
Launching *anything* is good:

How Governments Could Promote Development of Outer Space

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Government organizations have failed to develop space technology to the point where economies of scale apply and space activity becomes self-supporting. Private businesses may have the problem that in the early stages, before space is economically developed, there will be a limited market for space travel. When space is developed there could be significant economic returns, but development of the technology to achieve that could be hindered by the limited market in the early stages. This article suggests that a government can help with this by providing a guaranteed market for space travel and development.

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List of Abbreviations

NASA National Aeronautics and Space Administration

1 Introduction

At the time of writing (2009) space travel has not progressed very far. It is done by relatively few people at enormous expense and has no economy of scale. It does not pay for itself. This was not how some people imagined the future. Some people envisioned a future in which the resources of space would be available on Earth, in which space could be exploited for huge profits and in which space could be colonized. This has not happened in almost 50 years of human spaceflight. Some people are saying that it is now time to give up on any hopes of government organizations opening up space and that private business can do it by itself. In this article I will suggest that a different approach is followed: A weakness of the private enterprise route to space is that there is a limited market for the technology in the early stages, when it is being developed, and governments can help with this by providing a large enough, guaranteed market for spaceflight.

2 Space Travel and Economy of Scale

In his book *The High Frontier: Human Colonies in Space*, Gerard O'Neill envisioned the future expansion of humanity into space on a massive scale, with our civilization becoming a spacefaring civilization.¹ O'Neill's plan was for material to be mined from the moon and sent to the L5 point in Earth orbit where it would be used to build huge space colonies. (See Figure 1, below.) These would not rely on government money to sustain them. Instead, space would be developed and exploited by industry that would pay for itself. Similar proposals have been made by Thomas Heppenheimer.² More recently, Marshall Savage proposed a long range plan for space colonization.³

Proposals on this sort of scale cannot become reality with the existing economics of spaceflight in which a space shuttle launch costs \$450 million.⁴ Space activity needs economy of scale: It can be a lot cheaper if a lot more of it is done. This is necessary if humanity is to expand into the solar system in any significant way.

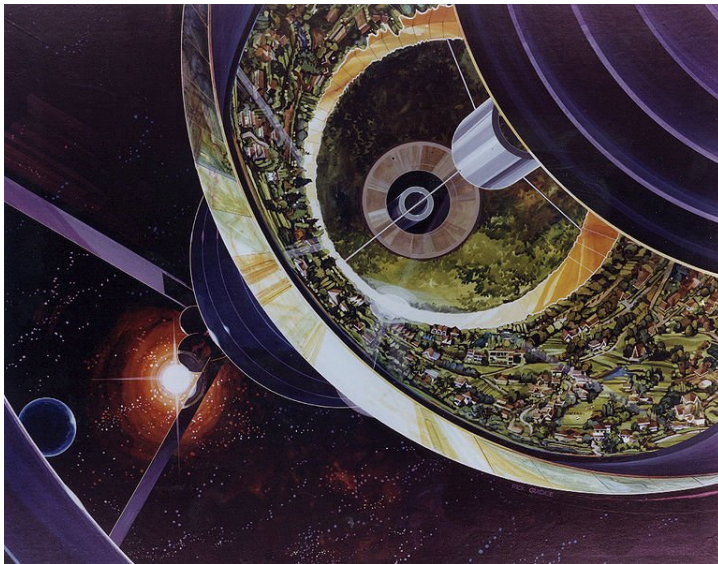


Figure 1: A Space Colony Design Proposed by Gerard O' Neill

¹ O'Neill, G. K. (3rd Edition, 2000). *The High Frontier: Human Colonies in Space*. Ontario: Apogee Books. (Originally published: 1977. New York: William Morrow and Company).

² Heppenheimer, T. A. (1977). *Colonies in Space*. Mechanicsburg: Stackpole. Also available online at <http://www.nss.org/settlement/ColoniesInSpace/index.html>.

³ Savage, M. T. (New Edition, 1994). *The Millennial Project: Colonizing the Galaxy in Eight Easy Steps*. New York: Little, Brown and Company. (Originally published: 1992. Denver: Empyrean Publishing).

