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Terra-Mar

ALTERNATIVE STRATEGIES FOR SPACE STATION FINANCING

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Innovative Utilization
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I. INTRODUCTION

The attributes of the proposed space station program are specifically oriented toward research activities. On the other hand, the ultimate goal of research is to develop technologies which can generate long term benefits for mankind. In our society, unless such technologies are deemed of national interest and thus are government funded, they must stand on their own in the marketplace. Therefore, the objectives of a United States space station should be based on "commercial" criteria; otherwise, such a project will not attract long term funding. The reality of this conclusion should be evident in these times when budgets will continue to be affected by lingering deficits.

At this point, there is encouraging evidence that some potential space station activities could be generating revenues from shuttle related projects within the decade. Specifically, the McDonnell Douglas and Johnson & Johnson electrophoresis prototype pharmaceutical processing experiments show significant promise. Other materials processing concepts as well as remote sensing, as documented by Terra-Mar's analysis for the TRW space station study, indicate substantial potential. Furthermore, the economics and thus the commercial feasibility of such projects will be improved by the operating efficiencies available with an ongoing space station program.

Thus, by the end of the decade, there may be several applications which will seek the services provided by or associated with a space station. That possibility can and should dictate the direction of current space station development. A future space station can generate a substantial proportion of its own funding on the basis of its commercial potential. This potential must be defined and documented in a format that will be well received by the investment community. In addition, each component of space station activity which has commercial potential must be matched with the appropriate financial vehicle available from the investment community. Wall Street is not a monolithic source of capital, and NASA must do its homework to appreciate the opportunities for private financing that a sophisticated investment banker, broker, or institution can provide.

This study will investigate the alternative methods available to NASA to finance the commercial component of its proposed space station. This analysis will be done in the context of Terra-Mar's previous research into the markets for remote sensing data and services and the financing concepts available for funding the next generation of orbiting remote sensing devices.

II. BACKGROUND

The space station as it is presently conceived may be quite different from its ultimate configuration in space. However, one thing is certain -- the space station will be an expensive undertaking. If NASA utilizes government financing (in other words, tax dollars), funding will be accomplished through the normal negotiations that are associated with obtaining money from Congress. On the other hand, if the space program takes on a commercial orientation, then it will be necessary to approach sources of private capital with a reasonable knowledge of their operating procedures and mechanisms. The latter are considerably different from those associated with Congressional funding.

The following analysis will describe in lay terms the process and procedures utilized by the investment community in funding desirable commercial enterprises. However, it should be recognized that investors are guided by one fundamental principle. They would like to get their money back in a reasonable amount of time with some compensation for the risks incurred and/or they would like to see sufficient growth in the fruits of their investment so they will continue to be secure in the knowledge that their dollars are well placed. Furthermore, they would like to see managers using their funds in an efficient and "lean" operation. Investors are generally extremely sensitive to time delays or deviations from proposed budgets. Although there may be some tintilation and indeed ego fulfillment associated with seeing one's investment floating in orbit, when it comes down to making decisions, the "bottom line" will almost always be the dominant factor. In this situation, NASA will be given no more or less consideration than a bright-eyed entrepreneur walking in off the street with a new idea. In fact, considering that the entire pool of venture capital within the United States is approximately $5 billion, even enthusiastic pronouncements regarding the benefits of a $10 billion space station may not be well received by the investment community.

Given this situation, NASA will have to learn the language and procedures of the financial services community and perhaps assume a little humility along the way. The space station will be composed of many elements, some of which may fall into the commercial category and may be financed from private sources. However, as with Congress, it will be necessary for NASA officials to approach sources of capital knowing full well the requirements and the correct protocol. An awareness of the psychological as well as financial aspects of raising capital will be necessary.

III. ELEMENTS OF RISK: TECHNOLOGICAL, FINANCIAL, AND POLITICAL UNCERTAINTIES

The financial community has some basic guidelines by which it evaluates all potential investments. The perpetual question is -- what are the risks involved in financing the project? These risks could take the form of technical, financial, or political uncertainties. First, as far as a space station type investment is concerned, technical risks would be those associated with the operation of the facility as specified or as required to generate revenues.

Second, financial risks would be those associated with the required funding and revenues of the project in question. In other words, can the device be built within budget and on schedule and will it generate the projected revenues over its lifetime?

The third element of risk is in the political domain but indirectly relates to the first two elements. Specifically, will a government sponsored space station continue to maintain its priority in the government budget cycle through changes in administration and congressional constituencies? Therefore, if I am an investor in this project that depends on a government supported system, I want to know if I risk finding that space station turned off someday due to lack of interest or due to changes in priority among political constituencies in the government.

In general, structuring a financial deal is a process of juggling the elements of risk and reward over time. Whatever NASA can do to minimize the risks and maximize the returns over the shortest period of time will increase the level of interest on the part of the financial community. However, within the two extremes of a low risk, high return opportunity and a project with high risk and negligible return, where the bulk of investment situations lie, the mode of financing depends upon the "perceived" level of risk as compared to expected rate of return. Thus, an investor in treasury bills (usually considered a safe investment) expects a return only slightly greater than his passbook savings account, while an investor in a new company producing a new product for a new market expects a substantially larger return based on the anticipated level of risk associated with the project.

In addition to the factors of risk, reward, and time, there is the size of the investment to consider. Two projects with comparable risk-reward ratios will still be handled quite differently if one project requires $5 million and the other requires $500 million. At first glance, it is natural to assume that any project associated with a space station will be a "megabuck" proposition. On the other hand, to a great extent the use of a space station for manufacturing and materials processing, as an example, will involve new and innovative concepts that may more rapidly emerge from a small group of entrepreneurial engineers rather than from a major corporation. Such small initiatives with such great potential will start with limited funding, low ground-based overhead, and lots of enthusiasm.

