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## Earth Alienation and Space Exploration: Uncharted Territory for Sociology

Sam Arroyo  
*Bard College*

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Earth Alienation and Space Exploration: Uncharted Territory for Sociology

Senior Project submitted to  
The Division of Social Studies  
of Bard College

by  
Sam Arroyo

Annandale-on-Hudson, New York

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## Introduction

“Man will not always stay on earth; the pursuit of light and space will lead him to penetrate the bounds of the atmosphere, timidly at first but in the end to conquer the whole of solar space”.

Konstantin Tsiolkovsky<sup>1</sup>

Imagine an artificial habitat floating within our solar system, ten million humans living in a cylinder four miles in diameter and twenty miles long. Oxygen pressure is set to 5,000 feet above sea level; the needs of gravity, water, land, oxygen, and natural sunlight met. Food is provided by small agricultural cylinders located on a ring attached to the main habitat, each agricultural cylinder having a separately controlled environment for the availability of diverse growing conditions and seasons. The amount of sunshine entering the colony can be controlled, giving residents the power to choose the length of the day, weather, temperature, and seasonal cycles. In the cylindrical habitat, there are twenty-mile-long “valleys,” containing small cities on mountain slopes, green areas, suburban towns, and light industry. This is a human-constructed and controlled environment in outer space envisioned by physicist Gerard O’Neill in the 1970s,<sup>2</sup> one of the countless visions, past and present, of human life extending beyond Earth (see image 1 and 2).

Referencing the funeral obelisk of rocket scientist Konstantin Tsiolkovsky quoted above, Hannah Arendt believes that dreams expressed in science-fiction, of human life and its creations extending into outer space, are “neither wild nor idle” but a “vehicle of mass sentiments and

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<sup>1</sup> O’Neill, Gerard K. *The High Frontier: Human Colonies in Space*. 3rd ed., (Burlington, Apogee Books, 2000) 36.

<sup>2</sup> O’Neill, *Human Colonies in Space* 37-44.

mass desires”.<sup>3</sup> Arendt begins *The Human Condition* with the October 5, 1957 launch of the first human-made satellite—Sputnik, into low Earth orbit by the Soviet Union. The launch of Sputnik marked the start of the space age,<sup>4</sup> comprising what Arendt sees as an event “second in importance to no other”; a “step toward escape from men’s imprisonment on the earth”.<sup>5</sup> For Arendt, Sputnik signified a step towards humans freeing themselves from their humanity and the realization of the human desire to replace the organic with the artificial, what Arendt refers to as “earth alienation”.

Historically, outer space has played a role in determining the course of humanity. For instance, Arendt views the invention of the telescope by Galileo and the ensuing development of science in which earth is thought of in the context of the universe, as an event which both determined and ushered in the modern age.<sup>6</sup> I see a potential in modern space initiatives to again determine the course of humanity. To explain the significance I am placing on modern space initiatives I return to Arendt’s idea of earth alienation, for now specifically the idea that mapping an area also has the effect of shrinking that area; as Arendt explains, “nothing can remain immense if it can be measured, that every survey brings together distant parts and therefore establishes closeness where distance ruled before”.<sup>7</sup> Through the mapping of the earth and advances in transportation, distance on the planet became meaningless given that now any point on earth can be reached in a matter of minutes or hours; our planet, with its approximate 24,901-mile circumference, has become a relatively small place.

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<sup>3</sup> Arendt, Hannah. *The Human Condition*. 2nd ed., (Chicago, Univ. of Chicago Press, 1998) 2.

<sup>4</sup> NASA. "Sputnik and The Dawn of the Space Age." *NASA*, edited by Steve Garber, 10 Oct. 2007, Accessed 15 Apr. 2019. [history.nasa.gov/sputnik/](https://history.nasa.gov/sputnik/).

<sup>5</sup> Arendt, *The Human Condition* 1.

<sup>6</sup> Arendt, *The Human Condition* 248.

<sup>7</sup> Arendt, *The Human Condition* 250.



In this project, I see space initiatives, be it the creation of habitable satellites placed at the Moon or Earth's orbit, or the extension of human life to Mars, as technological developments that extend the mapping of our universe, in effect reducing the meaning of distance in our solar system and by extension shrinking the solar system. Arendt explains that to map and chart an area not only shrinks it but also has the effect of removing a person from their surroundings, she writes, "The greater the distance between himself and his surroundings, world or earth, the more he will be able to survey and to measure and the less will worldly, earth-bound space be left to him".<sup>8</sup> Arendt uses the example of the airplane to show that, "any decrease of terrestrial distance can be won only at the price of putting decisive distance between man and earth, of alienating man from his immediate earthly surroundings".<sup>9</sup> If Arendt is right, the continuation and advancement of human travel within our solar system will not only have the effect of shrinking our solar system in the same way that the airplane shrunk the earth, but it will also have the effect of drastically alienating humans from the Earth.

My concern with outer space and the idea of Earth alienation is not only that humanity is tied to the Earth which in Arendt's view, "The Earth is the very quintessence of the human condition... a habitat in which they can move and breathe without effort and without artifice".<sup>10</sup> But also, that extending human travel deeper into our solar system can further alienate humans from Earth resulting in a relationship between humanity and Earth which negatively affects the planet and its living organisms. To further human's alienation from Earth raises questions concerning the future of our planet and the future of humanity. Exploring this idea from a perspective of environmental sociology, I engage with the question: what do developments of

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<sup>8</sup> Arendt, *The Human Condition* 251.

<sup>9</sup> Arendt, *The Human Condition* 251.

<sup>10</sup> Arendt, *The Human Condition* 2.

technology and science for the exploration and exploitation of outer space mean for the future of humanity and planet Earth?

In this paper, I make two arguments: the first argument is that we are in a new space age, in which the idea of outer space being the province of all mankind is changing to outer space being a new frontier offering economic opportunity subject to the exploitation of private entities. The second argument I make is that technological and scientific developments in the field of aerospace are advancing at a speed which requires reflection on what extending human life and artificial creations into outer space means for the future of humanity, Earth, and other living organisms.

The basic methodological approach taken in this project involves theoretical explication, comparative analysis, and content analysis, drawing on the following sources: Max Weber and Karl Marx through the interpretation of environmental sociologist John Bellamy Foster, contemporary documents from the Roman Catholic Church, the United Nations, and laws and treaties concerning outer space. The analysis is both descriptive and normative, and therefore involves an aspect of public sociology, in Michael Burawoy's sense, perhaps even politics, in Hannah Arendt's sense.

My first chapter, "Outer Space, Property Rights, and International Space Law", is more descriptive than normative. The specific problem addressed in this chapter is that the foundation of international space law expresses the view that outer space is the province of all mankind while in reality outer space is increasingly being seen more as a new frontier of economic opportunity subject to exploitation and privatization, rather than an environment belonging to all for the benefit of all. Because of the increasing involvement of the private sector in space

initiatives and the argument of the necessity of private property rights to secure private investments in outer space, there is an analysis of what the treaties state regarding the use and appropriation of outer space. There is a review of space law and treaties to make clear what the current agreements and proposals are regarding the use, benefits, and appropriation of outer space; and how contemporary advancements in technology and science, along with the increasing involvement of private entities in space initiatives call for further revision of international space law.

In the second chapter, “Space Exploration and Commercialization”, I use a report by the Swiss investment bank company UBS to show the current and projected value of the space economy and the prospects of space tourism, asteroid mining, and space-based manufacturing. Following this report is a review of American space exploration narratives from the Eisenhower administration to the Trump administration. I reference the remarks of Vice President Pence to show the Trump administration's prioritization of American leadership in space and the value placed on the private space industry. The remainder of the chapter provides information on the United States civil space agency and the three major private aerospace companies: SpaceX, Virgin Galactic, and Blue Origin. This chapter serves to establish the economic and social significance of outer space, provide the reader with information on what is going on in both the American public and private sector, and lay out the visions of the major private aerospace companies which will be returned to in the conclusion of this paper.

In the third chapter, “Climate, Capitalism, and the Environment”, I rely especially on the recent work of John Bellamy Foster to present the classical sociological theories of Max Weber and Karl Marx through the perspective of environmental sociology. Max Weber’s theory of

rationalization and Karl Marx's concept of ecological crisis under capitalism are presented as a form of earth alienation. The chapter begins with the idea that industrialization has given humans the power to change the physical Earth and its environment, at the cost of global warming and by extension the destruction of human and non-human life. Thinking of projected human population growth and sustainable development I note how the continuation and even escalation of the mismanagement of the environment have the potential for great harm. Finally, the papal encyclical letter *Laudato Si' of the Holy Father Francis "On Care for Our Common Home"*,<sup>11</sup> offers an overtly religious engagement with the topics of technology, human values, and the environment, one that may be placed in dialogue with the theories of Marx and Weber on contemporary environmental issues and earth alienation.

The study of outer space may seem like a trivial topic to pursue through a sociological perspective, given the social problems facing our world today, but there is a reason why this may be the first impression. Environmental sociology and by extension the study of outer space as a sociological object remains on the outskirts of mainstream sociology. Historically, sociologists have been resistant to environmental issues, a product of the discipline's early differentiation of itself from social Darwinists<sup>12</sup> and the taboo ideas of "geographical determinism" and "biologism". Sociologists moved away from the study of the physical and biological environments to a focus on social and cultural environments.<sup>13</sup> Within the discipline, the move

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<sup>11</sup> Francis, Pope. *Laudato Si': On Care for Our Common Home : Encyclical Letter*. Huntington, Our Sunday Visitor, 2015.

<sup>12</sup> Foster, John Bellamy. "Marx's Theory of Metabolic Rift: Classical Foundations for Environmental Sociology 1." *American Journal of Sociology*, vol. 105, no. 2, 1999, p. 366-405. *EBSCOhost*, doi:10.1086/210315, 367.

<sup>13</sup> Dunlap, Riley E., and William R. Catton, Jr. "Environmental Sociology." *Annual Review of Sociology*, vol. 5, 1979, p. 243-73. *EBSCOhost*, [www.jstor.org/stable/2945955](http://www.jstor.org/stable/2945955), 245.

away from nature and biology fostered the view of social autonomy from the natural environment and a commitment to acknowledging only the social and cultural.<sup>14</sup>

A change in the discipline of sociology followed after the emergence of scientific evidence in the 1970s of the human impact on the environment, the finding pushed the development of environmental sociology—the study of the relationship between the environment and society. Now in the 21st-century environmental issues have become the defining problem of our time. A recent analysis of forty years' worth of satellite data presents evidence that there is a "five-sigma" confidence level (99.9999 percent certainty) that humans are causing global warming,<sup>15</sup> a change in the Earth's temperature impacting the physical Earth and living organisms. While there are still scientists and individuals who argue that climate change is not happening or if it is climate change is not human-caused, this view is held by a decreasing minority. In my paper, I take the stance that climate change is both happening and that it is the result of human activities. Thus, as climate change and its impacts continue to affect Earth, humans, and non-humans it is increasingly important that the significance of the environment be recognized within sociology, especially given that environmental issues are fundamentally social issues.

As a contribution to the endeavor of integrating the physical and biological environments with the social and cultural environments, I analyze Earth's climate and outer space, physical environments which are argued to be the province of all mankind, a normative view of Earth's climate and outer space. The climate and outer space both affect and are affected by human activities. I chose these two environments because they have a significant impact on life on Earth

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<sup>14</sup> Dunlap and Catton, "Environmental Sociology" 245.

<sup>15</sup> Santer, Benjamin D., et al. "Celebrating the Anniversary of Three Key Events in Climate Change Science." *Nature Climate Change*, vol. 9, Feb. 2019, p. 180-82, doi:10.1038/s41558-019-0424-x.

in the present and in the future. The climate is necessary to the survival of all living beings which since the last two centuries has been altered to disastrous effects by human activities. Despite international recognition of the threat that climate change poses to future life on Earth, humans have yet to make progress in reducing activities contributing to climate change. On the other hand, outer space is a relatively new space, one that humans did not access until 1957. Outer space is an opportunity to manage an environment before it is damaged. Thoughtful consideration of the use, benefits, and appropriation of outer space can bring clarity to ideas concerning technology, humanity, and the environment.

# Chapter 1

## Outer Space, Property Rights, and International Space Law

### International Concern over the Use Outer Space

The United States and private space companies are working to develop the capacity to explore beyond low-Earth orbit, including “translunar space, near-Earth asteroids and eventually Mars”.<sup>16</sup> The progress being made in science and technology partnered with the increasing commercialization and privatization of space activities has raised international concern over the compliance of states to their obligations under space treaties. In the fifty-sixth session of the United Nations’ Legal Subcommittee on the Peaceful Uses of Outer Space<sup>17</sup>, attended by 65 States members of the Committee, concern was raised over states legitimizing private entities’ exploration of space resources that do not abide by the Outer Space Treaty—the treaty viewed as the foundation of all treaties and principles concerning outer space.

During the fifty-sixth session concern was raised over outer space agreements not keeping up with the technological and scientific developments of space activities and the increasing commercialization and privatization of outer space, the view that with, “current developments in space activities, specifically regarding commercialization, privatization and space safety, the application of the existing treaties on outer space should be constantly analyzed and reviewed to ensure the relevance of the current space law regime to the level of development in space activities.”<sup>18</sup> In connection to that concern over outer space treaties being relevant to contemporary developments in space activities and the space industry, there is the argument that

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<sup>16</sup> NASA. "Why We Explore." Accessed 22 Apr. 2019.

[www.nasa.gov/exploration/whyweexplore/why\\_we\\_explore\\_main.html#.XL4x06Z7nOR](http://www.nasa.gov/exploration/whyweexplore/why_we_explore_main.html#.XL4x06Z7nOR).

<sup>17</sup> Report of the Legal Subcommittee on its fifty-sixth session, held in Vienna from 27 March to 7 April 2017 A/AC.105/1122 [http://www.unoosa.org/oosa/oesadoc/data/documents/2017/aac.105/aac.1051122\\_0.html](http://www.unoosa.org/oosa/oesadoc/data/documents/2017/aac.105/aac.1051122_0.html)

<sup>18</sup> Fifty-sixth session, paragraph 51.

specific terms within the Outer Space Treaty need further clarification. There was a call for the following key terms in the Outer Space Treaty to be clarified: “common heritage of mankind”, “common province of mankind”, “national appropriation of outer space” and “exploitation/exploration of space resources”.<sup>19</sup> Interestingly, the argument was also made that the outer space environment needs to be cared for just as there is a need to care for the Earth’s environment, and to be wary of the “artificial” in influencing how we view the outer space environment, the view is that “there was a need to care for the outer space environment in the same way there was a need to care for the planet, and to avoid creating an artificial divide between this planet and the space around it, so that future generations too could enjoy the benefits of outer space”.<sup>20</sup> Here we see concerns over the use of outer space given the developments that have been made within the space industry and environmental concerns regarding how technology may be influencing how we think of the natural environment that is outer space.

The aforementioned views are significant because they signify that there are State members of the Committee on the Peaceful Uses of Outer Space that believe that contemporary developments in space activities and the space industry call for the analyzation and review of space treaties and further clarification on past treaties, especially the rules and intentions regarding the use of outer space, and the idea that outer space is an environment which needs to be protected. These ideas are becoming increasingly relevant to thinking about how we see our connection to outer space in the present and in the future.

