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Space Exploration as an Answer to Solve Earth's Energy Resource Problems

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Abstract: **It has been known for quite some time that the energy resources of the planet Earth is both limited and decreasing as the years go on. Many futurists fear for the state of the Earth, and wonder if the planet is capable of housing billions of inhabitants while basic energy sources such as water, food, and land are depleting in increasing numbers every year. Thus, many future theorists and scientists have proposed the enhancement of further development for space exploration as a solution. It is within the context of space exploration that a definite answer can be found when it comes to the Earth's energy level problems. And so, pushing more resources into NASA's "Mission to Planet Earth" program, which is to create a support system for civil engineers to study the Earth's climate more efficiently, can help gauge the overall health of the planet by overseeing empirical data. Therefore, providing assets and funds for the International Space Station and other future space missions can be helpful instruments to see how the Earth is functioning. By doing so, carbon trackers can be used from space in order to predict global warming as well as seeing and measuring the carbon levels of the Earth more precisely. Furthermore, considering colonization of other planets such as Mars is a notable solution as well.**

Keywords: **Space exploration and colonization, Earth energy level sufficiency and space, Mission to Planet Earth program, International Space Station and climate control, Mars colonization, carbon trackers.**

I. INTRODUCTION

The future of the Earth has always been a pressing concern for scientists. With energy such as food and water becoming a limited resource, and the diminishment of the Earth's environment becoming an increasing issue, many scientists and engineers have looked to space for the solution. The purpose of this paper is to address such a solution, and provide reasons and findings as to support space exploration and colonization. In order to do so, the paper will discuss NASA's "Mission to Planet Earth" program, carbon trackers, Mars colonization, and also exhort the need for more engineers. By doing so, this will help provide more context to the Earth's needs, but also show the need for more support in space exploration.

II. BACKGROUND

A. Future Space Exploration for Humans

Understanding space is crucial to further understand human physiology, psychology and advancements in a wide variety of fields. Technology and science will flourish from discoveries and experiments regarding space exploration. For future space exploration, there needs to be technology that is suitable for different environments and conditions of Earth, like gravity, atmosphere, radiation, planetary dust and storms, efficiency, reliability, autonomy, etc. These constraints once overcome will promote and give access to revolutionary technologies that will ultimately help us humans in exploring space in unmeasurable amounts. Robotic missions along with humans go hand in hand on exploring further, and get a deeper understanding of what we know. In space (ISS, outposts, other) a lot of conditions vary immensely. For example, on the ISS, the temperature range is around -300F to +300F depending on location on the ISS and location of the ISS in orbit. Systems need to be made to withstand such circumstances such as temperature, and other forces and effects one might face in the vast space. Solar radiation is just one of many presented harms from outer space. Recent studies have shown that this radiation increases the chances of cancer, cardiovascular disease and cataracts and damages the central nervous system. With this in mind, different technology needs to develop to counteract radiation including the ones emitted from the Sun and perhaps use it in our favor. Also, "The factors that contribute to the phenomenal growth in space exploration and utilization endeavors include national pride, recognition of technological superiority - commercial benefits and spin-offs in natural security and defense arenas" (Krishen, 2009). The best possible way in advancing space technology and exploration is changing harms/weaknesses to benefit us. Whether that be converting radiation to energy, or recycling and reusing wastes for the better. These changes are crucial in increasing our knowledge of the nature of space exploration, which can be applied in other areas other than space as well. Planet specific or "mission-specific" technology would probably come first before we make something that is suitable for a wide variety of missions. For example, humans have done extensive research on places like the Moon and Mars before actually sending humans there. Deploying robots/rovers/satellites to planets before can present us with information needed to make and modify technology better suited for said circumstances and conditions. Space equipment for the Moon would be somewhat different than those of Mars, so understanding the uniqueness and differences between planet to planet (or moon to planet in this case) is crucial in achieving the most success. However, some argue that human exploration is not necessary, and robots in place of us is enough. But on the contrary, "[Humans in space] ensures that space exploration and utilization will continue to have a predominant role in future human endeavors" (Krishen, 2009). As we have seen, technology advances faster than humans, so designing robots more suitable for different missions is more ideal. But, "Human presence in space and on planetary surfaces provides capabilities beyond the ones offered by robotic systems" (Krishen, 2009). There are many environmental differences on Mars compared to Earth. For example, there are small percentages of the vital elements that humans need to breathe and survive, where 95% of Mars's atmosphere is carbon dioxide. Also unpredictableness serves a great factor on Mars as well. Regional dust storms can cause harm on infrastructure, technology and humans and they can obliterate almost anything in its path.