⁴ Kennedy Space Center: Frequently Asked Questions, NASA – Space Shuttle and International Space Station. http://www.nasa.gov/centers/kennedy/about/information/shuttle_faq.html#10.

3 The *Otherland* Scenario

To show the problem facing development of space, here is an imaginary scenario, to serve as an analogy for the problem of space development.

Suppose we live on a much larger planet, on a continent called *Thisland* in a vast ocean. We know of another continent, which we call *Otherland*, but it is a great distance away. There is no other land that is closer: There are no islands in the ocean between *Thisland* and *Otherland*.

Ships have been developed and they are adequate for the only use to which they are put, which is sailing around the coastline of *Thisland*; however, *Otherland* is so far away that current ships could not even travel one percent of the distance. A crossing, if we had a ship with the range (which we do not), would take *years*.

A scientist has just found evidence that great riches are to be found on *Otherland*. The problem is: How do we get them?

Some people advocate improving ships, so that they are able to travel to *Otherland*. This is difficult and cannot be done immediately. It is thought that many generations of ships would have to be made, with the range increasing in each generation, until eventually a generation of ships will exist that can cross the ocean to *Otherland*.

Others advocate a staged approach in which many ships are used to form a supply chain extending across the ocean. A large set of ships would operate continually between *Otherland* and a staging point, called Staging Point 1, out at sea, and they continually transport supplies out to Staging Point 1. This would allow a smaller set of ships to be resupplied at the Staging Point 1, so that they could sail beyond Staging Point 1 to a second staging Point, Staging Point 2. A third, still smaller, set of ships would be resupplied at Staging Point 2, so that they could get to Staging Point 3, and so on. This would be a huge undertaking: Thousands of ships would be needed, operating over years, to get one ship to *Otherland*. Many people question the practicality of all this. Even with resupply at sea, ships are not capable of travelling the huge distances involved without repair and replacement of major components. Ships would need to be much more durable, or methods would need to be developed to repair them while at sea.

Others advocate a variation of the staged approach, which involves building huge floating islands. These islands will provide living accommodation, docks, facilities for ship repair and warehouses to store fuel, provisions and spare parts. The idea is that one of these islands will be built near the coast of *Thisland*, and will be kept resupplied by ships. This island will be used to launch ships further out, where another island will be built, and so on. Eventually a chain of islands will stretch across the sea from *Thisland*

to Otherland, being maintained by a huge fleet of ships. From the last island, Otherland will be easily accessible.

Others might propose various advanced technologies to get to Otherland.

All of the viable solutions have the same problem. They will not allow anyone to get to Otherland quickly. Even when Otherland is finally reached, it will have been reached at huge expense, and it will still be uneconomical to exploit its resources: That will have to come later when it is easier to get there. This is a serious obstacle in the way of developing Otherland. It may seem that this is no different from any of the other obstacles that a civilization may have to overcome to get anywhere. For example, before modern computers could be made, a long sequence of technologies had to be developed. People had to start things off by fabricating stone tools and then had to learn to extract metals. They then had to make a series of breakthroughs in such areas as mechanical engineering, electrical engineering and materials science before a modern computer were possible: Every sophisticated machine we currently use is at the end of a long sequence of breakthroughs, occurring over millennia. There is an important difference with Otherland, however: There is a lack of intermediate stages where big pay-offs occur. Before anyone can get to Otherland, they are going to have to be able to get halfway to Otherland, and halfway to Otherland *there is nothing there*. Anyone wanting to reach Otherland and exploit the resources is going to have spend decades developing machines, systems and technology to do it, and the emptiness of the ocean between here and Otherland means that there is no pay-off until the end.⁵

This lack of intermediate pay-offs is an obstacle to private enterprise developing Otherland. Businesses have to operate in the real world. If anyone sets up a business to get to Otherland it could be decades before any profit is made. This means that the business will have problems raising enough money to get started and to keep going. Investors are likely to regard the whole idea as a distant, nebulous dream. A lot can go wrong in the decades needed to get to Otherland, and the still longer time needed to get to Otherland in a practical way that allows exploitation of resources. Investments with a quicker return will always be available.