If NASA is truly committed to space commercialization in the future, its role may be to create a space processing "incubator" assuming it can relate to the venture capital elements of the financial community accordingly. At the same time, the "incubator" may cost several hundred million dollars to engineer and fabricate and thus NASA may also choose to deal with that segment of the financial community, (i.e., institutional lenders) that handles large investments (oil refineries and pipelines, for example) in an appropriate investment framework.

In bridging the range of investment possibilities, the remainder this report will concentrate on three major mechanisms for business financing and on variations and combinations of the three methods where appropriate. These financing methods include venture capital, R & D limited partnerships, and project financing. Each method is appropriate under different conditions and circumstances; however, considering the breadth of possibilities encompassed by these three techniques, there are relatively few viable business concepts that could not be financed by one alone or by a combination of the three.

IV. FINANCING METHODS

Venture Capital

Venture capital is a subset of equity financing -- in other words, financing involved with selling shares in the ownership of a company among individuals who may or may not be directly associated with the company. The majority of large companies are primarily funded through equity financing with their shares traded publicly either on one of the major stock exchanges or on the over-the-counter markets. The term venture capital is often associated with start-up companies or with companies that are small and have little or no operating history. Therefore by definition, there is greater risk involved with this kind of situation. Add the element of new technology and there is even more risk to be considered. On the other hand, the investors involved with venture capital are generally looking for higher return on their money and are willing to take calculated chances to achieve that objective.

The amount of money involved with most venture capital funding is small by NASA standards. The range is within $100,000 to $10,000,000 with the bulk of the financing occurring between $300,000 and $1,000,000. In this context, why should NASA be concerned with venture capital? As mentioned previously, new commercial technology is most frequently spawned in the venture capital environment. For example, the personal computer industry started in a garage in the Silicon Valley area of California in 1976 and now represents a $6 billion industry growing in excess of 50% annually. To a great extent, space commercialization will require the creation of product concepts which do not exist today. Large corporations will definitely be involved in this process, as are McDonnell Douglas and Johnson & Johnson in the current electrophoresis project on the shuttle. But based on recent past experience, it is more likely that new companies will respond to the challenge faster than large established companies. Facing competition from the up-starts, the large companies will then very rapidly respond to the challenge -- case in point, IBM's reponse to the personal computer market in 1981 after denying its existence in 1978.

Given a viable new product or service, the objective of the venture capitalist is to assist the new company through the risky early years of development and growth in anticipation of taking the company "public", the point when capital is raised through a public offering of stock. At this juncture, the value of the company is recognized in the price of the stock. Additionally, because the stock is widely traded at this point, the initial investors have significantly greater flexibility and latitude in "cashing in" their investment.

However, up to the point of going public, requirements for additional equity capital fall on the backs of the original venture capital group which must either insert additional funds to protect the viability of their initial investment or seek additional investment funds from other venture capital groups, thus diluting their share of the company. When such injections of capital are predictable and according to the business plan, then everyone is happy and content that the company is growing and progressing as planned. Also, if growth and potential profitability are ahead of schedule, the need for additional funds is not begrudged. It is the unexpected "negative cash flows" that make venture capital investors nervous. Outside influences of particular concern include unpredictable supplies of raw material and changing requirements for unique facilities and transportation, problems not unfamiliar to NASA.

In order to overcome this obstacle, NASA must be able to sign a contract which specifies the exact availability of facilities and the cost of those facilities to be used over a specified period of time. NASA, and thus the government, must be held liable for any delays that could affect commercial production schedules to the extent that short term sales revenues are lost and the viability of the company is jeopardized. Without such assurance, no sensible businessman would commit time or money to the space station program.

How can NASA best position its space station program for venture capital investment? Most immediately, by continuing the "joint endeavor" process while turning agreements around in weeks instead of months. In a similar manner, NASA must be prepared to provide space services rapidly and at a reasonable price to an investment community that cannot tolerate bureaucratic delays and that works on a very short, tight schedule with a limited budget. If a new venture calls for a 1990 space station facility at a $5 million annual lease rate, a "technical" or "budget" problem that delays the availability of that space station until 1992 and results in an annual lease rate of $10 million will not be tolerated.

Assuming that NASA can respond to this challenge, NASA must, in addition, sell its space station programs to entrepreneurs and venture capital sources in a manner responsive to their need for facilities. Will a new start company be interested in buying "up-front" a complete facilities module at $200 million? Unlikely. Will they rent or lease space starting at $200,000 per month if they can sell the resulting product for $400,000? There is a strong possibility. At this point, the pertinent questions are:

- can NASA fund the building of appropriate hardware and charge out its usage at an acceptable level so that it can recover its costs?

- if NASA cannot or chooses not to perform this function, are there other entities within the private sector who would willingly perform this function?

- if there are such "third party" opportunities, can NASA in turn respond to their needs?

The second and third questions above will be addressed later in this report. But an important point to make now is that all forms of commercial financing are tied together by common threads of self interest. Therefore, on a more earthly level, a new high technology company will require manufacturing facilities to do its R & D and to build its product. Consequently, the company leases office and laboratory space from a real estate investment company that in turn receives its financing from banks and insurance companies. Thus, NASA is confronted with not only the priorities of the venture capital community but also with how these priorities relate to other financial interests. Similarly, financial institutions involved with setting up limited partnerships and structuring project financing for the fabrication of space facilities must have commercial tenants with a viable application in mind. Indeed, a communications customer may walk in with contracts and commitments in hand. Yet, organizing and cultivating potential new venture concepts, and specifically their financial supporters, will be a fundamental requirement for stimulating the long term development of commercial space activities.

