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ENTERPRISE IN ORBIT: THE COMMERCIAL POTENTIAL OF SPACE

INTRODUCTION

The space shuttle Discovery's recovery of two satellites that had misfired earlier this year is a major step toward space commercialization. The demonstration of the capability to retrieve objects from orbit as well as place them there not only will help stem the rising cost of insurance for space ventures, but also will encourage firms to look more seriously at the manufacture of items in space for use on Earth. As a result, it should spur the momentum for space-based ventures, which has been growing for more than two decades.

Space commercialization actually began on July 10, 1962, and fundamentally changed man's relationship to the universe. Telstar, the world's first commercial communications satellite, was successfully placed in orbit, bringing the marketplace to the heavens. From that time, the notion of space commerce was no longer science fiction--it became a daily reality, holding vast potential for those willing to bear the risk.

Today the successful launch of a satellite is no longer considered particularly newsworthy. Still, there are those who question the viability of space commerce, warn that the capital requirements for space ventures are beyond the capabilities of the private sector, and predict that the uncertainties of space commercialization make its future doubtful. Such critics often call for continued government management of space commercialization.

While it is true that space ventures are capital intensive, the private sector has demonstrated a willingness to commit enormous funds to any project showing genuine potential. Over the last four years, private firms have spent more than $285 million on space-related research and development. Even greater

amounts are committed to future endeavors. In fact, space is already turning a profit. The Comsat Corporation, for example, had sales in excess of $440 million last year and earned $50 million for its stockholders. Through the next decade and beyond, space opportunities are even more promising. A research institute specializing in space commerce, the Center for Space Policy, has identified seven space-related products and services that should contribute $65.3 billion to U.S. gross national product by the year 2000. And Rockwell International has identified just three products that could generate as much as $30 billion annually by the mid-1990s.

More important are the industries, as yet unimagined, which will create new products and new markets. As man's knowledge of the potential and the limitations of space is enhanced through actual experience, these new endeavors will eclipse those that now seem most promising. To achieve this, man's commercial reach for the stars will go through a series of stages not unlike those of the industrial revolution. And like the industrial revolution, the progression must be guided by forces of the market.

Throughout history, economic progress has flourished when markets have been allowed to function and stagnated when government interfered with them. Government's role must be limited to those things that the market will not provide.

STAGES OF DEVELOPMENT

Just as the U.S. industrial revolution can be viewed in terms of the North American continent's settlement, the industrial revolution in space can be viewed in terms of man's colonization of the heavens. Each case represents the opening of vast new frontiers with all of the uncertainties, risks, and possibilities that a pioneering effort entails. Each gained its initial impetus from government-backed exploration efforts, but both reach full potential only through market driven commercial activity.

In The Space Enterprise,* G. Harry Stine cites four basic phases of development: (1) exploration, (2) utilization, (3) colonization, and (4) habitation. Each stage carries certain requirements for commercial activity and can be associated with a corresponding phase of industrialization.

Exploration

Serious exploration of space dates from the 1930s, when rocket pioneers like Willy Ley began to develop the technology that eventually would put man on the moon.

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*An ACE book (New York: Grossett & Dunlap Company, 1980).

Man is still in the earliest phase of exploration. As during the early settlement of North America, only a few particularly hardy and venturesome individuals are involved. They are the trailblazers, discovering what conditions exist in this latest frontier and how to survive under them. They also provide the initial maps and roadways and help establish transportation routes and methods. Most important, they are proving that man can exist beyond the Earth's atmosphere and perform the functions essential to survival. As was the case with many of this continent's explorers, their endeavors have been sponsored largely by the government and not aimed at any specific commercial purpose. This is understandable, since exploration, with no prospect of direct return, is unlikely to receive private support. Private sector support, notes Stine, normally appears during the next phase of development--utilization.

Utilization

The utilization phase marks the advent of genuine commercial activity. In its earliest stages, this commercial activity focuses on high-value products or services. During the early settlement of North America, for example, much of the commercial emphasis focused on the acquisition of gold, silver, and furs or on the export of such products as tobacco, which had high market value. As the utilization phase progresses, it becomes necessary to move more and more people into the frontier to manage and operate commercial ventures and in turn provide services to those involved in such management.