If private enterprise is not up to reaching Otherland, maybe the government can do it? We should know where that leads by now. We would end up with a huge organization building things at huge expense, supported by a huge bureaucracy, maybe with decisions that should be made on technical grounds being influenced by politics.

The problem of getting to Otherland and exploiting its resources is an analogy for getting into space and exploiting it. I may seem to be suggesting that the huge ocean between Thisland and Otherland represents some single technical problem, such as the

⁵ Some readers will probably be able to work out all kinds of clever schemes for resolving the problem in this scenario, but please remember that it is only an analogy.

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difficulty of getting into low earth orbit, but the analogy is meant to be more general than that. The huge ocean is supposed to represent all the technological challenges in the way of economically developing space. They could be, for example, the difficulty in reaching orbit, the difficulty in making spacecraft that fly between the ground and orbit many times without huge costs, the difficulty in developing mass drivers to get resources off the moon to use in construction of a space colony, the difficulty of developing systems for mining near-Earth asteroids, the expense of building space colonies and so on.

I am saying that there is a lack of intermediate pay-offs in development of space, but I am not claiming that there are none at all. A private company might make a lot of money in the early stages of space development, maybe by providing satellite launch and tourism. The problem is that any such intermediate pay-offs are very small compared to the pay-offs available later, but it is these intermediate pay-offs that need to fund development of the capability to get the later, much larger pay-offs. The issue is the *size* of the initial market and the amount of business activity, competition and innovation that it can support.

4 Who is going to solve the problem?

4.1 Governments?

One option is to leave development of space to government organizations like the National Aeronautics and Space Administration (NASA). The problem with this is that government organizations have been in space for (at the time of writing) about 50 years and so far there is little to show for it. Small numbers of people and machines are involved, at high unit cost. There is no economy of scale, no prospect of any economy of scale and no prospect of making it pay for itself. The evidence for this is that it has not happened.

4.2 Private Enterprise?

Another option is to leave it to private enterprise. Some businesses are trying to develop a low-cost launch capability and there is a widespread view that a tourist industry will be the first market for this. There is a problem with this, however. That problem is the size of the initial market for space travel. Of course, some people would pay to go into space, but I doubt that it would very quickly pay for the considerable scaling up of human activity in space needed to make things take off – and there is hardly a massive demand for satellite launches.

In the future, when space has been developed there could be a large market for space travel. For example, if O’Neill’s vision ever becomes reality there would be large numbers of people in space and significant industrial activity there. Launch from Earth would be in demand and space could be generating huge wealth. We do not yet have all these space colonies and all this industry in space yet though, so there is no significant market for space travel. We will not get this market for space travel until space has been properly developed with things like colonies and industry, but the companies developing this technology need to earn money in the meantime. This is a possible catch-22 of space development: Space travel could generate lots of wealth when there is enough economy of scale in space, but getting to this point needs a lot of investment which needs financing. Some advocates of private exploration of space ask governments to stay out of it and leave them to succeed where government is perceived to have failed, but this does not address the issue of the size of the market for all this technology.

5 A Possible Approach

The best approach may be for private businesses to do what they are good at and for a government to do what it is good at. Private businesses are good at developing technology to compete with other private businesses for markets. Governments are good at putting huge resources into projects. How could we combine the two? How could we do it in a way that encourages competition rather than creating the bloating that can often result from government intervention?

John Lewis indicated a possible approach in an essay, *Asteroid Resources, Exploitation, And Property And Mineral Rights or Keep Your Laws Off My Asteroid*, which was published in the expanded third edition of O'Neill's *The High Frontier: Human Colonies In Space*, Lewis stated:

*"The government can support private space endeavors by buying scientific data, in effect privatizing many research missions."*⁶

I suggest that this should be done, but with much wider scope. Rather than the focus being on what services private enterprise can provide, the emphasis should be on encouraging private enterprise to develop capability *as an end in itself*.