Research and Development Limited Partnerships

As a financial vehicle, the limited partnership has been around for many years. The concept centers on the utilization of funding from a group of investors, known as limited partners, and on the management group, composed of individuals or a corporation known as the general partner, all of whom are organized under specific legal and accounting guidelines. The primary objective of a limited partnership is to provide off balance sheet financing -- in other words, funding not affecting the credit status of the company -- while providing specific tax and income benefits to an otherwise unaffiliated group of investors. Specifically, the investors receive the immediate tax benefits associated with the purchase of hardware and equipment with the additional commitment to receive a specified percentage of revenues from the resulting project over a predetermined period of time. The company presumably does not need or want the tax benefits, avoids the use of debt financing or equity financing, and is not required to indefinitely share the profits of a specific project or the long term prosperity of the company with the investors/limited partners.

In the past ten years, a variation of the standard limited partnership has evolved which provides specific benefits to those companies developing new high technology products. Known as the R & D limited partnership, it is designed to complement rather than replace conventional equity and bank financing. The R & D partnership is particularly beneficial in that it is designed to efficiently utilize available tax benefits to minimize an investor's after tax capital at risk and thus substantially boost the after tax returns. Furthermore, if the research project proves to be successful, the royalties may be taxed at the long term capital gain rates. Consequently, these tax benefits enable an investor to take financial risks which would otherwise be unacceptable to venture capital as well as conventional equity investors.

The benefits provided by the R & D partnership are based on three major elements of the tax code and related legal decisions. First, the Internal Revenue Code, Section 174, permits an electing taxpayer to currently deduct qualifying research expenditures rather than capitalize them as part of a product's ultimate cost. Second, the tax code permits the partners to be taxed at the long term capital gains rates on the sale of all rights to a patent or patentable property by the inventor or a person who buys an interest in the invention from the inventor before it is commercially exploitable, regardless of the actual holding period. The third element is the decision made by the U.S. Supreme Court in a precedent setting case known as "Snow vs. Commissioner", 416 U.S. 500 (1974) which held that limited partners could offset their income with partnership research or experimental expenditures. This decision also further extended the boundaries of Section 174 to include businesses that have not yet offered any product for sale.

For example, a typical partnership would be initiated by an inventor, who as general partner would contribute his invention or idea while the limited partners provide capital to finance the required research and development to bring the concept to fruition. The partnership subsequently spends the funds for research allocating the resulting tax loss to the limited partners. This loss offsets the limited partners "nonpartnership" taxable income therefore reducing their after tax exposure and thus reducing the perceived risk of the research project. When the concept is perfected and brought to the marketplace, the general and limited partners share the income generated from the sales of the product.

Over the last ten years, many variations to this basic structure have been suggested and tested within the business community. In most cases, the partnership contracts out the

R & D to a research corporation, usually headed by the inventor. This procedure takes advantage of existing facilities, minimizing the requirement for the partnership to invest in new facilities while protecting the "trade secrets" of the inventor. Similarly, rather than manufacturing and selling the results of the research effort, the partnership will sell all rights to the invention to the research corporation/inventor in exchange for royalties based on sales. These royalties usually represent a significant proportion of revenues until the limited investors are paid back for their initial investment. At that point, the royalties decrease to a subtantially smaller percentage which, by contract agreement, usually terminate after a specified period of time. In this manner, the inventor maintains control of his company and his technology based products while minimizing external debt. The limited partner/investor minimizes his risk through the tax benefits while obtaining the prospect of above average returns on his dollar if the product is successfully developed. This prospect is particularly enhanced by the stipulation that tax on the royalties will be paid at capital gains rates rather than ordinary income rates.

Although the concept described for creating an R & D partnership is seemingly simple and straightforward, there are legal and accounting pitfalls which can jeopardize the integrity of such a project. Lawyers and accountants tend to get rich in the process, but their advice, gathered from other's experience, will be required in structuring an agreement which meets the requirements of all participating groups including the IRS.

NASA may not immediately appreciate the significance of the R & D partnership in financing the commercial elements of a space station. However, it should be realized that most R & D partnerships stress the development more than the research. In other words, where capital is required to test the feasibility of manufacturing a product or creating a process for manufacturing in space, the R & D partnership may represent an appropriate mechanism for achieving that objective. Again, it should be realized that such financing usually would not stand alone. Somewhere in the process of funding a new business, venture capital will be involved as well as those elements of financing required to fabricate the manufacturing facilities, which for NASA's purposes, would be modules of a space station.

Therefore, in covering the attributes of venture capital and the R & D partnership, the basis for using these financing tools for funding the most promising commercial space activities has been established. The methods for financing the components of the space station will be addressed in an overview of project financing.

Project Financing

Project financing is another relatively simple concept that is utilized by the business community to finance large, capital-intensive projects while minimizing the impact to the sponsor's balance sheet. The basis of project financing lies in the ability to confine the financing to a particular business unit or "project" without recourse to the sponsor. Thus, the project should stand by itself as a viable business concept or have access to specified third party guarantees which will ensure the project's ability to repay its lenders.

Project financing has been successfully utilized by companies involved in the transportation and processsing of new energy resources in particular. The amount of money and the time required to build such facilities frequently places an intolerable burden on a single sponsor unless the risks and rewards can be spread among several other interested parties. Such groups could include insurance companies, upstream suppliers, and downstream customers, as well as the lending institutions themselves. Collectively, the interests of all parties are achieved, usually through intense negotiations and compromise, and the credit viability of the project is established based on the combined qualifications and commitments of its constituents.

Although simple in concept, project financings can become quite complex when the often conflicting goals and requirements of its constituents are considered. Again, the experience of other companies, both their successes and failures, can be beneficial in determining whether project financing would be appropriate for a particular application and in determining how best to minimize delays in completing the transaction.