III. MISSION TO PLANET EARTH PROGRAM

The U.S. government is willing to spend around 10 billion dollars for NASA's Mission to Planet Earth to help study Earth and global change. It is known that, "[NASA's Mission to Planet Earth] will produce enormous data sets of physical and biological parameters of the Earth" (Mcelroy, 1994). Civil engineering is really important and society should uphold the efforts for the program. This is because, "The world's civil engineers are among the most likely users of the data archives and analyses that will flow from NASA's Mission to Planet Earth" (Mcelroy, 1994). NASA is best known for human exploration, planetary missions and the application of technology. Application of technology means that advancements and tech for space could be used on Earth through modifications, etc. For advancing in our knowledge of space, there is no "destination" but the "journey" becomes a growth of understanding for the years and generations to come. The Mission to Planet Earth is to get a better understanding of how everything about Earth works, for example the weather, its contents, oceans, temperature, magnetism, etc. As such, "Absence of civil engineering influence on the largest environmental-monitoring system in history stems from the NASA mission planners who, as scientists and aerospace engineers, do not spontaneously think in terms of the needs of the applications community" (Mcelroy, 1994). Civil engineers are the people who are gonna use this data to better our world. However, this mission shows almost no sign of civil engineers, in areas of data collecting, analyzing nor investigating. Researching is not all though. Applying what we have discovered to our world to benefit society and life is a goal since mankind was born. The applications from space to Earth can change many lives. Students are the workers and architects (figurative) of the future, and as technology and knowledge grows, so will these students. Ultimately they will be ever-so smarter than the past generations, and everytime the successors achieve more than their predecessors. Because of this, it is important that knowledge and industrial areas keep advancing, so these students have space to grow and accomplish more. Thus, "Just as each succeeding generation of students exceeds the capabilities and brings better skills to engineering tasks than did its predecessors" (Mcelroy, 1994).

IV. CARBON TRACKERS

Global warming and changes in the environment has always been a concern for the world. Around the world, countries are expending massive amounts of carbon dioxide into the atmosphere, from burning coal and other fossil fuels. Scientists have noticed, "Emissions for countries or cities are estimated by adding up reams of statistics about fuel consumption, deforestation, electricity generation, and other activities" (Cornwall, 2015). To measure the collective amount and its effects on the world, a satellite equipped with a sensor has been deployed to do just that. These sensors detect and analyze the flow of carbon around the globe. This same sensor technology could be used on Earth as well, which measures more closely.

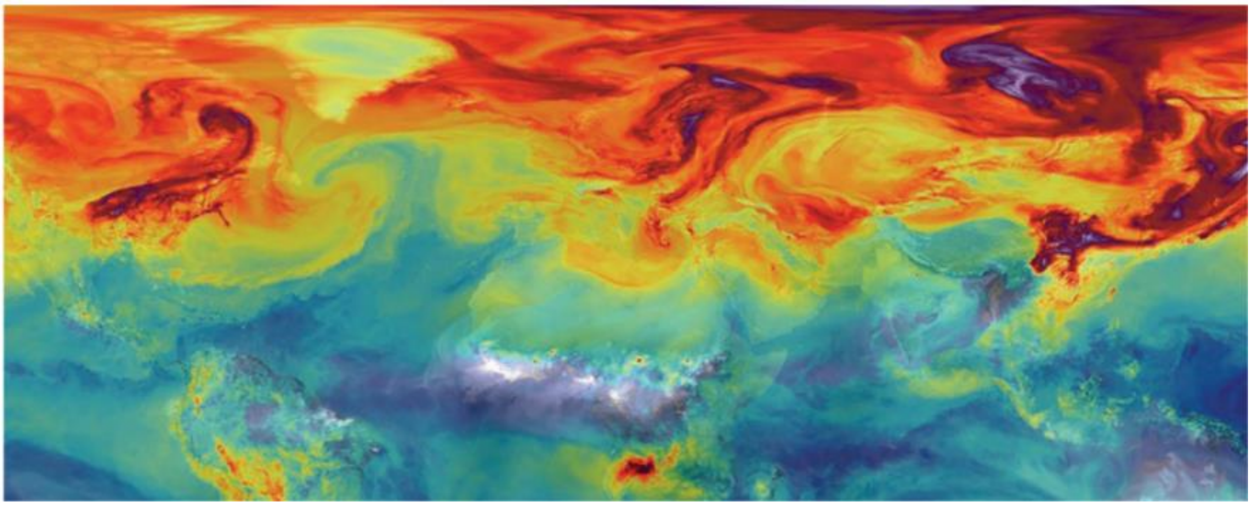

Figure 1: Image from carbon tracker taken by NASA's satellite (Cornwall, 2015).

Sensors from space have helped scientists and climate advocates pinpoint locations in need of assistance regarding dampening the effects of pollution. However in developing countries, carbon expenditure is less known, which still has an impact on the overall climate pollution. Different projects in outer space and on the ground can help figure out precise data of emissions - from where and how much. Also, "Even better results could come from geostationary satellites - providing a continuous view" (Cornwall, 2015). With this knowledge, individual countries or cities see if people are doing the right thing, and see if their own methods are working. For example, in Los Angeles, there are many sensor devices on top of tall buildings and towers to detect emissions and other gasses as well. Although the technology is advancing, it is not yet able to become a reliable source for weather reports. The inconsistent movement of wind and its effects on carbon emissions makes it hard for sensors to produce quick sudden changes. However, as of now, collecting data about carbon and gas expenditure is not a top priority as mentioned in the Paris talks of 2015. Even though there could be rules and legislation about helping the environment, unfortunately not everyone conforms all the time. For this reason some argue that these sensors and data collection provide useful information, but they are afraid it won't be used properly.