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<sup>19</sup> Fifty-sixth session, paragraph 34.

<sup>20</sup> Fifty-sixth session, paragraph 51.



## Property Rights to Natural Resources in Space

There is an increasing number of both public and private actors becoming involved in space; with several proposed missions for the return of people to the moon and possibly sending humans to the planet Mars for the first time. These proposed missions signify that in the near future there may be long-term human settlements in outer space which by necessity would require the exploitation of outer space resources. A problem that arises is that with both the public and private sector increasing their involvement in outer space there continues to be no clear legal framework for the exploitation of space resources. On earth conflict over the access, control and exploitation of natural resources is a major obstacle for peace and international security,<sup>21</sup> conflict over resources may extend to natural resources in space. Having clear laws and policies regarding the use and exploitation of space resources will be important to ensuring peace and the protection of outer space for its use by future generations.

Outer space contains resources that are scarce on Earth. For example, the isotope helium-3 is limited on Earth but present on the moon in substantial amounts. If mined from the moon helium-3 has the potential to be a future source of waste-free nuclear energy that could be worth trillions of dollars with the potential of meeting global energy demands for 250 years.<sup>22</sup> In the case of near-Earth objects, “a metallic asteroid only a kilometer in size would provide one billion tons of iron, two hundred million tons of nickel, ten million tons of cobalt, and

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<sup>21</sup> State of Bolivia. "Concept Note for the Security Council Briefing on the Theme 'Maintenance of International Peace and Security: Root Causes of Conflict—The Role of Natural Resources,'" Received by United Nations Secretary-General, 11 Oct. 2018. *Security Council Report*, United Nations, Letter. Accessed 16 Apr. 2019. [www.securitycouncilreport.org/atf/cf/%7B65BFCF9B-6D27-4E9C-8CD3-CF6E4FF96FF9%7D/s\\_2018\\_901.pdf](http://www.securitycouncilreport.org/atf/cf/%7B65BFCF9B-6D27-4E9C-8CD3-CF6E4FF96FF9%7D/s_2018_901.pdf).

<sup>22</sup> Kotoky, Anurag. "The Quest to Find a Trillion-Dollar Nuclear Fuel on the Moon." *Bloomberg*, 28 June 2018, [www.bloomberg.com/news/articles/2018-06-26/the-quest-to-find-a-trillion-dollar-nuclear-fuel-on-the-moon](http://www.bloomberg.com/news/articles/2018-06-26/the-quest-to-find-a-trillion-dollar-nuclear-fuel-on-the-moon).

twenty-thousand tons of platinum, with a net market value of about one trillion US dollars”.<sup>23</sup>

According to Goldman Sachs’s 2017 report, the barriers to mining asteroid resources have less to do with finance and technology and more to do with “psychological barriers”,<sup>24</sup> for public and/or private actors to invest in the exploitation of resources in outer space there needs to be a solid legal framework in which actors have a legal claim to what they extract.<sup>25</sup> But while an absence of property rights is a barrier to the space initiatives of the private sector, it is important to note that there is a call for the creation of a legal framework which recognizes the use of outer space for benefits all of humanity, not for the sole purpose of economic gain. A tension that arises in the discussion of space law and treaties concerning the use of outer space is that while some states are viewing outer space as an opportunity for economic gain, current international treaties frame outer space as the “province of all mankind”. How outer space can remain the province of all mankind while it is subject to the use and exploitation of private entities is a contemporary problem which involves confronting whether international agreements which frame space and its benefits as belonging to all mankind, will be defended against or rejected in the interest of profit and the belief of progress.

### Property Rights

The early modern debates about appropriation by John Locke and Thomas Paine, given that they provide different views on the rights and responsibilities concerning property. Their debates are relevant to a discussion of outer space exploration as they provide ideas that are fundamental to how property is viewed in modern capitalism, specifically John Locke; and

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<sup>23</sup> Coffey, Sarah. "Establishing a Legal Framework for Property Rights to Natural Resources in Outer Space." *Case Western Reserve Journal of International Law*, vol. 41, no. 1, 2009, p. 119-48. *HeinOnline*. ( p.121)

<sup>24</sup> Edwards, Jim. "Goldman Sachs: Space-Mining for Platinum Is 'More Realistic than Perceived.'" *Business Insider*, 6 Apr. 2017, [www.businessinsider.com/goldman-sachs-space-mining-asteroid-platinum-2017-4?IR=T](http://www.businessinsider.com/goldman-sachs-space-mining-asteroid-platinum-2017-4?IR=T).

<sup>25</sup> Coffey, “Establishing a Legal Framework”.

Thomas Paine who views property rights in the context of a common. Current international law on the use of outer space is inadequate because it does not directly address the appropriation of outer space. I do not take a side on what property rights in space should be or whether there should be property rights in outer space at all. Instead, I bring the discussion of the current problem of ambiguity concerning the use of outer space and its potential social impacts into the field of sociology.

In *Second Treatise of Government* (1689), John Locke begins his chapter “Property” by stating how the bible views Earth, referencing *Psalms* 115:16: “The heavens are the LORD’S heavens, but the earth he has given to the sons of men”.<sup>26</sup> The Bible views Earth as the heritage of mankind. Natural reason supports the idea that people are born with the right to sustain themselves on Earth. Locke argues that men, without the need for agreement among all mankind, have the right to own something that was given by God to all people. Locke justifies the right to property on the basis of reason. The premise of the argument is that an individual owns themselves and by extension, a person’s labor is their own, so what is removed out of the common state of nature through labor becomes the property of the laborer. Locke extends the idea of ownership through labor to resources and land, arguing that, so long as nothing is spoiled, such as a person who exerts their labor to gather acorns or cultivate the land, removes these resources or land from the commons and can claim ownership on the basis of the labor they exerted. With the right to have property limited to not having more than can be used, not limited by how much a person has. The criticism of this argument is that it legitimates a few people

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<sup>26</sup> *The Holy Bible*. Revised Standard Version, Reference ed., Thomas Nelson & Sons.

having a large portion of resources and land, while people who are born after the land and natural resources have been claimed as private property are placed in unfortunate circumstances.

On the other hand, in *Agrarian Justice*<sup>27</sup> (1797), Thomas Paine presents an argument for the creation of a national fund based on the cultivation of land. Similar to Locke, Paine's argument begins with the idea that God created Earth as the heritage of mankind. However, while Locke argues that labor—an extension of a person's self—provides a claim of ownership, Paine acknowledges the difference between cultivated and uncultivated land, with labor adding value to land but sees the value of the cultivated land, not the Earth itself, as private property. Here, Paine maintains both the ideas that Earth is the heritage of mankind and that the cultivation of land justifies private property with the specification that the value brought by cultivation, and not the Earth itself, can be claimed as private property. While in Locke's argument people who are born after land and resources have been claimed as private property are placed in unfortunate circumstances; Paine argues that because Earth is the common inheritance of mankind, in a civilization where land is made private property, people need to be compensated for the loss of their “natural inheritance” which he proposes should be done as a national fund which in the United States is the ideological basis of the social security fund.

Analogizing the arguments of Locke and Paine to the appropriation of outer space, on the one hand thinking through a Lockean perspective it can be said that those who have invested their labor and money to extract resources in space have the right to claim what they obtain as their private property, on the other hand, applying Paine's argument in *Agrarian Justice*, those who see space as the common heritage of mankind would argue that while the resources can be

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<sup>27</sup> Paine, Thomas. *Agrarian Justice*, [Electronic Resource]. Paris: printed by W. Adlard. London: re-printed for T. Williams, No. 8, Little Turnstile, Holborn, 1797. EBSCOhost, search.ebscohost.com/login.aspx?direct=true&db=cat03691a&AN=bard.b1676729&site=eds-live&scope=site.

claimed as private property because of the labor used to obtain the resources, because space is the common heritage of all humankind there needs to be compensation for the rest of humanity, with the benefits of space activities arguably needing to be distributed on a global scale.

### Space Treaties

In 1958, the United Nations created the Office for Outer Space Affairs (UNOOSA),<sup>28</sup> a forum for the development of international space law. UNOOSA has concluded five international treaties and five sets of legal principles on space activities. The five United Nations treaties on outer space are: the "Outer Space Treaty", the "Rescue Agreement", the "Liability Convention", the "Registration Convention", and the "Moon Agreement".<sup>29</sup> These five treaties opened for signature between 1967 and 1979,<sup>30</sup> created during the Cold War the treaties do not significantly address contemporary issues on space resources and the commercialization of outer space.<sup>31</sup> While the five sets of legal principles are: the "Declaration of Legal Principles", the "Broadcasting Principles", the "Remote Sensing Principles", the "Nuclear Power Sources Principles", the "Benefits Declaration", concluded between 1963 and 1996.<sup>32</sup> A focus will be placed on the two international treaties the Outer Space Treaty (1967) and the Moon Agreement (1979), the legal principle the Benefits Declaration (1996), and the United States bill (which never became law) the "Space Resource Act", as these four documents address the appropriation of outer space and the idea of outer space as the province of all mankind.

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<sup>28</sup> "History." *United Nations Office for Outer Space Affairs*, [www.unoosa.org/oosa/en/aboutus/history/index.html](http://www.unoosa.org/oosa/en/aboutus/history/index.html).

<sup>29</sup> "Space Law Treaties and Principles." *United Nations Office for Outer Space Affairs*, [www.unoosa.org/oosa/en/ourwork/spacelaw/treaties.html](http://www.unoosa.org/oosa/en/ourwork/spacelaw/treaties.html).

<sup>30</sup> "Space Law Treaties and Principles."

<sup>31</sup> Coffey, "Establishing a Legal Framework".

<sup>32</sup> "Space Law Treaties and Principles."

### *The Outer Space Treaty*

The *Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, including the Moon and Other Celestial Bodies* (“Outer Space Treaty”) provides the framework on international space law. The treaty entered into force in October 1967 and has been ratified by a total of 109 countries.<sup>33</sup> Article I of the treaty states that “The exploration and use of outer space, including the Moon and other celestial bodies, shall be carried out for the benefit and in the interests of all countries, irrespective of their degree of economic and scientific development, and shall be the province of all mankind.”<sup>34</sup> The beginning of the treaty establishes the idea that the exploration and use of outer space are for the benefit of all countries and that outer space belongs to all mankind. The two ideas—space benefiting all and belonging to all—are a foundation of space activities.

There is a global inequality of access to space resources which is further problematized by the global view of property rights, the UN report states:

The view was expressed that space resources were accessible to only a very limited number of States and to a handful of enterprises within those States. In that connection, the delegation expressing that view was also of the view that it would be important to assess the impact of a “first come, first served” doctrine on the global economy, with the creation of a de facto monopoly in complete contradiction with the letter and the spirit of the United Nations treaties and resolutions.

Since the beginning of the ‘Space Race’ between the United States and the Soviet Union in 1957, countries have had unequal access to space and its benefits. Access to space among

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<sup>33</sup> *Status of International Agreements Relating to Activities in Outer Space as at 1 January 2019*. Report no. A/AC.105/C.2/2019/CRP.3, Committee on the Peaceful Uses of Outer Space. *United Nations Office for Outer Space Affairs*, [www.unoosa.org/documents/pdf/spacelaw/treatystatus/AC105\\_C2\\_2019\\_CRP03E.pdf](http://www.unoosa.org/documents/pdf/spacelaw/treatystatus/AC105_C2_2019_CRP03E.pdf).

<sup>34</sup> “Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, including the Moon and Other Celestial Bodies” *United Nations Office of Outer Space Affairs*, Accessed 22 Apr. 2019. [www.unoosa.org/oosa/en/ourwork/spacelaw/treaties/outerspacetreaty.html](http://www.unoosa.org/oosa/en/ourwork/spacelaw/treaties/outerspacetreaty.html).

countries can be categorized in four different ways: the few countries that are able to access space, build their own satellites, apply the benefits of space to their society, and conduct experiments using space assets; the large number of countries that are able to both build satellites and conduct experiments and applications; then there are the many countries that are able to do experiments and applications but are only able to use satellites from outside their government; and at the end of the scale are the many countries that only indirectly benefit from space and do not have access to space.<sup>35</sup> Access to outer space, its resources, and the benefits derived from space activities are globally disproportionate.

The global inequality of access to space and its benefits is connected not only to the ability of countries to invest in space programs but also how the benefits of space activities are shared globally. A point in the treaty which needs further clarification is the meaning of, “benefit” in Article I of the Outer Space Treaty. Article I of the treaty states, “The exploration and use of outer space... shall be carried out for the benefit and in the interests of all countries...”.<sup>36</sup> The use of space “for the benefit... of all countries” has varying interpretations of meaning. On the one hand, Article I of the treaty can be interpreted as an encouragement to share the benefits (e.g. knowledge or resources) of space, while on the other hand, Article I can be interpreted as mandating the division and/or distribution of the benefits derived from space to all countries.<sup>37</sup> Most countries agree with the interpretation of the treaty which argues that there is an obligation to share benefits derived from space activities. Space-faring countries claim that they involve other countries in their space activities or share knowledge derived from their space

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<sup>35</sup> Kasturirangan, K. "Space Technology for Humanity: A Profile for the Coming 50 Years." *Space Policy*, vol. 23, no. 3, Aug. 2007, p. 153-66. *Researchgate*, doi:10.1016/j.spacepol.2007.06.015, 160.

<sup>36</sup> "Exploration and Use of Outer Space", Article I.

<sup>37</sup> Coffey, "Establishing a Legal Framework".

activities.<sup>38</sup> Even though most countries agree that there is an obligation to share benefits derived from space activities; the Outer Space Treaty does not detail how the benefits are to be shared, designate who is to make decisions on the sharing of benefits, and how much of the benefits are to be shared.<sup>39</sup>

How the benefits of outer space are viewed goes in tandem with the “use” of outer space. With the increasing commercialization and privatization of outer space, profit-motivated space activities can further the global inequality of access to the benefits of outer space. For example, a private entity investing its money in asteroid mining may be reluctant to share its resources/profits globally. In regards to the space activities of the private sector, Article VI of the treaty states that “The activities of non-governmental entities in outer space, including the Moon and other celestial bodies, shall require authorization and continuing supervision by the appropriate State Party to the Treaty”. The responsibility of authorizing and supervising the actions of private entities in space is placed on the State which the non-governmental entity is affiliated with, as mentioned in the introduction of this chapter, there is an international concern that states are legitimizing private entities’ use of space resources that do not abide by the Outer Space Treaty.

The Outer Space Treaty does not specifically address contemporary issues on the rights to claim space resources.<sup>40</sup> As of now, whether space can even be exploited for resources and what would be done with the benefits of those resources—in accordance with the Outer Space treaty—remains unclear. Broad and limited interpretations of the Outer Space Treaty offer

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<sup>38</sup> Gawronski, Christopher J. "Where No Law Has Gone Before: Space Resources, Subsequent Practice, and Humanity's Future in Space." *Ohio State Law Journal*, vol. 79, no. 1, 2018, p. 175-212. *HeinOnline*. , <https://heinonline.org/HOL/P?h=hein.journals/ohslj79&i=181>.

<sup>39</sup> Coffey, “Establishing a Legal Framework”.

