To Infinity and Beyond

Will Chiang, Jack Edgar, Sarah Mchugh, Alex Pitcher, Gray Thoron, Jessalyn Wang

Crown 1

Dr. Patton

12 December 2019

Introduction

The night sky has played a significant role across human history. In the stories we tell from every culture, the stars, the moon, and the planets all play their part. Now, in the past fifty years, we have gone to the night sky. We have sent men to the moon, robots to Mars, and probes beyond our solar system. There are many unanswered questions about how to move forward. How treaties will be negotiated, how we will survive in space, not to mention how we will get there and if we even should. However, our world will not support us forever and the universe is large and unexplored. The best way to explore it is to go there.

History of Space Travel

Humankind's restless imagination and insatiable hunger for knowledge drove the ancients to look to the stars, attempting to understand their place in the universe. The dream of space—or humankind's ambition to study or travel the cosmos—has driven the human race to achieve wonders: escaping the gravitational pull of the Earth's gravity, sending a man to space, sending a man to the moon, and may, in the future be what drives us to colonize Mars or reach Alpha Centauri. However, the dream of space is ever-changing throughout history: for the ancients, space represented a haunting existential question; later, it became the subject of wild fantasies; even later, space became a political goal post; and now, space represents business ventures or an existential escape route from our dying Earth.

Before the technology to traverse the heavens existed, the dream of space inspired science fiction writers, whose literature both echoed and spurred the public's imagination for other worlds. In his book, *The History of Rocketry and Space Travel*, rocket scientist Wernher

Von Braun claims, “As man’s astronomical knowledge increased … the fictional space voyages devised by his restless imagination became correspondingly more sophisticated” (8). Before the likes of H. G. Wells and Jules Verne, there was Lucian of Somata, whose piece of second-century A.D. fiction, *Vera Historia*, described the voyage of a sailing ship that is carried to the moon by a strong wind. Lucian imagined Lunar inhabitants called “Hippogypi, and they ride on three-headed vultures adorned with feathers” (10). Space was largely mythological—a barely understood dreamscape. In *Orlando Furioso*, a 1516 fantasy novel by Lodovocio Ariosto, the protagonist travels to the moon “in a chariot drawn by four red horses” (11). By the time Jules Verne released *From the Earth to the Moon*, technology was reaching a point where the public was actively imagining ways in which humans could reach space or communicate with extraterrestrial life, and they were slowly reaching more believable theories. In a rough prelude to rocketry, Verne proposed a “nine-hundred foot-long cannon, pointing straight up into the sky” with which a giant projectile, which contained an astronaut was fired into the cosmos (17). The works of Verne and H. G. Wells inspired the fathers of rocketry, Konstantin Tsiolkovsky, Robert Hutchings Goddard, and especially Hermann Oberth, to study space travel. Oberth, stimulated by Verne’s *From the Earth to the Moon*, eschewed Verne’s cannon theory and took an interest in the use of a “liquid propelled, long-range bombardment missile” (57 von Braun) for German use in World War One and made proposals of a similar ilk for that of space travel. Oberth’s book, the scientific speculatory piece *The Rocket into Planetary Space,* “ is a small book … but it is a thorough discussion of almost every phase of space travel, including the abnormal effects of pressure on the human body” (57 von Braun). Through his book, Oberth furthered humanity’s understanding of space at the inspiration of the previous generation’s imagination. At this point in history, space travel was pure, benign, and hopeful -- the dream of space was still that: a dream. From the mythos of Lucian and the optimistic speculation of Verne to Oberth's studies, they all shared a childlike desire to reach the stars simply because they were there. As Goddard, the American frontiersman of rocketry said, "It is difficult to say what is impossible, for the dream of yesterday is the hope of today and the reality of tomorrow" (Logsdon).

However, the dream of space changed with the two world wars in which rocketry was utilized for military purposes. The competition of war drove further progress, and rocketry was perfected in the form of the missile. As stated above, Oberth himself proposed a long-range missile for World War One, and by World War Two there was an explosion in interest in missiles from all countries involved with the war. While the U. S. developed J.P.L. for their own missile research, Braun spearheaded the V-2 missile for Germany, described by Braun as "the largest and most advanced missile in the world. It was 46.1 feet long, 65 inches in diameter… and it carried its 2,200-pound payload from 180-210 miles" (106). Braun later stated that the V2 missiles were "'a success, but we're hitting the wrong planet'" (Poole). At the close of the war, Braun and his team surrendered to U.S. troops and were quickly set to work on testing rockets for high-altitude research for the United States (Logsdon). The U.S. needed to enhance their understanding of sending heavy vehicles into the upper atmosphere and space, and Braun and his team were utilized for their wartime missile-launching experience. He eventually worked with NASA to travel to the moon. Rocketry as a means of military dominance had an obvious appeal. French theoretical astronauticist, Esnault Pelerie, proposed that the French army implement rocketry to their offensive—"A plan for the ballistic bombardment missiles against which he could imagine no defense" (75 von Braun). Countries quickly realized that superiority did not simply pertain to ballistic missiles, now, the use of satellites to watch rivals or provide navigational guidance for aircraft is imperative for a competitive military (Logsdon). The dream of space had become mixed with ideology, arrogance, global dominance and progress. Humans had a practical reason for traveling to space: killing and spying on other humans.

Post-war, the dream of space was still very much militaristic, but its functionality quickly devolved into the heated politics of the sixties, exemplified by the empty triumph of the Apollo missions. To begin, the clashing ideologies of the United States of America and the USSR ushered in a new definition for the dream of space: traveling to space was still such an arduous, mysterious endeavor that it became a way to exemplify the efficiency and power of either capitalism or communism. With the help of Von Braun, the U.S. studied advanced rocketry by launching repurposed V-2 missiles in White Sands, New Mexico (Braun). According to Braun, “The V-2 program, in addition to giving Americans experience in launching large vehicles, gave valuable information on every aspect of rocket flights” (125 Braun). In 1957, the Russian satellite, Sputnik 1, became the first man-made object to orbit the Earth. This came as a surprise to the global community, especially in the U.S., since “skepticism had been widespread about the U.S.S.R.’s technical capabilities to develop both a sophisticated scientific satellite and a rocket powerful enough to put it into orbit” (Logsdon). Four months later, the U.S. followed suit with their own satellite, Explorer 1,which, according to Braun, “helped salve America’s pride” (164). This throw away phrase in Braun’s book exposes the driving factor of many of these post-war cosmic achievements: pride. The pride of two nations pushed humankind to the stars. In 1961, cosmonaut Yury Gagarin became the first man in space. These two Soviet successes embarrassed the U.S., and in order to finally pull ahead in the space race, the U.S. decided to travel to the moon. The U.S.'s reasoning was that such a mission would require a "new, more powerful rocket … a lunar landing would be a very visible demonstration of American strength" (Logsdon). Exploration and expansion, had given way to political agenda. As a result, the Apollo 11 mission was indeed a triumph for humankind, but did not lead to further exploration. When Neil Armstrong stepped on the lunar surface on July 20, 1969 and said those iconic words, America's ambition in space was quenched: they had beaten the Soviets. Because the nation's goals—its dream of space—were political, the achievement was nothing more than that. "No equally compelling reason to continue to travel to the Moon or to send humans to Mars was put forth in the following years" (Logsdon). After seven more missions, the Apollo missions ended.

With America's resounding victory in the space race, the dream of space returned to one of scientific research, collaboration and coexistence. In 1975, a joint mission in which an Apollo and a Soviet Soyuz module docked was a symbolic olive branch extended between the U.S. and the U.S.S.R., and both countries resorted to developing space stations and sending more satellites into space. Salyut 1, the Soviet's first space station, launched in 1971, and the U.S.'s own Skylab launched in 1973, which carried out "solar and biomedical studies" (Logsdon). The international space station exemplifies this new sense of global collaboration. "Between 2000 and 2011, U.S., European, Japanese and Russian modules were added to the ISS, along with Canadian robotic equipment" (Logsdon). Furthermore, in 1977, unmanned space probes Voyager 1 and 2, were launched, the former of which has successfully escaped the heliosheath (the outer edge of the heliosphere, which is a bubble of solar wind emanating from the sun far beyond the planets) of the solar system, and the fly-bys the two probes have made of the four outer gas giants have provided invaluable information on the nature of the outer planets, Voyager 2 returning "detailed photos and other data on the planet [Uranus], its moons, magnetic field and dark rings" ("Voyager - Planetary Voyage"). On both of the Voyagers, a golden record, providing information about Earth in a hope to greet possible alien life that may encounter the probes, has been mounted, which only exemplifies a return to the dream of space from before the war -- one of hopeful expansionism and discovery.