V. MARS COLONIZATION

A. International Space Station

The completion of the International Space Station has been an incredible feat. With the efforts of 16 countries, the ISS served as a symbol of human unity and progress, while altogether pushing the boundaries of science and technology. For some, like Daniel S. Goldin, the ISS is a starting point for many future space projects, justifying tasks ahead and rationalizing space exploration/advancement. Goldin writes, "The next chapter in the history of space exploration will be written 250 miles above Earth at a construction site orbiting the planet at over 17,500 miles per hour" (Goldin, 1999). These projects, big on their own, but small in the big picture, will ultimately add on to our understanding of space and its effects on the human body and psyche. Going to Mars would be one of those that will require international cooperation; the U.S. alone cannot fund something of this scale, and working together is the only option in exploring beyond Earth. Many think exploring Mars is a necessary "springboard" for a deeper understanding of space exploration in general, as the ISS is a springboard for upcoming missions (including Mars). And, "As a global scientific community pushing the boundaries of science and technology, the International Space Station will also open new frontiers of international partnership and cooperation" (Goldin, 1999). Many billion years ago Mars looked similar to Earth, and the Mars Pathfinder has found dried out lake beds, and has discovered a faint magnetic field, which could have protected it from cosmic radiation in the past. Goldin also exhorts, "Such potential insights into the evolution of life can only be confirmed and unlocked through the ambition and united effort of an international scientific investigation" (Goldin, 1999). Evidence on Earth also pertains to there being a possibility of life on Mars. There have been organisms found living in extreme conditions, so there could have been some on our neighboring planet as well. The world is not ready to send astronauts and scientists to Mars, but the ISS is a step farther from Earth, and any research there will help for future discoveries. Finding life beyond Earth will change everything, from international relations to individuals. We need religion, technology and compassion in order for us to extend beyond and for questions science cannot answer. And so, "Ultimately, the effort to study space represents the journey into the origins of life itself" (Goldin, 1999). The construction and operation of the International Space Station is a fundamental cornerstone in all areas moving forward as humanity everso grows, beyond the skies of Earth.

B. Human and Robot Cooperation

A debate on the role of humans in space exploration. Some think it is cheaper to build some technological device or a robot and send them for us, while others say it is the humans that should be the one making these discoveries. However, robots and humans working in a junction can be a good idea as well. For NASA, "The venture [NASA] insists will be a cooperative one. Space exploration will be accomplished by "robots and humans together" (Launius, 2007). However, this cooperation created a competition; pitting humans against robots in space exploration. The debate between humans and robots presents a false dichotomy, where there are many perspectives involved. Humans managing these machines has been the current way of performing some activities and doing so allowed us to be more safe and discover things that we could not on our own. Before, near the beginning of the space age, machines could not operate effectively without some sort of human control and direction. By popular culture (general media) and technology, humans being in charge of space discovery and exploration seems to be idealized rather than robots or technology themselves. As the years went on, space technology developed, and so did our understanding. The new technology solved many problems, and the improvement of machines helped us explore through a different lense while on Earth. As computer technology got more sophisticated, controlling machines in long flights from large distances have been made possible, and easier. This new phase of space exploration has cut costs of space exploration, as funding for humans to go is relatively more expensive than sending in a mechanical device to do the work for us. Over the years, robots and machines are getting smarter than humans, so it is more efficient to use them to do the job, as well as to serve as test subjects. Society has been more lenient towards sending robots to space; humans losing the role they once had on being the one on such adventures. Some say that the classical vision of human space flight is outmoded, so the government might not support humans walking on the Moon or trekking the surfaces of Mars. Looking further, human flight beyond Mars as of right now seems really distant (figuratively and literally). We humans are not built to endure long durations of space travel, nonetheless conform to extreme or different conditions and environments of other planets compared to Earth. This is why, "The alterations might take the form of artificial intelligence computers that are smarter than human beings, or biologically reengineered human beings with exceptionally long life spans" (Launius, 2007). However in science fiction and popular science, space travel extends to galaxies and even universes, and many times are portrayed out of our time period. Investigations through the electromagnetic spectrum allow us to discover and look at sun-like stars and "extrasolar planets". Functioning like a telescope, observers just need to wait for the electromagnetic signals traveling at the speed of light to reach Earth. This method is ideal because now there is not really a need to send robots and humans to observe for us, as we can see a lot of things from Earth. Not only this, humans won't have to control any robots, making observations more efficient for all. This is because, "Robots are machines supervised by human beings that complete tasks too tedious or dangerous for humans to perform" (Launius, 2007). Crossing the borders of conventional human flight and robotic flight, an alternative appears. Sometime in the future, humans will evolve or biologically change to better suit space travelling. Either humans will become "transhumanist" or biologically engineered humans designed to be advanced. Also, "Robots by definition require human supervision, an impossible requirement for spacecraft light years removed from Earth-bound control centers" (Launius, 2007). The combination between artificial intelligence and humans is a possibility not too far off, and the advancement of humans as a race could go in effect. Along with this, the lines between robots and humans will be blurred, and the possibilities of life itself becomes endless. Throughout history, humans give humans attention. There won't be a parade or celebration of that extent for robots, and most of the recognition of successful space programs were to human exploits, even though the robots/machines might have played an equal or larger role. Also for the death of robots like the Mars Rover, there was no real acknowledgement for its death, but there were lavish funerals for the loss of an astronaut and cosmonaut crew. Not trying to put robots and humans on an equal level, but there are still some interesting things about what humans value. In the future, as humans have a less and less role in space exploration, the remembrance and reservation will be different. Robots exploring space alone is another side of the picture. Many questions then arise as well, from concerns of AI thinking for themselves, and how they will think.