Criteria for Implementation

As stated previously, project financings generally are associated with capital intensive business concepts that have a lifetime of significant duration. Therefore, it is necessary to consider various criteria for project financing in the context of the project phase in which these criteria are applicable.

For practical purposes, almost all projects can be divided into four distinct phases: planning, engineering and construction, start-up, and operation. The sponsor of the project will initially produce a business plan which will outline in detail the anticipated costs to be incurred, revenues, and milestones for the proposed project. In the case of a space station, the dollar amounts and time periods may vary, but the sequence of events will be the same. Thus during the planning period before implementation of project financing for a component of a space station, the following criteria will be carefully scrutinized by lenders who wish to minimize their exposure:

- Is the primary sponsor adequately backed by equity funding? (Banks and other lending institutions are not financially backed or organizationally prepared to take equity risks.)

- Are the projections for costs and revenues conservative and based on valid assumptions?

- Is there technology risk? In other words, are there components of the project which are technically unproven and potentially unreliable?

- Are components and raw materials readily available and reliably priced?

- Is transportation for raw material and finished product available and competitively priced and will it remain so for the lifetime of the project?

- Does a market exist for the finished product? If so, is it a mature or immature market that is growing, static, or relatively unpenetrated?

- Is there a threat of technological obsolescence?

- Is the contractor or any intermediary agency considered reliable, cost conscious, and noted for delivering according to contract schedule?

- Are the management personnel experienced? Have they operated similar projects under comparable conditions and what was their track record?

- Is there sufficient insurance to cover losses beyond the control of the operators?

- Is the project going to operate in a stable political environment? In other words, will all types of regulation be anticpated, will all forms of taxation be discounted, and will changes associated with fluctuations in government be minimal?

Leasing

Although debt of some type is present in almost all forms of project financing, various forms of leasing represent an important mechanism for facilitating the flexibility required in capital-intensive project funding. The basic or true lease provides the lessor the opportunity to claim the tax benefits associated with equipment acquisition which he flows through to the lessee in reduced lease payments. The lessee, who might otherwise be unable to take advantage of the tax benefits, thus is able to reduce his cost of financing his business. In a pure sense, the lease is a form of project financing. In a broader sense, the lease is a component of larger, long term equipment acquisition which has become known as project financing in the evolving use of that term.

Leasing typically appears in a project financing in the form of a "leveraged" lease. In this variation, the lessor borrows from 50% to 80% of the funds required to purchase the desired equipment from a long term lender such as a bank or institutional investor. At this point, the simple lease becomes somewhat more complex now that a third party is involved. The debt is secured by a first lien on the equipment purchased and an interest rate is negotiated based on the credit-worthiness of the borrower and the perceived risk of the transaction. The lessor is permitted to claim all the tax benefits of the equipment purchase which will initially reduce any negative cash flow from the transaction even though interest must be paid to the lender. In the short term, the lessee also benefits due to reduced lease rates. Assuming that the use of the equipment progresses as planned, the reduced negative cash flow in the short term will accelerate growth and development of the business to a point where a positive cash flow is achieved at a faster rate. Leveraging also increases the risk asociated with unanticipated losses -- that is, leverage can work in both directions.

In leveraged lease transactions of any significance, there may be a large number of lenders and owners. Thus, frequently, an owner trustee is established to hold title to the equipment and to represent the owners while an indenture trustee is named to oversee the interests of the lenders by holding the mortgages and monitoring the periodic flow of funds. The complexity of such transactions and the resulting legal costs usually limit their use to projects involving major equipment . Hardware for a space station operation would most certainly fall into this category.

Factors that could enhance or expedite the formation of project financing transactions would include government guaranteed debt (i.e., revenue bonds, guaranteed bank debt, etc.) and/or investment tax credit and accelerated depreciation for technology investment. In particular, this is an area where NASA and the Congress can play the most effective role by providing incentives for the investment community to become involved with space commercialization. New technology areas are always slow to attract investment dollars until one or another factor triggers the interest and awareness of investors. Positive publicity is a very important contribution. In that sense, space commercialization is receiving favorable coverage by the press. However, the public perceives that space activities are expensive and risky and prone to undefined time delays. Economic incentives would go a long way towards changing that image and putting space commericialization into a positive investment environment.

V. SPACE COMMERCIALIZATION: REMOTE SENSING AS A CASE STUDY

Satellite remote sensing, as typified by the Landsat series of satellites, has been utilized and scrutinized for more than a decade. And yet, within the government, very little has been done to understand the commercial potential of satellite remote sensing or to determine how it could be commercialized productively and efficiently. Landsat has been primarily an R & D program with heavy emphasis on the "R" and with only minor attention paid to the commercial "D". Unfortunately, this has left a very promising commercial technology with a very poor foundation for transition to private sector operations. Even the major aerospace contractors, who have been involved with the Landsat program, have a poor understanding of the business opportunities in this field. From their point of view, satellite remote sensing was only important to them in terms of government contracts and not in terms of developing a new market for earth resources information services.

The government, through the NASA Landsat and the NOAA meteorological satellite (Metsat) programs, has contributed significantly to the future economic potential of satellite remote sensing. In spite of this contribution, however, an unfortunate lack of understanding has developed concerning the context in which remote sensing fits into a commercial environment. In NASA's sphere of operation, remote sensing is primarily an aerospace technology. But in the commercial world, remote sensing is a computer and information technology and it should be packaged and marketed accordingly.

Of greater significance, however, is the fact that remote sensing has not been positioned by the government as a potential commercial technology; therefore, it has remained unnoticed by the financial community. Specifically, no government agency has ever conducted market research to define the true potential of an information system based on real-time data acquisition from a network of geosynchronous and low earth orbiting satellites. To a great extent, knowledgeable private sector groups understand that the potential gross revenues derived from all components of an earth (land and ocean) resources and environmental data industry can be numbered not in the millions, but in the billions of dollars annually.

