

Space Ethics: Ethical Implications of Commercial Space Projects

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Abstract

We face many challenges in human space travel and colonization. Critical human issues that worry us today are the effects of weightlessness and low gravity, radiation, long-term sustainability, and psychological stress. We have yet to develop a sustainability model for long-term survival, including breathable air, potable water, and consumable food without earthly resupply. We cannot yet answer the question of what is the economic model for space industry outside of earth orbit? Nor can we explain what is the economics of space colonization on Mars or other celestial bodies? We have not discussed in any meaningful way what is the human governance model for human space outposts, transport, and industry. We bring microbes and other life forms with us and some have already landed with rovers on Mars. In other words, we have not thought much beyond humans as explorers of space. The thesis of this talk is not to provide answers, but to begin to ask questions and explore some of the economic and human governance issues that we will need to address as we begin to colonize space and other celestial bodies, both for habitation and industry. In other words what are the ethics of human space colonization and

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industrialization? This discussion necessarily will require thinking about intergenerational justice over the course of many generations, not just the one or two that represent an individual's lifetime. Issues of governance, economics, human adaptations to low-gravity that may prevent return to earth, invasive species and divergent evolution of microbes are all long-term concerns that we should begin to plan for even before the first colonization efforts begin in earnest. Just as here on earth, these questions involve issues where sociologists, psychologists, doctors, biologists, economists, financiers, manufacturing specialists, political scientists, lawyers—all the specialists of the challenges of existence can help humans to better plan for an economically viable and long-term sustainable life in space.

History



Just months before President Kennedy announced his vision of putting a man on the moon before the decade was out, outgoing President Eisenhower gave his farewell address. In it he said, “The prospect of domination of the nation's scholars by Federal employment, project allocations, and the power of money is ever present – and is gravely to be regarded. Yet, in holding scientific research and discovery in respect, as we should, we must also be alert to the equal and opposite danger that public policy could itself become the captive of a scientific-technological elite.”

The military-industrial complex has dominated the space program since its beginning. Even before Sputnik, the idea of weaponizing space with missiles and satellites has been the centerpiece of government policy. Industry has elbowed its way into the fray, capitalizing upon communication, GPS, and other military advances to improve communication, weather forecasting, and the lives of people and business around the world. Like any effort begun in war as was the space race, technology finds its way into the hands of people who are not associated with war. It is unfortunate that war is the genesis of such improvements, but we as a species seem not able to extract ourselves from conflict and combat.

The Space Opportunity

Why Space Colonization?

“The National Space Society (NSS), a space advocacy group based in Washington, claims its rationale for promoting space settlement is ‘survival of the human species’...prosperity/unlimited resources,’ ‘growth/unlimited room for expansion,’ individual rights, unrestricted access to space, personal property rights, free-market economics, democratic values, enhancement of Earth’s ecology, and protection of new environments.” (Billings, L., 2006, p. 251).

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Why Space Colonization?

“The Space Frontier Foundation, a California-based advocacy group with a similar ‘vision’, claims it is ‘dedicated to opening the Space Frontier to human settlement as rapidly as possible’” (Ibid).

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In 2008 Jacques Arnold and Andre Dubus declared, “Ethics is in some senses the next frontier in space exploration.”ⁱ The frontier of space exploration is being pushed outward at a rapid pace, bringing the need for complex ethical analysis to the fore—today, not in the future.

We are embarking upon a new use for space—peace. Physicists and astronomers increasingly use space to improve our understanding of the universe and its forces. We have discovered water, precious metals, and rare earth elements on celestial objects. We scan the heavens for alternative earths in Goldilocks zones where conditions for life might be adequate. We gaze longingly at Mars for opportunities to support a separate colony for life outside of Earth.

Companies like Planetary Resources have been formed to mine asteroids once the technology becomes available to do so (Ketcham, 2015). Moon Express plans on mining rare

earth element Helium-3 on the moon within the next few years (<http://www.moonexpress.com/>). Enigmatic India with its intractable poverty also has since the nineteen sixties built a successful and very economic space program that undoubtedly will attract many who want to keep the costs of space entry and exploitation to a minimum.

What's our Vision

- US visions of a human future in space are constricted by a peculiarly 'all-American' world-view. (Billings, L., 2006, p. 251).
- Is this what the world wants?
- Is this what we will get?
- What do corporations see?
- What do people think they will be getting?