<sup>40</sup> Coffey, “Establishing a Legal Framework”.



varying answers.<sup>41</sup> Beginning with whether a country has the right to claim a part of space as theirs, Article II of the Outer Space Treaty states, “Outer space, including the moon and other celestial bodies, is not subject to national appropriation by claim of sovereignty, by means of use or occupation, or by any other means”.<sup>42</sup> The Outer Space Treaty clearly states that nations cannot claim sovereignty over outer space and its celestial bodies. In 1969, when American astronauts placed the United States flag on the Moon, the United States was not claiming the Moon as its property but instead “the action signified that "America went in peace for all Mankind."”.<sup>43</sup> While the prohibition of the national appropriation of outer space and its celestial bodies can be interpreted as the Outer Space Treaty prohibiting private property in outer space, it can also be argued that the prohibition applies to only nations and the not to the appropriation of outer space by private entities.

To better understand whether or not the Outer Space Treaty allows for the appropriation of space resources requires clarification on what the treaty means by the “use” of outer space. Article I of the treaty states, “The exploration and use of outer space...shall be carried out for the benefit and in the interests of all countries...and shall be the province of all mankind”.<sup>44</sup> A broad interpretation of the “use” of outer space argues that the exploitation of resources in space is allowed under the Outer Space Treaty.<sup>45</sup> This broad interpretation of the “use” of outer space is supported by, “specific wording, the overall sense of the treaty, and the general premise that “international law permits freedom of action for states, unless there is a rule constraining” a

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<sup>41</sup> Gawronski, “Humanity's Future in Space”.

<sup>42</sup> “Exploration and Use of Outer Space”.

<sup>43</sup> “Science.” *NASA*, Accessed 29 Apr. 2019.

[www.nasa.gov/centers/kennedy/about/information/science\\_faq.html#20](http://www.nasa.gov/centers/kennedy/about/information/science_faq.html#20).

<sup>44</sup> “Exploration and Use of Outer Space”.

<sup>45</sup> Gawronski, “Humanity's Future in Space”.

particular action”.<sup>46</sup> Referring back to Article II, which states that nations cannot claim sovereignty over outer space and its celestial bodies, another interpretation of the “use” of outer space as stated in Article 1 of the Outer Space Treaty argues that the treaty allows for the exploitation of resources in space as long as a claim to sovereignty is not made on the land in which the resources are extracted.<sup>47</sup> Alternatively, a more limited interpretation of the “use” of outer space argues that a state claiming ownership over space resources would be in violation of the prohibition of “national appropriation” of outer space expressed in Article II of the treaty. This argument sees the ownership of space resources as “national appropriation by exercise of sovereignty”<sup>48</sup> therefore in violation of the Outer Space Treaty.<sup>49</sup>

Historically, the United States has claimed legal property rights over space resources they have obtained. The United States’ six lunar landing mission, Apollo 11 (1969) to Apollo 17 (1972), brought back an approximate total of, “382 kilograms (842 pounds) of lunar rocks, core samples, pebbles, sand and dust from the lunar surface”.<sup>50</sup> The United States Government has claimed property rights over the lunar material collected by the six Apollo missions.<sup>51</sup> The 2011 audit report *NASA’s Management of Moon Rocks and Other Astromaterials Loaned for Research, Education, and Public Display*, states, “Apollo lunar samples or other astromaterials that NASA has collected in space...are the legal property of the U.S. Government”.<sup>52</sup> The United States claim of property right over lunar material they collected during the Apollo mission has

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<sup>46</sup> Gawronski, “Humanity's Future in Space” 186.

<sup>47</sup> Coffey, “Establishing a Legal Framework”.

<sup>48</sup> Gawronski, “Humanity's Future in Space” 187.

<sup>49</sup> Gawronski, “Humanity's Future in Space”.

<sup>50</sup> “Lunar Rocks and Soils from Apollo Missions.” *NASA*, [curator.jsc.nasa.gov/lunar/](http://curator.jsc.nasa.gov/lunar/). Accessed 23 Apr. 2019.

<sup>51</sup> Gawronski, “Humanity's Future in Space”.

<sup>52</sup> *NASA's Management of Moon Rocks and Other Astromaterials Loaned for Research, Education, and Public Display*. Report no. IG-12-007, NASA, 8 Dec. 2011, [oig.nasa.gov/docs/IG-12-007.pdf](http://oig.nasa.gov/docs/IG-12-007.pdf).

gone uncontested by other countries;<sup>53</sup> based on the Law of Treaties and subsequent practice, in the case of resources obtained in missions like the six Apollos there seems to be international agreement that states can claim property rights over material that is taken from outer space.<sup>54</sup>

This view would be beneficial to the activity of private entities interested in the exploration and use of outer space; as for private companies to invest in costly missions to use resources in space there needs to be the reassurance that their investments are protected by property rights over the resources they obtain.<sup>55</sup>

The Outer Space Treaty encourages space exploration and the use of space. But there are three main clarifications of the treaties that need to be made: what the treaty means by, “benefit”, “use” and if space can be exploited for resources, what the rights and responsibilities for public and private entities are. Since the creation of the Outer Space Treaty, additional international treaties and legal principles on space activities have been created to specify the “use” and “benefit” related to space resources; more specifically The Moon Agreement (1979), Benefits Declaration (1996), and The Space Resources Act (2015).

### *The Moon Agreement*

The *Agreement Governing the Activities of States on the Moon and Other Celestial Bodies* (“Moon Agreement”) opened for signature in 1979. As of January 2018, 18 states are party to the treaty.<sup>56</sup> With the exclusion of India, which signed the treaty in 1982 but has not

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<sup>53</sup> Coffey, “Establishing a Legal Framework” and Fabio Tronchetti, *Title IV --Space Resources Exploration and Utilization of the US Commercial Space Launch Competitiveness Act: A Legal and Political Assessment*, 41 Air and Space L. 143, 145-46.

<sup>54</sup> Coffey, “Establishing a Legal Framework”.

<sup>55</sup> Gawronski, “Humanity's Future in Space”.

<sup>56</sup> “Agreement Governing the Activities of States on the Moon and Other Celestial Bodies.” *United Nations Office for Disarmament Affairs*, United Nations, [disarmament.un.org/treaties/t/moon](https://disarmament.un.org/treaties/t/moon).

ratified it,<sup>57</sup> countries with high ranking space agencies like the United States, China, Japan, and Russia have not signed the Moon Agreement. The Moon Agreement was created with the intention to “establish an international regime... to govern the exploitation of the natural resources of the moon”.<sup>58</sup> The Moon Agreement fails to be ratified by countries with major space agencies because the treaty denies property rights over resources taken from the moon, the treaty states, “Neither the surface nor the subsurface of the moon, nor any part thereof or natural resources in place, shall become property of any State, international intergovernmental or non-governmental organization, national organization or non-governmental entity or of any natural person”.<sup>59</sup> Not only does the treaty deny property rights over space resources but its “international regime” would also seek to manage space resources<sup>60</sup> and distribute the benefits derived from space equitably among all States Parties.<sup>61</sup> A concern about creating an international regime to govern activities involving space resources is that member states in the international regime without space programs could make risky business decisions at the expense of member states with space programs.<sup>62</sup>

The Moon Agreement elaborates on sections of the Outer Space Treaty which concern the Moon and other celestial bodies while reinforcing the idea that space is to be used for peaceful purposes and is “the common heritage of mankind”.<sup>63</sup> But while the Moon Agreement shares principles expressed in the Outer Space Treaty, it failed to gain support among states with

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<sup>57</sup> *United Nations Office for Disarmament Affairs*.

<sup>58</sup> “Agreement Governing the Activities of States on the Moon and Other Celestial Bodies.” *United Nations Office for Outer Space Affairs*, [www.unoosa.org/oosa/en/ourwork/spacelaw/treaties/moon-agreement.html](http://www.unoosa.org/oosa/en/ourwork/spacelaw/treaties/moon-agreement.html). Article 11. paragraph 5

<sup>59</sup> “Activities of States on the Moon and Other Celestial Bodies”, Article 11, paragraph 3.

<sup>60</sup> “Activities of States on the Moon and Other Celestial Bodies”, Article 11. paragraph 7b.

<sup>61</sup> “Activities of States on the Moon and Other Celestial Bodies”, Article 11. paragraph 7d.

<sup>62</sup> Coffey, “Establishing a Legal Framework” 128.

<sup>63</sup> “Activities of States on the Moon and Other Celestial Bodies”, Article 11.

major space programs, for reasons concerning property rights over space resources and ideas of an international regime to govern space activities on celestial bodies that could disadvantage investments in space.

### *Benefits Declaration*

The *Declaration on International Cooperation in the Exploration and Use of Outer Space for the Benefit and in the Interest of All States, Taking into Particular Account the Needs of Developing Countries*<sup>64</sup> (“Benefits Declaration”) was adopted in 1996. The Benefits Declaration elaborates on the Outer Space Treaty, specifically on the principle that the use of outer space and its celestial bodies is to be “carried out for the benefit and in the interest of all countries... and shall be the province of all mankind”.<sup>65</sup> Elaborating on the obligation that states have for sharing benefits obtained from their space activities, the declaration states that, “All states... should contribute to promoting and fostering international cooperation on an equitable and mutually acceptable basis...particular attention should be given to the benefit for and the interests of developing countries and countries with incipient space programmes”.<sup>66</sup> But while the Benefits Declaration calls for “international cooperation on an equitable and mutually acceptable basis” and the sharing of benefits, especially with developing countries and countries with space programs in its early stages, the Benefits Declaration gives states the freedom to determine the manner and degree of their participation.<sup>67</sup> A weakness of the Benefits Declaration is that there is both an obligation on states to share the benefits derived from space activities and

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<sup>64</sup> *Declaration on International Cooperation in the Exploration and Use of Outer Space for the Benefit and in the Interest of All States, Taking into Particular Account the Needs of Developing Countries*. Report no. A/RES/51/122, United Nations, 4 Feb. 1997, [www.unoosa.org/pdf/gares/ARES\\_51\\_122E.pdf](http://www.unoosa.org/pdf/gares/ARES_51_122E.pdf).

<sup>65</sup> *Declaration on International Cooperation*.

<sup>66</sup> *Declaration on International Cooperation*, paragraph 3.

<sup>67</sup> *Declaration on International Cooperation*, paragraph 2.

the freedom for states to decide how to manage and distribute the benefits. States having both an obligation to share benefits derived from space activities while also the freedom to choose how to do so results in a weak obligation to share benefits.<sup>68</sup>

### *The Space Resource Act*

The United States *Space Resource Exploration and Utilization Act of 2015* (“Space Resource Act”) is legislation written by the Committee on Science, Space, and Technology that aims to establish a “domestic legal framework to govern property rights of resources obtained from asteroids”.<sup>69</sup> In addition, the Space Resource Act calls for “the President to facilitate commercial utilization, discourage government barriers” and “promote the right of United States commercial entities to explore outer space and utilize space resources”.<sup>70</sup> The Space Resource Act supports commercial investments in space by clarifying the legal framework on property rights over space resources while following the United States obligations under the Outer Space Treaty.

The Space Resource Act is viewed as following the United States’ international obligations under the Outer Space Treaty. The Space Resource Act specifically states that it “does not claim sovereignty over outer space or any celestial bodies” or national appropriation of outer space.<sup>71</sup> The bill (which never became law) is proposed domestic law to strengthen the American private space industry through clarification of the private sectors right to “remove, take possession of, and use in-situ asteroid resources”.<sup>72</sup> The legal framework that the bill puts

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<sup>68</sup> Gawronski, “Humanity's Future in Space” 193.

<sup>69</sup> United States, Congress, House. Space Resource Exploration and Utilization Act of 2015. *Congress*, 114th Congress, House Bill 1508, introduced 19 03 2015, 3. [www.congress.gov/bill/114th-congress/house-bill/1508/text](http://www.congress.gov/bill/114th-congress/house-bill/1508/text).

<sup>70</sup> Space Resource Exploration and Utilization Act of 2015, 3.

<sup>71</sup> Space Resource Exploration and Utilization Act of 2015, 6.

<sup>72</sup> Space Resource Exploration and Utilization Act of 2015, 7.

forward states that in regards to property rights, any resource obtained from an asteroid is “the property of the entity that obtained such resources”.<sup>73</sup> The bill argues that the Outer Space Treaty expression of the right to explore and use outer space includes the rights to remove, possess, and use resources from celestial bodies and that the right can be extended to the private sector.

In addition to the bill stating that the private sector has property rights over space resources, it also emphasizes the United States obligation under Article VI of the Outer Space Treaty to “bear international responsibility for national activities in outer space, including the moon and other celestial bodies, whether such activities are carried on by governmental agencies or by non-governmental entities...”.<sup>74</sup> To comply with Article VI of the treaty, the Space Resource Act called for a report on the responsibilities of Federal agencies related to the exploration and use of space resources and the authorities needed for the United States to meet its respective international obligations.<sup>75</sup> The Space Resource Act sought to strengthen the American private space industry through clarifying the legal framework on the exploitation and use of space resources and property rights over space resources, while also following the United States obligations under the Outer Space Treaty and other conventions and agreements that the US is a party to.

An analysis of the Outer Space Treaty (1967), the Moon Agreement (1979), the Benefits Declaration (1996), and the Space Resource Act (2015), shows that international and national discussion of outer space offers divergent views of the use and benefits of outer space. In the Outer Space Treaty, the foundation of international space law, there are two important points that need further clarification: that space is the province of all mankind and thus the use and

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<sup>73</sup> Space Resource Exploration and Utilization Act of 2015, 2, 51303a.

<sup>74</sup> "Exploration and Use of Outer Space", Article VI.

<sup>75</sup> Space Resource Exploration and Utilization Act of 2015, 2, 51302b.

exploration of outer space is to be done to the benefit of all countries, and second that space is not subject to national appropriation. As the space industry has grown and complexified there have been efforts to further clarify the Outer Space Treaty, but these efforts have been insufficient. The Moon Agreement stands against the claim of private property on space resources, this agreement has not gained international support especially not by the main space-faring nations. And while the Benefits Declaration further argues for the need of the benefits of outer space to be shared among all countries, the declaration leaves the responsibility to share the benefits of space up to the discretion of those conducting the space activities. On the other hand, the Space Resource Act, the bill introduced in the United States in 2015, views the private sector as having the right to claim property rights over space resources. Although this bill was not made into law it demonstrates intentions within the United States to legally frame space resources as subject to being made private property.

There is continuing interest in space resources by the United States government. In February 2019 a bill titled the Space Resources Institute Act was introduced to Congress. This bill calls for the establishment of an institute related to space resources. One of the responsibilities of the institute would be, “Developing options for using space resources to— support current and future space architectures, programs, and missions; and enable such architectures, programs, and missions that would not otherwise be possible”.<sup>76</sup> Even though the Space Resource Act and the Space Resources Institute Act are bills that have not passed or not yet passed, they signify interest in space resources and more significantly, especially the Space

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<sup>76</sup> United States, Congress, House. Space Resources Institute Act. *Congress*, 116th Congress, House Bill 1029, introduced 06 Feb. 2019. [www.congress.gov/116/bills/hr1029/BILLS-116hr1029ih.pdf](http://www.congress.gov/116/bills/hr1029/BILLS-116hr1029ih.pdf).