This past underestimation of the commercial potential of satellite remote sensing certainly does not help NASA now when promoting remote sensing as a component of a commercial space station program. Estimates by TRW in their Space Station Needs, Attributes and Architectural Options Study (SSNAAO) indicate that the contribution of the space segment (namely, the sensors and platforms) of remote sensing to overall space station revenues could be as much as $5.15 billion between 1995 and 2000. However, this contribution to the support of the space station program is highly dependent on aggressive development of the satellite data user market at this time, paralled by a dedicated commitment to developing a commercially viable follow-on to the Landsat program.

The government's past attitude towards remote sensing may be attributed to its orientation toward research rather than business in space. There is also a seemingly "governmental" quality to the meteorological satellite observation process. Nevertheless, it is apparent that the current activities of the Landsat program will be transferred to the private sector within the next several years with other application functions (i.e., ocean and meteorological remote sensing) being assumed by private companies during the latter part of this decade as a function of a gradual transition to commercial operations.

Terra-Mar recognizes that future revenue from appropriate satellite sensors is directly tied to growth associated with the next generation of computer services. In this context, digital satellite imagery will be a valuable source of input into earth resources information services. Within the private sector, the infrastructure for this service capability is now in the development stage. Highly refined applications software for converting imagery into information will soon greatly expand the current limited user base. Furthermore, computer networks and distributed processing will provide convenient access to new markets for specialized earth resources data bases. This is a factual not a speculative scenario that is based on generally accepted trends which are fundamental to all computer service companies.

In building investor confidence in the commercial potential of remote sensing, it is essential to establish the connection between these trends and the commercial opportunities that accurate information generated from satellite imagery will provide. Assessing and analyzing the market becomes an important function of capitalizing a new industry.

Assessing the Potential Market

Previous government studies have at best defined the value of satellite remote sensing in terms of a "cost-benefit" analysis using techniques inappropriate for assessing future high-technology markets. Specifically, the mechanism for gathering information about the future user community -- the market survey -- has misrepresented the substantial potential of an earth and environmental resources information industry. The market survey can be a very useful tool in predicting sales figures, depending upon how the information is gathered and how it is utilized. In the case of past surveys of users of remote sensing data, the general questions have been along the lines of "...how would you use remote sensing data", "... how much remote sensing data would you buy", and "...how much are you willing to pay for remote sensing data". The absurdity of such questions can be put into some perspective if one considers how a "potential customer" for computers or plain paper copiers would have answered similar questions in 1950. Most people cannot even begin to imagine how remote sensing data could relate to the way they do business or to how they make decisions.

In order to correctly assess the potential market for remote sensing "information" -- that is, highly processed and refined remote sensing data -- one must ask questions which relate to how people use any type of earth resource information in their business and how critical this information is to their decision making process. This type of information could be as seemingly mundane as a newsletter from the state fish and game department or the morning weather, livestock, and commodities report on the local television news. It could also be as expensive and complex as a $100,000 per year crop forecasting service received daily by a commodities brokerage business. Each use of information is extremely significant for the forecasting of the market for remote sensing derived products. Even this market research is irrelevant if put into a market forecasting model which does not account for the real world environment. In the case of forecasting remote sensing information markets, models which do not include industry concentration (revenues per establishment), user sophistication (ability to utilize and adapt to computer generated products), and technology leverage (growth of computer generated services) should be considered useful to the academic economist but otherwise useless in a commercial environment.

Unfortunately, such an incorrect market analysis has been generated in past market forecasts from current sales of Landsat data from the EROS Sioux Falls Data Center. Sales of products from an R & D system in a format not readily interpreted by the "masses" does not constitute the basis for accurate market projections.

In evaluating market potential, Terra-Mar has assessed the gross requirements of users for all forms of renewable and nonrenewable resource and environmental information in terms of operating revenues which are specifically affected by the availability of that information. Thus, an oil company managing a $100 million offshore oil field may spend $500,000 per year for wave, current, and meteorological information derived from satellite data and associated value-added services. Or, 10,000 commodity brokers may each utilize $50 worth of a commodities information service in making trades equaling $50,000,000.

Based upon the availability of appropriate remote sensing data, earth resources and environmental information services will eventually penetrate and expand these current markets with improved products. Projecting the growth and development of such a business becomes a function of quantifying the size of that potential market and then calculating rates of market penetration based on historically documented algorithms for comparable technologies (namely, those based on computer and communications technology).

Terra-Mar's market projections derived from analyzing these marketing and technological trends provide a positive basis for pursuing commercial satellite remote sensing services. These projections assume an aggressive marketing environment -- one that is unregulated and very competitive. Similar promising revenue estimates for materials processing products and services have been made outside the government. NASA must recognize that the technologies, which are partially the fruit of NASA's own R & D efforts, must be nurtured in an environment stimulated by the application of creative marketing techniques. The creation of the technology establishes the potential of a new business. Application of sound marketing and management techniques makes that potential business a reality.

The Leverage of Improving Technology

To a great extent, growth in the markets for earth resources and environmental information will be made possible by advances in semiconductor and computer technology. The growth in the sales of personal computers from zero in 1976 to over $6 billion in 1983 is indicative of a trend towards less expensive, distributed computing which will shape the marketing strategies for computer services in the future. In essence, the personal computer has created a mass market for software and data services on an individual level. Like the scientific hand-held calculater of the last decade, a high percentage of scientists, engineers, and businessmen will own a desktop personal computer to use in their day-to-day decision making process. It will not be a luxury but a necessity.