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Space has been made available for humanity. However, we must face and overcome considerable hurdles to do so. As Eisenhower warned us, we are still primarily thinking technology in the race to space. It is now we must begin to consider the human, and not just long-term survivability on a Mars lander—but the sociology and ecology of space colonies and its companion, the macroeconomics of space industry and commerce. Here is why we must begin now.

Humanity in Space

All Aboard

- Beyond Space Tourism
 - Bezos and Musk
 - Mars 1
 - Space X
 - Other?



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Successful International Space Station re-supplier Space X is working on a rocket capable of holding 100 passengers on a long trip in order to place their goal of one million persons on Mars (Wall, 2016). Mars One from the Netherlands wants to send a colony to Mars on a one-way ticket to be funded by a Truman Show-like reality television series about the colonists (<http://www.Mars-one.com/>) Space X warns that the risk of death for these new age astronauts will be high. Why? Colonists will be ordinary humans, not the logic-driven, risk-calculating, cool under pressure first seven mercury astronauts who had years of technic experience in experimental aircraft and who entered a program where technic was purely experimental.



While the National Space Society (<http://www.nss.org/spacemovement/>) has been discussing space settlement since the mid nineteen seventies, we remain today like Lewis, Clark, and Sacajawea, who on the urging of President Jefferson, set out into the wilderness of the Louisiana Purchase to see of what use the new republic could make of all this wilderness. Of course, we did make use of the land and have prospered and grown because of it. We also did some nasty things to the indigenous inhabitants both human and animal. The wilderness of space is our next place of exploration. However, distance, radiation, vacuum, cold, and time itself far exceed the considerable obstacles that Lewis, Clark, Sacajawea, and others endured on their early nineteenth century voyage of discovery.

Military or Civilian Rule

- Military
 - Star Wars
 - Star Trek
- Business
 - Red Rising
- Civilian
 - ????

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Star Wars and Star Trek both present space as a place of war. Whether armed with the force or photon torpedoes, military organizations pit right against might through federations or empire with efforts towards diplomacy, but diplomacy backed up with weapons we can only imagine. Little mention is made of the millions of people who go through their lives of quiet desperation in the frontier outposts exposed to adverse weather, hostile forces, corruption, and bandits, just like our own pioneers endured in the nineteenth century.

We read dystopian novels like *Red Rising* about the Martian mining community that has become a caste system, complete with its disposable untouchables. These fictional accounts explore not so fictional human proclivities to put profits before people in far outposts where industrialists create new mining communities reminiscent of those company towns so prevalent in the early industrialization of this country and Europe. When we build space colonies we will bring our human issues, frailties, and problems with us.

Space gives us an opportunity to rethink our own propensity towards war and hegemony. However, our nascent efforts foretell an inauspicious beginning. We continue to weaponize space. We conduct science and business alongside spy and weaponized satellites. Like the rivers of the nineteen sixties we have riddled the near-earth space lanes with space junk that have become critical navigation hazards. Even as we pursue space productivity we are confined to a little world of twenty-five thousand miles circumference which we continue use with considerable abandon.

Why Out There

- Nothing for me down here
- Ask a pioneer why
- There is money to be made yonder
- A get rich quick ticket please
- It solves our overpopulation problems
- Could solve our prison problem—Early Australia model
- Undocumented problem solved?

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Space is huge, measured in light years not kilometers. We can rationalize that should we litter some place, there are many others that are pristine. We can solve problems of overpopulation, refugees, and poverty by establishing colonies on Mars who will take our tired, poor, and huddled masses yearning to breathe free. Breathe is the first operative word. The second is radiation, the third gravity, a third of our own. We may have to live underground like moles on Mars because the planet has no magnetic field to deflect the sun's radiation. For the foreseeable future, we must to import everything. Even water, if we cannot distill whatever water that is near the surface which is likely even more salty than the Dead Sea.

Show Me the Money

- Economics of Space?
 - Distance
 - Time
 - Cost
 - Commodities markets
- Regulation?
- Governance?
- Alien Life?