The growing personnel requirements that accompany the utilization phase require rapid improvements in transportation technology. In the case of space development, this means a need to reduce the cost per pound of lifting men and material into orbit. There are two reasons for this. First, a high cost/weight ratio places severe limitations on the nature of commercial space activities. Second, cost/weight ratios provide an easy way for commercial firms involved in private launches to compete, since they can develop specialized vehicles for specific purposes to achieve greater efficiency than multipurpose vehicles such as the space shuttle. In this way, competition and the need to expand the scope of space ventures will spur rapid reductions in the cost of lifting materials and people to orbit.

As lifting costs are reduced, and it becomes less expensive to transport individuals to orbit, there will come a point when it is more economic to maintain many support personnel and facilities in orbit than on Earth. It is at this point that the first vestiges of tourism will become economic and that the next phase will begin in earnest.

Colonization

Colonization will mark the maturing of space commerce. It will be characterized by a number of factors. First will be the

use of raw materials extracted from the surrounding environment. Other factors will include energy, probably solar power, and minerals, probably from the asteroid belt. Colonization will also be marked by products and services that do not necessarily have high values, such as steel and food. Colonization will also require courts of law, entertainment facilities, complete medical services, and basic food production capabilities.

As with the early stages of North America's colonization, the large-scale industrial and commercial endeavors of this phase probably will concentrate on basic commodities, and while largely self-sufficient, will still need to import many specialized and luxury items from Earth. This will create elements of a true market system with comparative advantage being the primary determinant of what product is produced where. In all likelihood, labor-intensive goods, such as clothing, in large part will be imported during this phase, as will specialty goods. As the number of colonists grows, however, it may become practical to manufacture some labor-intensive goods in space, and the need to import such items will gradually diminish. As this trend increases, then accelerates, the nature of the relationship between the colonists in space and bases on Earth will also begin to change.

As the colonization period draws to a close, much of the heavy industrial activity that currently takes place on Earth probably will shift to orbiting factories. Some finished goods will still be manufactured on the ground, but commerce on Earth increasingly will be oriented toward servicing the orbiting factories and providing administrative and technical support to the growing population outside the atmosphere.

Habitation

The final phase of the development cycle is habitation--the permanent presence of man outside Earth's bounds. It is likely that, by the middle of the next century, the boundaries of man's habitat will have been extended to include much of the solar system. The area immediately adjacent to Earth, near-space and the moon, should have well-established colonies that are independent or at least self-sufficient economic units. More distant areas, including the asteroid belt, will by then represent frontier areas akin to the northern reaches of Alaska, or areas of the Pacific Ocean.

Achieving the ambitious goal of spreading man's vistas to include the solar system within a century requires more than courage and determination. It requires the proper economic and political environment. During the transition from exploration to ultilization, the role of government must be eliminated, and the private sector must assume responsibility for development.

PRIVATE SECTOR RESPONSIBILITY

Stine notes that Lewis and Clark walked across the vast mineral wealth of America without realizing it was there. This simple fact underscores the need for nongovernmental entities to guide the commercial development of space--or of any other frontier. By its very nature, government is not likely to respond to forces of the marketplace--a prime requisite for any commercial endeavor. In fact, by definition, government's role in society is to mitigate "externalities," that is, activities in which costs and benefits cannot be readily assigned to individuals--such as national defense or the operation of a court system--but which are essential to the society's operation. Since this emphasis on externalities makes government insensitive to the normal considerations of cost, benefit, and risk that are inherent in marketplace transactions, government is particularly ill-suited to foster commercial development. Therefore, during the transition from the exploration phase, which is by nature an externality, to the utilization phase, which is essentially commercial, a transition from government to nongovernment guidance must also occur. For this, the commercial sector must develop the mechanisms to fill certain critical needs.

Capital Formation

As long as government dominates the development of space, the allocation of capital to that effort will remain largely a political decision. Noneconomic factors drive government efforts, and economic risk is not the primary factor for government in setting budgets, funding programs, or designing programs. Therefore, no adequate mechanism will provide the risk assessment function necessary to capital formation. There also will be no mechanism to allow capital formation. This is particularly important in relation to the early stages of space utilization, since the initial capital requirements will be high and the uncertainties large. It will be necessary then to create such a mechanism if capital formation is to take place.