Resource Act, the defense of the right of private entities to claim property rights over space resources.

In the United States, the private sector is investing in and developing the technology needed to explore and use space resources. With the United States growing private space industry, a clear legal framework on property rights over space resources is needed. Analyzing international agreements on the rights and responsibility of the private and public sectors in regards to the use and exploration of outer space is significant for two reasons. On the side of securing private investments in space activities, in order for large investments to be made in missions that utilize space of resources be it in celestial bodies such as the moon or near-Earth objects like asteroids, investors need assurance that they legally own the resources that they obtain in space. On the other hand, given the growing investments in the private space industry, an unclear legal framework on the rights and responsibility in obtaining resources from outer space can risk setting customary international law that did not involve international input, a law which could arguably be in contradiction to past international agreements.<sup>77</sup>

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<sup>77</sup> Coffey, "Establishing a Legal Framework" 127.

## Chapter 2

### Space Exploration and Commercialization

"Human beings aren't heading to the stars to become poor."

Takeshi Hakamada, CEO of iSpace<sup>78</sup>

This chapter describes a range of space-related initiatives to provide the necessary factual background for understanding the economic and social importance of outer space. I begin with introducing the contemporary commercialization of outer space and the United States civil space agency. Then there is a summary of American space exploration narratives since the Eisenhower administration to the Trump administration to demonstrate the shift towards seeing current space initiatives as falling under a “new paradigm” in which commercial involvement is of increasing value. Following the discussion of Trump’s administration's space exploration narratives is a review of the growing space economy. The latter part of the chapter provides information public-private partnerships, and the visions of the three major private aerospace companies: SpaceX, Virgin Galactic, and Blue Origin.

#### The Commercialization of Outer Space

Outer space has become increasingly commercialized. In the “new paradigm” of outer space use and exploration, significant investments are being made by both the public and private sectors. According to The Space Foundation’s annual report on the global space industry, there is a 200 percent increase in the number of commercial spacecrafts deployed<sup>79</sup> and a reported \$17.8 Billion has been invested in the more than 600 emerging space companies founded between the

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<sup>78</sup> Berrisford, Carl. "Longer Term Investments: Space." *UBS*, 30 Nov. 2018, [www.ubs.com/content/dam/WealthManagementAmericas/documents/space-p.pdf](http://www.ubs.com/content/dam/WealthManagementAmericas/documents/space-p.pdf).

<sup>79</sup> "Space Foundation Report Reveals Global Space Economy at \$383.5 Billion in 2017." *Space Foundation*, 19 July 2018, Accessed 16 Apr. 2019, [www.spacefoundation.org/news/space-foundation-report-reveals-global-space-economy-3835-billion-2017](http://www.spacefoundation.org/news/space-foundation-report-reveals-global-space-economy-3835-billion-2017).

years 2000-2018.<sup>80</sup> Three billionaires, Elon Musk, Richard Branson, and Jeff Bezos are leading private space initiatives with their respective companies SpaceX, Virgin Galactic, and Blue Origin.<sup>81</sup> Private aerospace companies are not working independently, public-private partnerships are a defining feature of contemporary space activity.

### The United States Civil Space Agency

The United States runs the largest civil space agency in the world: the National Aeronautics and Space Administration (NASA), created under the 1958 National Aeronautics and Space Act.<sup>82</sup> NASA was created for the purpose of national defense during the Cold War when the United States and the Soviet Union engaged in a space race to show superiority in their scientific and technical capacities. In July 1969, NASA's Apollo 11 mission landed the first two people on the moon. After the Cold War, Russia, the United States, and international partner joined together in 1993 to construct the International Space Station (ISS).<sup>83</sup>

The International Space Station is a habitable artificial satellite in low Earth orbit. Its first components were launched into space in 1998 and the first astronauts took residence in the space station in 2000. Since the year 2000, approximately 230 individuals from 18 countries have visited the ISS.<sup>84</sup> Continuously occupied, the ISS has aided in more than 2,500 research and technology development investigations and generated more than 2,100 scientific publications across various fields. For example, the space station is able to observe and monitor real-time

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<sup>80</sup> Northern Sky Research. "The Emerging Space Market: \$17.8 Billion in Investment to Date and Climbing." *GlobeNewswire*, 12 Feb. 2019, Accessed 16 Apr. 2019. [www.globenewswire.com/news-release/2019/02/13/1724270/0/en/The-Emerging-Space-Market-17-8-Billion-in-Investment-to-Date-and-Climbing.html](http://www.globenewswire.com/news-release/2019/02/13/1724270/0/en/The-Emerging-Space-Market-17-8-Billion-in-Investment-to-Date-and-Climbing.html).

<sup>81</sup> Smith, Matthew. "Commercialized Space and You." *Harvard University*, 11 June 2018, Accessed 16 Apr. 2019. [sitn.hms.harvard.edu/flash/2018/commercialized-space-and-you/](http://sitn.hms.harvard.edu/flash/2018/commercialized-space-and-you/)

<sup>82</sup> National Aeronautics and Space Act of 1958, Pub. L. No. 85-568, 72 Stat. 426-438 (Jul. 29, 1958)

<sup>83</sup> <https://www.history.nasa.gov/factsheet.htm>

<sup>84</sup> Garcia, Mark, editor. "International Space Station Facts and Figures." *NASA*, 21 Mar. 2019, Accessed 16 Apr. 2019. [www.nasa.gov/feature/facts-and-figures](http://www.nasa.gov/feature/facts-and-figures).

weather, crops, and the global climate.<sup>85</sup> Not only is the ISS an example of international cooperation in outer space but it also functions for the benefit of humanity.

Currently, NASA has ambitious goals for the coming years. In alignment with the goals of the current administration, which are to strengthen current human spaceflight efforts, ensure US leadership in space, grow the space economy in low-Earth orbit, and extend the US presence further into the solar system;<sup>86</sup> NASA's fiscal year 2019 budget request is \$19.9 billion; of which \$10.5 billion is to be directed to space exploration and missions for the return of humans to the moon, as well as a human mission to Mars and other destinations.<sup>87</sup>

NASA sees the next step for reaching the goal of extending US presence around and on the moon, and further into the solar system, as the US having a presence near the moon's orbit through the operation of a US-led lunar orbital platform called the "Gateway". The Gateway is expected to be constructed and deployed in the early-mid 2020s, it will serve to support human and robotic missions on and around the Moon and missions further into the solar system, including Mars. The Gateway would serve to advance the development of US industry and ensure US global leadership in the growing domain of space, which will allow the US to "chart the course by which others may join" and "set "rules of the road" for activities in space".<sup>88</sup> The Gateway will also play a part in NASA's plans to send American astronauts to the moon by 2024 with the help of public-private partnerships. In preparation for returning astronauts to the moon's

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<sup>85</sup> *International Space Station Benefits for Humanity*. National Aeronautics and Space Administration, Apr. 2019. NASA, [www.nasa.gov/sites/default/files/atoms/files/benefits-for-humanity\\_third.pdf](http://www.nasa.gov/sites/default/files/atoms/files/benefits-for-humanity_third.pdf).

<sup>86</sup> *Gateway Memorandum for the Record*. National Aeronautics and Space Administration, 2 May 2018. NASA, [www.nasa.gov/sites/default/files/atoms/files/gateway\\_domestic\\_and\\_international\\_benefits-memo.pdf](http://www.nasa.gov/sites/default/files/atoms/files/gateway_domestic_and_international_benefits-memo.pdf).

<sup>87</sup> *FY 2019 Budget Estimates*. National Aeronautics and Space Administration, NASA, [www.nasa.gov/sites/default/files/atoms/files/Nasa\\_fy\\_2019\\_budget\\_overview.pdf](http://www.nasa.gov/sites/default/files/atoms/files/Nasa_fy_2019_budget_overview.pdf).

<sup>88</sup> *Gateway Memorandum*.

surface NASA will send science and technology to the lunar surface, as NASA Administrator Jim Bridenstine explains:

Using new landers, robots and eventually humans, we will conduct science and technology demonstrations across the entire lunar surface of the Moon to learn more about resources on the Moon and how we can use them for future exploration... We will move forward to the Moon, this time to stay. And then we'll take what we learn on the Moon, and go to Mars.<sup>89</sup>

Analyzing the current plans of NASA it is clear that the United States plans to continue its partnerships with private aerospace companies, further explore the solar system including the Moon and Mars, and learn more about space resources and how they can be utilized for future, possibly long-term, exploration of outer space.

#### American Space Exploration Narratives

Since the founding of the United States civil space agency under President Eisenhower, the narratives behind American space initiatives have changed in each administration. Dora Holland and Jack O. Burns<sup>90</sup> analysis of US policy releases, leadership statements, and policy recommendations related to space exploration—from the Eisenhower through the Obama administration—has revealed five themes in American space exploration: competition, prestige, collaboration, leadership, and “a new paradigm.” In the beginning of the “space age” during the Eisenhower administration (1953–1961) through the Nixon administration (1969–1974), with the rivalry between the United States and the Soviet Union during the Cold War (1955–1991), there was a strong presence of competition in space exploration narratives. The theme of competition was much less prevalent after the Reagan administration (1981–1989).

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<sup>89</sup> "Sending American Astronauts to Moon in 2024: NASA Accepts Challenge." *NASA*, 9 Apr. 2019, [www.nasa.gov/feature/sending-american-astronauts-to-moon-in-2024-nasa-accepts-challenge](http://www.nasa.gov/feature/sending-american-astronauts-to-moon-in-2024-nasa-accepts-challenge).

<sup>90</sup> Holland, Dora, and Jack O. Burns. "The American Space Exploration Narrative from the Cold War Through the Obama Administration." *Space Policy*, vol. 46, Nov.2018, p. 9-17. *ScienceDirect*.

American prestige, in this case, the narrative that the United States success in space initiatives will increase its status globally, has been an important theme from the Eisenhower to the Obama administration.<sup>91</sup> As the theme of American prestige, the rhetoric of international collaboration in American space initiatives was present from the Eisenhower to the Obama administration. During the Cold War, the theme of international collaboration dominated in the Nixon and Reagan administrations, this can be attributed to the United States reaching out to its allies to surpass the Soviet Union in its space initiatives.<sup>92</sup>

The theme of American leadership was also consistently present throughout the administrations, it peaked during the Reagan Administration (1981–1989). It then decreased during the Clinton (1993-2001) and George W. Bush administration (2001-2009) and rose again during the Obama administration (2009-2017). The authors note that the narrative of international collaboration in space took place simultaneously with the narratives of American leadership in space.<sup>93</sup> The final theme, a “new paradigm”, meaning that we are in a new era of space exploration, first appeared during the Reagan administration (1981–1989) and peaked during the George H. W. Bush administration (1989-1993).

Two themes stand out under the current Trump administration: (1) the narrative of American leadership in space, as seen in the rhetoric of government officials and in the administration’s space policy, and (2) the idea a “new paradigm” is reflected in the importance placed on the private sectors’ involvement in space initiatives.

At the second meeting of the National Space Council, relaunched by the Trump administration in June 2017 to more efficiently coordinate national space policy, Vice President

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<sup>91</sup> Holland and Burns, “The American Space Exploration Narrative”.

<sup>92</sup> Holland and Burns, “The American Space Exploration Narrative”.

<sup>93</sup> Holland and Burns, “The American Space Exploration Narrative”.

Pence gave his remarks on the significance of outer space to the future of the United States.

Pence views the progress in outer space activities as influential to the leadership of the United States, and public-private partnerships being essential to achieving success in American domination of outer space. In his remarks, Pence parallels the exploration of outer space to the western frontier, he says:

Not long ago, no one would have dreamt of landing a vehicle on an asteroid to mine its minerals, or opening a private space station for tourists, scientists, and entrepreneurs, or operating a satellite refueling station hundreds of miles above the Earth. But today, these are all emerging businesses. And like the railroads that opened up the American West to explorers and entrepreneurs, these technologies will extend the range of American action and values into new worlds, and usher in a new era of job creation and innovation driven by space.<sup>94</sup>

Since the 1950s, human involvement in outer space has crossed from imagination to reality.

There is an acknowledgment that the visions of the exploration and exploitation of outer space are not the wild dreams of a few but is being worked towards with the investment of billions of dollars by both public and private investors and the work of thousands of people in the space industry. Outer space is being framed as a new frontier with promising economic and social potential to create “new businesses and entire enterprises” with “no limit to the jobs and prosperity that will be created across this country”.<sup>95</sup> Now, “at the dawn of a new era of American leadership in space” and the vital role of private aerospace companies in the achievement of space initiatives, Pence’s sees no reason that the “federal government should stand in the way of the trailblazing companies that are forging and re forging American leadership in space”.<sup>96</sup> Under the Trump administration, there is a willingness to “discuss new

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<sup>94</sup> Pence, Mike. "Remarks by Vice President Pence at Second Meeting of the National Space Council." 21 Feb. 2018. *White House*, Speech.

[www.whitehouse.gov/briefings-statements/remarks-vice-president-pence-second-meeting-national-space-council/](http://www.whitehouse.gov/briefings-statements/remarks-vice-president-pence-second-meeting-national-space-council/).

<sup>95</sup> Pence, “Second Meeting of the National Space Council”.

<sup>96</sup> Pence, “Second Meeting of the National Space Council”.

policy recommendations to break down” the “bureaucratic hurdles” facing private aerospace companies. In the current administration, two narratives are strongly present, the first being that American leadership in space is a priority and the second, that achieving American leadership in space requires the cooperation between the public and private sector. In addition, attention is being placed on the creation of new policies which align with the two narratives of the administration, especially the latter which favors the space initiatives of the private sector.

### The Space Economy

Investments in outer space are projected to grow significantly, in part due to investments being made by the billionaires Elon Musk, Richard Branson, and Jeff Bezos and advances in rocket and satellite technology such as the development of reusable rocket technology. As of 2018 the value of the space economy stood at USD 340 billion and is forecasted to grow to USD 1 trillion over the next two decades. The cost of launching space services is predicted to decline 10-fold over the next decade due to the development of reusable rocket technology. The reuse of rockets makes space more economically accessible, for example, SpaceX’s reusable rocket Falcon 9 v1.1 cost USD 22 million to construct but only USD 4 million to refurbish.<sup>97</sup> Currently, government and military use of outer space dominate, with a quarter of the approximately 1,500 satellites currently in orbit being used for military purposes and three-quarters of space spending stemming from military or surveillance applications.<sup>98</sup> But with the growth of private sector investment in space, there is increasing opportunities to use space for other opportunities such as space tourism, asteroid mining and space-based manufacturing. Multinational investment bank UBS sees the potential of the growing space economy to play a role in sustainability as it can

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<sup>97</sup> O’Connell, Cathal. "Launch, Land, Repeat - Reusable Rockets Explained." *Cosmos Magazine*, 6 Feb. 2018, [cosmosmagazine.com/space/launch-land-repeat-reusable-rockets-explained](https://cosmosmagazine.com/space/launch-land-repeat-reusable-rockets-explained).

<sup>98</sup> Berrisford, "Longer Term Investments: Space”.