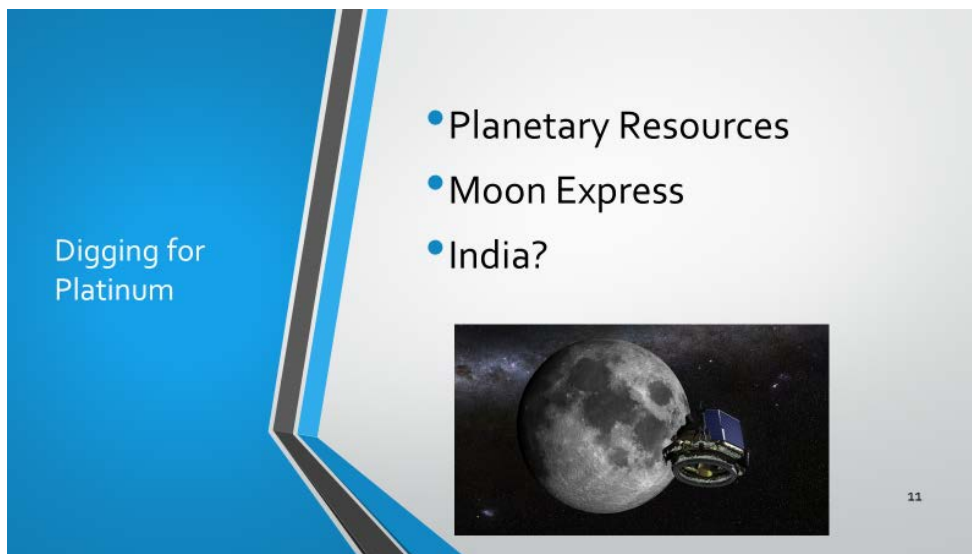



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I suggest that before we go too far into conquering space using the same brute force as we have with our own planet and its orbit, that we pause and begin to understand both the implications and opportunities space provides. In other words, we need to consider what might become an ethics of space, including how we govern and police ourselves as we begin the human occupation of the cosmos. Any ethics we have of space necessarily will involve societal, organizational, and business implications. We went to the moon to prove military superiority. We now must think beyond pure science, weapons, and begin to reason like businesspersons—but with an eye towards a reasonable ethical foundation as a restraint against undue exploitation

of people or celestial bodies. Economics will be an early challenge of deep space, once we figure out how to thrive outside of this planet.

Regardless of the persistent outcry against regulation, we let business and commerce run without significant hindrance. This is a good thing because it produces competition, innovation, and wealth. On Earth, we can inspect manufacturing facilities, products, and monitor how people are treated by industry. How long will it take and how much will it cost to send an inspector to a human outpost ten million miles away? Where are the patrol vessels that will stop piracy, looting, and malfeasance? Will commercial vessels need to be like Star Wars' Millennium Falcon, bristling with guns? Will its Captain Hans Solo operate like an eighteenth-century pirate in the rich space lanes of the asteroid belt? Are we ready for a Klondike gold rush where everyone is for himself? Are we ready for bad Bart, hanging judges, and cattle wars in the prairie outposts of space?



The slide features a blue background on the left with the text "Digging for Platinum". To the right, a white background contains a bulleted list: "• Planetary Resources", "• Moon Express", and "• India?". Below the list is a photograph of a satellite in orbit around the Moon. A small number "11" is visible in the bottom right corner of the slide.

Planetary Resources, the would-be space miners, have identified asteroids consisting of nearly pure platinum each worth as much as a trillion dollars if mined and brought back to the earth (<http://www.planetaryresources.com/asteroids/#roadmap-asteroid-prospecting>). Will we let miners like we did in the Klondike simply rush towards these celestial objects because they can and have the will and finances to do so? The first will likely be robot miners and space dump trucks that will bring ore back to the earth or even facilities in space for processing. How much will it cost to bring this material down to earth? We as yet do not know. As was the case in the Klondike and other gold rushes, this platinum rush will benefit the first miners the most. After we saturate the earth with more platinum than we can use even as we create markets for platinumware, hubcaps, and bathroom faucets, the cost to mine asteroids will become prohibitive when the market crashes.

Mining the asteroid belt carries its own risks to Earth's environment, perhaps even more so than the gold rush and other mines have. Errant equipment, disasters, and other accidents can alter the orbits of space objects, perhaps even sending one or more on a trajectory towards the earth.