C. Condition of Mars

Recently the idea of colonizing Mars has been brought up frequently, many believing the barren planet could be "terraformed" to sustain life. Mars has the best conditions for life compared to other neighboring planets. Moreover, findings from Mars rovers support subglacial liquid water underneath the surfaces. Also minerals and other natural resources may be of abundance for extraction. Ongoing advances in different fields of technology and engineering increased the efficiency and reliability of spacecrafts and over the years the development has gone a long way. The Falcon Heavy delivered around 17 tons to the surface of Mars, making it known that sending such a payload is possible and can be further improved upon. Engineers have noted, "Indeed, a recent example of successful firing of thrusters on Voyager 1 after 37 years of space operation attests to our ability to overcome such significant challenges of spacecraft development as longevity, reliability, and operational readiness decades after launching" (Levchenko, 2019). 4 people have already been selected to be sent to Mars in 2031, to collect data and set up the first permanent settlement. Orwig presents 5 reasons why Mars colonization is a necessity, rather than merely an option. He lists: survival of humans as a species; exploring the potential of life on Mars to sustain humans; Using space technology to positively contribute to our quality of life; developing as a species; gaining political and economic leadership. As of right now, a self-sustained colony on Mars would require a "continuous supply" of resources like food, water, and oxygen. And, "Upon reaching the surface, the astronauts will be expected to establish a permanent settlement on Mars - with the clear expectation never to return to Earth again" (Levchenko, 2019). This means that there would need a spacecraft going bringing in supplies consistently. Also, not only would the colonists need to survive, but they need to develop as well. However, recent technological advancement gives way to energy efficient devices for scientific research which can ultimately save money. Creating technology to make life better on Mars can be used on Earth as well, as devices and ideas made for Mars could be applied to better life here. In the beginning, the colonists in Mars would consist of individuals who will most likely give up their own desires for the good of the group, but as the colony grows, this will obviously not be sustained. As a result, "Colonization of other planets could potentially increase the probability of our survival" (Levchenko, 2019). Questions are asked about whether the "tremendous amount" of financial and material resources should be invested on something as distant as Mars colonization, or if it would be better to use them on Earth. The Outer Space Treaty is the main document that governs international relations regarding activities related to space and celestial bodies. Although as of right now there are no regulations about colonizing Mars, if something to that magnitude was to occur, there would need to be a development of new laws. The first of the settlers would need to overcome a harsh environment, with physical and psychological difficulties that are bound to arise. It is hoped that the settlers overcome these problems quickly but effectively, providing more time with developing the colony and conducting various researches. Sovereignty of Mars will be a problem within the growing colonie(s). As the settlement grows and our understanding expands, there are no doubts that there will be conflicts between people about power and its divisions. Right now it is not possible for an organization or nation to claim sovereignty over a celestial body or outpost, but in the future hopefully there will be peaceful conclusions in upholding this. There are many human rights issues that can result from doing something as big as colonizing Mars.

The ideal distance between Earth and the Moon makes the first step of the stepping stones. Recently, the Moon has been seen as a "boost" to human exploration of space. Like the military strategy "island hopping" used in WW2, astronauts go from Earth, to Moon, to Mars, to etc. Small but consistent leaps, developing technology and knowledge along the way. Since the Moon is the closest natural space body, there won't be a strain on resources and time when completing such projects. The reason for doing so is because, "The main purposes of the base should be to offer a valuable platform for technologies validation and scientific activities, offering also potential commercial opportunities among the framework of multinational cooperation" (Casini, 2018). Because it is a moon, the orbiting patterns are very consistent and it is something that has been the most accurately studied, compared to the distant planets. Setting up something like an outpost on the Moon can serve as a dock or aircraft carrier for future space missions and explorations. Engineers also note, "Another critical aspect of crewed space mission is stowage and payload accessibility: optimization is desirable to not waste time in retrieving objects and tools, and to operate with them" (Casini, 2018). As technology and VR develops on Earth, we can use these tools to be more connected with missions and projects that happen on Mars. The Moon's environment is ideal as well; a vast open rocky land, suitable for setting up things like these. The weather is very consistent and besides the small rare asteroids there are no natural disasters that can occur. Many think creating a strong physical bond with the Moon is the next logical step for space advancement. With our very own Moon used as a digital and physical harbor to exceed current limits, humanity will be on its way to space exploration. However as of now, the goal for establishing devices and infrastructure on the Moon is to set up a virtual reality system to more accurately and safely "explore" Mars. Using the composition of water and an external energy source (i.e. solar panels), sufficient electrical energy could be used and reused throughout the day and nights on the Moon.