A government should provide a *large, guaranteed market* for space travel and development. In the early stages this would really mean a guaranteed market for launch. This is one example of how it might work:

The government announces that it has a certain amount of payload that it wants placed in orbit each year for a number of years and that it will pay private businesses to launch it. This is a *guaranteed launch market*. Private companies could then compete for their share of this market to ship the payload into space. This might be done on a financial basis. It might be made to work like stocks or shares, with an amount of money available for shipping a kilogram of payload, which varies depending on the price for which space companies in the market place are prepared to ship. This, however, is just one possibility. There may be various standards that a company has to meet to get a share of the market, or its share of the market may depend on a lot of factors.

What should the payload be? *It does not matter*. That is the point. This is not about getting a useful payload into space: That is almost irrelevant. It is about guaranteeing a market for companies offering launch services to get things going. I mean this totally. If

⁶ O'Neill, G. K. (3rd Edition, 2000). *The High Frontier: Human Colonies in Space*. Ontario: Apogee Books. (Originally published: 1977. New York: William Morrow and Company). p144.

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we could think of nothing better to launch, *concrete blocks would be fine*. My philosophy is:

Launching anything is good.

To some readers, the idea of a government paying private industry to launch concrete blocks into space might seem silly, but it should seem less silly when we think about the technological development we are funding which will launch other things later. Admittedly, the concrete block example is a bit extreme to make its point. The government should try to use something more useful or sensible than concrete blocks, but if it cannot think of anything, or if bureaucracy would cause delays or waste of money in developing something to be launched, then this should not be allowed to interfere. Launching *anything* now is more important than launching something very useful eventually. What we need is the competition between private companies to develop the technology to launch things – anything.

This would continue, year after year, with the government occasionally giving guarantees for future launch requirements for various periods of time into the future. There are numerous variations on the basic idea which could deal with encouraging private business to develop the capability to do things such as place people in orbit and it could be done in more complex ways than what I have described here. The main point is that the government's entire role should be providing a guaranteed market and private businesses should have to compete for it. CEOs of private businesses would not have much time to enjoy any feeling they were getting a "free ride" in this: They would be too busy fighting off their competitors in a demanding launch market which would require companies to continually develop the technology needed to do things faster, better and cheaper.

As the technology needed to place things in orbit becomes more advanced the government would start to withdraw its support from that and would support some other aspect of space exploration and development, such as colonizing space permanently or shipping payload to the moon or Mars. The support would always take the form of a guaranteed market. Even when the early phases are not being directly supported anymore, they would still be getting indirectly supported because of their contribution to the later phases. For example, if the government has ceased to support launch directly, but is providing a guaranteed market for transfer of payload to the moon, then the businesses competing over the market for shipment to the moon will still need to use a launch capability, but the role of government funding in this would be more distant and it would have more resemblance to a conventional business operation. This process would continue, with the government guaranteeing markets for various stages, reducing the level of intervention for earlier stages when they will be naturally supported by their need in later stages which still have guaranteed markets, or when they generate enough wealth that they are self-funding.

6 Comparison with Prizes

There is some similarity between the proposal in this article and the approach of offering prizes to encourage technological progress. Prizes have been previously offered for aviation, such as the \$25,000 *Orteig Prize* won by Charles Lindbergh when he flew from New York to Paris in 1927. The *Orteig Prize* inspired the *Ansari X PRIZE*, for the first privately built spacecraft to carry the equivalent of three people into space twice in two weeks.⁷ This was won by the *Tier One* project's experimental spaceplane, *SpaceShipOne*, in 2004.⁸ The company *Mojave Aerospace Ventures* was then founded to exploit the technology commercially.⁹

Prizes can cause progress, and they can be considered an attempt to provide a minimal kind of market. The *Ansari X PRIZE*, for example, created a minimal market for a private, suborbital spaceplane. In a way, the proposal in this article is that governments could help development of space by giving out "prizes" to encourage technological development. Having a specific prize for a single act, such as flying across the Atlantic or into space, however, is more suited to encouraging one-off technological achievements. To get economically viable, practical systems developed, together with the companies and procedures needed to operate them, a better approach is to create a proper market for the technology, and then allow private enterprise to compete for this market. The idea of a company making thousands of orbital spaceflights, earning a modest amount of money for each one, may not seem as exciting as a one-off payment for a successful launch, but it would provide a market that would sustain the development that would make things practical. This does not mean there cannot be a big pay-off for a company for being first: If you want, you can arrange the market so that the first time someone does something they get a lot of money, but doing it many times later would still earn some money.