In this marketing context, remote sensing data will become an important component of the future information revolution. Terra-Mar has determined that a substantial proportion of important decisions made by the business community are related to having accurate information about the earth's resources or its environment. Improving the raw satellite imagery with value-added services -- essentially, customizing the data to user needs -- will make remote sensing data a strategic element of the future decision making process of international business.

In addition to advances in computer technology, the next decade will see improvements in the methods of deploying orbiting earth sensors. More reliable, interchangeable, and thus less expensive sensor components will be operated from space platforms such as the Fairchild Leasecraft and the MBB SPAS in coordination with manned space stations. On these platforms, scheduled maintenance and repair will prevent the costly loss of satellite sensor systems, as previously experienced with Seasat, for example. The requirement of efficiency and economy will replace the "gold-plated" specifications generated by the previous era of R & D sensors.

Approaching the Investment Community

Unfortunately, the investment community has not been well informed about the commercial opportunities regarding utilization of remote sensing technology. Government officials have not only failed to educate Wall Street but have also failed to understand how private investors can play an important role in developing this strategic technology. As mentioned previously, investors are guided by certain criteria in evaluating prospects for placing their funds.

Four criteria are particularly applicable in the case of remote sensing. First, is the technology far enough removed from research and development that there is small risk of technical surprise along the path to the marketplace? Second, is this a market with substantial opportunity for long term growth? Third, after considering development and operating costs, are revenue projections sufficient to provide adequate return-on-investment (ROI) in comparison with other investment opportunities? And fourth, is there minimal near and long term risk of the type of government regulation that could inhibit earnings growth? In other words, are we dealing with a politically benign technology?

Ten years of successful R & D in Landsat and related environmental satellite programs will provide the basis for initiating commercial remote sensing ventures with little threat of technical uncertainties or unknowns. Solid state sensor technology will minimize many of the risks of mechanical sensors, while improved modes of deployment such as SPAS and Leasecraft serviced through a manned space station can minimize the risks of on-orbit failure.

Discounting the government evaluation of remote sensing generated information markets, private studies such as those prepared by Terra-Mar adequately document the potential of a market for products and services primarily generated from the availability of appropriate remote sensing data. Paralleling other computer generated information service markets, this business should generate approximately $12 billion in revenues (in constant 1980 dollars) from sales of data, computer hardware and software, and value-added services by the year 2000. Such rapidly growing and sustained market opportunities are currently highly valued by the investment community.

Thus, the projections for revenues and profits become equally appealing as costs decrease with improved computer and sensor technology, while progress along the "learning curve" creates well defined methods for decreasing unit cost for data generation. Subsequently, remote sensing will follow the trend of other computer technologies as near term dominance of hardware sales is rapidly displaced by requirements for software and then raw data, as the market becomes more broad-based and sophisticated in its utilization of available products.

This leaves the fourth factor -- the issue of politics -- as the remaining unknown and the single issue which could inhibit commercial development of remote sensing products and services. The current controversy over the disposition of Landsat 4 and the environmental satellites poses a serious problem for the business community to overcome. Specifically, Landsat 4 and the Metsats are encumbered with technical and political problems which make their transfer to the private sector rather complex. The original value of the satellite and related data processing assets is significant; however, on the open market, that level of technology is considered obsolete. Given the computer technology which is available today and which will make another substantial leap by 1984, Landsat 4/Metsat-type equipment, primarily oriented for R & D applications, could be considered in financial circles to be a commercial liability. There is also a negative stigma associated with "Landsat" as a commercial concept. The entire process of "analysis" has politicized Landsat to the extent that the financial community views Landsat with a certain skepticism -- it is expensive, unreliable, and may entail unknown political traps.

Nevertheless, Landsat 4 and the Metsats do represent a significant contribution to our understanding of the technology associated with developing viable commercial information products. The addition of the Thematic Mapper to Landsat 4 has provided new insights into the potential usefulness of satellite resource surveillance. However, Landsat 4 is not configured to be an operational satellite system, and no investor who is seeking to compete in an open marketplace would consider owning that system. The NOAA and GOES environmental satellites, although existing in an operational environment, are similarly not configured for commercial utilization. The government's preoccupation with "selling" Landsat and NOAA satellites has missed the true objective of promoting satellite remote sensing as a viable commercial technology. Emphasis should be placed on creating incentives for investment in the next generation of reliable and efficient satellite sensing systems, rather than on unloading the product of past R & D programs. Similar errors cannot be made in developing commercial space station programs, otherwise investors will show little interest in these programs.

The proper government orientation and strategy should be to stimulate the groundswell of value-added activity which is already occurring, thereby increasing revenues from satellite data sales as new applications become entrenched in the marketplace. Strength among private sector operators will eventually permit backward integration into data receipt and archiving as well as the development and operation of orbiting sensors. In this mode, healthy competition will encourage the creation of new applications software as well as encourage the companies with the best capabilities to assume a leadership role in developing a fully integrated earth resources information system.

In this frame of reference, the investment community can properly interact with those private companies, objectively evaluating the strengths and weaknesses of various competing concepts, evaluating their management's strategic planning skills and knowledge of the market, and putting each to the ultimate test -- looking at the "bottom line". The government should not compete with Wall Street in making these decisions. The government's self-interest, as probably the largest single customer for earth resources information services, will be best served by letting the marketplace determine which companies are best qualified to own and operate remote sensing satellite systems. A similar approach would expedite and enhance the investment potential of other commercial space activities.

Creating an Investment Model for Commercial Remote Sensing

Assuming a creative and stimulative transition of satellite remote sensing from current government operation, a remote sensing/earth resources information industry can finance its space segment using many of the techniques and tools outlined in Section IV. A further assumption must be made that the cost of remote sensing systems will decrease substantially during the next decade as improved electronics are incorporated into operational sensing platforms. As discussed previously, this capability will be further improved by the ability of sensing platforms to be serviced on orbit by astronauts from a manned space station. Changes in the competition and cost structure within the aerospace industry will also lead to the availability of space qualified components at prices approaching those for aircraft avionics. Within this structure, multiple sensor "platform" systems will be feasible under project financing guidelines.