Any effective mechanism to accumulate capital earmarked for space-related ventures must: (1) be capable of assembling large blocks of funds because of the scale of enterprise involved in space; (2) be capable of yielding a high return, commensurate with the high degree of risk involved; and (3) have the capability, within the limits of science, to provide some reasonable assessment of the risks to permit reasonable investment decisions.

One means of achieving this could be to extend the research and development investment tax credit currently enjoyed by certain limited partnerships to a broader segment of the public. This could be accomplished by allowing the formation of large limited partnerships, similar conceptually to tax deductible Individual Retirement Accounts (IRAs). This would allow many small investors to pool their money, while obtaining a significant tax benefit. This would mobilize the funds needed for research and development

of space commercialization projects. The tax credit would offset the long payoff time normally associated with space-related projects. Most important, such firms would be guided by market considerations and therefore would be far more concerned about economic efficiency than about political or other considerations.

Staging Companies

A second key requirement, as noted by Christian O. Basler, an attorney formerly with Western Electric, is the "staging company." Such companies also involve many small investors. They differ from limited partnerships in that they initially would operate as conventional investment funds by using their capital to purchase high-yield equity securities. Also, they would lack the tax advantages gained through the Research and Development Tax Credit. This would reduce risk in the early stages because the investments would be of a relatively conventional nature until the process of capital accumulation was completed. Once enough capital was accumulated, the "company" would cease operating as an investment company and turn its efforts to space industrialization. The staging company, moreover would reinvest its dividends in research and development aimed at paving the way for space commercialization. It would also concentrate its investment in equity securities with companies with which it has research contracts. Therefore, it would initially be helping to finance the research and development that would eventually allow it to move on to actual industrialization of the heavens.

Other Options

Where projects pose less risk, as with the now routine launching of commercial satellites or the development of specific processes to be performed in space, somewhat conventional means of financing are possible. In fact, there has already been a considerable amount of capital generated for such ventures. Example: Orbital Sciences Corporation of Vienna, Virginia, has attracted more than $50 million in private funding for its rocket booster designed to place communication satellites in orbit from the space shuttle. Several small Texas-based firms, such as Space Services, Inc., and Startruck, have attracted private investors to projects aimed at developing private launch vehicles. There has also been some $180 million dedicated by major corporations such as MacDonnell/Douglas, Johnson and Johnson, and General Motors to space-related projects. These commitments are in addition to funds for the relatively well-developed communication satellite market.

It would seem that a principal hurdle to the transition from the exploration phase of space development to the utilization phase does not appear to be insurmountable. Further, the willingness of major corporations to commit funds to such ventures indicates clearly that the notion of doing business in space is being taken seriously by responsible forces in the economy. More important, it means that the market is beginning to play a role

in assessing the merits of space ventures. This, in turn, means that economic efficiency will become a major component in investment decisions. As this occurs, the movement toward a full realization of the economic potential of space-based industries should begin to accelerate.

THE AUTOMOBILE INDUSTRY AS A MODEL

In many ways, automobile industry growth paralleled what may be expected of space industrialization. The auto industry, for example, was based on the development and marketing of a totally new product. It therefore went through a number of evolutionary phases before reaching its current state of relative maturity--stages similar to the commercialization of space.

During its earliest period, from 1900 to around 1910, automobiles were basically a rich man's toy. Even relatively inexpensive models, such as the Curved Dash Oldsmobile (the first large-scale production car built in the U.S.) cost the equivalent of a year's salary for an average worker. This early stage of the auto industry's development is similar to the current circumstances within space commercialization. At present, the only items worth manufacture are those with high relative values, such as microchips and pharamaceuticals. A second consideration is weight. This did not affect auto development, but is the principal cost factor for space manufacturing at present, because commercial materials must be sent into orbit and then retrieved.

Around 1910, when the Model T Ford introduced the assembly line, a second phase of growth occurred. This transformed the automobile from a toy to a genuine vehicle. It still was largely a product for the well-to-do, but prices moderated to a degree, and availability increased. As a consequence, auto sales increased by 760 percent over the next five years, bringing the total sales in 1915 to 989,930 units, as compared with 127,287 in 1910, and a mere 4,192 in 1900.

