was built in 2007 on a server called Dixon City, the moon base from Robert Heinlein's The Moon Is a Harsh Mistress, the cyber city from William Gibson's Neuromancer, the spaceship named Enterprise from Star Trek were all built on these online platforms. These projects were built based on the exact SF novels, supported by their server names, such as 'New Frontiers – For Star Trek Fans,' 'The Space Elevator at Sri Lanka,' etc. The details of these projects match the description of the technology as well - the palace ruins on 'Second Life' are extremely similar to the actual ruins at Sigiriya in Sri Lanka. The fictional peak, Sri Kanda, which serves as the foundation for the space elevator, is strikingly similar to the actual mountain, Sri Pada.

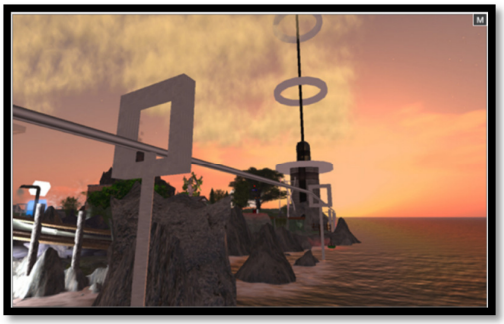

Figure 2: Space Elevator Built in 'Second Life'
Taken from: https://secondlife.com

For fans of these platforms, we can claim that science fiction novels act as guidebooks for some building projects created on multimedia collaborative online platforms. Hard SF novels tend to be built into reality more often. This may be due to their characteristics of being extremely focused on details when hard SF authors describe their visions of technology and the authors' more scientific mindset. As mentioned above, science fiction novels serve as guidebooks for building these technologies. These projects serve as pioneers/a bridge of transforming the imagined technologies from a book to reality because now engineers and architectures such as Dr. Lim and his team can see what the technologies will look like in real life, test the limitations and feasibility of these technologies, and can derive useful information and vision for the ongoing scientific direction.

4. Inspirations for Innovation

My survey to the Advanced Science Program students asked an open question: "Any evidence supporting the relevance between science fiction and reality? Such as the rocket, submarine, space ship, etc."

The question was meant to find evidence of SF novels being capable of 'predicting' the invention of technologies before people found a feasible engineering solution to some existing problems. Some interesting technologies were mentioned, and I looked at secondhand information about the invention of these technologies, trying to find out how SF novels inspire innovations.

Circumnavigation – Around the World in 80 Days. 'Around the World in 80 Days' was written by French author Jules Verne in the late 1800s, when planned international travel was still mostly a science fiction concept. However, his techno-futuristic book encouraged regular adventurers to circumnavigate the globe on foot, on bicycles, ships, and trains—beating the record set by his protagonist (Riordan, 2022).

SpaceX and Tesla - Hitchhikers' Guide to the Galaxy, Foundation Series, Spaceballs. SpaceX has deep sci-fi roots. Three drone ships owned by the business are named after vessels that can be found in Iain M. Banks' Culture series. Isaac Asimov's Foundation series was transported into space on a '5D quartz' storage device by Musk's Tesla Roadster, which

was sent into orbit in February 2018. 'Heart of Gold,' the first vessel to bring people to Mars, is named after a vessel mentioned in Douglas Adams' 'Hitchhiker's Guide to the Galaxy.' The titles of Tesla's powerful Ludicrous and Plaid modes were influenced by the science fiction comedy 'Spaceballs' from the 1980s. To quote Elon Musk: "Worth reading Asimov's Foundation," referring to the works that describe the demise of civilization that visionary Hari Seldon attempts to flee by founding research colonies on far-off planets. The lesson I learnt from what Musk explains to Rolling Stone is: "You should try to take the set of actions that are likely to prolong civilization, minimize the probability of a dark age and reduce the length of a dark age if there is one." This claim shows the direct link between science fiction and Elon Musk's career goal, as he was known for his claim of establishing a million-strong, self-sustaining city on Mars by 2050. SF literature is an important source to educate, inspire, and provoke currently one of the most influential innovators' visions of the world (Author, 2021).

Atomic power - The World Set Free. H.G. Wells predicted that artificial atomic energy would appear by 1933, causing a terrible world war before a peaceful worldwide government would eventually take power. Leo Szilard, a physicist, read the book in 1932, which motivated him to find a solution to the nuclear chain reaction puzzle in 1933. The same book served as Szilard's inspiration for his post-World War II advocacy work for nuclear disarmament and non-proliferation (Popa-Simil, 2011). The science fiction novel 'The World Set Free' not only acted as a pioneer/guide that not only showed Szilard a feasible way of harnessing nuclear fission power but also influenced Szilard's opinions about nuclear power by showing and encouraging him to think about the implications of nuclear power.

