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Future Directions for the Space Program with Special Reference to the Commercial and Industrial Opportunities

Ronald J. Philips

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RONALD J. PHILIPS

It is a pleasure for me to be here, and I welcome the opportunity to discuss with you the subject of space commercialization in the 1980's and beyond.

Let me say at the outset that the only forecast of the future that can be made with certainty is that our predictions don't often come to pass; at least, not in the manner or at the time we envision. It is especially difficult to forecast in a field as young and rapidly evolving as that of space flight. We have, after all, an experience base of less than 25 years on which to make projections.

We can however, usefully think about likely directions of the space program, however, and it is perhaps instructive in this regard to reflect on the development of aviation as an historical model in which great technological changes caused rapid growth in both capabilities and markets.

The Analogy to Space

As with the early decades of aviation, the first two decades in space show evidence of evolving with distinct phases. In the decade of the 1960's, large investments were made in the technologies necessary to enable growth in space mission objectives, starting with Sputnik and Explorer and eventually leading to the explorations of Apollo astronauts on the surface of the Moon. The decade of the 1960's was clearly analogous to the first twenty-year period of aviation; namely, a time when technology was to prove that space flight and space systems were technologically feasible; just as the first period in aviation had proven that aircraft flight was feasible. The technologies that made these space accomplishments possible were also similar to those in aviation, including new propulsion, power, structural, and electronic systems.

The 1970's witnessed a phase of consolidation and assessment of technology directions and, like the second period of the aviation era, we focused our technology in directions required to demonstrate utility. The 1970's proved beyond peradventure that space activities could be justified by more than just the challenge of adventure and the spur of international competition. Comsats, Landsats, Metsats, Seasat, and other applications spacecraft firmly demonstrated the potential advantages of relating to our own planet from the vantage point of near-earth space--the area that former NASA Administrator Tom Paine calls "the new continent". Again, as with aviation, communications was the first competitive market for the demonstration of utility. Just as mail transport provided the economic impetus for early exploitation of aviation, Intelsat's "Early Bird" satellite in 1965 led the way to radio, telephone and television communications, as the first arena for the early commercial exploitation of space.

As we now enter the 1980's, it is interesting to reflect on how far we have come and to compare our present state of maturity with the corresponding period in the evolution of aviation. While we have come a long way down the path to demonstration of utility, the task is not truly complete until we have demonstrated the operational usefulness of the Space Shuttle. Therefore, a fair comparison of our present status in space with an equally mature period in aviation is set in the mid-1930's. The present state of evolution of space systems seems to compare with the Ford Trimotor aircraft of 1933. The space equivalents of aviation's wide-bodied jets can be expected near the turn of this century.

With this analogy in mind, what can be said about space activities in the decade of the 1980's? Every sign points to a decade of vigorous activity. This activity will clearly be international in character, highly sophisticated in its technology, and rich in its contribution to scientific knowledge; and it will be activity that has an important commercial dimension as the economics of space flight become increasingly attractive.

I would now like to consider what I believe will be some of the overriding issues influencing space commercialization during the next decade and beyond.

The United States' reliance on space, no doubt, will continue to grow as we pursue our national goals. Well over $100 billion have been invested in the American space program to date. To gain maximum benefit from that investment, our space program must make significant progress toward achieving certain goals.

While it is true that the trend in space transportation cost has been constantly decreasing, the cost of transportation, even for a fully operational Shuttle, will still tend to inhibit very large space ventures. Progress must be made in the delivery of more units of "product" at lower unit cost.

A second goal deals with data processing. As a result of past technology developments, the end-to-end cost of processing this data has decreased substantially from $100 per processed megabit to something on the order of $6 per processed megabit. However, if the current rate of decrease is projected to 1990 ($1/processed megabit), the annual cost of processing daily full-coverage data from one operational Earth-resources satellite could still be as much as a third of a billion dollars. Such costs would clearly inhibit the achievement of the very valuable Earth-looking missions that will help us observe and more effectively manage our biosphere, our resources, and the surface activities of commerce and industry.