VI. SPACE STATION MODULAR FINANCING

Various circumstances may evolve which will dictate the design and operating priorities for space station development. Assuming that commercial applications become a significant factor in the planning process, a strategy must be implemented that will accomodate differing requirements for orbiting facilities by various commercial users. Besides being sound from an engineering point of view, this strategy must also be financially viable. Ideally, early commercial users of an orbiting space station will pave the way for other users. For example, every new technology market has its identifiable source of market leverage. In this situation, communications provides that source of leverage. Or, in the parlance of corporate America, telecommunications could be the "cash cow" of space commercialization and could provide the core facilities to support commercial remote sensing and materials processing projects.

Commonality and interchangeability of hardware will become a key criterion not only for operational convenience but also to minimize fabrication costs and consequently investment risk. Investors will be favorably inclined towards facilities where the risks associated with engineering and fabrication are borne by a number of users. "Custom" facilities have the aura of high cost and unknown operating history. Those risks are commonly taken for granted by NASA but are to be avoided if possible when presenting projects for financing to the investment community. If engineering risks are to be part of any project, they should be "packaged" as part of an appropriate financial vehicle -- namely, venture capital or R & D limited partnerships.

In that sense, for financing reasons the space station should be engineered in a modular framework that is both functional and practical. Individual projects planned for the separate space station modules (or components), and their operating facilities, can then be matched with the financing mechanism best suited for the element of risk and the return on investment associated with that project. In reviewing the space station feasibility studies prepared over the last decade, Terra-Mar has concluded that an appropriate concept reflecting this logical, modular approach is embodied in the "Manned Orbital Systems Concepts Study" (MOSCS) prepared by McDonnell Douglas for NASA in 1975. Vestiges of this philosophy can be found within the reports completed earlier this year in response to the SSNAAO, although there appears to be an inclination to engineer a facility on a more elaborate scale. The reader is referred to the MOSCS Executive Summary for a review of a conceptual approach to a commercial space station which, if repackaged for Wall Street today, would probably be favorably received.

VII. SPACE STATION INVESTMENT SCENARIO

There are many possible variations on how and under what conditions the investment community would participate in some component of commercial space station financing. For illustrative purposes, this section contains an investment scenario in which the previously discussed financing techniques are interwoven into a deal reflecting the priorities of investors as they relate to an actual opportunity. In this analysis, all individuals and companies are fictitious and the circumstances do not represent current or proposed ventures of any kind.

Cast of Characters

Tom Evans	- Senior Chemical Engineer at Consolidated Electronics Industries
Fred Dexter	- Tom Evans' boss
Roger Barrett	- Fred Dexter's boss and V.P. of Engineering at Consolidated Electronics Industries
Pete Baxter	- Tom's brother-in-law and an investment tax lawyer with Kroger, Michaels & Cresap
Phillip Donley	- President of Aerospace Devices, parent company of Space Facilities Inc.
Bob Lambert	- Board member of Aerospace Devices and retired bank executive
Gary Hansen	- Board member of Aerospace Devices and former president of Crosby Steel
Ted Lambert	- Bob's brother and a partner at Kroger, Michaels & Cresap
Al Pearson	- Pete Baxter's tennis doubles partner and a partner in Advanced Technology Concepts

Tom Evans is a senior chemical engineer at Consolidated Electronics Industries in Lake Pleasant, New York. He has worked for Consolidated for twenty-five years and now heads their semiconductor crystal fabrication laboratory which synthesizes and tests various materials used in semiconductor fabrication. An aerospace buff for many years, Tom has been intrigued by the possibility of growing pure crystals of gallium arsenide in microgravity. He knows that NASA is building a space station where migrogravity experimentation time will be available at a reasonable cost for R & D and feasibility studies. Thus inspired, he took some of his own time over a three-month period to develop the chemical analysis, engineering fabrication plans, and the business plan for a gallium arsenide crystal growing project which he subsequently presented to his boss, Fred Dexter, for review. Fred was impressed, put his stamp of approval on the project, and referred it up the chain of command to the V.P. of Engineering, Roger Barrett.

Consolidated Electronics, for reference purposes, is a $10 billion conglomerate with investments in everything from aerospace to agribusiness. Forty percent of its annual revenues is derived from government contracts, primarily with the Department of Defense. However, 1986 was not a good year for Consolidated. Hit hard by the unexpected recession, Consolidated got caught with "fat" inventories when contracts were cancelled and anticipated orders did not arrive. In fact, its defense business was the only factor which kept Consolidated in the black for the fiscal year.

Roger Barrett considers these facts as he reviews Tom Evan's proposed project. Roger is also only three years from retirement and is being considered for promotion to Senior Vice President during the next annual review. He decides that he does not want to give the impression to the boys at the top that he is experiencing early senility by advocating any "Buck Roger" ideas in this economic climate. Therefore, he places his REJECT stamp on Tom's proposal and passes it back down to Fred Dexter.

Tom Evans is very disappointed. He thinks out loud, "what a great opportunity for Consolidated to utilize their experience in semiconductor R & D and to get a leg up on their competition. But those guys at the top must know what they're doing -- they really have the big picture."

By chance, Tom tells his story to his brother-in-law, Pete Baxter, who is an investment tax lawyer with the New York investment banking firm of Kroger, Michaels, & Cresap. Pete is intrigued by Tom's project. Pete knows that Tom is the best in his field, and he has a feeling that a recent project in which he was primary legal counsel may be related in some way to Tom's idea.