4.1. Science Fiction Literature and Its Social Impact

4.1.1. SF Culture among Young Generations

I designed my own survey based on a series of previous reader polls conducted by SF periodicals since 1954 (Adams & Wallace, 2011; Hamilton, 1954; Van Gelder, 2003). They summarized that science fiction is popular among younger readers. The respondents to the surveys fit the profile of a group that is highly educated, consistently avid readers, and open to or believe in science. Thus, my own SF survey is designed for a young group of science students in Singapore – students who are admitted into the Advanced Science Program at Anglo-Chinese School Independent – to find out to what extent SF literature is involved in their exploration of science and technology, and what kind of role SF literature plays in their vision of the future. Until now, 83% of the students in the program have answered the survey, which gives us 21 responses from a group of science students with an average of 17.7 years old.

Questions	**Response**
How many SF novels have you read	books (on average)
What interests you the most in SF novels	Interesting characters and stories: 23.8% Futuristic technologies and background: 42.8% The reflection of the future society, social criticism: 33.3%
3. To what extent do you think science fiction novels influence our science development and technological innovations? (Influence level: lowest 1- highest 5)	3.85 (on average)
4. To what extent do you think science fiction novels influence what you think about society in the real world? (Influence level: lowest 1- highest 5)	3.90 (on average)
5. Do you believe in the self-actualization of science fiction?	The ratio of yes to no = 1.33
6. Is there any evidence supporting the relevance between science fiction and reality, such as the rocket, submarine, spaceship, etc.?	

Table 1: Online Survey

As the results shown above, young generations who are taught high-level knowledge of science at high school are very likely to be SF readers. This result demonstrates that the previous conclusions from the research mentioned above are solid. The average of SF novels the students have read has reached an average of 13.2 books. This proves the conclusion of a previous research, "Who Reads Science Fiction and Fantasy, and How Do They Feel About Science? Preliminary Findings From an Online Survey" (Menadue & Jacups, 2018), to be correct. This survey wants to understand what interests the young science students the most among the three factors: 'interesting characters and stories,' 'futuristic technologies and background,' and 'the reflection of the future society, social criticism.' The social group tested in this survey was the most interested in the technologies (42.8%), followed by the societies (33.3%) depicted in science fiction novels. In terms of the impact of SF on technologies and readers' perception of society, the surveyees gave both very high average scores of 3.85 and 3.90. From these two results, we can, therefore, claim that science fiction novels are not only likely to impose a high influence on young generation scientists' vision of the development of technology but also on the direction of how society should be developed. Clayton O'Donnell, an innovative entrepreneur, describes how SF novels encourage children to think: "It certainly can't hurt the creative mindset. Science fiction has long been known to push the

boundaries of what will happen to society at a later date. Often a writer like Bradbury will almost seem prophetic 30 years down the road."

5. Forming New Impactful Communities

"Back to when I was a junior postdoc, and I was attending these conferences as academics, too. And I realized that even though I wasn't necessarily attending conferences with explicit technology themes, a lot of the presentations around that time, much like they are now, were talking about 'Star Wars,' 'Second Life,' except that now they're talking about say NFTs, virtual reality, and the metaverse, but more or less the same thinking. So, as we're doing, (I thought to myself:) I'm not attending an SF conference; why are you talking about these things? So, I realized that actually, this was a bigger cultural phenomenon than just an SF story."

As we continued our interview, Dr. Lim told me how he realized that there is something about SF, more than just a story. There is a cultural phenomenon built around science fiction. According to Wiebe E. Bijker's theory of the social construction of things, an artifact has different relevant social groups. The different relevant social groups can be found by 'rolling a snowball.' In the snowball method, according to Bijker: "typically one starts by interviewing a limited number of actors (identified by reading the relevant literature) and ask them, at the end of each interview, who else should be interviewed to get a complete picture." In previous research (Berger, 1977), the relevant social groups of science fiction are identified as 'author,' 'audience,' 'critics,' and 'scientists/scientific critics.' Science fiction has caused the formation of these new social groups in society. A community is defined as "a group of people living in the same place or having a particular characteristic in common" (Gooch, Betsy, 2008). Different communities consisting of the 4 social groups above are formed, such as the 'Star Trek' community, the 'Star War' community, and the 'dystopian SF' community, due to the community member's passion for the same SF novel (Gooch, Betsy, 2008). Dr. Lim explained to me the influence of 'Star Trek' culture, or community, as a member of the 'Star Trek' community. One of the clearest examples from 'Track' is the whole mythos surrounding the name 'Enterprise.' 'Enterprise' has been used many times in track for different starships. However, 'Enterprise' is by no means 'Enterprise.' There is a long history. There were sailing ships named enterprise, and one of the clearest examples would be the 'Space Shuttle Enterprise,' which was a prototype space shuttle and not actually used for orbital missions. The space shuttle was named 'Enterprise' because the tech community lobbied NASA to name it 'Enterprise.'