Third, while we often are led to think of space energy as free or, at least, cheap, and while the introduction of advanced space power modules will provide an order of magnitude reduction in energy costs, the kilowatt-hour cost of space energy will still be a thousand times that of current Earth-based electrical energy. This means that, without further development, space energy can only be used for the generation of very high "value-added" products and processes in space.

Given these trends and others and the historical perspective afforded by the analogous evolution of aviation, the path to the future appears reasonably clear.

Early in the space age, the communications industry recognized the commercial possibilities of space-based technologies. Today, the world's dependence on commercial satellite communications systems is significant and continues to grow as the requirements for transfer of information increase at a rate of 15 to 20 percent per year.

Fierce competition in the field of satellite communications will, I believe, abate little, if at all, over the coming two decades. Jockeying for priorities in the relatively limited region of geosynchronous orbit will continue. The economic importance of this space utilization is established; the battle for markets is underway.

Beyond communications satellite systems, the commercial pioneering of space has been limited by a number of factors. In the materials processing area, for example, the experiments that have or are being performed are small in scale, and secondly, they have predominately (and necessarily) involved ground-based model systems rather than systems of potential industrial importance designed for the microgravity space environment. This is a natural consequence of the test limitations of access to space.

In the 1980's the Space Shuttle will provide a routine access to space and hence, a materials processing capability. Materials processing in space, it appears, has great potential application for the production of low weight, high unit price products. A few U.S. companies have recognized this potential and are now in the process of committing substantial corporate funds for commercial materials processing endeavors aboard the Space Shuttle.

While the United States taxpayer and NASA heretofore have taken the initiative, committed funds, and given direction to our domestic space program, those in the government certainly have no monopoly on generating ideas for technologies and projects with potential commercial rewards, nor should that be expected to be the case.

Rather, it is the willingness of the private sector to make a greater commitment to the exploitation of space in its own commercial self interest that is a key missing element in our nation's space program. It is critical that business begin to act on these new opportunities for commercialization in space by providing the needed imagination, coverage, and risk-taking.

A real opportunity that can be pursued immediately is private sector commercialization in partnership with the government. One such approach, called "joint endeavors" is now being pioneered by NASA. A joint endeavor enables NASA and an industrial partner to share in the cost while providing for maximum incentives and flexibility and risks of a particular endeavor. Under a joint endeavor arrangement, NASA and a participating U.S. company are co-equal partners with no exchange of funds, property, or services taking place. Although each Joint Endeavor is negotiated on a stand alone basis,

some common elements have emerged in those agreements concluded to date.

NASA provides flight time on the Space Shuttle, technical advice, and, consultation, and use of facilities through the pre-commercial phases. The industrial concern funds its own R&D and hardware development activities and, under negotiated conditions, agrees to commercialize the resultant product or process. Release of data and background information and the form of process exclusivity are individually negotiated, since NASA recognizes the need to be open-minded and flexible if it is to encourage this level of private enterprise participation.

This is obviously only one approach; to take advantage of this opportunity as well as any others, business must provide the entrepreneurial spirit, courage, and imagination and take the same risks that made the United States a world economic power.

Space Shuttle and enhancing technology can accelerate the transition to a thriving commercial activity in space--but only if the beneficiaries themselves are willing to invest as well.

I believe that the technological challenges to commercialize space are no more difficult--and no easier--than those we have accepted and met successfully in the past. An extensive understanding of likely technological approaches for advancing the disciplines of space structures, power, electronics, automation, and propulsion which will lead to large increases in system efficiency and affordability already exist within the aerospace sector; the entrepreneurial leadership beyond that technical community is just beginning to recognize these expanding possibilities.

The development of space industry can take significantly less time than the approximately 30 years it took for the aircraft industry. Today's technology is, after all, driven not just by the scientific community or national security interests but also by the enormous worldwide consumer markets. The impetus for commercial growth exists and satisfying such markets is limited only by imagination; the challenge of multi-fold returns in power and profit is as real now as it was in early industrial America.

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R.J. Philips