

Building a place to trade in space

The San Francisco model

by Donald F. Robertson

Why would anyone invest the hundreds of millions, or billions, of dollars needed to develop routine transportation to space? After all, the only existing market each year is a few dozen communications, scientific, and military satellites. An unfortunate number of would-be entrepreneurial launch companies are finding themselves asking just that question.

The Golden Gate Bridge, San Francisco.

Lucy Owens

Inevitably, the question leads to others. Should The United States' National Aeronautics and Space Administration continue to pour money into the Space Station? Should the space agency continue to plan for a Lunar Base, or even flights to Mars or an asteroid? Or, should the United States drop all of those grandiose and currently unaffordable ambitions? Instead, should NASA concentrate her limited resources on helping entrepreneurs develop the ultimate prerequisite to large-scale, affordable operations in space - cheap access to orbit?

Which should come first, the orbital chicken, or the transportation egg?

These are not new questions, but, in today's climate of slowly improving technology and rapidly decreasing funding, answers to them are more important than ever.

For a government bureaucracy, the NASA institution has done a remarkable job of changing in recent years. In the face of steadily declining funding, NASA's "Faster, Better, Cheaper," strategy has dramatically reduced the cost of planetary exploration. Recent embarrassing failures aside, it has clearly produced significant science, albeit on a smaller scale and closer to the home world.

The strategy has been even more successful with low-Earth orbiting geoscience and astronomical missions. Likewise, the Space Shuttle orbiters have their ongoing problems, but the Shuttle is by far the world's most reliable launch vehicle while costing somewhat less than before. Only the Space Station remains a consistent thorn in the space body politic. With new budget overruns rapidly climbing toward five billion dollars, the project seems immune from any attempts at reform.

The Space Station is an expensive and highly visible target. Some currently influential groups want NASA to drop all the agency's expansionist goals and push cheap access to low orbit as hard and as fast as possible. They imply that space travel will never become routine until NASA forgets the Space Station and its associated two-billion dollars annual investment. Instead, they argue that NASA must figure out a way to legally place some of that money into the hands of entrepreneurs to create radical new ways of getting into orbit.

Humanity has never tackled a frontier as difficult as the Solar System before, so we cannot know the answers to the questions that introduced this article with any certainty. But

history does provide some pretty strong clues, at least to what has worked in the past.

The expansion of the first trans-continental rail road across the wastes of the American West is often used as an historical analogy for commercial expansion into space, and that is as good an analogy as any. The trans-continental rail road involved relatively high technology, great government subsidies, and a large amount of high-risk private investment. All of that was required to achieve a transportation goal that may approach the difficulty and scale of effort required to create routine access to orbit. Significantly, the goal was demonstrably attained; it can be done. However, most people who use this analogy ignore a vital element of the time line.

The trans-continental rail road was not built into the empty interior. It was built to supply San Francisco more cheaply than could be done by sailing all the way around South America. San Francisco was started with great difficulty, and at great expense, as a Spanish military outpost. Later, the growing base was used by a different country as a logistics centre to supply the gold rush in California, and then silver mining in Nevada.

The key point is that the latter two events happened first. Before cheaper transportation could be developed, there was an existing and high-cost military and commercial logistics base supporting high-value mining operations. These activities in turn led to the rise of financial and communications service industries. All of that was established and in place before the trans-continental rail road could even begin to attract private capital.

Historically, this pattern has been fairly typical of commercial expansion into a difficult frontier. An initial forward base is established. Often this is at public expense for military purposes, mining, or even for trading. Sometimes the initial outpost is closely followed by religious or political colonists, who are willing to endure great hardship and expense for no obvious measurable gain. Then, once the new colony is a firmly established market for supplies, entrepreneurs develop techniques to supply the growing base at lower cost. Large public companies eventually take over, and, finally, the base grows into a self-sufficient commercial city.

The historical analogy most often used by would-be launch vehicle entrepreneurs is the more recent model of aviation development. But aviation has always been about point-to-point transportation, and has rarely had to worry about creating the destination point.

What entrepreneurial launch vehicle developers are trying to do is analogous to building a rail road to an empty California. They are trying to reverse the process that has worked in the past. If San Francisco and the gold and silver mining had not existed, it is unlikely that, even with the help of Federal land grants, private money could have financed a trans-continental rail road. Like a new launch vehicle, an incomplete rail road could earn little money. Funds had to be raised up front, and held for a long period of time at high risk, before they had a chance to earn a return.

There is no reason to believe that any of this will be different in space. As would-be developers of new-generation commercial rockets are finding out, there needs to be a place to deliver material to, before private individuals or banks will pour vast sums of money into new methods of sending that material into space.