How will we regulate space mining? Just as important, who will own the asteroids? In 2015 President Obama signed H.R 2262 which permits US Citizens to own asteroid resources,

this means those in space and those that fall to earth. Will we divvy it up the asteroid belt like the colonial powers of the eighteenth and nineteenth century, or will we declare the asteroid belt, as we have the open sea on earth, the heritage of humanity and subject to no individual sovereign? Will we lease asteroid fields like we do oil drilling rights? For how long? Will we create depletion deductions and taxes as we whittle away space rock and return it to earth, the moon, or Mars for processing? Who will be tasked with enforcing the asteroid acts we will need to create? The UN? The UN has been useful dealing with many earthly issues, and has debated, and many countries have signed space related treaties and declarations. Is the UN the right place for space governance? This is an important concern because there are many question about governance in space. One looming one is, who will police the incredibly vast space lanes against piracy, space junk, and other navigation issues, or step in when interplanetary mining dump trucks are hijacked and ransomed or sold on the black market?

Intergenerational Justice

- How long into the future?
- Sustainability – earth, space?
- What do we need to be concerned about?



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We will send earthly microbes to empty space, the planets, their moons, and other celestial bodies. We have already done so despite the heroic efforts of the NASA Office of Planetary Protection and the statements by COSPAR (Committee on Space Research) scientists who are committed to microbe free landers (Ketcham, 2016). While we have diligent cleanliness standards for orbiters and landers, the operable standards cannot prevent some spores and bacteria from hitching a ride to the Moon, Mars or any other body we have visited or intend to visit. We have brought life to Mars. Whether it will reanimate we cannot yet be sure. It just takes one bacteria to find a niche and divide. When we land, the first human with a gut full of bacteria and skin crawling with tiny mites, viruses, and other critters and step outside the airlock we bring life to the place where we step. Any breach in air-suit or hull will let life escape. Some life may take in some places in the wild or inside of closed colonies and begin to evolve separately from earth.

We know, for example, that the international space station is creating its own ecology. Microbes are evolving to thrive in the conditions present in the station and the migration of people in and out. When we establish a colony on Mars it must become more or less self-sufficient. What scheme of ecology will we establish to maintain a viable system of life? What mix of plants and animals? How will we deal with evolution or normal cycles, or even accidents that threaten the contained ecosystems we likely will need to maintain for our early existence on Mars? Later we may want to terraform Mars if we can discover how. In either case, we will

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create a separate evolving world where microbes that once evolved only on Earth will evolve independently. Travel back and forth will create opportunities for invasive species to wreak havoc on other celestial bodies and even earth itself.

Humans have little regard for intergenerational justice beyond the next two generations comprising children and grandchildren. Our lives extend only that far and our desire to think beyond becomes clouded in uncertainty and quite frankly the notion that it isn't our problem. Business performance horizons are often ninety days or perhaps a year. We rationalize and say things like, "They must deal the hand we have left them, just like our parents and grandparents did." Our own death is a finality we cannot seem to think beyond. What I am asking is that we think beyond the next two generations and at least begin a dialog on the major issues that we as a species and even life itself will be facing over countless millions of generations into the future.

I am not asking us to predict the state of humanity, the world, and our ventures in space a billion years from now. What I am asking is that we establish a line of dialog for as many of the issues of space and space ethics we can envision that we will likely encounter. We are entering a new phase which I call the cosmocene (Ketcham, 2016). Recall that the Anthropocene is the term used by many to describe humanity's impact on the world ecology. The dinosaurs had their own scene; we have ours. The cosmocene asks what impact we will have on space, first space in our solar system which is vast enough, and then next, the milky way galaxy that is distance unimaginable.

If we can better phrase the basic questions we will need to continually address, I suggest we will embark upon a path towards an intergenerational ethics of space for which we eventually look back and say that this was as much a crowning achievement as the theory of relativity, the first manned moon mission, and the idea of democracy. The independent scientific Committee on Space Research (COSPAR) and our own NASA are good places to begin, but we must add economists, businesspersons, financial analysts, financiers, social-psychologists, sociologists, and biologists in addition to engineers, doctors, and physicists. We want to create not only an economic engine in space but also a viable ecological and sociological colonization system in places hostile to humanity and life itself.

There is not enough time in this forum to discuss each of the questions associated with commerce, travel, habitation, alien life, and other topics that we will need to explore. We need more forums like this one where such questions can be developed and debated before we begin the process of living and working in space and on other celestial bodies in earnest. I suggest that we must do this before those who want to exploit the heavens set problematic precedents that may be difficult to overcome.

I will spend the rest of the time I have with you to begin the discussion just one issue in more depth and that is human space governance which has received very little attention.