In arguing for a government supported economy, I am saying that the basic approach of prizes is fundamentally sound, but that it needs to be taken further.

⁷ Some other conditions had to be met as well. <http://space.xprize.org/ansari-x-prize>.

⁸ *Tier One* (<http://scaled.com/projects/tierone/index.htm>) is a program run by Scaled Composites. The craft was designed by Burt Rutan.

⁹ *Mojave Aerospace Ventures* is a partnership of Scaled Composites (<http://www.scaled.com/>) and Virgin Galactic (<http://www.virgingalactic.com/>).

7 Possible Objections

7.1 What about the cost?

This would be expensive, but anyone criticizing this on the grounds of expense is almost tacitly admitting that it would be necessary. If you think it would be too expensive for a government to provide enough money to finance space development, how do you expect private enterprise to find the same money? The government gets something in return for this money: an economy in which advanced space technology exists. If the approach were followed properly, the cost would be huge, but so would be the eventual pay-off. The pay-off is all the resources in the solar system. This would be much greater than the cost of getting things started.

It should be pointed out that cost is not the same as risk. The government incurs the cost, but it does not incur the main part of the risk. It only pays for things that it wants to happen, when private enterprise makes them happen, and if nobody makes them happen it does not pay. The main risks are taken by private enterprise, as they should be.

7.2 Space exploration is already done by private enterprise.

Some people think that it is meaningless to advocate private enterprise for space development, as development of a lot of space technology is already contracted out to companies. The problem with this, however, is that a single large program, run by people who decide what is needed and then award contracts to develop specific systems to private industry, is not remotely close to being private enterprise. It is vulnerable to political interference. It tends to cause large bureaucracies. It prevents meaningful competition between radically different systems, instead only allowing competition between companies to develop the specific systems that the government organization wants. Although there are times when proposals are requested for a new vehicle, and proposals for different kinds of systems are submitted, the different proposals are not tested in the marketplace, but according to how well they get through the selection process. There is ultimately very limited market input into what happens. Doing things this way effectively makes space exploration a centrally controlled, nationalized industry. This would be very different to private enterprise competing for a market, even if that market is provided by a government.

As an analogy, imagine if the Ansari X PRIZE had been replaced by a committee who were going to decide which systems were most promising and award funding for them: It would not have been the same. What happened in the Soviet Union should be adequate evidence that this kind of intervention is the wrong kind.

7.3 Some companies have been successful, or will be, without help.

Some people might point to companies which have been successfully involved in space exploration. Some companies, for example, build satellites. Private enterprise has now managed to launch manned, sub-orbital space flights and put satellites in orbit.

As already mentioned, Tier One successfully flew SpaceShipOne suborbitally to win the Ansari X PRIZE. In September 2008, *SpaceX* used their *Falcon 1* launcher to place a satellite in earth orbit and in July 2009 they placed their first commercial satellite in orbit.¹⁰ Clearly, private companies can meet some of the challenges of space development.

Nothing in what I have said, however, implies that private enterprise cannot do things like this, and such activity is impressive, and valuable in terms of developing the technology to get to the later pay-offs. The problem is the *amount* of such activity that the market can support in the intermediate stages, before the really big pay-offs later.

¹⁰ <http://www.spacex.com/>.

8 Conclusion

Although government organizations have so far failed to open the space frontier, it may be optimistic to expect private enterprise to manage this by itself in any reasonable amount of time. This is because a large scale operation will be required to develop space, but a large market for spaceflight will not come until there has been some economic development of space, creating a catch-22 situation. A solution to this might be for a government to promote space travel and development by providing a large, guaranteed market for space activity and allowing private companies to compete for this market, giving private enterprise the necessary incentive to develop the technology while still promoting competition.

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