“provide solutions to address environmental and resource scarcity issues arising from urbanization and population growth”.<sup>99</sup>

*Space Tourism, Asteroid Mining and Space-Based Manufacturing*

Three major future developments in the space economy are space tourism, asteroid mining and space-based manufacturing. As of November 2018, 550 people have been to space. In 2001, the first space tourist, Dennis A. Tito, paid USD 20 million to spend eight days in orbit inside the international space station. Eighteen years later, the prepaid cost for a 90-minute flight to sub-orbital space with Virgin Galactic (which offers a few minutes of weightlessness and a view of the earth curvature) is priced at USD 250,000 a ticket: in February 2019 the company’s first test flight with humans abroad was successfully completed.<sup>100</sup>

In the case of asteroid mining, it has not yet happened but there are companies working towards making it a reality. The company Planetary Resources is currently collecting data for global hydration mapping which will help in the construction of the first commercial mine in outer space.<sup>101</sup> Asteroid mining is argued to have the potential to “help eliminate the scarcity of several resources on Earth, as well as transfer the pollutive aspects of mineral extraction off planet”, as asteroids can contain large quantities of water, carbon, phosphorus, and precious metals like platinum.<sup>102</sup>

Space-based manufacturing is already happening in outer space. Currently, in the international space station, space-based manufacturing is done by 3D printers for the

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<sup>99</sup> Berrisford, "Longer Term Investments: Space".

<sup>100</sup> Culliford, Elizabeth. "Virgin Galactic's First Test Passenger Gets Commercial Astronaut Wings." Edited by Leslie Adler. *Reuters*, 9 Apr. 2019. Accessed 23 Apr. 2019.

[www.reuters.com/article/us-space-exploration-wings/virgin-galactics-first-test-passenger-gets-commercial-astronaut-wings-idUSKCN1RL2SO](http://www.reuters.com/article/us-space-exploration-wings/virgin-galactics-first-test-passenger-gets-commercial-astronaut-wings-idUSKCN1RL2SO).

<sup>101</sup> Berrisford, "Longer Term Investments: Space".

<sup>102</sup> Berrisford, "Longer Term Investments: Space".

manufacture of tools and parts. The development of robotics and artificial intelligence will advance the capacity of space-based manufacturing and will be essential to future space activities involving long-duration space missions and the construction of infrastructure on the moon, planets, or free-space settlements.

### NASA Partnerships

Public-private partnerships play a significant role in working towards realizing the exploration and exploitation of outer space. The private aerospace company SpaceX, has demonstrated the value of private-public partnerships for space travel and exploration. SpaceX made history on May 24, 2012, when its Dragon spacecraft became the first commercial vehicle to deliver cargo to the International Space Station and safely return cargo to Earth, this had only previously been accomplished by four governments—the United States, Russia, Japan, and the European Space Agency.<sup>103</sup> The partnership between NASA and SpaceX pushes commercial innovation. Commercial businesses in the space industry focus on profits, in effect, reducing costs and increasing efficiency allowing for NASA to both save money and focus more on space travel and exploration.<sup>104</sup>

NASA has created new forms of private-public partnerships which push commercial innovation in the space industry. NASA's public-private partnerships are a "form of *partial privatization* through competitive sourcing contracts".<sup>105</sup> Traditionally, NASA's partnerships with the private sector, such as Boeing and Lockheed Martin, have been on a "cost-plus" where "companies are reimbursed the cost of a project plus a guaranteed profit" while under new

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<sup>103</sup> Grantham, Kristin. "SpaceX Makes History." *SpaceX*, 25 May 2012, [www.spacex.com/press/2012/12/19/spacex-makes-history](http://www.spacex.com/press/2012/12/19/spacex-makes-history).

<sup>104</sup> Anderson, Chad. "Rethinking Public-Private Space Travel." *Space Policy*, vol.29, Nov. 2013, p. 266-71. *Science Direct*, doi:10.1016/j.spacepol.2013.08.002.

<sup>105</sup> Anderson, "Rethinking Public-Private Space Travel" 268.

agreements “NASA pays in increments once milestones are met”<sup>106</sup> the added efficiency and cost-effectiveness of this newer model is seen in SpaceX’s ability to build the Falcon 9 launch vehicle for one-third of NASA’s estimate.<sup>107</sup>

Public-private partnerships in the space industry impact the private sector, public sector, and society.<sup>108</sup> NASA’s performance-based payment in its public-private partnerships can be said to create competition and increased innovation. In the case of the international space station, the public sector benefits from public-private partnerships in the space industry through cost savings and an increase in public sovereignty, as the US can increasingly partner with the American private space industry instead of continuing its reliance on foreign governments for costly transport to the International Space Station.<sup>109</sup>

### The Three Major Private Aerospace Companies

#### *SpaceX—Elon Musk*

Space Exploration Technologies (SpaceX) is a private aerospace company founded in 2002 by Elon Musk, the owner of the automobile company Tesla and co-founder of PayPal and Zip2. As of spring 2018, the company was valued at \$25 billion.<sup>110</sup> SpaceX’s mission is to “enable humans to become a spacefaring civilization and a multi-planet species by building a self-sustaining city on Mars”.<sup>111</sup> On September 17, 2018, SpaceX announced its plan to fly its first private passenger, Japanese entrepreneur Yusaku Maezawa, around the moon in 2023. This

<sup>106</sup> Anderson, "Rethinking Public–Private Space Travel" 268.

<sup>107</sup> Falcon 9 Launch Vehicle NAFCOM Cost Estimates. NASA Associate Deputy Administrator for Policy. Aug 11. [https://www.nasa.gov/pdf/586023main\\_8-3-11\\_NAFCOM.pdf](https://www.nasa.gov/pdf/586023main_8-3-11_NAFCOM.pdf)

<sup>108</sup> Anderson, "Rethinking Public–Private Space Travel".

<sup>109</sup> Anderson, "Rethinking Public–Private Space Travel".

<sup>110</sup> Hull, Dana, and Tom Metcalf. "SpaceX's Valuation Climbs to \$25 Billion with New Funding Round." *Bloomberg*, 12 Apr. 2018,

[www.bloomberg.com/news/articles/2018-04-12/spacex-s-valuation-climbs-to-25-billion-with-new-funding-round](http://www.bloomberg.com/news/articles/2018-04-12/spacex-s-valuation-climbs-to-25-billion-with-new-funding-round).

<sup>111</sup> "Elon Musk." *SpaceX*, Accessed 26 Apr. 2019. [www.spacex.com/elon-musk](http://www.spacex.com/elon-musk).

private passenger flight will serve to fund the development of SpaceX's single system Super Heavy rocket (booster) and Starship (ship). Starship will replace SpaceX's current Falcon vehicles used for delivering satellites to Earth's orbit and cargo to the International Space Station.

Starship will be able to deliver cargo and people, and in the future as much as a hundred people to the surface of the Moon or Mars. The current timeline for the mission to Mars is the delivery of cargo to Mars in 2022 for the study of the planet and initial establishment of infrastructure then a target year of 2024 for the delivery of cargo and people to Mars to begin the development of a Mars base, the foundation of human civilization on Mars.<sup>112</sup> The reason SpaceX gives for its ambitions to colonize Mars is not only to make humans a multiplanetary species and push the space frontier forward, but to also have a "Plan B" in the case of a nuclear war, if such a thing was to happen, Musk says, "we want to make sure there's enough of a seed of civilization somewhere else to bring civilization back and perhaps shorten the length of the dark ages. I think that's why it's important to get a self-sustaining base, ideally on Mars, because it's more likely to survive than a moon base".<sup>113</sup>

#### *Virgin Galactic—Richard Branson*

Virgin Galactic is the world's first commercial company in the space tourism industry,<sup>114</sup> founded in 2004 by Richard Branson—founder of the Virgin Group. The vision of the company is not the colonization of space but to facilitate space tourism. Virgin Galactic's goal is to be able

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<sup>112</sup> "Making Life Multiplanetary." *SpaceX*, [www.spacex.com/mars](http://www.spacex.com/mars).

<sup>113</sup> Robinson, Melia. "Elon Musk Wants to Colonize Mars with SpaceX—Here's What He Said It Will Be like as One of the First Residents." *Business Insider*, 11 Mar. 2018, Accessed 23 Apr. 2019. [www.businessinsider.com/elon-musk-colonization-of-mars-sxsw-2018-3?utm\\_source=feedburner&utm\\_medium=referral](http://www.businessinsider.com/elon-musk-colonization-of-mars-sxsw-2018-3?utm_source=feedburner&utm_medium=referral).

<sup>114</sup> "About Virgin Galactic." *Virgin Galactic*, [www.virgingalactic.com/articles/vss-unity-prepares-for-fifth-supersonic-powered-test-flight/](http://www.virgingalactic.com/articles/vss-unity-prepares-for-fifth-supersonic-powered-test-flight/).

to send paying customers to space. Virgin Galactic frames their commercial pursuits in the context of space being the great unifier. By creating the technology needed to reliably and safely travel to space, private sector investment in space initiatives will increase, resulting in innovation and expansion needed to bring an increasing number of people to space with potentially global impacts.<sup>115</sup> Representatives of Virgin Galactic have expressed the belief in the “overview effect”—a “perspective-altering experience” that can come from seeing the Earth from outer space, the experience can produce a “feeling of awe for the planet, a profound understanding of the interconnection of all life, and a renewed sense of responsibility for taking care of the environment”.<sup>116</sup> As of 2019, there are over 600 people from more than 50 countries who have reserved tickets to fly to space with Virgin Galactic.<sup>117</sup> On December 13, 2018, Virgin Galactic’s spacecraft SpaceShipTwo successfully reached space for the first time, making history as the first crewed commercial spacecraft, built for passenger service, to reach space.<sup>118</sup> Speaking of this milestone, George Whitesides, CEO of Virgin Galactic, said:

What we witnessed today is more compelling evidence that commercial space is set to become one of the twenty-first century’s defining industries. Reusable vehicles built and operated by private companies are about to transform our business and personal lives in ways which are as yet hard to imagine. New enterprises are being created which will become hugely valuable, while enabling humanity to better manage some of its greatest future challenges.<sup>119</sup>

Virgin Galactic sees itself participating in an industry that has the potential to make significant profit while also contributing to the betterment of humanity and the challenges faced on Earth.

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<sup>115</sup> "Vision: Where We're Heading." *Virgin Galactic*, Accessed 26 Apr. 2019. [www.virgingalactic.com/vision/](http://www.virgingalactic.com/vision/).

<sup>116</sup> "Video: Overview Effect." *Solar System Exploration Research Virtual Institute*, NASA, Accessed 26 Apr. 2019. [sservi.nasa.gov/articles/video-overview-effect/](https://sservi.nasa.gov/articles/video-overview-effect/).

<sup>117</sup> "About Virgin Galactic".

<sup>118</sup> "Richard Branson Welcomes Astronauts Home from Virgin Galactic's Historic First Spaceflight." *Virgin Galactic*, 12 Dec. 2018, [www.virgingalactic.com/articles/first-space-flight](http://www.virgingalactic.com/articles/first-space-flight).

<sup>119</sup> "Virgin Galactic's Historic First Spaceflight".

*Blue Origin—Jeff Bezos*

Blue Origin is a private American aerospace company founded in 2000 by Jeff Bezos, the CEO and founder of Amazon and current richest person in the world.<sup>120</sup> Blue Origin is building its experience with rocket systems by sending commercial, research and education payloads to space. The company hopes to soon develop the technology needed to enable private human access to space. In 2019, Blue Origin expects to send its first commercial flight for paying passengers past the Kármán line—the internationally recognized boundary of space which lies at an altitude of 100 kilometers (62 miles) above Earth's sea level.<sup>121</sup> In a private talk at the Yale Club in New York, Jeff Bezos spoke of his ultimate vision for the future of humans.<sup>122</sup> Bezos vision is “a future where millions of people are living and working in space”.<sup>123</sup> In his lecture, before he explains his vision, Bezos criticizes the idea of settling Mars; the long-term vision of Elon Musk and his aerospace company SpaceX. Bezos does not support what he calls the “Plan B” argument for colonizing space, meaning that we will want to have the option of living on another planet such as Mars in the case that the Earth gets destroyed or becomes uninhabitable by a force such as an asteroid or climate change. Instead, Bezos sees the Earth as the “gem of the solar system” and we need to go to space, not because of a “Plan B” but to protect the Earth. In addition to protecting the Earth, Bezos hopes to prevent what he refers to as the stagnation of civilization: “population control combined with energy rationing”. Preventing population control and energy rationing are the long-term social problems that Bezos’ Blue Origin seeks to address.

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<sup>120</sup> Kroll, Lusia, and Kerry A. Dolan, editors. "Billionaires: The Richest People in the World." *Forbes*, 5 Mar. 2019, [www.forbes.com/billionaires/list](http://www.forbes.com/billionaires/list).

<sup>121</sup> Mosher, Dave. "Jeff Bezos Just Gave a Private Talk in New York. From Utopian Space Colonies to Dissing Elon Musk's Martian Dream, Here Are the Most Notable Things He Said." *Business Insider*, 23 Feb. 2019. Accessed 16 Apr. 2019.

<sup>122</sup> Mosher, “Jeff Bezos Private Talk in New York”.

<sup>123</sup> "Our Vision." *Blue Origin*, Accessed 26 Apr. 2019. [www.blueorigin.com/](http://www.blueorigin.com/).

On the topic of energy, Bezos states that although the Earth is finite the long-term problem is not that humans will run out of minerals, something that he says has for long been predicted but has yet to come true, but that more energy will be needed to support increased development and population growth. Bezos explains that we currently use solar panels on a small scale, gathering only a very small fraction of the solar energy that enters Earth. He argues that if we were to compound the current global energy usage by just a few percents a year for a few hundred years the entire surface of Earth would have to be covered in solar panels to provide the amount of energy needed. According to Bezos, in the future, everyone on Earth “is going to want to be a first-world citizen using first-world amounts of energy” with the current “first-world citizen” wanting to use even more energy than they do now. Bezos recognizes that the demand for energy is projected to increase in the future and that meeting that demand is a pressing issue.

Bezos advocates for an increase in the human population. He argues that our solar system has the capacity to support a trillion humans and by having such a large population civilization would improve by having for example, “1,000 Mozarts, and 1,000 Einsteins”. In his vision a population of a trillion humans will be made possible by humans living further out in the solar system, thus being able to capture more solar energy and use the natural resources available in space. The first step in his plan is to build a “low-cost, highly operable, reusable launch vehicle”. For the future of human civilization, Bezos envisions not colonizing other planets in our solar systems such as the planet Mars, but instead creating our own habits in space such as those envisioned by physicist Gerard O’Neill in the 1970s. As described in the introduction, O’Neill hypothesized that instead of colonizing planets it would be better to build our own habitats close to Earth. In Bezos vision, space colonies in orbital vehicles would house millions of people who

would both live and work there, it would be used for heavy industry while Earth would “be zoned residential and light industry”. Bezos sees the transition to heavy industry taking place in space as “natural” given that “the energy and resources will be so much cheaper off-planet that industries will naturally gravitate to those lower-cost environments”.<sup>124</sup>

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<sup>124</sup> Mosher, “Jeff Bezos Private Talk in New York”.