Currently, with private space companies, the dream of space has altered once again. It has the urgency of the cold-war era space race yet the hopefulness of the original ambition of early writers. But the dream is neither of these, it is one of existential risks where humans believe that they must colonize new worlds in order to survive as a species. Starshot Breakthrough and SpaceX both hope to reach other stars and planets. Elon Musk's Starship is set to orbit the Earth within the next six months and it will send space tourists around the moon in the 2020s. According to Musk, "This is the fastest path to a self-sustaining city on Mars." The popularity and ambition of this new era of space travel echoes that of the space race without its political calculation -- with, of course, an added sense of capitalist motivation.

All in all, the motivations for humanity's voyages to space have evolved from childlike ambition, to military applications, to political power plays, and finally to an urgent attempt to save our own species.

SpaceX and Mars

Elon Musk imagines our future as a space-faring civilization. A civilization where space travel is as cheap and common as air travel is today. With this goal in mind, Elon Musk plans to have a sustainable colony on Mars by 2050. Although Musk's plans are ambitious, his company, SpaceX, has been working hard for the past two decades to achieve this vision. In September of 2008, SpaceX built their first rocketship, the Falcon 1. Its goal was to reach space and deliver a satellite to orbit around Earth. This launch proved that a private company has the capability to launch a spaceship to orbit and marked the beginning of SpaceX's achievements. SpaceX's most notable launch occurred last year when they successfully returned Falcon 9's boosters back to Earth. This launch marked a new era for space travel. It proved that rockets going into space do not have to be single use, and that the boosters or capsules can be automatically returned to Earth for reuse in future missions, meaning space travel can be much more efficient and cheap (Horvath 2017).

After SpaceX showed the world that space travel can be affordable, they shifted their focus towards settling on Mars. Just a couple of months ago, in late September 2019, Musk held a conference to unveil the prototype version of Starship, the rocket ship that will take people and cargo to Mars. As Musk spoke to the press, the 160 foot tall prototype stood tall behind him. The Starship, covered in stainless steel plates, reflected the lights shined on it. At launch, Starship will be combined with the Super Heavy rocket booster, making it about 380 feet tall in total. The Starship is different than any other rocket ship currently in use because it focuses on total reusability. The ship is primarily made of stainless steel, a metal that is significantly cheaper and in certain scenarios, stronger than other metals used for space ships. At first glance, stainless steel seems weaker than other metals, but SpaceX uses it because at subzero temperatures, the temperatures in space, it becomes about twice as strong. Another important property of stainless steel is that it has a higher melting point than other metals, meaning that Starship is less likely to take damage on reentry to Earth. Starship and its booster, Super Heavy, plan to return to Earth and be used for later missions. The launch of the Falcon 9 proved this to be a possibility and a cost effective strategy (SpaceX 2019). Although the Starship is bigger and more expensive than existing rocket ships, the ship has the lowest marginal cost per launch because of its full reusability (SpaceX 2016). SpaceX plans to allocate their ship building assets towards perfecting the Starship and creating a fleet of them for a variety of missions. Starship can be used for putting satellites into space, transporting astronauts to the International Space Station, creating a Moon base, and most importantly, sending people and cargo to Mars (SpaceX 2019).

Even though SpaceX's plans are ambitious, their timeline to achieve their goal is quite short. Due to planetary alignment, it is most efficient for SpaceX to launch Starship to Mars every two years. The next time this alignment occurs is in 2020, but that is too soon even for a fast working company such as SpaceX. According to Musk, the first of their initial Mars missions begins in 2022. The goal of this mission is to provide cargo and set up infrastructure for future Mars missions. SpaceX wants to land at least two Starships on Mars filled with supplies to set up power, mine for ores, confirm water resources, identify potential hazards, and provide life support infrastructure for future flights. This unmanned mission will help SpaceX get their first foot on Mars and provide resources for future trips. After 2022, SpaceX is not slowing down at all, as their next Mars mission is planned for 2024. This mission will launch two Starships carrying cargo, and another two Starships carrying people. The goal of this mission is to set up a propellant production plant and prepare a Mars base for expansion. Due to the complexity of the mission, some humans are required for setup. This propellant plant is an essential part of having a sustainable life on Mars, as the plant will provide fuel solely from the materials on Mars.

Starting with these two initial missions, SpaceX plans to start small and eventually build up to a large colony over the coming years (SpaceX 2017).

SpaceX's plans are quite exciting for the future of our civilization, however SpaceX's plans seem too good to be true for the timeline that they have given. In a TED Talk Interview, Gwynne Shotwell, the COO of SpaceX, is questioned about the huge projects SpaceX is undertaking and how they handle that amount of work. The word "Elon Time" is brought up, meaning that Elon Musk operates on a different time scale when it comes to project timelines and he predicts projects to be finished much sooner than what is possible. No matter the size of the project, Musk believes he can achieve the project in a relatively short amount of time, such as launching engineers to Mars by 2024. Shotwell describes several realizations she came to when working with Musk, "First of all, when Elon says something, you have to pause and not immediately blurt out, "Well, that's impossible," … so you zip it, and you think about it, and you find ways to get that done" (Shotwell 2018). With this first realization, Shotwell believes that it is better work ethic to try and find ways to get the project done rather than disagreeing with Musk's ambitious plans. With this mindset, she is also able to focus on getting the project done rather than arguing with Musk and spending time rearranging the SpaceX timeline. The second realization that Shotwell has pertains to her role in finishing projects, "I noticed every time I felt like we were there, we were rolling over, people were getting comfortable, Elon would throw something out there, and all of a sudden, we're not comfortable … But then I realized that that's his job, and my job is to get the company close to comfortable so he can push again" (Shotwell 2018). While Shotwell's job is to get workers comfortable with finishing the project, Musk's job is to create more projects and put pressure on the workers. This type of work dynamic means that

SpaceX is always working on something and that they are getting as much work done as possible. When SpaceX workers always have a project to work on, it means that they can get much more work done in the long term and achieve the timeline that Musk proposes. Even with this work dynamic, Shotwell admitted that "Elon Time" exists and that projects generally do take longer than Musk states. When the interviewer asked how much longer "Elon Time" is, she jokingly agreed that it would be around two times any normal project time (Shotwell 2018).

Another problem with SpaceX's plans comes with the hazards of space travel. During space travel and on Mars, the crew will be subject to large amounts of radiation exposure. While in space flight, Starship has no shielding technology that would protect the crew from radiation once they leave Earth's atmosphere. Also, Mars has a much thinner atmosphere compared to Earth, meaning that humans on Mars will be much more subject to radiation. So far, SpaceX and Elon Musk have no real solution to this other than mentioning being able to angle Starship so that there is the least amount of radiation exposure. However, this solution is about minimizing radiation rather than preventing it entirely (Durante 2014).

Irregardless of how long it takes for SpaceX to achieve their goals, the projects they are currently working on are sure to create important infrastructure for the world. SpaceX has already made space travel cheaper by minimizing the damage taken by ships in Earth reentry and by making rocket boosters able to automatically land back on Earth. This not only means that space travel is cheaper for companies such as SpaceX, but it means that space travel will be cheaper for the consumer. If the marginal cost of a space launch is significantly reduced by the reusability of rockets, it means that people have to pay less to take a trip on Starship or any other rocket ship. For example, NASA estimated that sending people to Mars would cost approximately $10 billion per person. SpaceX plans to reduce this cost down to $200,000 per person because of the ways they have found to be cost effective (Schroder 2016).

SpaceX has also set up infrastructure by creating reusable ships. These rocket ships can both be returned to Earth for reuse and have a wide variety of missions they can complete. Rockets ships such as the current Falcon 9, and the future Starship, could be used be SpaceX or any other company to put satellites in orbit. In fact, SpaceX is currently using Falcon 9 to launch satellites into low-orbit in order to create a world-wide high-speed internet. In the short future, they plan to have thousands of these satellites in orbit, so reusable rockets are almost a necessity (Foust 2018). By using reusable rockets, SpaceX also plans to setup a system of Starships to create Earth to Earth rocket travel. Everyday citizens could take a short boat ride out to the location of a Starship and its launchpad located in a body of water. With this rocket ship, people could take a trip from Los Angeles to Hong Kong in approximately 30 minutes. Although the cost of this rocket ship trip may be a bit more expensive than a plane ticket, the amount of time you save compared to a normal 15 hour airplane flight can be worth it to many. Earth to Earth travel was explained by Shotwell, and she believed that this system could be fully fledged in about 10 years (Shotwell 2018).

SpaceX is a company that has many ambitious plans coming from the CEO, Elon Musk. Despite the uncertainty of when they will be able to colonize Mars and setup an entire other civilization, the work that SpaceX is doing has already sent humanity into a new era of space travel. With the infrastructure that SpaceX has provided and the plans they have for inhabiting Mars, SpaceX will provide humans the capability to explore space both more cheaply and more efficiently.

As companies such as SpaceX launch humanity into a new era of space travel, it is important to create a system for governing other planets and deciding what the laws are in space. In order to divide planets between countries or make laws in space we must make an entirely new set of rules, or we can continue to follow some of the laws that are already set in place for space exploration.