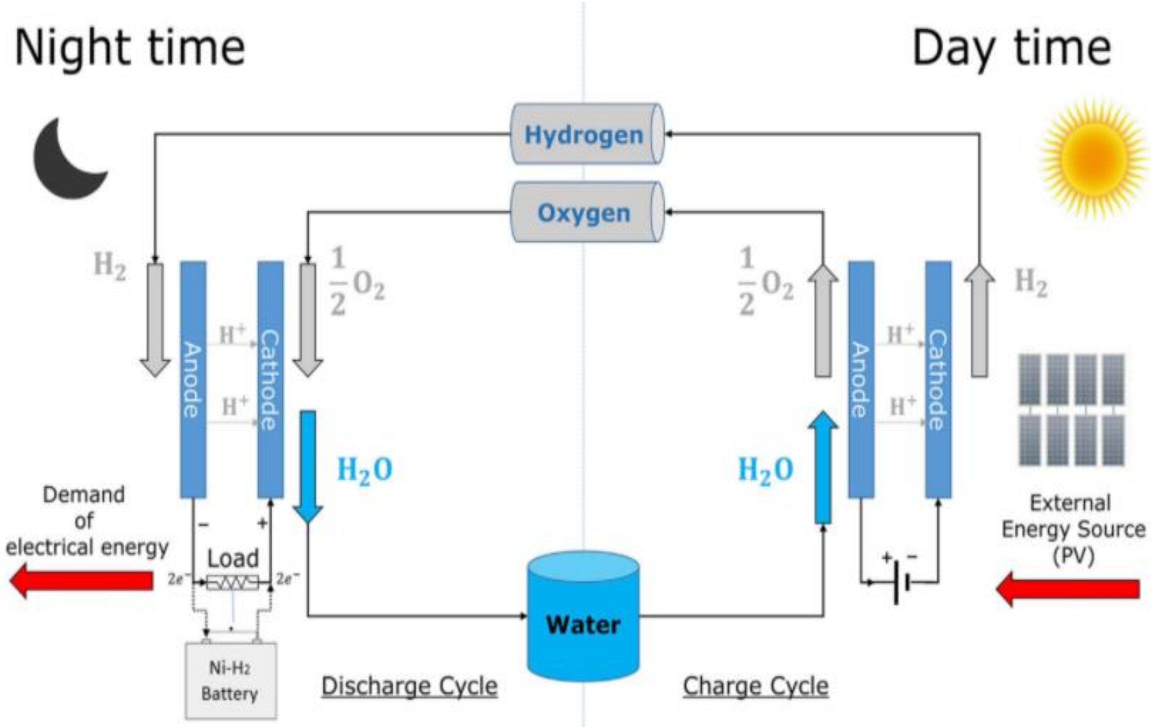

Figure 2: Photovoltaic-hydrogen structure for sustainable energy on Mars (Casini, 2018).

With VR and machine-controlling devices, human involvement is increased in the digital aspect, so scientists and astronauts alike can take advantage and feel as if it were actually real. These new digital technologies can help solve current problems of space engineering and the shortcomings of space technology. For now, VR will suffice in discovering new things specifically on Mars, and if things go well it could be a new alternative. And, "Since the human exploration of the Moon is considered preparatory towards potential Mars exploration, and thanks to the versatility of the virtual tool used, a similar fictitious base on Mars has been simulated" (Casini, 2018). Observing and exploring space safely has been something that is taken seriously by NASA and governments, and VR let's astronauts do just that. With VR, humans can control robots/simulations with ease, and they can do exactly what they want. The limitations of robots will be no more as with more human control, desirable information and experiments will be easier to perform.

Getting a sample of Mars's atmosphere composition and dust particles is crucial in accurately understanding the conditions of Mars's atmosphere. Creating technology that can help us breathe or use the atmosphere to better suit humans is a great step in colonizing Mars. The Mars Aeroflyby Sample Collection (MASC) is a mission aimed for doing just that. After collecting the desired samples from Mars's atmosphere, it will return to Earth for study, One of the many challenges is Mars's orbit in relation to Earth's. Then, "The landers and the orbiters are transported to Mars and initially inserted into an extended elliptic orbit altogether, then the landers are transferred into the atmospheric entry orbit by using the orbiter as the entry service module, after which the orbiters are maneuvered to their respective final orbit" (Fujita, 2013). There needs to be enough fuel and energy for the craft to get to the atmosphere, fly back to Mars's orbit, and use the rotational force along with fuel to propel the craft back to Earth, so that Earth's gravitational field can catch it back. A missed calculation of the trajectory can lose the spacecraft, so precise measurements to get the vehicle back to Earth. By study, "The trajectory calculations have shown that a wide AOT corridor acceptable for the state-of-the-art GNC technologies in planetary explorations can be achieved by use of a lifting aeroshell" (Fujita, 2013). Also, since Mars and Earth are on different axes rotating at different speeds and lengths, the distance between the two planets is always changing. Every two years, one month and 18 days Mars is closest to Earth. Without this condition, space travel between the planets will be harder and put more strain on the resources and could jeopardize the mission.

Many challenges arrive when designing a spacecraft for a planet like Mars, and not fully understanding what Mars can entail does not help. Since the atmosphere is very thin, landing safely becomes a problem. Heat shields and parachutes have been tested but only do so much, and more technology and machinery just for landing makes it that much harder (as mass increases). Simulations of Mars's atmosphere have been created to test and model the effects of different parachutes. Scientists have discovered, "Parachutes function by increasing the amount of aerodynamic drag experienced by the object deploying the parachute" (Conway, 2015). Around 1962, the Voyager engineers could not produce a single model of Mars's atmosphere, so instead had to make 6 different models as many people had conflicting views of what the atmosphere was actually like. Later on, different tests were performed with different conditions and different parachutes/heat shields. On one of the trials, in launch, there was a failure that caused some damage on the parachute. However, what gave them more confidence was that the trial with the same parachute turned out successful. So in this aspect they over-prepared for the full-scaled test. A few years later, the Mars Pathfinder appeared, which was similar, but different in its own aspects to Viking/Voyager. For the Mars Pathfinder, expanding a multi-airbag system around the whole craft was the plan, and there were many tests to find the right ratio, size and composition to protect the Pathfinder inside. There were many failures in the trials, but soon finally found the design that could withstand the impact and meet the requirements. But, "These varieties of simulation contributed to engineers' understanding of how their designs were likely to perform when they reached Mars" (Conway, 2015). During the real thing, it has been said that there were a few mistakes in the landing process, like firing the retro rockets (rockets fired in the opposite motion to decelerate the overall motion of the craft) early and the landing was not smooth at all.