## Chapter 3

### Climate, Capitalism, and the Environment

Chapter 1 focused on the use, benefits, and appropriation of outer space through a content analysis of two international treaties, a legal declaration, and a United States bill. The divergent views of these documents made it clear that there is national and international ambiguity concerning the rights and responsibilities of public and private actors engaged in space activities. Chapter 2 presented information on the American public and private sectors' engagement in space initiatives; it stated the economic growth and potential of the space industry along with the visions of the three major private aerospace companies. This third chapter explores environmental and social problems that are being faced on a global level. It provides a foundation for the concern over the possibility of space initiatives to further alienate humans from the Earth to the negative effect of exacerbating contemporary global issues.

Climate change, meeting energy demands, population growth, and development are recurring factors in the discussion of space initiatives, especially those arguing for the extension of human life into outer space. This chapter will begin by providing a factual background of these topics, important for understanding the theories which follow and their application to space initiatives. As interpreted by environmental sociologist John Bellamy Foster, I introduce an environmental perspective of Max Weber's theory of rationalization, the idea of the transition from pre-industrial capitalism's traditional-organic world to modern capitalism's rational-inorganic world. To illustrate the transition, industrial agriculture is used as an example of a rational-inorganic development. Industrial agriculture is also used as an example of what Foster identifies as Karl Marx's Metabolic Rift, the inability of industrialization to maintain the

fertility of the soil as preserved by the organic cycles of nature. Following Weber and Marx will be the papal encyclical by Pope Francis, this religious text engages with the topics of technology, human values, and the environment. It will be placed in dialogue with the environmental interpretations of Weber and Marx. Hannah Arendt's idea of Earth Alienation serves to bridge the ideas presented on Weber, Marx, and Pope Francis to contemporary space initiatives. This chapter puts forth the argument that technological and scientific developments in the field of aerospace are advancing at a speed which requires reflection on what extending human life and artificial creations into outer space means for the future of humanity, Earth, and other living organisms.

### *Climate Change and Energy Consumption*

Humans are a geophysical force, as a whole our species possess the power to change the physical Earth and its atmosphere. Writing during the peak of the Second World War, Russian-Ukrainian scientist Vladimir Vernadsky reflects on what he sees as the transition from a biosphere to a noösphere. The biosphere is the “domain of life” extending from the Earth's troposphere to below its surface, it includes “inert matter” and “living matter”. Vernadsky saw the power and destruction of WWII as not just a historical event but as “a part of a single great *geological process*”;<sup>125</sup> evidence of humankind's place as the most powerful organism on the planet. This change of position of power has brought about the noösphere: “the *reconstruction of the biosphere in the interests of freely thinking humanity as a single totality*”.<sup>126</sup> In this changed biosphere—the noösphere—humans as a whole are able to change the planet and its atmosphere. For example, the energy use of a single human has a negligible effect on the Earth's atmosphere

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<sup>125</sup> Vernadsky, W. I. "The Biosphere and the Noosphere." *American Scientist*, vol. 33, no. 1, Jan. 1945, p. 1-12. *JSTOR*, 5.

<sup>126</sup> Vernadsky, "The Biosphere and the Noosphere." 9.

but, post-industrial revolution, the energy use of all humans is powerful enough to alter the chemical composition of the atmosphere. Seeing the power of humans in the noösphere led Vernadsky's to believe that, "Man is striving to emerge beyond the boundaries of his planet into cosmic space. And he probably will do so".<sup>127</sup> Shortly after the completion of Vernadsky's article in 1938, the launch of Sputnik I on October 4, 1957, the world's first artificial satellite to orbit the Earth, marked humankind's' extension from the Earth into outer space.<sup>128</sup> Now humans are not only reconstructing the biosphere but are extending their power beyond the boundaries of our planet. With the increasing extension of humanity and its creations into outer space our understanding of humans as a geophysical force, the environment, and our responsibilities as users and manipulators of the environment, needs to keep pace with the advancement of technology.

Human activities resulting in the emission of greenhouse gases is increasing Earth's temperature. Through the burning of fossil fuels, deforestation and agriculture humans are altering the atmosphere and global temperatures; these actions add vast amounts of greenhouse gasses to the atmosphere. The greenhouse gases, carbon dioxide (CO<sub>2</sub>), methane, nitrous oxide, fluorinated gases, trap heat in the Earth's atmosphere resulting in global warming. Since the nineteenth century, the global average temperature increased by 0.85°C. Scientists speculate that an increase of 2°C compared to the pre-industrial average temperature is the limit before rising temperatures pose the risk of severely damaging the global environment.<sup>129</sup> Carbon emissions account for 64% of human-caused global warming and are currently 40% more present in the

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<sup>127</sup> Vernadsky, "The Biosphere and the Noosphere." 10.

<sup>128</sup> NASA. "Sputnik and The Dawn of the Space Age." *NASA*, edited by Steve Garber, 10 Oct. 2007, Accessed 15 Apr. 2019. [history.nasa.gov/sputnik/](http://history.nasa.gov/sputnik/).

<sup>129</sup> "Causes of Climate Change." *European Commission*, Accessed 23 Apr. 2019. [ec.europa.eu/clima/changecauses\\_en](http://ec.europa.eu/clima/changecauses_en).

atmosphere than when industrialization began. Currently, humans are not on track to reducing global carbon emissions from the burning of fossil fuels. Since 1970, global carbon emissions have increased by about 90%, with industry responsible for approximately 78% of the increase of greenhouse gas emissions from 1970 to 2011 and agriculture and deforestation making the second-largest contribution to global greenhouse gas emissions.<sup>130</sup> More recently in 2017, carbon emissions from energy consumption increased by 1.6% a step backward in reducing global warming.<sup>131</sup>

### *Population Growth and Development*

The global population is increasing dramatically. In 2017, the Department of Economic and Social Affairs of the United Nations Secretariat found that the current global population of 7.6 billion is expected to grow to 9.8 billion in 2050, and 11.2 billion in 2100.<sup>132</sup> Population growth is concentrated in the poorest countries—between the years 2010-2015 the group of 47 least developed countries held a fertility rate of 4.3 births per woman, while for the same time period Europe's fertility rate of 1.6 births per woman stood below the replacement level of 2.1 births per woman.<sup>133</sup>

Although the global population is increasing and is concentrated in the poorest countries it is important to make clear that population growth does not equate with higher energy consumption. An analysis of the average carbon emissions per person for 185 countries between

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<sup>130</sup> "Global Greenhouse Gas Emissions Data." *United States Environmental Protection Agency*, [www.epa.gov/ghgemissions/global-greenhouse-gas-emissions-data](http://www.epa.gov/ghgemissions/global-greenhouse-gas-emissions-data). Accessed 23 Apr. 2019.

<sup>131</sup> *BP Statistical Review of World Energy*. Technical report no. 67, BP, June 2018, [www.bp.com/content/dam/bp/business-sites/en/global/corporate/pdfs/energy-economics/statistical-review/bp-stats-review-2018-full-report.pdf](http://www.bp.com/content/dam/bp/business-sites/en/global/corporate/pdfs/energy-economics/statistical-review/bp-stats-review-2018-full-report.pdf).

<sup>132</sup> "World Population Projected to Reach 9.8 Billion in 2050, and 11.2 Billion in 2100." *United Nations*, 21 June 2017, [www.un.org/development/desa/en/news/population/world-population-prospects-2017.html](http://www.un.org/development/desa/en/news/population/world-population-prospects-2017.html).

<sup>133</sup> "World Population Projected"

the years 1980 and 2005 shows that many of the nations with the slowest population growth rate had the fastest growth rates for carbon emissions, while many of the nations with the fastest population growth had the slowest growth rates in carbon emissions.<sup>134</sup> Energy use is associated more with the economy than population growth. While energy use through the burning of fossil fuels is increasing in low- and middle-income economies, high-income economies consume almost five times as much energy per capita.<sup>135</sup> Population growth does not cause an increase in greenhouse gas emissions, the consumption of goods and services that require the emittance of greenhouse gases does.<sup>136</sup>

With high energy consumption in developed countries and an increasing global population concentrated in developing countries, there is a need to more efficiently use energy resources. In 2015, concern over global sustainability and sustainable development led the United Nations to create 17 Sustainable Development Goals with a target completion year of 2030.<sup>137</sup> Among the Sustainable Development Goals are no poverty, zero hunger, clean water and sanitation, affordable and clean energy, sustainable cities and communities, responsible production and consumption, climate action, life below water and life on land.<sup>138</sup> There are international efforts to guide population and economic growth in a sustainable direction.

In March 2018, the United Nations Office for Outer Space Affairs held a seminar on the “Exploration and Development of Space Opportunities and Issues in the Context of the

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<sup>134</sup> Satterthwaite, David. “The Implications of Population Growth and Urbanization for Climate Change.” *Environment and Urbanization*, vol. 21, no. 2, Oct. 2009, p. 545–567, doi:[10.1177/0956247809344361](https://doi.org/10.1177/0956247809344361).

<sup>135</sup> “Energy Use (kg of Oil Equivalent per Capita).” *The World Bank*, [data.worldbank.org/indicator/EG.USE.PCAP.KG.OE](https://data.worldbank.org/indicator/EG.USE.PCAP.KG.OE).

<sup>136</sup> Satterthwaite “Population Growth and Urbanization”.

<sup>137</sup> “About the Sustainable Development Goals.” *United Nations*, [www.un.org/sustainabledevelopment/sustainable-development-goals/](https://www.un.org/sustainabledevelopment/sustainable-development-goals/). Accessed 23 Apr. 2019.

<sup>138</sup> Sustainable Development Goals.

Sustainable Development Goals”.<sup>139</sup> The report of this seminar establishes that the use of space is beneficial to society in a multiple of ways, such as to: “monitor climate change, survey crops, respond to disasters, learn remotely, achieve gender equality, and more”.<sup>140</sup> The seminar brought together experts for a discussion of how space technology can support international efforts to address climate change and achieve the 17 Sustainable Development Goals. Interestingly, the framework of the discussion was the “Holy See,” the Roman Catholic Church. Referenced in the report is the *Encyclical Letter Laudato Si’ of the Holy Father Francis “On Care for Our Common Home”* by Pope Francis.<sup>141</sup> This encyclical offers an analysis of the social dimensions of contemporary environmental, technological, and social issues.

In sum, thinking about the future of our planet and the quality of life of current and future generations of both humans and non-humans will require an understanding of the global impact of climate change, increasing energy consumption, a growing human population, and developing economies. How space initiatives, be it mining for resources in space, space tourism, or space colonization plays a role in either improving or worsening environmental and social issues on Earth is the topic I put forward, viewing it through the lens of environmental sociology and the complementing idea of earth alienation.

*Max Weber*

Throughout his works sociologist Max Weber wrote of the tension between capitalism and the environment. As interpreted by environmental sociologist John Bellamy Foster, Weber’s

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<sup>139</sup> A/AC.105/2018/CRP.2328 *Report on the United Nations Office for Outer Space Affairs/Holy See Seminar Exploration and Development of Space Opportunities and Issues in the Context of the Sustainable Development Goals*. Report no. A/AC.105/2018/CRP.23, 28 June 2018. *United Nations: Office for Outer Space Affairs*.

<sup>140</sup> A/AC.105/2018/CRP.2328 *Holy See Seminar*.

<sup>141</sup> Francis, Pope. *Laudato Si’: On Care for Our Common Home : Encyclical Letter*. Huntington, Our Sunday Visitor, 2015.

work expressed the idea that the transition from pre-industrial capitalism to modern capitalism also marked the change from living in a traditional-organic world to a rational-inorganic world.

<sup>142</sup> In the traditional-organic world of pre-industrial capitalism, life was under the power of natural cycles; the transition to the rational-inorganic world of modern capitalism freed humans from natural cycles by “substituting inorganic raw materials and means of production for organic raw materials and labor forces”.<sup>143</sup> Modern industrial capitalism’s reliance on the inorganic and its high-resource consumption has resulted in unsustainable rational-inorganic forms of development and high demand on the Earth’s natural resources.<sup>144</sup>

Industrialized agriculture is an example of a rational-inorganic development of modern capitalism. In the traditional-organic world of preindustrial capitalism, the productivity of agriculture was limited by natural cycles and direct solar energy. On the other hand, the rational-inorganic world of modern capitalism increases productivity by the use of inorganic methods such as “fertilizers, irrigation, pest control, and crop architecture through genetic selection”,<sup>145</sup> along with fossil fuels—stored non-renewable solar energy resources such as coal, oil and natural gas.<sup>146</sup> Industrialized agriculture is not only a rational-inorganic development it is also an example of a tension between capitalism and the environment, which carries significant social risks. While rational-inorganic methods increase agricultural productivity, it does so at the expense of the environmental. Industrial agriculture pollutes the air and water and utilizes

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<sup>142</sup> Foster, John Bellamy, and Hannah Holleman. “Weber and the Environment: Classical Foundations for a Postexemptionalist Sociology.” *American Journal of Sociology*, vol. 117, no. 6, 2012, p. 1625–1673. *JSTOR*, [www.jstor.org/stable/10.1086/664617](http://www.jstor.org/stable/10.1086/664617).

<sup>143</sup> Weber, Max, et al. *From Max Weber : Essays in Sociology*. (New York, Oxford UP, 1946) 364.

<sup>144</sup> Foster and Holleman, “Weber and the Environment”, 1636.

<sup>145</sup> Odum, Eugene Pleasants. *Fundamentals of Ecology*. 3rd ed., (Philadelphia, Saunders, 1971) 411.

<sup>146</sup> Odum, *Fundamentals of Ecology* 98.

high-levels of fossil fuels, an energy source which releases carbon gas into the atmosphere when burned.

To sustain the necessary levels of agricultural production for the sustenance of the increasing human population requires addressing how the need for energy resources powering industrial agriculture will be met. Without the use of fossil fuels or another form of energy which could replace it, agricultural production would not be able to sustain the world's population. As Weber notes, the system of modern industrial capitalism consumes natural resources as if they were limitless when in fact some are not.

Industrial capitalism is dependent on the environment because of its reliance on natural resources. Weber wrote of the contradiction between capitalism and its high demand for natural resources, “We must not forget that the boiling heat of modern capitalist culture is connected with headless consumption of natural resources, for which there are no substitutes. It is difficult to determine how long the present supply of coal and ore will last”.<sup>147</sup> Modern capitalism uses resources as if they are limitless however, as Weber points out, the energy resources powering industrial capitalism is a real limiting factor that at some point in time will need to be confronted.

At the end of *The Protestant Ethic and the Spirit of Capitalism*, Max Weber states, “This [modern economic] order is now bound to the technical and economic conditions of machine production which today determine the lives of all the individuals who are born into this mechanism . . . with irresistible force. Perhaps it will so determine them until the last ton of fossil fuel is burnt”.<sup>148</sup> Weber recognizes the significance of technology and economics on the lives of those under its domination. Industrial capitalism is powered by mainly inorganic and

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<sup>147</sup> Weber, Max, et al. *Essays in Sociology* 366.

<sup>148</sup> Weber, Max. *The Protestant Ethic and the Spirit of Capitalism*. Edited by Richard Swedberg, (New York, W.W. Norton, 2009) 95.



non-renewable energy sources and thus its dependence on inorganic methods limited sources of energy is the weakness and threat to its longevity. This issue becomes increasingly relevant given the continuous and increasing transitions from the organic to the inorganic; as we have seen in the example of industrial agriculture—a rational-inorganic development created under the illusion of its power source being unlimited.