Governance



Governance of human space travel to this point has been in the command and control style of the military. This is expected to continue for other exploratory missions such as the first human landing on Mars. Command and control likely will continue to be the norm in the international space station. Science and military work together not only to design scientific protocol but to produce the discipline and chain of command in the limited space of the space station or future exploratory landings. Astronauts have been like Seal teams, prepared, dedicated, and committed to one another and the mission. Astronauts are a rare breed. Look at the good, bad, and ugly in our world. Our colonies will contain all types of persons and attitudes.

The scope and size of things will change once industry and government begin permanent colonization endeavors. There are a number of possible governance models.

One we can call the off-shore oil platform. This would be a commercial venture where workers are employed by a specific business or government enterprise to work full time for a period of time at the site, for example, an asteroid mining operation. While we have employment rules for US companies on employee treatment, pay, safety, and other requirements, we do not yet have a workable mechanism to govern business ventures on other worlds. Granted we have five space treaties governing to some extent, space exploration, near-earth orbit rescue, liability, and equipment registration, and a treaty to make space a peaceful region. None of these has really been tested. None includes human governance to any great extent.

Distance, conditions of space, force majeure, lack of transparency, are all issues when enforceability from earth or even other outposts may be challenging. Distance and time also complicates worker-only outposts. Workers may be required to work for years or even decades without relief because the cost to transport them to and from the work site more frequently will be prohibitive. With present equipment capabilities, a round trip journey to Mars will be like a sea voyage around the world in Magellan's time, long, stressful, and quite often boring. Magellan could stop and replenish food and water stocks at islands and other shores. There are no opportunities for such replenishment of goods in space today. We can expect troubles, fights, medical emergencies, insurrections, suicide, and any other manner of irregularities when persons are confined in restricted space with the same persons for months or years on end. The lack of

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social structure in the off-shore model compounds this as there may be no spouses, children, and life outside of the work environment. We will likely find that the offshore oil platform model is not sustainable ultimately because of the time and distance challenges of space for anything other than our moon.

Another model is what we might call the ex-pat community. This is where the business ships the workers and their families to the remote work outpost. This will become a more-or-less permanent outpost where families live, work, socialize, and go to school. The ex-pat community is really the model for the old company town. The question of governance looms large here as it did in the company towns of old. If the employer is the community administrator, the source of commerce, the owner of property, and the purveyor of justice there will be limited power of the community to overcome oppressive tactics by the business itself. One cannot challenge the work conditions on the threat of being sacked...What if one is sacked? What does a sacked person do in a company outpost town especially if there is no transport vessel that will arrive for years? This form of governance may be touted as being fair and in some respects equitable by the shiny pamphlets of employers who will work lucrative asteroids or planetary mines, but all it takes is one cruel administrator who restricts communication with the rest of humanity and we have a recipe for disaster. We recall the bright and shiny posters to recruit fruit pickers in California during the dust bowl that promised good jobs and pay but produced neither.

A third approach has a number of options. All are based upon a pioneer model. Recall that when we decided to populate the prairies in the nineteenth century, we offered free land. In the space pioneer model we probably will have to offer the equivalent of the sod house—the containment vessels essential for life at a remote outpost. People will arrive as settlers. Rather than squat and improve the land as were the requirements to own the land during our pioneer days, persons will be picked based upon skills required to sustain the outpost.

In a strong governance approach the colony legally and constitutionally is attached to earthly governments. This form of governance early on will look like current command and control space ventures but will need to evolve checks and balances not unlike what is available in the US today.

In this type of outpost, there will need to be all of the things we find in small communities and more. Governance, jobs, entertainment, education, medical care, and justice are all elements of such a colony. The beginning colony likely will have as its primary goal to become self-sufficient and self-sustaining. This likely will require regular supply missions from earth to replace medicines and machinery that may not be possible to produce at the earliest outpost. Early outposts of this sort may be run almost like communes where there will be little need for a capitalist economy, just survival. Likely these colonies will be expensive to establish and operate.

An alternative to the same model we might call the pioneer condominium colony. In this form of governance, the colonists invest their own money in the colony and pay off creditors, which might be governments or industry in the beginning. Eventually, each colonist will own a piece of the colony and can sell or dispose of it per colony regulations. We must also worry that billionaires will buy up units and turn tenants into sharecroppers.

In another variation of the pioneer condominium model, the government subsidizes the entire colony, but colonists are then weaned off subsidy over time as they begin to produce

surplus goods which can be exchanged for earthly goods. Individuals may then be deeded title, much the same as their pioneer ancestors. What if they can't produce enough value to eliminate the subsidy? What happens then? We have no provisions for this now.