D. Benefiting Humanity

Eventually, colonizing outer space will be a necessity to the human race to prevent things like cosmic catastrophes and human extinction. If successful, there will be great advantages to the survival of humanity, and the possibilities are infinite. Whether by terraforming planets (the Moon, Mars, etc) or establishing space colonies similar or in respect to those imagined by Gerard O'Neill. Although the idea seems far off now, mankind was never meant to be confined in the boundaries of Earth, but to expand and explore beyond. But, "Some philosophers have argued that we have no obligations to human beings who are not even born, but that is surely mistaken" (Munevar, 2019). Around 4 to 5 billion years later, the Sun will become a red giant, and Earth will probably be inhabitable before then. As our Sun ages, its mass decreases, and its gravitational pull on the planets will weaken, making Earth cooler. So, "And when the sun comes to an end, we will have allowed humanity and much of Earth life to find places, sometimes to build places, for them to endure" (Munevar, 2019). Space colonization gives humanity and other living beings more opportunities to thrive and develop as a race, and we will be better prepared for the catastrophes that may occur in the future. By expanding our knowledge "out there", we can learn more about the Earth itself and the resources and information we discover can improve life here. As of now, the most likely and researched extraterrestrial catastrophe is a collision of asteroids and meteors. Interestingly, "According to present models, meteors large enough to create Meteor Crater in Arizona would hit an urban area every 100,000 years on average" (Munevar, 2019). Chances of a meteor striking an urban area are pretty low, but no zero, and with time this chance might increase. Other collisions might occur from "rogue planets", which are planets that have abandoned their solar system and are adrift in space. These rogue planets can range in size and composition, and one colliding with our own solar system can disrupt many things like gravitational fields, planet orbit paths, etc. Colonizing space can grant us the technology and opportunity to deflect and/or prevent such catastrophes. Whether it be colliding the asteroid with one of our own, or shooting a nuclear missile, expanding mankind's footprints beyond Earth will prepare us. Some even say that humanity is not worth saving, and think at some point that preparing for the future will not be necessary, and extinction is a viable option. However, before humanity runs its course, we should do everything we can so that our children and grandchildren can carry on and uphold the responsibilities of protecting mankind. An investment, if you will. Colonizing outer space can extend the time of humanity, and as humans and other beings explore, we might cross paths with new opportunities. So it is our obligation to do all it takes to better the future, like how our predecessors did before and before.

In 1993, Congress saved the International Space Station by one vote, and this was a crucial point in history as there were many benefits and discoveries that followed that could not have occurred without the ISS. The Congress stated, "There is no doubt that exploration of new lands and conquests of new frontieres have always been creative forces throughout the history of humanity and have promoted the advancement of knowledge and culture" (Kistler, 1999). As society and humanity develops, there is a larger need of resources, and energy from space is where some are looking. With the help of the ISS and other space crafts, creating an orbital solar power plant can just exactly be what the world needs.

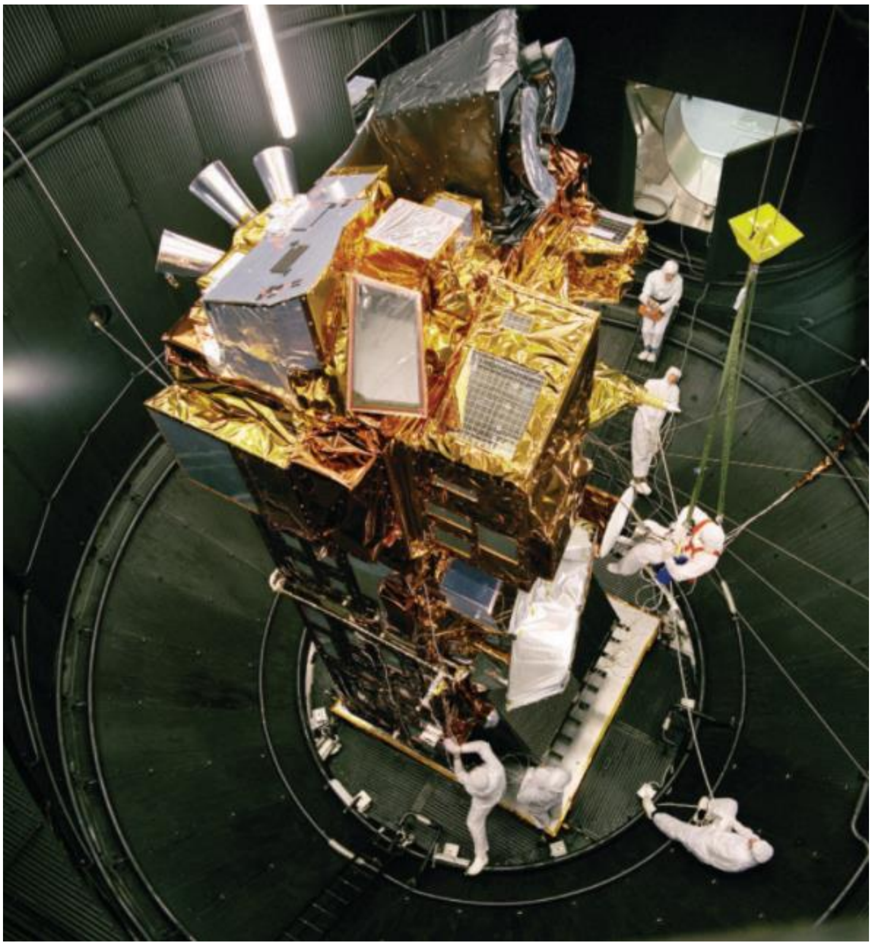

Figure 3: Picture of a Super Satellite launched in January 2002 ("Saving the Earth from Space, 2001).