During the next decade, space industrialization could enter this intermediate phase. By then, orbiting space factories will be a reality, at least for high-value products, benefiting from breakthroughs in the cost of lifting materials to orbit. The range of products and services that could be manufactured or rendered in space then will increase.

The third phase of the auto industry's development began in 1915, with the introduction of a number of inexpensive models aimed at a larger market. Innovative financing brought the automobile within the financial reach of an ever increasing segment of the population. This period also witnessed the evolution of a support infrastructure that included gasoline filling stations, repair facilities, and a host of other commercial services needed for using automobiles on a large scale. More important, there were a number of technical improvements in auto

design that reduced the need for constant servicing. The refinement of the automobile as a product was the first step toward making it a genuine consumer good instead of merely a luxury.

As more products are produced in space, an infrastructure will evolve. By the end of the century, more of the services required by those working and living in orbit will be provided on site. Transportation costs, too, will fall drastically, and initial steps toward obtaining raw materials from the surrounding environment probably will begin. By early in the next century, it is likely that some mining of asteroids at least will be underway.

This period of space industrialization will see a maturing of the space transportation system. Specialized vehicles will have been developed, costs dramatically lowered, and regular schedules established on a relatively routine basis. It will also witness the evolution of service industries in space. Early candidates for investments would include medical facilities, entertainment centers, and some light manufacturing. It is during this phase that the transition from the utilization of space to its colonization will begin.

In a broad sense, the development of the auto industry and the anticipated development of space commerce closely track the gradual development of the North American economy. High-value products are manufactured, to be followed by less expensive ones, and ultimately by mass-produced items. As volume increased, costs dropped and quality improved.

HOW LONG WILL IT TAKE?

The discovery, colonization, and industrialization of North America, from 1492 through the post-World War II period, took about four and one-half centuries. The evolution of the automobile industry took about half a century, from roughly 1900 through the middle 1950s. By comparison, the commercial development of space may occur much more rapidly.

Just three decades after Willy Ley's experiments in space, Telstar launched the commercial development of space. Today, the communications satellite industry has reached a first plateau of maturity; it has become accepted as part of the world's economic system. Other ventures, which will help accelerate the growth of economic activity and the pace of colonization, are within sight. By the end of the 1990s, just 70 years from the earliest space exploration, permanent colonies almost surely will be established. Industrialization will follow in short order. As a consequence, the economic development that took four and one-half centuries for North America could well be compressed into less than a quarter the time for space commerce. There are two reasons for this: (1) the world's technological base has increased greatly; and (2) accordingly, the ability to build on this base has accelerated.

One consequence of these two factors has been the increasingly short life cycles for products, which has facilitated the introduction of new products into marketplace gaps. According to one estimate, 75 percent of the products available today did not exist four decades ago. The microchip industry, for example, did not even exist two decades ago; yet it is estimated that world microchip sales will reach $10 billion this year and up to $90 billion in the next decade. This demonstrates that the time required for the birth and development of new industries is shortening, and that such a truncated time frame will apply to the evolution of space industrialization as well.

CONCLUSION

It is difficult to estimate the dollar value of space commerce, because this commerce will depend largely on industries as yet unimagined. Yet, using the relatively conservative model of the automobile industry as a guide, it seems likely that space commerce could come to dominate the U.S. economy in nonagricultural production by the year 2050. At that point, it would roughly equal the current Gross National Product of the U.S. In fact, it would roughly equal current GNP within 25 years of the turn of the century. Moreover, taxes paid by industry in orbit would virtually pay the entire cost of the current federal budget by the year 2050. The only question is whether these predictions will be allowed to come true.

The one obstacle to space commerce is the heavy hand of government. With all the best intentions, there are those in Congress and the White House who prefer that government play the dominant role in guiding commercial space development. They ignore the dismal record of attempts by government to help industries evolve--from synthetic rubber and synthetic fuels to nuclear energy. These have one characteristic in common: they are failures. Government does have a role in helping to provide a legal framework, in encouraging exploration, in providing for the common defense. This should be sufficient to demand the full attention of the bureaucracy. What it should not do is attempt to "steer" commercial development in space. Only the private sector and the marketplace can do that.

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