Treaties in Space

The U.S. was both the first to land a manned spaceship and plant their flag on the moon. But does that mean that the moon falls under U.S. territory? No, because there is a treaty called the Outer Space Treaty which states that the moon and other celestial bodies are the provinces of all mankind and to be used for peaceful purposes. There are treaties, laws, and committees in place to allow free access to all areas of celestial bodies as outer space should not be restricted to someone and that no one can claim ownership in and of outer space.

UNITED NATIONS
Office for Outer Space Affairs

Starting from the beginning in 1958, the United Nations Office for Outer Space Affairs (UNOOSA) was created. They ended up serving a committee that was created a year later at the General Assembly, called The Committee on the Peaceful Uses of Outer Space (COPUOS) which was established as a permanent body. The UN General Assembly is the main deliberative, policymaking, and representative organ of the United Nations. COPUOS controls the exploration and affairs of space. It enables the exchange of information from the Committee and any other related affairs. The committee was created to help with most matters that are connected to outer space, programs that are connected with the United Nations and share outer space information. In 1966, the Outer Space Treaty was first introduced and considered by the Legal Subcommittee and was agreed upon in the General Assembly (UNOOSA). As of 2019, 109 countries have signed with the Treaty, while another 23 have signed, but have not completed ratification. The Outer Space Treaty was based on a declaration that had been accepted by the General Assembly three years before but had a few provisions added to it. And on January 27th, 1967, it was opened for signatures in Russia, the United Kingdom, and the United States (UNOOSA). The first article of seventeen, states that “The exploration and use of outer space, including the moon and other celestial bodies, shall be carried out for the benefit and the interests of all countries...Outer space, including the moon and other celestial bodies, shall be free for exploration and use by all States without discrimination of any kind”(NASA, 2006). In addition, nuclear warheads and other large scale weapons aren't permitted within Earth's orbit, celestial bodies, or in other outer space locations. As stated in article 4,” The use of any equipment or facility necessary for peaceful exploration of the moon and other celestial bodies shall also not be prohibited”(UNOOSA). States are responsible for any damage that their crafts cause, holding them accountable for what they do in space. Following the OST, four more treaties were made: the "Rescue Agreement", the “Liability Convention”, the “Registration Convention”, and the “Moon Agreement” from 1968 to 1984 (UNOOSA). During the creation of the four treaties, COPUOS created five principles to support all the treaties called the Declaration of Legal Principles, the Broadcasting Principles, the Remote Sensing Principles, the Nuclear Power Sources Principles and the Benefits Declaration which took place from 1982 till 1996. In addition, the UN held four UNISPACE conferences which were held from 1968 to 2018

(Howell, 2017). All these conferences and treaties/laws that were held/created allow everyone equal rights and holds them responsible for all space activities.

With the laws set in place, the world is able to preserve peace and advance in space travel and exploration. This allows a fair chance for everyone to explore without any restrictions. If the laws and treaties had not been established, then, modern-day would be imagined differently because there could be weapons in space.

The Resources in Our Solar System

Justification for gathering resources extraterrestrially

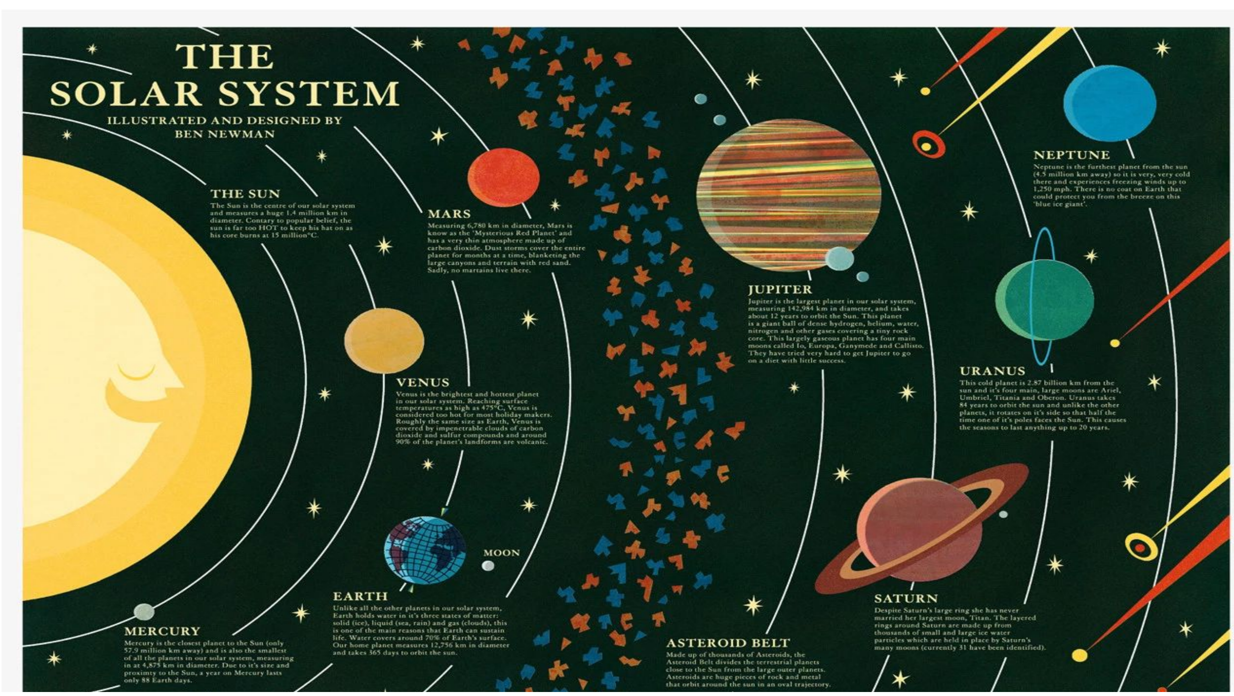
The planet Earth has limited natural resources, and humans have been fighting over miniscule pockets of material for thousands of years. This is not set to change anytime soon, and as supplies wane, the problem will become more pronounced. At our society's current rate of expansion, it is necessary to have access to more resources to supply future generations, as well as more large scale efforts such as space travel.

Why Earth doesn't have many accessible resources

Earth does not have a large quantity of accessible metals because metallic elements are heavy, and as a result, settled into the core of the planet as molten metal (Metzger). At the same time, the lighter molten rocky materials rose up and formed the crust, a process called differentiation. The planets closest to the sun, like Earth, have the largest quantities of heavy elements, but we can not reach the majority of those resources. They are cut off from us due the extreme temperatures and pressure which bar our attempts to drill much deeper than 12.3km, the current record (Umino, Nealson, Wood). This is not a promising venture, it would be far too expensive and inefficient to gain anything from breaching Earth's core, assuming it is even possible.

Valued Resources in the Solar System

Fortunately, Earth is not the only place we can seek resources from. There are two broad classifications of resources: volatiles—e.g water, hydrogen, and helium—and metals (NASA). Although extensive investigation and sampling is still required to determine the composition of many space bodies, we do know where these resources exist in the solar system. There are large quantities of numerous metals in M-class asteroids, although scarce in water. Water is not uncommon in the solar system. In fact, the Earth has very little water in comparison to other planets, some being composed almost entirely of liquid water or ice.



Asteroid classifications

The asteroid belt lies between Mars and Jupiter, and it is estimated to "contain between 1.1 and 1.9 million asteroids larger than 1 kilometer (0.6 mile) in diameter, and millions of smaller ones" (NASA). Another classification of asteroids are the Trojans, which share a planet's orbit due to being in the balanced gravitational sweet spot between the sun and said planet. Jupiter's Trojans alone are estimated to be as numerous as those in the Main Asteroid Belt (NASA).The last classification is the group of asteroids closest to earth which are classified as NEA's (Near Earth Asteroids), and these are the first asteroids we would attempt to access due to their proximity. There is a separate set of classifications for asteroids based on their composition rather than location. The C-type is the most common, likely made up of clay and silicate rocks, but depleted of volatiles. S-types are made up of silicate and nickel-iron. The M-types are metallic, and the most coveted, but are mainly found in the Asteroid Belt farther from Earth (NASA).

The Main Asteroid Belt contains the most Class M asteroids. This is because in the past there were at least two planets which had undergone differentiation, that later collided and broke apart, revealing their metal cores (Metzger). These asteroids are the best chance humans have for creating any large scale projects, such as space colonization and even the ever distant interstellar travel.

Cost effectiveness and transportation

With our current technology, we do not have the means to mine asteroids and return the resources to Earth. Despite present limitations, it is not closed off for the future. It will likely always remain prohibitively expensive to transport materials between bodies, so rare Earth metals are the primary target (Hein, Saidani, Tollu), since they have the chance of an actual profit margin. For instance, platinum is an extremely valuable metal, but it is supplied almost entirely by three countries: South Africa, Russia, and Canada (Hein, Saidani, Tollu). For many countries, having a supply available outside of trade is invaluable, because their industry would be unaffected in the event of trade restrictions.