Having a solar power planet orbiting Earth is beneficial in multiple ways. First of all, it is another way to get energy directly from the Sun. With the 3 axis stabilization method, the power plant can be adjusted to point in any desirable direction, so energy production rates could be maximized. Second, a power plant in space would not bring as much radiation compared to a power plant directly on Earth. This is because, "The only clean, acceptable solution conceivable today is solar energy from space. This could be supplied by a number of solar power plants in orbit around Earth, radiating their collected solar energy to Earth in the form of microwaves" (Kistler, 1999). This means that it is safer as there will not be as much radiation right next to us, and as more countries are urbanizing, land usage is more important than ever. Another benefit is that it helps us practice being better at going to space. New problems will make way for new technology, and things like maintenance and transportation of the power plant will help us in other space missions. As there are already over 2000 satellites (functioning or not), there are ways to program these satellites and soon power plants to orbit in a unique path, away from all the others. Another idea that was brought out was placing these solar plants on the Moon, which could be more safe in general, but its maintenance and manufacture will be something not possible as of right now. Aside from space power plants, there are some key technologies that are needed for humans to successfully prepare for the future. Such as developing tools to mine resources on other planets, high-frequency communications systems, and shielding computer memories and electronics from radiation. As resources on Earth become more scarce and limited, we will have to look beyond Earth to sustain life. It also has to be realized, "Today's growing and more-affluent societies require greater amounts of electric energy" (Kistler, 1999). With these mining tools, we can extract valuable minerals and resources that may not yet be known to us, which can be useful in so many different ways. Refining our interplanetary communications systems is a must, because as we expand our reaches away from Earth, communicating with one another will be harder but more important. Not only will this help with communicating, but these high frequency systems will allow us and robots to send images and videos of their findings, which is a big part of the mission itself. Shielding electronics and memory from radiation will be crucial in storing data as we trek farther from home, radiation levels can fluctuate, and protection will be necessary.

Humans being in space is considered one of the most extreme conditions known to mankind. Since more and more astronauts go to space, an increase of medical attention is needed. A countermeasure program has been made to counteract many things the astronauts might have been exposed to, such as microgravity, radiation, etc. In space, aging is accelerated, so many of the problems and conditions one would normally find in an old person could be seen on the astronauts. These conditions include but are not restricted to mild hypothyroidism, increased stree hormones, decreased sex steroids, insulin resistance, impared anabolic response to food intake, anorexia, altered mitochondrial function and systemic inflammatory response. However, the effects of microgravity on the astronauts seem to more or less dampen once they are back on Earth. In fact, space medicine can help with, "[Aging and unhealthy lifestyle type] diseases, although basically incurable, are highly preventable if only medicine would be able to offer personalized preventive programs similar to the ones developed for astronauts" (Ongaro, 2014). Many of the chronic diseases that are found in humans are directly related to aging, so many people are targeting medicine to treat for old age. Practicing healthy lifestyles, some alterations to nutrition, and personalized drugs and nutraceuticals with psychological support can all take part in something called the "anti-aging" medicine. And thus, "What is urgently needed in healthcare today is a personalized lifestyle approach provided within the architecture of a new form of scientific integrative medicine" (Ongaro, 2014). These changes (drastic or not) all help in reconstructing lost DNA and tissues that were once contributing to a healthy body. Using the medical technology discovered and methodized during human spaceflight, they can be modified to fit the everyday person, or specifically individuals to better their lives.

VI. FUTURE ENGINEERS

A. Need for Future Engineers

There are not a lot of people who know and understand the technology, policies, laws and economic motives in the space community. So it is important that, "All people in all nations be exposed to the knowledge and information concerning the development of outer space" (Weeks, 2014). Equity comes first in developing out to outer space. Everything space related is advancing rapidly, and more people need to be aware. Soon, another "wave" of development will make way, putting new technologies and ideas put to work on Earth. For example, faster and reliable space travel, improved wave signals (GPS, WiFi, etc), and improvements in our everyday lives. Thanks to the legalization of private space travel from the Commercial Space Launch Amendments Act and then the NASA Authorization Act. Now, "Private corporations are now taking on duties and responsibilities, production and profits associated with space travel" (Weeks, 2014). These acts encourage for-profit and private companies to try and develop better technology and research, giving them a chance at taking on a larger role in the space community. Since there are more opportunities now, by teaching students what they need to know in the general space field will make way for more development and advancements in the future to come. The lack of education of this particular area can make students feel they are somehow not ready or that they "are not supposed" to take part in the space community. In general if more people were given access and exposed to any information regarding space and technology, there will be exponential growth.