Arendt's notion of Earth alienation involves the transition from the organic to the artificial (inorganic). Arendt writes, "a great many scientific endeavors have been directed toward making life also "artificial", toward cutting the last tie through which even man belongs among the children of nature".<sup>149</sup> While humans are able to create the artificial and the inorganic, an ability that separates us from animals, we as a species are nonetheless always tied to the organic. Despite our ability to construct an artificial world our mortality, remains along with our dependence on water, food, and oxygen for survival. As illustrated by the application of industrial agriculture to the environmental interpretation of Weber, the transition from the traditional-organic world of pre-industrial capitalism to the rational-inorganic world of modern capitalism; means that we are increasingly creating a system that is artificial and inorganic, so much so that even the sustenance of billions of people depend on it. However, as we will soon see in the analysis of Marx's Metabolic Rift the artificial world we have created fails to replicate the sustainability of natural cycles. So not only are our developments unsustainable because of the limitedness of the sources of energy which power them but also because we are ruining the inorganic resources which we as humans rely on for our survival.

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<sup>149</sup> Arendt, *The Human Condition 2*.

*Karl Marx*

Sociologist Karl Marx also wrote of the tension between capitalism and the environment. John Bellamy Foster has extended Marx's notion of the "irreparable rift in the interdependent process of the social metabolism"<sup>150</sup> into a theory of Metabolic Rift.<sup>151</sup> As Foster notes, Marx thought of the socio-ecological metabolism as a complex interdependence between humans and nature with factors such as industrialization, urbanization, population and trade affecting the fertility of the soil. In "The Genesis of Capitalist Ground Rent" in *Capital* Volume III, Marx wrote:

Large landed property reduces the agricultural population to an ever decreasing minimum and confronts it with an ever growing industrial population crammed together in large towns; in this way it produces conditions that provoke an irreparable rift in the interdependent process of the social metabolism, a metabolism prescribed by the natural laws of life itself. The result of this is a squandering of the vitality of the soil, which is carried by trade far beyond the bounds of a single country.<sup>152</sup>

The idea of the metabolic rift is that there is a metabolism between nature and society—we grow food, eat it, and through compost and our waste, the nutrients we consumed are returned to the soil from which they came. The large concentration of people in town and urban areas which industrialization is responsible for disrupts the natural cycles which return nutrients to the soil. With low populations in the rural areas which produce the food that feeds large populations in towns and cities, the nutrients of the soil are for the most part moving from rural to urban areas without being returned to the agricultural lands which grew the food. Instead, the nutrients which came from the soil, through the mismanagement of waste, becomes pollutants and the soil of the agricultural lands lose their fertility. Trade creates an even greater rift by further distancing

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<sup>150</sup> Marx, Karl (1863-65) 1981. *Capital*, Vol. 3. New York:Vintage. in Foster, "Marx's Theory of Metabolic Rift"

<sup>151</sup> Foster "Marx's Theory of Metabolic Rift".

<sup>152</sup> Marx, *Capital*, Vol. 3, 949-50 in Foster "Marx's Theory of Metabolic Rift".

agricultural lands and the consumption and release of nutrients that were taken from the soil. In Marx's view, capitalism works through the commodification of land, it exploits the land and disrupts the metabolism created by natural laws and organic cycles.

The idea of capitalism's transition from organic to inorganic, as previously discussed in the environmental interpretation of Weber's writing, is also present in Marx's writing. In the section on modern industry and agriculture in *Capital* Volume I Marx writes:

All progress in capitalistic agriculture is a progress in the art, not only of robbing the labourer, but of robbing the soil; all progress in increasing the fertility of the soil for a given time, is a progress towards ruining the lasting sources of that fertility... Capitalist production, therefore, develops technology, and the combining together of various processes into a social whole, only by sapping the original sources of all wealth—the soil and the labourer.<sup>153</sup>

In the above quote, Marx explains that technological and scientific developments for the increase of the productivity and fertility of the soil, are inorganic methods which destroy the lasting fertility of the soil. The temporary increases of soil fertility by the use of inorganic methods are unsustainable given that technology has not yet been able to replicate the long-lasting level of soil fertility as maintained by the natural laws and cycles before the advent of industrial agriculture.

Today, damage to soil fertility is referred to as desertification—land degradation caused by a combination of climate change and human activities. While food production is expected to increase 70% by the year 2050 in order to feed the world's population, every year 12 million hectares of fertile soil becomes barren.<sup>154</sup> More than half of the world's agricultural land is

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<sup>153</sup> Marx, Karl, and Friedrich Engels. *The Marx-Engels Reader*. Edited by Robert C. Tucker, 2nd ed., (New York, Norton, 1978) 416-17.

<sup>154</sup> "Land and Human Security." *United Nations Convention to Combat Desertification*, [www.unccd.int/issues/land-and-human-security](http://www.unccd.int/issues/land-and-human-security).

classified as either moderately or severely degraded.<sup>155</sup> It is estimated that by the year 2045 as much as 135 million people may be displaced as a result of desertification.<sup>156</sup> Unless land is managed by a more sustainable method, one which can maintain soil fertility as done by the natural cycles and laws of nature, in the future, there will be either mass conflict or mass migration in response to food insecurity.

The concept of ecological sustainability—meaning the stability of Earth's ecological systems, including climate systems, the quality of air, land, and water, land use and soil erosion, biodiversity, and ecosystem services such as pollination and photosynthesis<sup>157</sup>—conflicts with modern industrial capitalism. Using again the example of industrial agriculture, Marx expresses the tension between capitalism and the environment in *Capital* Volume III:

The way that the cultivation of particular crops depends on fluctuations in market prices and the constant change in cultivation with these prices—the entire spirit of capitalist production, which is oriented towards the most immediate monetary profits—stands in contradiction to agriculture, which has to concern itself with the whole gamut of permanent conditions of life required by the chain of successive generations.<sup>158</sup>

In this quote, the idea of time and priority stand out. Because of the availability of inorganic methods to increase the fertility of the soil, what is cultivated in industrial agriculture is decided based on what would make the most profit at the given time—the time is both short-term and constantly changing with the priority always being profit. On the other hand, pre-industrial agriculture is under the power of natural cycles. What is cultivated is dependent on the growing

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<sup>155</sup> "Tackle Causes of Drought, Desertification, Land Degradation, Secretary-General Urges at 'Save the Earth' Exhibition Opening." *United Nations*, 28 Sept. 2016, [www.un.org/press/en/2016/sgsm18160.doc.htm](http://www.un.org/press/en/2016/sgsm18160.doc.htm).

<sup>156</sup> "Land and Human Security." *United Nations Convention to Combat Desertification*, [www.unccd.int/issues/land-and-human-security](http://www.unccd.int/issues/land-and-human-security).

<sup>157</sup> "Ecological Sustainability." *KTH Royal Institute of Technology*, [www.kth.se/en/om/miljo-hallbar-utveckling/utbildning-miljo-hallbar-utveckling/verktygslada/sustainable-development/ekologisk-hallbarhet-1.432074](http://www.kth.se/en/om/miljo-hallbar-utveckling/utbildning-miljo-hallbar-utveckling/verktygslada/sustainable-development/ekologisk-hallbarhet-1.432074). Accessed 16 Apr. 2019.

<sup>158</sup> Marx, *Capital*, Vol. 3, 754. in Foster, "Marx's Theory of Metabolic Rift".

conditions and seasons—the time is long-term and cyclical with the “priority” being sustainability by the maintenance of equilibrium.

In the *Economic and Philosophic Manuscripts* of 1844, Marx explained the interdependence of humans and nature, he states, “Man *lives* on nature—means that nature is his *body*, with which he must remain in continuous interchange if he is not to die. That man’s physical and spiritual life is linked to nature means simply that nature is linked to itself, for man is a part of nature”.<sup>159</sup> Despite the ability of humans to create the inorganic and artificial, they have not yet been able to escape their dependence on nature to meet their needs of food, water, and air for survival. The human is a natural being which relies on nature, they are one and the same.

Marx views the Earth’s land as the heritage of humankind, passed forward through generations. In viewing the land as a commons, Marx rejects private property rights in its management:

From the standpoint of a higher socio-economic formation, the private property of particular individuals in the earth will appear just as absurd as the private property of one man in other men. Even an entire society, a nation, or all simultaneously existing societies taken together, are not owners of the earth, they are simply its possessors, its beneficiaries, and have to bequeath it in an improved state to succeeding generations as *boni patres familias* [good heads of the household].<sup>160</sup>

In this context, the Earth is seen as the heritage of all mankind. It is not to be owned but instead is to be protected for the use of future generations. Marx’s metabolic rift shows a consequence of technology entering the relation between humans and nature, specifically when it is done for the short-term and for the gain of profit. Marx argued that while

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<sup>159</sup> Marx, Karl, and Dirk J. Struik. *Economic and Philosophic Manuscripts of 1844*. (New York, International Publishers, 1997) 112.

<sup>160</sup> Marx, *Capital*, Vol. 3, 911. in Foster, “Marx’s Theory of Metabolic Rift”.

technological developments under capitalism work to further agricultural production it also results in social relations that conflict with modes of sustainable agriculture. Because of this, he saw the solution to problems resulting from industrial agriculture not deriving from innovation in technology and science but a change in social relations towards agriculture. Marx was able to see through a sociological perspective the connection between humans and nature in the context of environmental sustainability at the early stages of industrialization. Not only can sociology be extended to environmental concerns, but it is vital to formulating solutions to the contemporary environmental crisis which at its foundation is a social problem.

The environmental interpretations of Weber and Marx's writing points to the idea that modern industrial capitalism uses inorganic methods that are dependent on limited resources and methods that in the long-term are unsustainable given that they ruin the organic resources which we rely on as humans. As we continue to create an inorganic and artificial world to replace the organic we are damaging the Earth and threatening its preservation for the use of future generations. Taking the stand that the solution to fixing the damage caused by humans to a natural environment is not technical but instead social, what follows is an engagement with the religious work of Pope Francis, who in his papal encyclical letter makes note of the technological and social aspects of the destruction of Earth's environment and the severing of the connection between the Earth and humans.

*Pope Francis*

The *Encyclical Letter Laudato Si' of the Holy Father Francis "On Care for Our Common Home"* by Pope Francis, addresses the social dimension of environmental issues with a

focus on the “spirit of globalized technology”. As discussed earlier, there is global awareness that humans’ exploitation of nature risks the destruction of Earth’s environment and its inhabitants. Thinking in this context, Pope Francis recognizes the advantages of economic growth and the technological advances that followed after the industrial revolution, however, he argues that humanity urgently needs social and moral progress. The human tendency to view the natural environment as an object which is to be used and consumed is directly related to the ongoing destruction of nature; with human-caused environmental issues and climate change having far-reaching social and ecological impacts, from global inequality to the loss of biodiversity.

At the foundation of the environmental crisis is the fact that the global industrial system currently conflicts with natural ecosystems. As explained earlier with Marx’s Metabolic Rift, the industrial system turns to pollution what is part of natural ecosystems. It disrupts interactions between living and nonliving organisms which work in cycles to maintain equilibrium. The industrial system has not yet been able to “adopt a circular model of production capable of preserving resources for present and future generations, while limiting as much as possible the use of non-renewable resources, moderating their consumption, maximizing their efficient use, reusing and recycling them”.<sup>161</sup> At the basic level, our forms of production and consumption are unsustainable in the long term, and in the present, they are damaging the environment and living organisms.

Pope Francis first presents an analysis of the present environmental crisis and its impact on the physical planet and life on Earth. Beginning with the speed of development, he points out

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<sup>161</sup> Francis, *On Care for Our Common Home* 18.

that while change is part of a system, the speed that human activity has developed contrasts starkly with the natural pace of biological evolution. Rapid changes which come from human activities occur without much reflection and without clear goals aimed towards “the common good” and sustainable development. But as we are becoming more aware of our “irrational confidence in progress and human abilities”,<sup>162</sup> there is increasing recognition of the importance of the environment, the need to protect it, and the need to reflect on the impacts of human activities.

The Earth’s climate is necessary for the existence of human life. As discussed at the beginning of the chapter, human-caused climate change has resulted in global warming, the effects of which includes: rising sea levels which put at risk the quarter of the world’s population which lives on or near coastal areas, extreme weather, and by the connectedness of living and nonliving organisms, a host of other phenomena. The major contributor to the emission of greenhouse gases is our global model of development and energy system based on the burning of fossil fuels followed by our uses of the soil, such as agriculture and deforestation. Pope Francis goes into detail on the consequences of global warming’s effect on the carbon cycle. He notes that the carbon cycle affects the availability of essential resources like, “drinking water, energy and agricultural production in warmer regions”,<sup>163</sup> in addition to affecting the acidification of the oceans and thus the marine food chain.

While climate change is typically framed as a problem that will affect future generations, the world's poorest are already experiencing its destructive effects.<sup>164</sup> A strong advocate for

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<sup>162</sup> Francis, *On Care for Our Common Home* 16.

<sup>163</sup> Francis, *On Care for Our Common Home* 19.

<sup>164</sup> *Report: Inequalities Exacerbate Climate Impacts on Poor. United Nations*, [www.un.org/sustainabledevelopment/blog/2016/10/report-inequalities-exacerbate-climate-impacts-on-poor/](http://www.un.org/sustainabledevelopment/blog/2016/10/report-inequalities-exacerbate-climate-impacts-on-poor/). Accessed 16 Apr. 2019.



people facing poverty, Pope Francis points out that the consequences of climate change will be felt worst by the world's poorest. Many people living in poverty are dependent on natural resources for their livelihoods such as agriculture, fishing, and forestry.<sup>165</sup> When the effects of climate change are strongly felt, such as during extreme natural disasters, those with few financial means to respond to the challenges and/or relocate are left to suffer in a multitude of ways. A recent example is tropical cyclone Idai which made landfall over Mozambique in March 2019, affecting neighboring countries Malawi and Zimbabwe. Cyclone Idai was the worst natural disaster in southern Africa in nearly two decades; covering 900 miles of land in water,<sup>166</sup> resulting in the death of at least 750 people<sup>167</sup> and affecting an estimated 1.85 million people.<sup>168</sup> Making landfall weeks before harvesting season, tropical cyclone Idai destroyed or damaged an estimated 1.2 million acres of crops and impacted nearly 40,000 subsistence farming households,<sup>169</sup> in effect risking food security in the country and causing its citizens to require immediate and long-term food assistance.

The effects of climate change and humans' use of Earth's resources include more than the suffering experienced by humans, it is also responsible for the loss of plant and animal life. Pope Francis describes humans' use of Earth's resources as, "short-sighted approaches to the economy, commerce, and production".<sup>170</sup> He notes that human intervention, such as the use of technology and science, in trying to remedy the damages caused by climate change and humans'

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<sup>165</sup> Francis, *On Care for Our Common Home* 20.

<sup>166</sup> "Cyclone Idai Response." *USAID*, [www.usaid.gov/cyclone-idai](http://www.usaid.gov/cyclone-idai). Accessed 16 Apr. 2019.