Viability of extracting resources and the steps we have to take before that

Before any attempts to create an extraterrestrial mining operation, we must first make large advancements in technology at the very least. We still have not been able to return any samples of Mars for more extensive analysis, and it would be very costly yet beneficial to do so. The same is true for Venus, the Moon's South Pole Aitken Basin, and sending an orbiter to observe Mercury. These are very possible in the present, provided proper funding. They would revolutionize our current understanding of the formation of planets, and usher forth the advancement of technology. In order to even begin planning for asteroid mining, it is necessary to be capable of the simplest retrieval missions (NASA).

Cost of the different types of missions

NASA commissioned a survey a couple decades ago about what missions would be most useful, and their price to complete it. Small missions (less than $325 million) like an orbiter mission to Saturn, Medium missions (less than $650 million) like a Venus In Situ Explorer, and Large missions (more than $650 million) like a Mars return sample or a Europa Geophysical Explorer (NASA). This is the general scale of any of the missions necessary toward space advancement. It has been suggested that countries collaborate in ease to ease the financial burden.

Extrasolar travel

In the far future if humanity colonizes Mars and begins exploiting the resources of the asteroid belt and perhaps Jupiter, the question of “what next?” will eventually arrive. To that, one must look beyond the orbits of Uranus and Neptune, exceeding Pluto and the millions of asteroids making up the Oort cloud, to other solar systems. However, other stars are not nearly as convenient as nearby planets. The closest system that has Earth sized planets within the star’s habitable zone is Wolf 1061—a small and cool star, radiating red light—not visible to the unaided eye. Planet K2-3d, the second planet from the Wolf 1061 has a radius of 1.5 Earth radii and orbits in a 45-day year (Méndez). If a ship carrying passengers reached the speed of the Parker Solar Probe, one of the fastest man made objects in the universe, the ship would only reach 0.06% of the speed of light and take 21854 years to reach Wolf 1061 (“Journey to the Sun”). This is unacceptably slow. We need something faster.

To get humanity to the stars, some assumptions must be made. First, we want to go beyond our solar system, second, we have all the money and resources our solar system gives to use, and third, we are going to Wolf 1061. Much of technology that would expel us from the solar system is from the realm of science fiction. From the warp drives of *Star Trek* and *Star Wars* to the light sails of hard science fiction, nearly every science fiction story in space has a different engine. Many of these propulsion systems are unlikely, if not impossible but there are a few that are quite feasible and could send us to interstellar space. Ion engines, solar sails and nuclear engines are all real and have well documented pasts.

Ion Engines

An ion engine, or ion thruster, takes its propellent and ionizes it by firing electrons into it to create positively charged ions. Guided by electromagnetics, the ions are channeled into a beam that propels the craft forward (Dunbar). The thrust of ion engines is very low; as of 2004 ion engines gave only half a newton of thrust (Zona). However, ion engines burn for much longer times than current chemical rockets, and despite their slow acceleration, they can reach speeds around 90,000 meters per second (Kaku). This technology is not a far-off vision from the world of science fiction, it is possible and has been implemented. Many geosynchronous communication satellites are kept in their orbits with the help of ion thrusters, the European Space Agency's BepiColombo Mercury mission uses ion thrusters as their main propulsion system, NASA's plans for a manned mission to Mars includes multiple vehicles powered by ion thrusters ("BepiColombo's Beginning Ends"). While ion engines can outperform traditional chemical rockets in final velocities, 90,000 m/s is still not fast enough to get us to Wolf 1061. At that speed (0.03% the speed of light), it would take 46,666 years to get to Wolf 1061. As one might notice, ion engines, one of the fastest propulsion methods mankind uses only goes half as fast as the fastest man-made object the Parker Solar Probe. This difference in speed is due to the probe's orbit around the sun. The sun provides a great deal of acceleration that has the planets moving at similar magnitudes. If we want to get closer to the speed of light, the sun may be the solution.

Solar Sails

For most of humanity, the primary mode of transportation across the oceans was sailing. Wind powered vessels, typically use some type of sail, were simple, effective and took advantage of a naturally occurring and easily harnessable force. The thought behind solar sails is the same. Light is a particle called a photon. When they collide with objects and bounce off, they push back on the objects. This pressure is miniscule, undetectable on Earth but in the vacuum of space, and given a large enough surface, the light pressure can add up. At 1 Astronomical Unit from the Sun, light provides 9.2 micronewtons per square meter. If a sailcraft, a spacecraft using sail technology, had a mass of the ISS, the sail would be about 5 million square meters and provide an acceleration of around 0.0001 m/s^2. While this might not be much, like with ion thrusters, solar sails last a long time, in theory indefinitely, so a spacecraft might reach speeds nearing 20 AU per year. This would mean a trip to Wolf 1061 would take 44269 years. This is slightly faster than ion engines, around 0.03% the speed of light, but still not fast enough. Despite their feasibility, solar sails are rarely used. As the space race wound down, NASA fought hard for solar sails to do a rendezvous with Halley's Comet which was met by political and bureaucratic forces, causing it never to happen. NASA proceeded to disregard solar sails from technical discussions, focusing on other propulsion methods such as ion engines. Japan's space agency, JAXA, launched the first solar sailcraft. NASA was to launch a solar sail mission to monitor solar storms called Sunjammer in 2016, but NASA ceased work on it in 2014. Many people might see the solar sail as a preposterous idea, but it makes as much sense as exploding bombs as means of propulsion (Friedman).

Nuclear Engines

Since the days of the Manhattan Project, there has been the idea of using the energy resulting from nuclear fission to power rockets. Nuclear fission is the process by which atomic bombs and nuclear power plants work. The original thought process was to use a nuclear reactor to heat hydrogen, or some other fuel and expelling it out. These types of engines were developed by NASA under the name Nuclear Engine for Rocket Vehicle Applications or NERVA. After the Threshold Test Ban Treaty of 1974, work ceased on the engines until it regained interest during the early 2000s and into the 2010s. The tests in the 1970s showed a velocity of 8,600 m/s and a thrust of 73 kilonewtons. This was impressive for their time; however, in comparison to the other technologies discussed, this is trivial, a measly 0.0003% of the speed of light. However, there were more ideas about how to harness nuclear energy.

There are many complicated ways of using physics for space travel; everything from photons to electrons to warping the fabric of space-time. However, as physicists Ted Taylor and Freeman Dyson showed, not all ideas have to be complicated. Taylor and Freeman's idea is simple. Build a spacecraft with a large, well shielded plate and attach a nuclear bomb to it. Fire the nuclear bomb and soar into the heavens. If the energy of Little Boy, the bomb that dropped on Hiroshima, were converted into exclusively kinetic energy, it would send a 10,000 kg payload at 50 m/s. However, this energy would be released over microseconds, resulting in an acceleration that would kill anyone aboard the vessel; for such a vessel to be a success, it must keep its thrust in check. This is only one of three major design challenges when building a nuclear engine. There needs to be a well plated hull to keep the passengers from the high amounts of radiation as well as a mechanism that launches nuclear bombs once per second and detonates it (Adler). Despite the flaws in the design, the concept was seriously considered by Dyson and Taylor for several years as "Project Orion". Facing criticism over the possible nuclear fallout a nuclear-powered rocket could cause, and following the nuclear test bans, Dyson and Taylor abandoned Project Orion. Taylor, the architect of many nuclear bombs, also lost interest when he realized that Orion may use small highly powerful nuclear bombs that could be a real threat if they were in the hands of bad actors (Kaku). Now, the nuclear engine belongs to the realm of science fiction.

The conventional, or at the very least more feasible, options for interstellar space travel require traveling at fractions of a percent of the speed of light. There is no easy solution that we can utilize right now. However, science fiction does not concern itself with the possibilities of the present. If the idea is possible, or even probable, science fiction authors have used it. Whether it is antimatter engines, warp drive, or wormholes, there are stories of it.

Antimatter Engines

Antimatter is the opposite of matter. While "opposite" can mean many things in physics, in this case it means that it has the same properties of matter except the particles are of the opposite charge. Anti-electrons have a positive charge and anti-protons have a negative charge. When antimatter collides with matter, both are annihilated and transformed into pure energy as predicted by Einstein's E=Mc^2 (Kaku).

Chemical, ion, and nuclear engines work under the same principle, expelling a propellant and use the reactionary force to propel itself forward. An antimatter engine uses the same principle. In an antimatter engine, antimatter and matter collide in the combustion chamber and the resultant gamma rays and X-rays are expelled out the exhaust, giving the engine thrust (Kaku). For every kilogram of payload, one kilogram of matter would have to react with one kilogram of antimatter, for the payload to reach 60% the speed of light (Adler). While this will result in a trip to Wolf 1061 taking only 23 years, there are some issues. Most importantly, antimatter is hard to make. While antimatter is real, observable in space and manufacturable here on Earth, the process to make it is extremely taxing. As the process is creating matter from energy, we must work E=Mc^2 in reverse. A kilogram of antimatter needs 25 billion kilowatt-hours to be produced. If all the antimatter CERN, the European Organization for Nuclear Research, has ever made reacted with matter, it would power a light bulb for a few minutes (Kaku). A spacecraft would require a lot more energy than a light bulb. Storage is a complete other issue. While the idea of an antimatter engine will continue to fascinate science fiction authors it might simply not be possible. It may be easier to manipulate the fabric of space-time.