As the field of engineering changes along with technology and society, more problems and difficulties can arise regarding environment and resources. But,"Unfortunately, few engineering schools have made major updates to their courses and curricula over the past few decades" (Davidson, 2010). As society grows, there is more stress on spending and expending, and finding the most efficient way to handle the resources is crucial in the world's survival. Reducing waste and conserving/converting energy/resources are challenges that ask for new training for future engineers. Some universities and colleges have begun to teach areas in sustainable engineering, which includes ideas like "life cycle assessment, concepts in renewable energy, and methods of waste minimization." Workshops for engineering faculty have been organized to share and compare different methods of teaching and what works well. Some workshops have begun incorporating the idea of implementing and addressing sustainability issues for the students and classes. The Center for Sustainable Engineering (CSE) has created an electronic library and made the resources all available for free. Many believe creating a strong foundation in the early education system and awareness of sustainable engineering will help in the future. As the human population develops and the world ages, many new problems may arise and it is to humankind's best interest to be best prepared.

B. An Engineer's Perspective

Traditional civil engineering solutions may not be enough for later missions and projects, so changing the process and methods may be required when thinking long term. Since Mars and the Moon are the closest large celestial bodies to Earth, so extensively studying and exploring them is the first step for other missions in the future. Changing and modifying the role of civil engineers in the scope of space exploration is crucial as the world is modernizing into a different generation. As technology and knowledge advances, civil engineering needs to keep up to accommodate for the demand. Civil engineers will be the most important when we have to construct a new world and colonize a new planet. But in order to do so, "To contribute effectively to space exploration and development, civil engineers need to focus on simple, easy to construct solutions that can begin to be assessed for first stage mission planning" (Farrier, 2000). Specifically for a Mars Mission, these engineers will have to think of new ways to convert energy, reuse and recycle matter and waste, and find the most effective way to harbor and sustain human life.

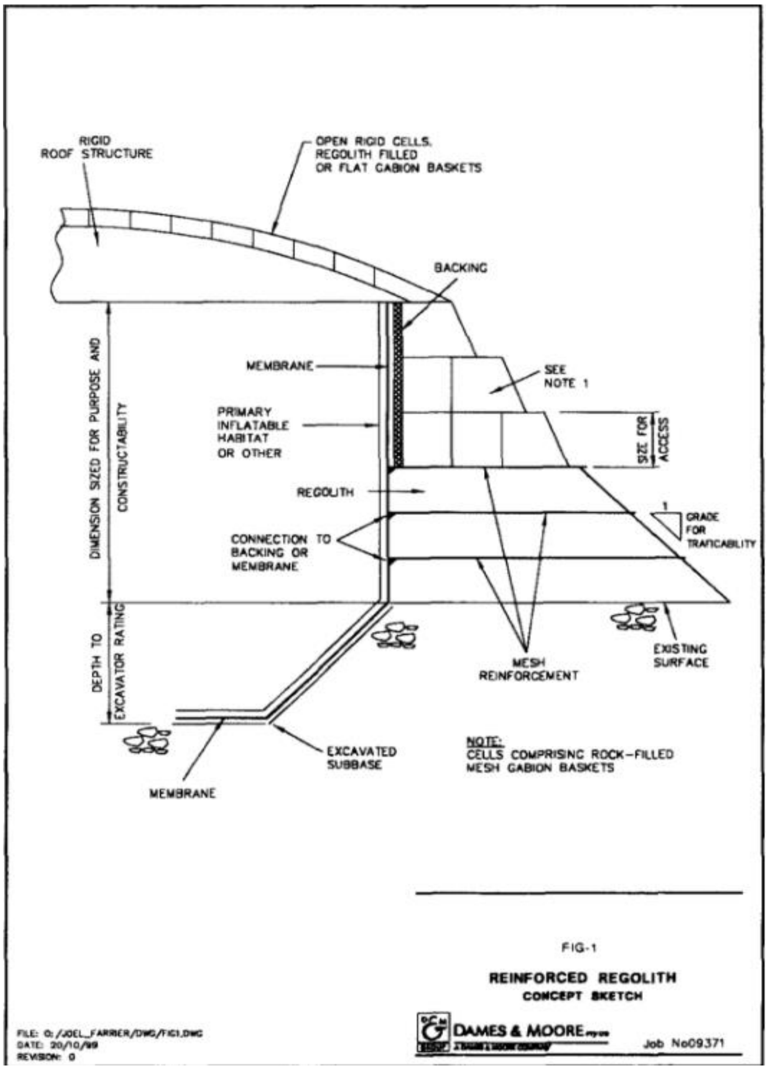

Figure 4: Structure for Mars settlement optimization (Farrier, 2000).

More research and experimentation is necessary to find the best resources and materials for an environment like Mars. Also equipment that is adaptable to the nature of the red planet is crucial in preserving the infrastructure and facilities. Another important job as a civil engineer is to provide safety in its equipment and technology, especially considering the magnitude of the mission. Safety for humans and the equipment (external forces) is something that will always be of concern, as environments will always change, and so as ourselves, and technology will always improve and advance.

VII. CONCLUSION

In conclusion, space exploration is needed more than ever, especially in light of the circumstances surrounding the Earth's condition. Thus, sending satellites to monitor the carbon levels of the Earth can help provide information on the Earth' "health". Colonizing Mars will reduce the stress of over expending the Earth's energy. And, both the education and work system must push for more next generation engineers to be trained, as engineers are needed for space exploration to take place. By doing so, one can hope for a brighter future as humanity looks forward and beyond towards the horizons of the universe.

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