<sup>167</sup> Sevenzo, Farai, and Anna Cardovillis. "Cyclone Idai: Death Toll Rises to 750 as Mozambique City of Beira Begins Long Road to Recovery." *CNN*, 25 Mar. 2019, [www.cnn.com/2019/03/24/africa/mozambique-cyclone-idai-destruction/index.html](http://www.cnn.com/2019/03/24/africa/mozambique-cyclone-idai-destruction/index.html). Accessed 16 Apr. 2019.

<sup>168</sup> "Mozambique - Tropical Cyclone Idai - Fact Sheet #2 FY2019." *USAID*, 25 Mar. 2019, [www.usaid.gov/cyclone-idai/fy19/fs2](http://www.usaid.gov/cyclone-idai/fy19/fs2). Accessed 16 Apr. 2019.

<sup>169</sup> "Mozambique - Tropical Cyclone Idai"

<sup>170</sup> Francis, *On Care for Our Common Home* 24.

use of Earth's resources can result in more problems than it resolves. We as a species have come to believe that we are able to create through science and technology a human-constructed environment. Instead, there needs to be thought on the long-term preservation of the ecosystem, not the short-term economic profits that come from the exploitation and alteration of Earth's resources and living organisms.

The growth that humans have experienced since the last two centuries have not always led to the improvement of quality of life but has instead led to social decline.<sup>171</sup> We undeniably live under a global system which prioritizes financial gain while dismissing its destructive effects on life and the natural environment. Living in a finite world our present global system is unsustainable, at the least in terms of its destructive modes of production and consumption and its use of Earth's limited resources as if they are limitless: at the expense of the environment, non-human life, and the world's poorest.

Pope Francis argues against the idea that the solution to improving global issues is a reduction in the increase of the global human population. He argues that framing population growth as the central problem negates the role of "extreme and selective consumerism", that, "It is an attempt to legitimize the present model of distribution, where a minority believes that it has the right to consume in a way which can never be universalized, since the planet could not even contain the waste products of such consumption".<sup>172</sup> In the contemporary state of global inequality, the unsustainable consumption levels of developed countries use and destroy the natural resources of undeveloped countries, in effect, it brings death and destruction to the

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<sup>171</sup> Francis, *On Care for Our Common Home* 32.

<sup>172</sup> Francis, *On Care for Our Common Home* 36.

physical Earth, biodiversity and the world's poorest. Robbing others and future generations of even the basic needs of survival: access to clean air, water, and food security.

Instead of population growth, Pope Francis argues that the “dominant technocratic paradigm and the place of human beings and of human action in the world” are at the root of the human-caused ecological crisis.<sup>173</sup> Since the previous two centuries advances in science and technology have resulted in significant changes in society, along with progress in a number of fields such as medicine, transportation, engineering, communications, and art: positive benefits to the quality of human life. However, Pope Francis stresses that while advances in science and technology have benefited the quality of human life in a multitude of ways it is vital to recognize the power that it has granted us; that technology has, “given those with the knowledge, and especially the economic resources to use them, an impressive dominance over the whole of humanity and the entire world”.<sup>174</sup> Laying out the problem that Pope Francis refers to as the “globalization of the technocratic paradigm”, he begins by stating that technological development and its resulting increase in power does not automatically follow with development in “reality, goodness and truth”, “human responsibility, values, and conscience”.<sup>175</sup>

Deeper into the problem of humans becoming a geophysical force through the development of technology and its accompanying lack of human development is the change of humans' relationship with nature from receiving from nature what it released to extracting anything that is accessible. By using Earth's resources as if they are unlimited we are living under the false idea that “an infinite quality of energy and resources are available, that it is

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<sup>173</sup> Francis, *On Care for Our Common Home* 75.

<sup>174</sup> Francis, *On Care for Our Common Home* 77.

<sup>175</sup> Francis, *On Care for Our Common Home* 78.

possible to renew them quickly, and that the negative effects of the exploitation of the natural order can be easily absorbed".<sup>176</sup>

The unsustainable view and use of Earth's resources are held together by the role that technology has taken in human and social life, such as the idea that problems such as climate change have a technical solution and that with enough innovation the damage caused by global warming can be remedied. Pope Francis states, "Technological products are not neutral, for they create a framework which ends up conditioning lifestyles and shaping social possibilities along the lines dictated by the interests of certain powerful groups".<sup>177</sup> The recognition that technology is not neutral; that it conditions and shapes social life, begins to address that we live in a world that is dominated by the artificial and inorganic guided by those with economic means and power.

An environmental interpretation of Weber's writing shows a change of humans' relation to the Earth following the transition from pre-industrial capitalism to modern capitalism, we have changed from living a tradition-organic world to a rational-inorganic world. Living in a rational-inorganic world means that through the use of inorganic methods we have gained control over aspects of this Earth. We are no longer under the domination of the natural laws and cycles which dominated pre-industrial life. The application of this idea to industrial agriculture showed that there are significant risks brought about by rational inorganic developments, such as our reliance on polluting limited sources of energy for powering the present day global system.

Marx's Metabolic Rift showed that not only are capitalist developments reliant on limited sources of energy but that capitalism's transition from the inorganic to the organic has disrupted

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<sup>176</sup> Francis, *On Care for Our Common Home* 79.

<sup>177</sup> Francis, *On Care for Our Common Home* 80.

the metabolism created by natural cycles. Technological and scientific developments are created to close the rift of the metabolism of nature and society but while it temporarily does by increasing the productivity and fertility of the soil, it destroys the lasting fertility of the soil. The present-day global desertification is the social implications of the Metabolic Rift.

Pope Francis takes the idea of the solution to global environmental problems not to be found in further technical innovation but in social change. While recognizing the social advantages of economic growth and technological innovation; he too notices that there is a transition from the organic to the inorganic and disruptions to the natural cycles, with technological and scientific applications failing to be more than short-term solutions. Like Marx, Pope Francis calls for the long-term preservation of the Earth for the use of future generations, while criticizing the prioritization of short-term economic profit that comes from the exploitation and alteration of the physical Earth and living organisms. Being a globally influential religious leader, it is interesting to see Pope Francis take the idea of the consequences of technology on the relation between humans and the Earth even further. He puts forth the argument that we are living in a “technocratic paradigm”, under which people with the economic resources and power have dominance over both humanity and the Earth. Technological developments are not neutral, technology and science have the power to shape social possibilities, in the case of industrial agriculture as discussed in this chapter technology and science enabled inorganic methods to increase agricultural productivity to the effects of unsustainable food production and damage to the soil and Earth climate.

## Conclusion

The most radical change in the human condition we can imagine would be an emigration of men from the earth to some other planet. Such an event, no longer totally impossible, would imply that man would have to live under man-made conditions, radically different from those the earth offers him. Neither labor nor work nor action nor, indeed, thought as we know it would then make sense any longer.

Hannah Arendt<sup>178</sup>

The research question leading this project is: what do developments of technology and science for the exploration and exploitation of outer space mean for the future of humanity and planet Earth?

In Chapter 1, I presented the international concerns over the ambiguity of the use, benefits, and appropriation of outer space as outlined in international agreements. I started by presenting the early modern theories of property followed by an analysis of two international treaties, a legal declaration, and a United States bill. These documents offered various ideas of property, the commons, and the appropriation of natural resources. In all, they reveal the significance of an emerging problem: technology and scientific developments in the field of aerospace are advancing simultaneously to an unclear legal framework concerning the use, benefits, and appropriation of outer space.

To emphasize that space activities are of relevance and importance, Chapter 2 gave information on the current and projected value of the space economy. A focus of the chapter was the value of private space companies in furthering space initiatives. The accomplishments and visions of the three private aerospace companies, SpaceX, Virgin Galactic, and Blue Origin are evidence of the accelerating progress being made in outer space activities and the increasing

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<sup>178</sup> Arendt, *The Human Condition* 10.

need to have clear international agreements concerning space. In the present day, there is significant investment in the exploration and exploitation of outer space, including space tourism, asteroid mining, and space-based manufacturing. The possibility of humans' traveling to, living, and working in outer space is connected to Hannah Arendt's idea of earth alienation as described in the introduction of this project. Extending humanity further into our solar system is a form of mapping an environment, and as Hannah Arendt explains; as humans' map an area they distance themselves from their surroundings to the effect of alienating themselves from the Earth. To further think of space initiatives as a form of earth alienation, chapter 3 focused on humans' relation to the Earth's environment.

Chapter 3 began by presenting information on global environmental and social problems. Climate change, energy consumption, population growth, and development were discussed because they reoccur in the visions of major private aerospace companies, they are of importance to the future of humanity and our planet, and they are related to the connection between humanity and the earth. Then, I used the environmental interpretations of Weber and Marx to show that the transition from pre-industrial capitalism to modern industrial capitalism also meant a transition from inorganic to organic, the result of which has been unsustainable developments and damage to the earth and living organisms. The end of the chapter used the ideas of Pope Francis to further articulate the significance of technology in the relation between humans and the Earth. The point made was that in our current world technology has dominance over both humanity and the Earth while simultaneously severing their connection to one another.

The ideas I present are not technophobic or a call to return to the times of pre-industrialization. Instead, they introduce outer space to the field of sociology by drawing a

connection between environmental sociology and technology. Looking at the future of technology, specifically the current developments to obtain the capacity to travel deeper into space, exploit resources beyond our planet, and possibly one day have humans living and working further into our solar system, calls for thought on the social implications of technology and the influence of the artificial and inorganic on the relations to environments.

The legal subcommittee of the United Nations' Committee on the Peaceful Uses of Outer Space has scheduled for its fifty-ninth session in 2020 a, "General exchange of views on potential legal models for activities in exploration, exploitation and utilization of space resources".<sup>179</sup> The use, benefits, and appropriation of outer space is an ongoing discussion dealing with various political, economic, philosophical and ideological visions. Nonetheless, the impact of the activities of humans and their artificial creations in outer space are sure to make their way back down to Earth.

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<sup>179</sup> Proposals to the Committee on the Peaceful Uses of Outer Space for New Items to Be Considered by the Legal Subcommittee at Its Fifty-Ninth Session. Report no. A/AC.105/C.2/L.309/Add.6, United Nations, 11 Apr. 2019, AC105\_C2\_L.309Add06E.pdf. Accessed 29 Apr. 2019. [www.unoosa.org/res/oosadoc/data/documents/2019/aac\\_105c\\_21/aac\\_105c\\_21\\_309add\\_6\\_0.html/](http://www.unoosa.org/res/oosadoc/data/documents/2019/aac_105c_21/aac_105c_21_309add_6_0.html/), paragraph 11.



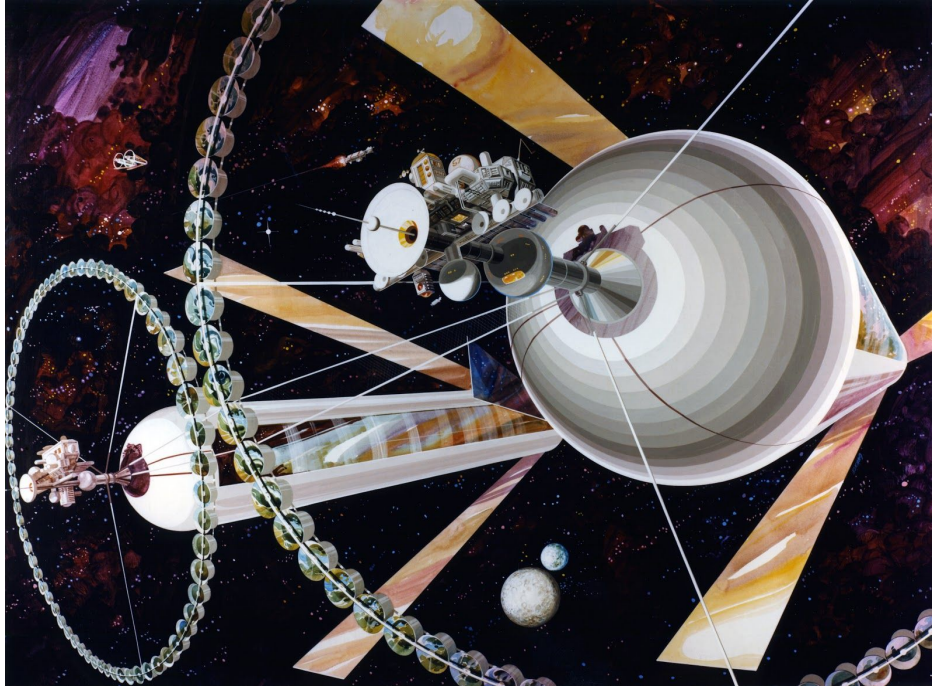


Image 1: Exterior view of a double cylinder colony  
Credit: NASA Ames Research Center

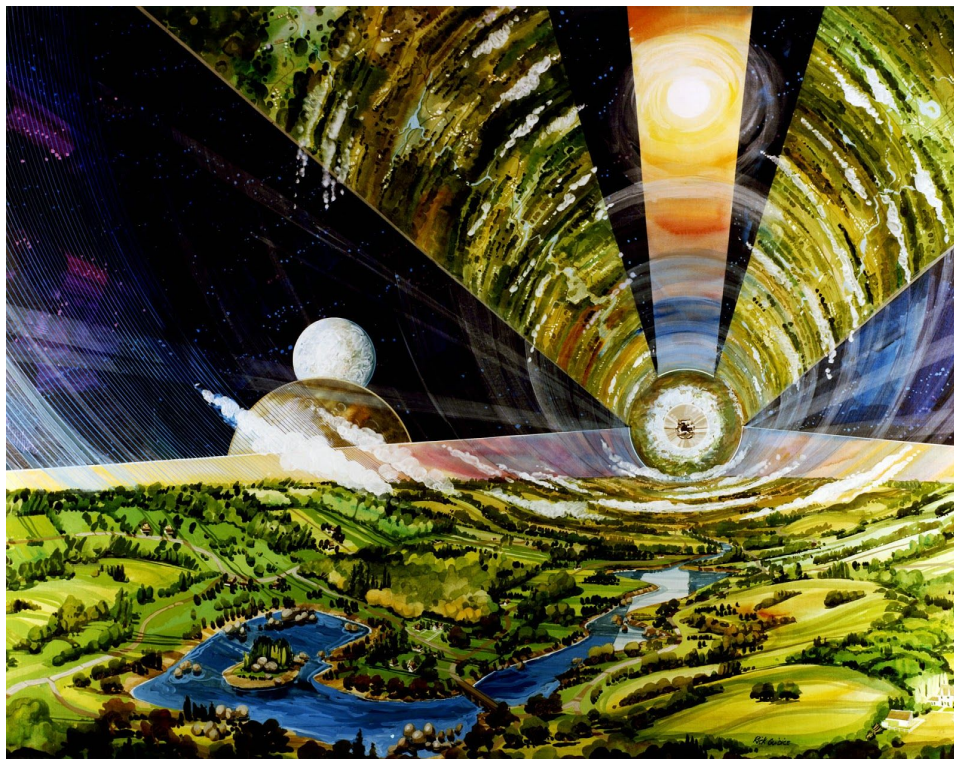


Image 2: Interior view looking out through large windows  
Credit: NASA Ames Research Center

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