Impatient space advocates also should note the time scales involved. San Francisco was founded as a Spanish Presidio and Mission in 1776. The gold rush did not start until 1848 when the city had big plans but only some five-hundred residents. It was not until 1862 - not much less than a century after the city was founded - that San Francisco became an important enough destination for Congress to



Humanity's second large base in orbit, the International Space Station, should remain the world's largest priority in space. NASA

pass the Pacific Railroad Act. This act allowed local entrepreneurs to begin constructing the Western half of the trans-continental rail road. Then, it was nearly another hundred years before San Francisco grew into one of the world's important second-tier cities. The point is, even in an ideal environment, the growth of colonies does not happen as fast as space advocates would like to hope.

The wishful refusal by would-be space industrialists to look realistically at what has happened in the past has resulted in some odd disconnects in today's thinking. Many American advocates for entrepreneurial space transportation have not only ignored their most likely near term large scale market, but have actively attacked it in Congress. That market is humanity's second large base in orbit, the International Space Station.

Entrepreneurs are desperately trying to prove to potential investors that there is a large enough launch market to justify spending hundreds of millions of private dollars to develop innovative launch vehicles. Meanwhile, many of the Space Station's earlier troubles were caused by

problems with today's rickety rockets. Recently, the Russian Proton was grounded because of persistent failures of second stage RD-210 engines. Reportedly, these were built by a factory that only recently re-started production after a long post-Cold War stand-down. Likewise, wiring problems in the aging orbiters grounded the Space Shuttle fleet for much of the latter half of 1999. In the future, similar problems are inevitable.

The lesson is obvious. Over the long haul, no one should expect NASA's current plan for supplying the Space Station to work. That plan relies almost entirely on Russian Progress transports that the Russians cannot afford, a small Space Shuttle fleet that is certain to face another extended stand-down, and occasional help from the European Ariane-5. Other than Ariane, there is essentially no provision for commercial launch support of the Space Station.

It is past time for a change of strategy. NASA needs to put Space Station logistics missions out to bid, reserving the limited and irreplaceable Shuttle capacity for building the orbiting base. Few of the new launch vehicles under design



Despite ongoing problems, the Space Shuttle orbiters are by far the world's most reliable launch vehicle. NASA

would be much help with building or maintaining the Station, but, with modification, almost all of them could support logistics flights to a permanently inhabited base.

Space Station logistics is an already existing steady market that will grow rapidly as the Space Station evolves. Even early on, this market is likely to dwarf all of the traditional satellite markets combined. If there were a serious political likelihood that the Space Station market might be opened up to new launch vehicles, some investors might well see this as a sufficiently sure market to risk a few hundred million dollars.

In a key sense, it does not matter how inefficiently NASA conducts the Space Station project, or how much it costs, just so that something - anything - that needs regular supply gets up there. Likewise, it does not even matter what the Space Station is used for, the only requirement is for a base that needs frequent delivery of a large mass of material into orbit, and someone willing to pay for it.

In this light, recent efforts by Spacehab and Boeing to install commercial modules in the Russian sector of the Space Station are good news, not only because they are commercial projects, but also because they will increase the supplies that must be regularly delivered to the Station. The larger the Space Station's logistics

requirements, the better it is for the launch vehicle industry. If NASA someday manages to sell a lunar, asteroid, or Mars base to Congress, so much the better, as logistics chains will grow even faster, and to greater distances from the home world.

To let the Space Station encourage the development of commercial trade more quickly, NASA needs to stop fighting commercial resupply of the Space Station. Rather than insisting on developing a next-generation space shuttle for Station support, NASA should simply state a logistic requirement and let private developers find a way to meet it. The commercial launch industry is now sufficiently mature that this would not be an unacceptable risk. The Space Shuttle, Ariane, and Russian Soyuz launchers would keep the Station alive in the short term, while several new solutions are privately developed, possibly with government loan or payload guarantees. An "asteroid mining grant" similar to the land grants that worked so well in the American West might be tried.

The end result would be a number of new and innovative launch vehicles, and almost certainly a much more robust and lower-cost launch capability. NASA, constrained by both politics and budgetary limitations, could never develop multiple new-technology vehicles on its own.

If the Space Station market can be leveraged

to develop lower-cost ways to get into space, this will benefit the Space Station itself, as well as every other activity in space. As orbiting bases in near-Earth space get cheaper to supply, the process should feed on itself. Just as in the American West, lower transportation costs should allow us to build larger, more capable bases, as well as smaller more-specialised communities. Bigger bases, and larger numbers of them, need more supplies. A bigger logistics market should drive launch costs lower still. Before long, early space stations may grow into trading ports, and eventually full-fledged commercial cities and towns in cis-Lunar space.

To start that beneficial feedback, we must have that first, initial destination in space - the San Francisco of low Earth orbit. Those who want to quickly develop new launch vehicles are understandably resistant to putting more money into the Space Station. But, history strongly suggests that, until it is more-or-less complete, the Space Station should remain the world's highest priority in space - no matter how much it costs.

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