Wormholes

In 1915, Albert Einstein put forth a radical idea: the universe has four dimensions, only three of which we could observe as spatial dimensions, the fourth we observe as time. Not only that, but these are warped by objects. An object with mass bends space-time around it like an object on a waterbed warps the waterbed or a ball on a rubber sheet bends the sheet. This is what we observe as gravity. Einstein proceeded to write equations describing space-time and while scientists continue to look for flaws, these equations are functioning extremely well.

Wormholes are tricky business, as the field equations presented by Einstein show, they are possible but not all are traversable. For example, there is a theoretical wormhole called the Einstein-Rosen Bridge. This wormhole rips a hole in space-time and leads to a parallel universe where it spews out what enters the wormhole in what is called a white hole, similar to the big bang. However, Einstein-Rosen Bridges look identical to black holes. Not only is there no way to see through a Rosen Bridge, entering one would mean certain death. Even if an explorer was to pass through, they would not be able to return as the white hole is not possible to traverse

(Kaku). This is rather useless for the purposes of space travel, so we must look elsewhere in Einstein's equations for an answer.

A traversable wormhole should not have any event horizon, nor should it take too long to cross, and, most importantly, it should not kill those traversing it. With these criteria in mind, wormholes, according to Einstein's equations, should be possible. However, gravity tries to close wormholes, breaking them off from each other and creating black holes. To keep this from happening, wormholes need a substance unknown to humans: exotic matter. Exotic matter is fundamentally different than normal matter as it does not have positive mass, it has negative mass. While normal mass pulls things closer to it, exotic matter pushes things away from it (Morris). From Einstein's equations, we know exotic matter is a mathematical possibility but we have no evidence of exotic matter, if it exists, it keeps moving away from normal matter. If exotic matter does exist, it would repel itself away from other matter and would probably be in the unreachable parts of the universe. However, physicists have been able to create exotic energy, or negative energy, which, according to Einstein's equations, should mean that exotic matter is possible (Kaku). Wormholes can not only traverse space but also time which creates many causality paradoxes which have led some scientists to believe that wormholes are not possible, rather a fluke of the math. But the math can lead to some interesting places.

Warp Drive

The fabric of space-time can not only be warped and cut into wormholes, it can be folded and bent. Imagine an area rug with two objects on it. One object slides frictionlessly across it while the other one, for all intents and purposes, is stuck to the carpet. No matter what happens to the carpet, the frictionless object will remain in the same place in reference to the environment around the rug while the other object will move with the rug. If the carpet is folded in between the two objects, the objects are now closer together in relation to the environment, however, the length along the carpet is still the same. The rug is then pulled out from behind the frictionless object until the rug is unfolded. The frictionless object remains in the same place, but the other object is now closer, both along the carpet and the rest of the room. If a spaceship were to do this, Mexican physicist Miguel Alcubierre supposed, it would not be going to the stars, it would be bringing the stars to it. Alcubierre tested his hypothesis with Einstein's equations and found that they held up. A ship with an Alcubierre drive would be in a warp bubble. Space-time inside and out of the bubble would be disconnected and around the bubble, space time would warp in front of it and expand behind it like the area rug. There are major weaknesses in Alcubierre's theory. As space-time is disconnected in the warp bubble, no information would be able to come in or out of the bubble, making steering impossible. And, in order to create the warp bubble and compress space-time one would need something like negative energy or negative matter (Kaku). Like with wormholes and antimatter engines, the required resources are not easily available to us. Withstanding a comet of antimatter or exotic matter, if we go to the stars, it will be very slowly.

Passenger Ships

If humanity is to travel beyond our solar system, we will face new paradigms that we cannot comprehend at this time. However, there are some theories about what might happen. Going to another system, as previously stated, will be slow. The method of getting there will likely take hundreds if not thousands of years. For the sake of argument, assume a ship using a combination of nuclear propulsion, ion engines and solar sails takes 400 years to get to Wolf

1061. No person can survive the length of that journey. Instead, large colony ships must be sent. Ship populations will have hundreds of thousands of people and, theoretically, remain roughly the same size until landing on the planet. Such a mission fails to take into consideration the human element of the journey. 400 years can see the widespread changes in culture, politics, religion, philosophy, technology, and countless other things. 400 years is the span of time between William Shakespeare's death and release of *Finding Dory*. 400 years is the time between the birth of Martin Luther and the death of Karl Marx. Assuming a human generation occurs every 25 years, and the crew starts at 100000 people, 400 years will mean 16 generations, 1.6 million people. 15 generations, 1.5 million who would likely have never seen Earth, and 14 generations, 1.4 million people, that will never see their origin nor destination. It is close to impossible to know what these people might be like. Will they want to complete the mission? Will they form nations and states within the ship? Will there be bloody revolutions? Will there be companies, money, poverty? The passenger ship may be our only hope to leave the solar system but the sheer length of time it would take might make the trip impossible. As Albert Harrison puts it in his book *Spacefaring: The Human Dimension*, the ship might begin as authoritarian, with a strong emphasis on the mission but as Earth and the passenger ship drift away they will become increasingly different. "New developments on Earth will not be readily available to people in interstellar flight. At first, it will be possible for terrans and spacefarers to exchange ideas, but this will become increasingly difficult as a function of growing real-time communication delays." While those on Earth might tell stories about the colony ship and still have hope the mission is continuing as it should, there's no guarantee that the colony ship still thinks this way. Too much is unknown at this point. It might not be possible for humanity to maintain focus for that long.

Indigenous Aliens

No matter how we go to interstellar space, we must confront a deeply upsetting part of our history and how we will grapple with it as we go forward: colonization. From the 15th century to the 20th century, European countries, with their ships, guns, and viruses decided to manifest destiny and take over the world. Through brutal tactics and ruthless pillaging and slavery, the Europeans decimated and ignored the rest of the world's population. When we venture beyond our solar system, we have the possibility of meeting another group of natives, aliens (Finney). While we have not received any signal that there are civilizations as advanced as us, there could still be alien civilizations we stumble across. They might be building giant structures made of the unique stone of their world, riding across alien plains on the backs of beasts with unfathomable shapes, or sailing large saline seas that all glow slightly at night. These aliens may be doing complex math or can observe the fourth dimension as more than just time, but any way, it is in our best interest not to conquer them like the Europeans conquered the Americas. If we come to find a new home, then we must come without war, with the utmost consideration.

In *Colonizing Other Worlds: A Field Manual*, John Macvey lays out six cases of what may happen when humanity comes across a planet with life. Case 1 states that the planet has "extensive flora and fauna but contains no intelligent life." Macvey claims this would not cause a problem, however this fails to consider the introduction of an invasive species has on an ecosystem. Humanity would not be the only thing to cross interstellar space in our spacecrafts, bugs, animals we brought, and our bacteria could all escape into the ecosystem causing unknown havoc on the environment of this alien world. Case 2 states that there is intelligent life, but it has only reached a stone age level of civilization. In this case colonists would land and start colonizing efforts. Communication between the two civilizations could be limited or broad, allowing for information to be shared. Colonists will likely endure some level of xenophobia as the indigenous population will be suspicious of these newcomers to their world. Case 3 presents a more complex civilization, one on par with the Incas or Aztecs. As with all situations, genocide and destruction of the native civilization is an option. However, it would be morally reprehensible if humanity decided to destroy another civilization of intelligent beings as this being would have emotions and complex thoughts that we can not morally strip them of.

Case 4 shows a world that has no native intelligent life. However, the planet was colonized by some other intelligent life. Macvey supposes that the outcome of this meeting and an attempt by humanity to colonize the planet that “a very sanguinary and destructive war may result. Only if the Earth colonists have superior weapons and are prepared to accept a high number of casualties will the aliens be defeated.” This assumes that war is inevitable but if humanity can band together as a planet, war must be thought of as a taboo between nations. This sentiment may be shared by the aliens and together war could be avoided, and the two civilizations could coexist. In space, meeting another civilization and trading knowledge and information could be essential to the survival of humanity. Case 5 presents humanity coming across a world with a civilization with technology equal to or superior to our own. This civilization would likely not welcome the Earth colonists and if there was to be a war, as Macvey supposes there will be, the native civilization would likely win. Like with Case 4, this meeting of our two civilizations could benefit from such a meeting. However, the colonists' fate might be uncertain. In one world they might be able to integrate with the native society, living out full lives within the alien plane. On another planet, humanity might be expelled from the system. Case 6 shows a system with a planet that has no native intelligent life and is comfortably habitable for humanity, but another planet is inhabited by an alien civilization like our own. In this case, peace is quite possible. However, mixing this case with another case could lead to dangerous places. A civilization able to cross their solar system having contact with the planet we choose to colonize might view themselves as a parent or older sibling of the intelligent life on the other planet and may try to protect them from us.