Likely you can imagine other organizational systems. The pioneer form of organization is more likely to be feasible on a large celestial body such as the Moon or Mars. Colonies may be established next or near to industrial operations such as mines or manufacturing facilities. Some workers will work in the factories or mines and some will have jobs producing food, recycling waste and water, governing, policing, education, and providing justice.

In any of these scenarios is the question of independence and what that means. All colonies will have measures of independence just like the early pioneer towns. However, we know that our own revolution was fought in part because of taxation without representation. Earth, what services are you really providing us now, will be the operative question as it was with the American colonists. Distance and time will spread earthly resources thin. Insurrections, revolts, mutinies, and takeovers by despots could occur and become entrenched before a policing vessel can arrive at the colony.

In a weak earth governance approach, colonies may also become separate countries which means the need for galactic organizations that govern inter-spatial commerce, defense, and immigration. Enforcement to rein in rogue colonies presents other humanitarian issues. For example, projectile weapons could easily wipe out an entire colony that requires a hermetically sealed environment.

What Could Go Wrong?

- Epidemics
- Suicide
- Despots
- Piracy
- Mechanical failure; catastrophic accidents
- Radiation
- Gravity
- Life mutations
- Economic ruin



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No matter what the system of governance, these will be pioneer outposts. It is not likely that medical care will approach that on earth. Mortality rates likely will be higher. Psychological issues associated with depression, phobias, anxiety, and suicide will likely require a different approach to psychiatry in close-environment outposts. Think submarines. However, as we have seen before with the pioneers, those who left the east coast to settle in the plains were a hearty bunch who sought relief from crowded cities or farming communities where there the land was too expensive for the poor to purchase. With atmospheric challenges before any terraforming occurs, space settlers will not find the same opportunities to stretch out.



However, with growing populations on earth, there may be persons who can see the value of migrating to a space outpost because they have no opportunity to rise above their subsistence on earth. As production becomes more automated and we enter into an era of driverless vehicles, and store-less purchasing, what will people do with their lives without jobs? Likely US sensibilities will resist any attempt at providing a living wage to those who cannot find jobs, even when they want to work, because their education or skill levels do not qualify them for more technical jobs. Will space colonies be the places where these workers will go to find work?

No matter what form of outpost we can envision or even build, early efforts are likely to produce economic equations that will first rely heavily upon subsidies or large debts to entrepreneurs. We do not yet have an economic model of space that accounts for the extraordinary costs of travel and existence in the pursuit of profits from productivity. While we may see the early asteroid miners make fortunes, the law of supply and demand on precious metals and other commodities will likely make these remote operations less and less profitable until there is a large enough space economy. We require a better understanding of just what the economic engine of space will be and how it will operate to better understand the forms of social organization and governance that will work in space. We must factor in transportation, operating, and existence costs in space compared to earth.

We might discover that the economics of space does not require including the earth as a viable two-way trading partner except for select products or commodities that cannot yet be made in space. Industry and persons on earth probably will supply earthly societal needs at significantly lower costs than space colonists. The cost to lift from the earth the necessary goods for space colonies likely will continue be prohibitive, further isolating the earth from space trade. Presuming low-cost robotic vessels, the expense to do the same may be less from our moon to Mars or through asteroid belt because all experience less gravity than the earth.

I suggest that there is a distinct possibility that trade between space parties might become independent from Earth in many ways, including raw materials such as ores for smelters and manufacturing facilities, seeds, and frozen foods trade, medicines, and the like. Persons who become accustomed or are born into lower gravity may not be able to visit earth, let alone fend

off earthly diseases. Education might also become a commodity as candidates compete for entry to Mars's elite Olympus Mons University.

Finally, what about democracy? That all depends upon how much in return and control will the billionaires like Elon Musk and others want from their investment? How beholden will space colonists and travelers be to space entrepreneurs? Will they install their governors and administrators as the European monarchies did when they established colonies? These are all questions that must be asked now before the ships begin to launch.

Which form of governance or form of economics am I advocating? I am not advocating one over another. We do not know enough about what it is we will be trying to accomplish in our long-term settlement in space stations and on celestial bodies. What I am asking is that we begin today to ask questions and put the question of governance, social organization, and justice at the forefront of any long-term discussion of ventures of commerce or colonization outside of earth's orbit.

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ⁱ (Arnould & Debus, 2008, p. 1094)