6. Improving Race Relations

There was this whole thing about the original series of 'Star Trek,' which would have been in the late 60s and 1970s. 'Star Trek' was brave enough to turn the lens on to present a culture. For example, 'Star trek' would have featured women in tech and people of color. On family time television in America, they were doing roles that they would not normally be associated with. I am referring to black women, for example, who were in the late 1960s and early 70s. In America, on television, black women would normally have been associated with domestic servants, but they played a vital role in communications. And then, of course, there was 'Sulu,' played by George Takei. Moreover, he was an Asian man. However, for example, that was not how Asian men were perceived in or portrayed in America in the late 1960s. The most common, obvious, and famous example would have been Bruce Lee. However, Bruce was the sidekick of a white male in 'Green Hornet.' So he played a subordinate role in the 'Green Hornet' to the lead white male. Whereas in 'Star Trek,' George Takei was the pilot of the enterprise. Moreover, that was so tricky that it basically broke a lot of cultural norms.

One area where 'Star Trek' made great advancements and incorporated into its core was respect for minorities. Dr. Lim told me about the improvement he thinks 'Star Trek' has made for racing relations, combined with the example of Bruce Lee, the famous Chinese Actor in the 1960s. Initially, the crew of the Enterprise was racially diverse. "The ship, which represented all of humanity, had to be mixed-race. How can the human species ever hope to become friends with extraterrestrial races if it can't even get along with itself?" Two regular characters who portray American minorities are Lt. Sulu and Lt. Uhura (Gerold, 152).

George Takei played the role of Mr. Sulu, the captain of the USS Enterprise. It was a major step forward to have a Japanese American in such a powerful position. There was some uncertainty about whether adding a Japanese American character would harm the show's popularity in Indonesia (Stine, 160). However, George Takei, like the other Star Trek's minority performers, pushed and lobbied hard for his role. Lt. Uhura, the Enterprise's communications officer, was the other minority character that frequently appeared in 'Star Trek.' It must be emphasized once more how daring it was for 'Star Trek' to cast a Black character in such a crucial role on a 1960s television program. However, the first inter-racial kiss was one of the significant historical firsts that 'Star Trek' made with Lt. Uhura in science fiction and television (widely acknowledged as such in the literature). The contentious kiss took place in the 'Plato's Stepchildren' episode, which aired on 11/22/68. After the episode, a male fan criticized the kiss, essentially suggesting that Captain Kirk would not hesitate to kiss a lovely woman in his arms (Gerrold, 80).

Thus, it seems that 'Star Trek' has helped to improve racial relations in America (Synder, 1995). To operate as a 'safety-valve' for racist ideas, minority characters in prominent roles emphasizing the equality of minorities were mixed with Mr. Spock, who has an alien parent. The ability to do this subtly as societal commentary is probably due to Star Trek's science fiction setting, which has the advantage of being remote in time and space.

7. Conclusion

Our reality deals with facts, but we cannot go anywhere without dreaming up the stories first. Through summarizing the history of science fiction, conducting interviews, online surveys, and case analysis, I have examined the

different roles of science fiction to understand why science fiction stories are becoming a reality. I have come to the conclusion that instead of making predictions, science fiction literature is actually involved in the production of reality. To some extent, we conclude that it accelerates or shapes the formation of a certain reality.

The first aspect of science fiction literature's influence is in terms of technological innovation. SF literature plays the role of a guidebook to construct a virtual world and inspire certain technological innovations. The characteristics of a virtual world – easy-to-control variables, different laws of physics, and convenience of testing different ideas – help to construct the technologies and futuristic world with detailed descriptions into people's sight. SF fans, scientists, and innovators are finally able to 'see' the science fiction world without having to build a physical one with our currently very limiting engineering level. Regarding scientific research or innovative engineering products, SF literature provides a pathway/guidance from a long-time scope perspective and a reminder to always think critically about advanced technologies. The second aspect of science fiction's influence is demonstrated within our society. SF literature serves as an influential source of ideas in changing young science students' vision of technology and society, the center for forming impactful SF communities, and the factor that is capable of improving social issues such as race relations. The societal influence of science fiction novels is also a crucial reason behind SF stories becoming a reality. Without being able to persuade, resonate, and motivate different social groups to be willing to believe in their visions and stories, science fiction will never become a reality. In this way, submarines, atomic power, and SpaceX's goal of establishing a sustainable city on Mars will all disappear.

This study can be further extended by studying the mutual relationship between science fiction and reality. During this research, I have come to realize that SF literature has impacts on reality, the reality also has an influence on the creation of science fiction. Evidenced by the evolution of science fiction during World War II and after Congress had passed numerous Civil Rights Acts, science fiction novels started to discuss and reflect more issues regarding social issues such as utopian ideology, racism, feminism, etc. (Synder, 1995). After the invention of certain technologies, such as the iPhone, science fiction novels started to use smaller telecommunication devices in their stories. This research can also be further improved if the statistics of building projects utilizing science fiction ideas are investigated and a larger sample of science students are asked about their opinions regarding science fiction.

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