Macvey claims that only Case 1 and Case 5 have clear cut responses, but this dismisses the complex layers that might exist on a case by case basis. A Case 1 planet might have octopus-like creatures using tools and working in hunter gatherer tribes on the ocean floor. These creatures give many millennia might evolve into the colonists' neighbors. A Case 5 planet might be fine with our arrival. Even if humanity never encounters intelligent life elsewhere in the universe, it is important to ask these questions now instead of when we do come across another civilization as it would be reprehensible if humanity was to repeat the sins Europe committed while on their quest for world domination.

The Fermi Paradox

While it is interesting to speculate about alien civilizations, for all intents and purposes, humanity knows of no other life in the universe. The universe is silent for the most part. We hear radio waves from the beginning of the universe, but we hear no one trying to communicate with us. We look to the universe for alien megastructures and ships flying past us, but the skies are quiet, and we are alone. But there are millions of stars and countless planets orbiting those stars. There must be other planets with the right atmosphere, the right size, and the right temperature for life to form—it ought to be countless. This is the Fermi paradox, first summarized by Enrico Fermi, an Italian physicist. If life has so many chances to exist, then where is it? It is possible that life is common but there are some hurdles, or filters, that all life must first cross and if they fail to cross it, they go extinct. These hurdles might be things we have yet to solve like climate change or nuclear war or they are things that we cannot yet imagine. They could be far behind us, the domestication of beasts of burden, the formation of multicellular life. There is no way to know until we find the ruins of alien life. It may be possible that life knows to stay quiet. Like at the bottom of the ocean, a successful species might camouflage itself to keep itself from being destroyed. There might be something larger than us coming to stop us from expanding. Our search for others might lead us to our end. However, these fears have no basis in science, what is more likely is that humanity is alone (Finney).

Conclusion

We live alone in a large and strange universe. We have been blessed with communication, comprehension and consciousness, one of the many ways we can harness these gifts is to observe the observable universe. In millions of years, galaxies other than our own will fade from view and whatever lifeform exists then will look out at the universe and see only their galaxy. Right now, we live in a time when we can explore worlds beyond our own. If we are alone in this universe, then we not only can see it, we have a responsibility to. No animal will ever look to the sky and see the vivid colors and stunning sights that we can. If we are alone, then the universe may go unexperienced for the rest of time, and time has no indication of ending.

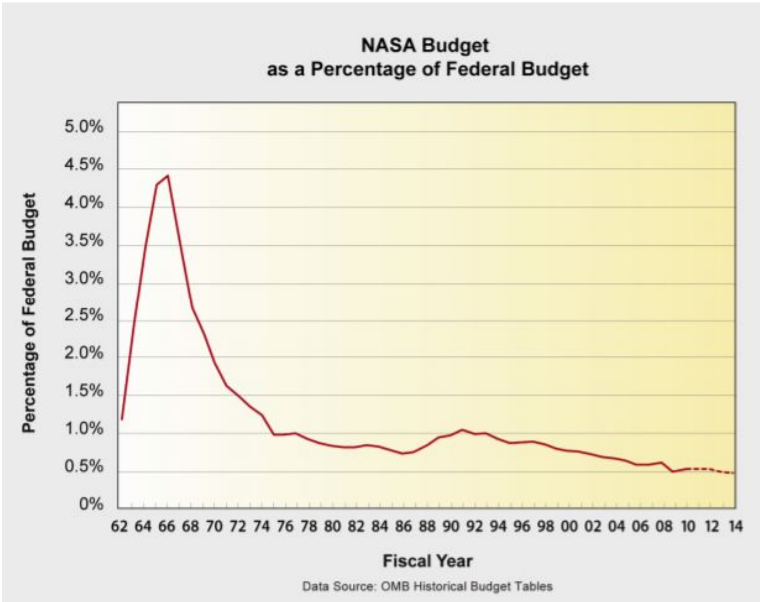
Ethics

Introduction

Space exploration, particularly the colonization of Mars, is advertised with ego and romanticism. It is sold with the glory of pioneerism, the fame and fortune that will come with being the first to reach the Red Planet. Others paint Mars as the savior of humanity, and directly associate our ability to colonize it with the survival of humanity. In the past decade, public exposure to the idea of interplanetary colonization has significantly increased, which makes sense. Space is the next big frontier, and as we are in the middle of a climate change crisis that could very well lead to human extinction, people are finding fantasies to clutch to rather than facing their mortality head on. However their fantasies are just that, fantasies. The reality of space travel is much different. Underneath a thin skin of potential glory and species-saving hopes lies a tumult of unanswered questions, all of which should be answered before we even begin to think seriously about space travel. What is our ultimate goal in space? How should we treat other species and planets? What (or whom) are we willing to potentially sacrifice in the name of successful space travel? Space travel should be put on hold, or at least a significant amount of research and thinking needs to be done before we attempt it. Given the number of corporations that have begun to dip their toes into space, we need to figure out whether we will be allowing privatization of space. The ultimate goal for space exploration should simply be for the furtherment of scientific knowledge. While taking from space may be allowed, we should not be colonizing for the purpose of saving humanity. Finally, as it stands, space travel is unsafe. There are many issues that need to be straightened out before we can be assured of the safety of our astronauts. No life should be unnecessarily sacrificed just because we are hasty in our mission to explore space.

Marketing - How we can solve issues with funding

Mars is many different things. To some it is a gold mine of profit, to others it is a hub of scientific discovery. Some consider it as the savior of the human species. With all the news buzzing around Elon Musk and his SpaceX adventures, and declarations of space travel made by other companies such as Mars One, one might think funding and public interest for space exploration is high. In fact, it is the opposite. According to Raya Elizabeth Slobodian in *Selling space colonization and immortality: A psychological, anthropological critique of the rush to colonize Mars*, for most of the public "the problem of buying into the space agenda is an 'out of sight, out of mind' phenomenon." Simply put, when there is a lack of public interest, there is a lack of funding. NASA is a prime example. The Lunar and Planetary Institute created a graph of NASA's budget (below) ranging from year 1962 to 2014. As can be seen, the budget has been decreasing since the Apollo mission in the 1960s. This supports the idea that the nationalistic, space race argument is no longer in effect. For successful space missions there needs to be good funding, and the current dilemma is finding both the most profitable and the most ethical method of marketing.



An example of failure: Mars One. Started in 2011, the Mars One mission was advertised as a manned mission to Mars for the purpose of science (and also the potential to make billions on a TV show). While the CEO of the company did nothing to deny the TV show aspect of the mission, its website primarily focuses on the scientific portion of the mission. They aggressively pushed the public to register themselves as volunteers to go to Mars and had success there, but it was not mirrored in the funding department. According to *Forbes* article “Goodbye Mars One, The Fake Mission To Mars That Fooled The World,” 4 years ago, one could not go a day without hearing about Mars One and its goals. However, despite the constant press, no money was raised. The “Current Mission Status” portion of Mars One’s website reports that the company has only raised about US$1 million in funding from its inception to 2019. In the scope of space costs, 1 million is not even a drop in the bucket of the funding required. NASA is considered underfunded and its proposed budget for 2020 alone is 21.7 billion dollars. Elon Musk has claimed that his starship rockets are some of the cheapest out there, and they will fly for 2 million a pop. 1 million, in the grand scheme of things, is akin to a bit of dust, easily swept away and forgotten. In February 2019, Mars One declared bankrupt with about $25,000 left in their accounts (O'Callaghan, *Forbes*). Although adjustments to the Mars One plan could be made, and perhaps the mission could be marketed better, there is still the issue of videotaping the astronauts as they live on Mars. Given the possibility of death and the troubles that would come with living on a foreign planet, it would be unethical to film the astronauts at all, which was the main strategy for attracting investors proposed by the company. On their website, Mars One states that "all activities will continue...in the case of death or illness." From a libertarian point of view this is horrible, as the people close to the astronaut that has passed would not be allowed the freedom to mourn in private, as the death and resulting grief would be broadcasted for all to see.

Using space as a resource might be an option. We live in a time where the Earth is losing resources way faster than it can replenish. But while Earth might be running out, space is still a wealth of important metals and other substances, one of which is water. If we mined from space, we could extend the lifespan of humans on Earth. In the article *Space Mining: the new Goldrush*, author Elizabeth Pearson explores the possibilities of asteroid water. She points out that not only could we use water for ourselves on Earth, using asteroid water would help space missions begin to fuel themselves, as rocket fuel is made by "tak[ing] the water molecule and split[ting] it into hydrogen and oxygen" (Patterson). Using resources for space mining seems great, though it would likely direct space travel in the direction of private companies. The book *Space Mining and its Regulations* explores this concept. As it stands, government funded space organizations do not receive enough funding to run by themselves. NASA "relies on commercial vehicles to access the International Space Station," and commercial vehicles have been made that can "provide suborbital tourist experiences" (Ram. S et al). The governments are also supporting commercial space companies, as there is the U.S. Federal Aviation Administration Office of Commercial Space Transportation, an organization that "serves a dual role of regulator of commercial space safety as well as encourager of new space enterprises" (Ram. S et al) Privatization is already in space, and with mining it will only go in deeper. A key law that basically ensures the role of private companies in space is the U.S Commercial Space Launch Competitiveness Act. In an article of the law it states, "A United States citizen engaged in commercial recovery of an asteroid resource or a space resource under this chapter shall be entitled to any asteroid resource or space resource obtained, including to possess, own, transport, use, and sell the asteroid resource or space resource obtained in accordance with applicable law, including the international obligations of the United States." In other words, as long as the process of mining is law abiding, anyone who takes from space as a US citizen is allowed the right to keep everything they took. With this law, it will be easy for companies to profit. Asteroids have been confirmed to possess water and minerals, and asteroid mining is already in consideration. Within the next century mining from space is bound to become a part of the economy.

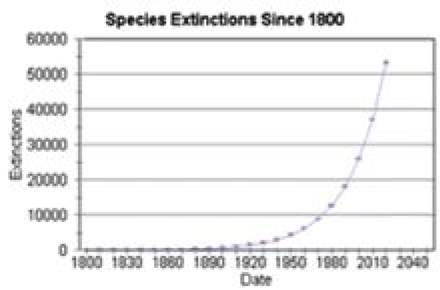
In the past, nationalism has been used to promote public interest. Some believe it should be implemented again to encourage the public to support another kind of space race to Mars. Today the threat of a space race still exists, but many other countries have joined the fray. Engineer and multi-millionaire Dennis Tito aims to encourage the race again (Slobodian). Tito's Inspiration Mars mission encourages a fly-by of Mars. Although the astronauts will not land on Mars, Tito is hoping his mission will inspire Americans to get there before the rest. With Tito, nationalism plays a role, but currently there is not much propaganda that encourages the rest of the nations to support space.A large part of what made Kennedy's speech to conquer space so powerful was the Cold War. The whole nation was against the USSR, and that helped fuel the sense of urgency in spades. Currently we are not in the same mental state of national emergency. Perhaps if we entered one it would rile the masses. The biggest caveat, however, is that nationalism will pitter out. If we were to force nationalism, it would not be to the same extent as before. Currently there is no real threat, as many scientific advancements need to be made before any country is any closer to reaching Mars or deeper space. If some significant scientific breakthroughs are made, however, national emergency could possibly be reached.

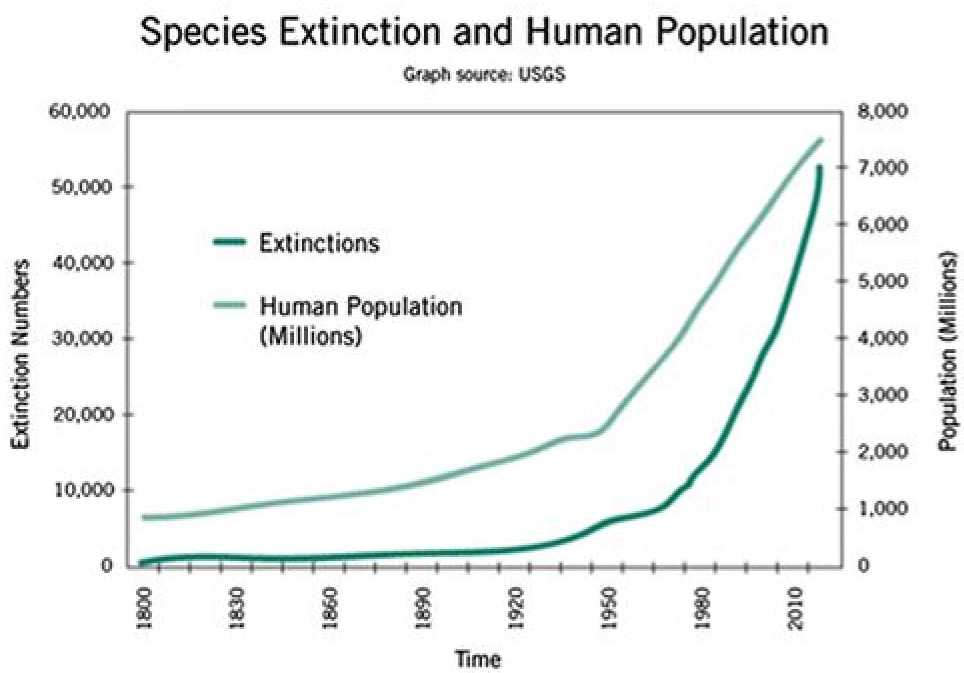
Environment and Reality - Where our priorities should lie

We can not take care of ourselves. What gives us the right to care for another planet? 95% of the oldest and thickest ice in the Arctic has already melted (WWF). Melting glaciers result in rising sea levels, more coastal erosion and an increase in storms. Dr. Daniel Fagre predicts that within 30 years, all of the glaciers in Montana's Glacier National Park will disappear (Glick). And glacier melting is just one instance of climate change. According to NASA, by the end of this century extreme heat days that would normally be considered once-in-20-year events are projected to occur every two or three years over most of the US. We have trashed the Earth, and now many of us are looking to trash Mars instead. There are a myriad of reasons why we cannot just ditch our planet.

We have no right to infect another planet. NASA researcher and professor Linda Billings describes the situation well from a humanist point of view. In her work *Should Humans Colonize*

Mars? No, she describes the Unitarian Universalism principles she lives by. One of the principles is having a “respect for the interdependent web of all existence.” This is an important idea to carry into space travel. Statistics can determine the destructiveness of humans. A graph made by the U.S Geological survey highlights the number of extinct species in relation to the growth of the human population.





As can be seen, species extinction has essentially parallel our growth. Extinction by our hand is something we still have yet to control, which could result in the death of all extraterrestrial beings. Or, conversely, in the death of humans as they come in contact with such beings. We have yet to discover life outside of Earth, so there is little possibility of an apocalyptic alien invasion just yet. However, us contaminating soil on a planet such as Mars could result in the development or growth of colonies of space bacteria, or it could kill any microorganisms that exist on the planet that we have yet to discover. Having anticipated this, NASA and other organizations have laws in place to prevent cross-contamination (Billings). Still, if we are to colonize Mars, we will have to break these laws, as contamination would be inevitable.

We should value fixing life on Earth over life on Mars, simply because we do not and will not all be able to leave the Earth. Space travel is expensive. As stated before, some of the cheapest rockets that barely leave the Earth cost 2 million a piece. There is no way an average human could afford to travel to Mars. And while many of the billionaire's plans to settle Mars seem ideal, they follow the sentiment that not everybody can go. Elon Musk's famed Mars colonization plan will only bring 1 million people to Mars (*Business Insider*). That is less than 1% of the human population. If we were to leave, it is very likely that only the rich will go. With the issues of climate change coming to their climax in these next few decades, focusing on space travel rather than Earth will mean two options: either the human species becomes extinct, or the lucky million get an extended lease while the rest of us die. Rather than focusing our efforts into leaving the Earth, we should focus on using space to help the Earth, such as in mining resources from asteroids. Asteroids would provide us with an abundance of resources that would lead to new scientific discoveries. Some even talk about routing our energy creation to outer space with dyson spheres, basically capturing the power of a star (Forbes). While the latter is very unlikely, innovations like space-based solar power (of which some Caltech scientists have a prototype on) could be in our future.

Works Cited

Adler, Charles L.. *Wizards, Aliens, and Starships : Physics and Math in Fantasy and Science Fiction*, Princeton University Press, 2014. ProQuest Ebook Central, https://ebookcentral-proquest-com.oca.ucsc.edu/lib/ucsc/detail.action?docID=1535180.

"BepiColombo's Beginning Ends." *ESA*, ESA, 22 Oct. 2018, https://www.esa.int/Enabling_Support/Operations/BepiColombo_s_beginning_ends.

Billings, Linda. "Should Humans Colonize Mars? No." *Taylor & Francis*, 24 July 2019, https://www.tandfonline.com/doi/full/10.1080/14746700.2019.1632524.

Braun, Wernher Von, and Frederick I. Ordway. *History of Rocketry and Space Travel*. Crowell, 1975.

"Climate Change Evidence: How Do We Know?" *NASA*, NASA, 30 Sept. 2019, https://climate.nasa.gov/evidence/.

Dunbar, Brian. "Ion Propulsion." *NASA*, NASA, 18 Aug. 2015, https://www.nasa.gov/centers/glenn/about/fs21grc.html.

Durante, Marco. "Space radiation protection: destination Mars." *Life sciences in space research* 1 (2014): 2-9.

"Explore Budget Estimates Briefing Book" *NASA*, NASA, https://www.nasa.gov/sites/default/files/atoms/files/fy2020_summary_budget_brief.pdf

Finney, Ben R., and Jones, Eric M. *Interstellar Migration and the Human Experience*. Berkeley: University of California Press, 1985. Print.

Foust, Jeff. "SpaceX's space-Internet woes: Despite technical glitches, the company plans to launch the first of nearly 12,000 satellites in 2019." *IEEE Spectrum* 56.1 (2018): 50-51.

Friedman, Louis. *Human Spaceflight : From Mars to the Stars*, University of Arizona Press, 2015. ProQuest Ebook Central, https://ebookcentral-proquest-com.oca.ucsc.edu/lib/ucsc/detail.action?docID=4412496.

Glick, Daniel. "Global Climate Change, Melting Glaciers." *Global Climate Change, Melting Glaciers*, 18 Jan. 2017, https://www.nationalgeographic.com/environment/global-warming/big-thaw/.

Hancock, Lorin. "Why Are Glaciers and Sea Ice Melting?" *WWF*, World Wildlife Fund, https://www.worldwildlife.org/pages/why-are-glaciers-and-sea-ice-melting.

Harrison, Albert A.. *Spacefaring : The Human Dimension*, University of California Press, 2001. ProQuest Ebook Central, https://ebookcentral-proquest-com.oca.ucsc.edu/lib/ucsc/detail.action?docID=224633.

Hein, Andreas M, et al. "Exploring Potential Environmental Benefits of Asteroid Mining." *ArXiv*, 10 Oct. 2018, https://arxiv.org/pdf/1810.04749.pdf.

Horvath, Thomas J., et al. "Advancing supersonic retro-propulsion technology readiness: infrared observations of the SpaceX Falcon 9 first stage." *AIAA SPACE and Astronautics Forum and Exposition*. 2017.

Howell, Elizabeth. "Who Owns the Moon?: Space Law & Outer Space Treaties." *Space.com*, Space, 27 Oct. 2017, www.space.com/33440-space-law.html.

"In Depth." *NASA*, NASA, https://solarsystem.nasa.gov/asteroids-comets-and-meteors/asteroids/in-depth/.

Jakhu, Ram S., et al. Space Mining and Its Regulation. Springer International Publishing, 2018.

"Journey to the Sun." *Parker Solar Probe*, The Johns Hopkins University Applied Physics Laboratory LLC., http://parkersolarprobe.jhuapl.edu/The-Mission/index.php#Journey-to-the-Sun.

Kaku, Michio. *The Future of Humanity : Terraforming Mars, Interstellar Travel, Immortality, and Our Destiny Beyond Earth*. First edition. New York: Doubleday, a division of Penguin Random House LLC, 2018. Print.

Logsdon, John M.. "Space Exploration." *Encyclopedia Britannica, Inc.*. 18 October 2019. https://www.britannica.com/science/space-exploration.

Macvey, John W. *Colonizing Other Worlds : a Field Manual*. New York: Stein and Day, 1982. Print.

"Mars." *SpaceX*, SpaceX, 20 Sept. 2016, https://www.spacex.com/mars.

"Mars One." *Mars One*, http://www.mars-one.com/.

McCarthy, and Kevin. "Text - H.R.2262 - 114th Congress (2015-2016): U.S. Commercial Space Launch Competitiveness Act." *Congress.gov*, 25 Nov. 2015, https://www.congress.gov/bill/114th-congress/house-bill/2262/text.

Méndez, Abel et al. *Searching for Habitable Worlds : an Introduction.* Morgan & Claypool Publishers, 2016. Web.

Metzger, Phillip. "The Pattern of Resources in Space." *Philip Metzger*, 20 Mar. 2015, https://www.philipmetzger.com/the-pattern-of-resources-in-space/.

Morris, Michael S., and Thorne, Kip S. "Wormholes in Spacetime and Their Use for Interstellar Travel: A Tool for Teaching General Relativity." *American Journal of Physics* 56.5 (1988): 395–412. Web.

Mosher, Dave. “Elon Musk Says SpaceX Is on Track to Launch People to Mars within 6 Years - Here's the Full Timeline of His Plans to Populate the Red Planet.” *Business Insider*, Business Insider, 2 Nov. 2018, https://www.businessinsider.com/elon-musk-spacex-mars-plan-timeline-2018-10.

NASA, NASA, https://nssdc.gsfc.nasa.gov/planetary/text/asteroids.txt.

Newman, Ben. “The Solar System.” *Soma,* https://www.somagallery.co.uk/products/solar-system-poster

O'Callaghan, Jonathan. “Goodbye Mars One, The Fake Mission To Mars That Fooled The World.” *Forbes*, Forbes Magazine, 11 Feb. 2019, https://www.forbes.com/sites/jonathanocallaghan/2019/02/11/goodbye-mars-one-the-fake-mission-to-mars-that-fooled-the-world/#4e3b24ff2af5.

“Outer Space Treaty of 1967.” *NASA*, NASA, history.nasa.gov/1967treaty.html.

Pearson, Elizabeth. “Space Mining: the New Goldrush.” *BBC Science Focus Magazine*, BBC, 11 Dec. 2018, https://www.sciencefocus.com/space/space-mining-the-new-goldrush/.

Poole, Robert. “The Challenge of the Spaceship: Arthur C. Clarke and the History of the Future, 1930-1970” *History and Technology: An International Journal*, Vol. 28, no. 3, 2012, pp. 255-289. Web.

“Read ‘New Frontiers in the Solar System: An Integrated Exploration Strategy’ at NAP.edu.” *National Academies Press: OpenBook*, https://www.nap.edu/read/10432/chapter/4#15.

Schröder, Christian. "How feasible are Elon Musk’s plans to settle on Mars? A planetary scientist explains." *The Conversation* (2016).

Shotwell, Gwynne. "SpaceX's plan to fly you across the globe in 30 minutes." TED: Ideas Worth Spreading, April 2018. https://www.ted.com/talks/gwynne_shotwell_spacex_s_plan_to_fly_you_across_the_globe_in_30_minutes?language=en#t-638686

Siegel, Ethan. “Dyson Spheres, The Ultimate Alien Megastructures, Are Missing From The Galaxy.” *Forbes*, Forbes Magazine, 4 May 2018, https://www.forbes.com/sites/startswithabang/2018/05/03/dyson-spheres-the-ultimate-alien-megastructures-are-missing-from-the-galaxy/#800447131386.

Slobodian, Rayna Elizabeth. “Selling Space Colonization and Immortality: A Psychosocial, Anthropological Critique of the Rush to Colonize Mars.” *Acta Astronautica*, Pergamon, 6 Apr. 2015, https://www.sciencedirect.com/science/article/pii/S0094576515001277?via=ihub.

SpaceX. "Making Life Multiplanetary" Youtube, Sept. 29, 2017. https://www.youtube.com/watch?v=tdUX3ypDVwI

“Starship.” *SpaceX*, SpaceX, 28 Sept. 2019, https://www.spacex.com/starship.

SpaceX. "Starship Update" *Youtube*, Sept. 28, 2019. https://www.youtube.com/watch?v=sOpMrVnjYeY

“The Committee in the Peaceful Uses of Outer Space (COPUOS).” *Représentation Permanente De La France Auprès Des Organisations Internationales Et Des Nations Unies à Vienne*, 20 Oct. 2017, onu-vienne.delegfrance.org/The-Committee-in-the-Peaceful-Uses-of-Outer-Space-COPUOS.

Umino, Susumu, et al. “Drilling to Earth's Mantle.” *Physics Today*, American Institute of Physics, 1 Aug. 2013, https://physicstoday.scitation.org/doi/full/10.1063/PT.3.2082.

“United NationsOffice for Outer Space Affairs.” *Moon Agreement*, www.unoosa.org/oosa/en/ourwork/spacelaw/treaties/moon-agreement.html.

“United NationsOffice for Outer Space Affairs.” *COPUOS History*, www.unoosa.org/oosa/de/ourwork/copuos/history.html

“United NationsOffice for Outer Space Affairs.” *The Outer Space Treaty*, www.unoosa.org/oosa/en/ourwork/spacelaw/treaties/introouterspacetreaty.html.

“Voyager - Planetary Voyage.” *NASA*, NASA, voyager.jpl.nasa.gov/mission/science/planetary-voyage/.

Watanabe, Susan. “What’s it Like Where Voyager is?” *NASA*, NASA, 24 May 2005, https://www.nasa.gov/vision/universe/solarsystem/voyager-interstellar-terms.html

Zona, Kathleen. “Ion Propulsion: Farther, Faster, Cheaper.”*NASA*, NASA, 2 May 2008, https://www.nasa.gov/centers/glenn/technology/Ion_Propulsion1.html.