K.M. & C. acted as an advisor and broker in a project sponsored by Space Facilities Inc., a subsidiary of Aerospace Devices, a $100 million fabricator of specialty electronics components for NASA and the Department of Defense. Aerospace Devices' president, Phillip Donley, wanted to exploit his company's distinctive competence in building custom aerospace hardware in the new arena of commercial space operations. Phil had been impressed two years before at a NASA briefing where the NASA brass really put forth a well-oiled plan for stimulating commercial space activities. Phil organized a plan with his chief of engineering to build materials processing modules that would be compatible with the space station design established by NASA.

In essence, it was NASA's innovative approach to this design that convinced Phil they were really serious about commercialization. First, they locked in a design within a year of the SSNAAO studies thus giving everyone outside the system a chance to evaluate the design and come up with their own interfacing ideas. Second, the design was a masterpiece of simplicity -- flexible, taking advantage of all that was learned in the Skylab and Shuttle programs, and incorporating the latest advances in computer and electronics technology. For Phil, it was a piece-of-cake to come up with a compatible design that was equally flexible, using off-the-shelf technology and their own ingenuity to fabricate a relatively inexpensive module for materials processing experimentation.

Phil presented the idea to his board of directors. Bob Lambert, a member of the board and retired bank executive, was enthusiastic but had some reservations about getting such a project financed. He told Phil after the board presentation that Aerospace Devices really needed a customer for the module or at least a couple companies who were willing to sign up for long term contracts to rent space on one or more of the experimentation modules. Gary Hansen, another board member and former president of Crosby Steel Corp., had heard that his former company had been doing some microgravity metal alloy experimentation with NASA Marshall and offered to see if they were interested in committing to some long term project. Well, Crosby Steel was quite cooperative, particularly after realizing that all their R & D experimentation could be expensed, rather than capitalized, based on the 1984 Space Commercialization legislation that Congress had passed.

Thus, Aerospace Devices received a contingency "take or pay" contract from Crosby Steel for module rental as well as a similar contract from the National Science Foundation for collective university studies. At that point, Aerospace Devices also established their Space Facilities subsidiary which sought additional potential large and small customers through advertisements in various professional journals. NASA, impressed with Aerospace Devices' concept and their initiative, expedited the engineering review documents and enthusiastically gave the materials experimentation modules their seal of approval.

Then, Bob Lambert stepped back into the picture and got the wheels turning at K.M.& C. where his brother Ted was a partner. Ted and Bob put their heads together and decided that a project financing approach would be the most appropriate form of financing for the materials processing modules. Pete Baxter, Tom Evans brother-in-law, was in charge of writing the legal opinion for the project financing, in collaboration with Aerospace Devices' counsel, and orchestrating the final negotiations for a leverage lease with General Credit Corp. backed by loans from Gotham National Bank, the lead lender among eight participating banks. Aerospace Devices could not take advantage of all the tax write-offs associated with the fabrication of experimentation modules, particularly the 15% investment tax credit and accelerated depreciation which was also part of the Space Commercialization legislation. Thus, the project financing involved the sale of the modules to General Credit who in turn leased them to Space Facilities Inc. for resale of services to their customers. Outer Limits Insurance, Inc. brokered the insurance covering all risks incurred in transporting and operating the microgravity modules on orbit. So, all issues of risk, liability, and compensation were covered by a complex but mutually acceptable project financing agreement.

In reviewing the project financing documents, Pete Baxter saw an opportunity for his brother-in-law, Tom Evans. Space Facilities was offering special incentives for small experimental users to rent space for 250 hours or more of their microgravity module time. Tom did not have the money or even his company's backing but he did have the reputation and a great concept on paper. Pete called his tennis doubles partner, Al Pearson, who was a partner in the venture capital firm of Advanced Technology Concepts, Inc. (ATC), and arranged a meeting between him and Tom. The meeting went very well and Fred and his partners decided to back Tom's gallium arsenide crystal business, to be known as MicroSpace Devices, with a $1.5 million equity investment -- however, the proof of concept would require up to $6 million in equipment, processing facility time on the Space Facilities' microgravity module, and transportation costs on the shuttle. And there was the issue of release of proprietary ideas from Consolidated Electronics.

Good lawyers and good brokers can solve most problems, at a price. The REJECT stamp on Tom's proposal was his ticket to freedom from Consolidated since employers must either utilize their employees ideas or provide them the opportunity to develop their ideas on their own, according to legal precedent. The $6 million issue was settled with an R & D limited partnership brokered by ATC's parent, Ferrill Bench, and offered through their 276 offices nationwide. With "Space" and "Semiconductor" in the same prospectus title, it was an instant sellout, in spite of all the boilerplate warnings and disclaimers.

Now, hypothetically, we are in the year 2000 and we are reviewing the long term fruits of this initiative. MicroSpace Devices, better known as MSD to the financial community, is a $3 billion annual sales company, dominating the market for ultra fast logic devices, primarily designed for the MEGAVAX type computer that most people wear on their wrist. Aerospace Devices, referred to as ADI, now has annual sales of a $2.5 billion supplying microgravity manufacturing, processing, and habitation modules to their estimated 2500 customers worldwide. They have also just entered the market for prefabricated hotel modules which they will initially sell to Hilton International. By the way, NASA rents hangar and habitation modules from Space Facilities for their interplanetary exploration vehicles. Collectively, the Gross National Product has been expanded by $100 billion by direct and indirect capitalization expansion due to space industrialization. And the federal government no longer has a national debt, in great part due to the additional tax dollars generated by commercial space development.

For review purposes, the foundations of this free enterprise fantasy may be traced in Figures VII-1 and VII-2 which diagram the ADI project financing and the MSD limited partnership and venture capital funding.

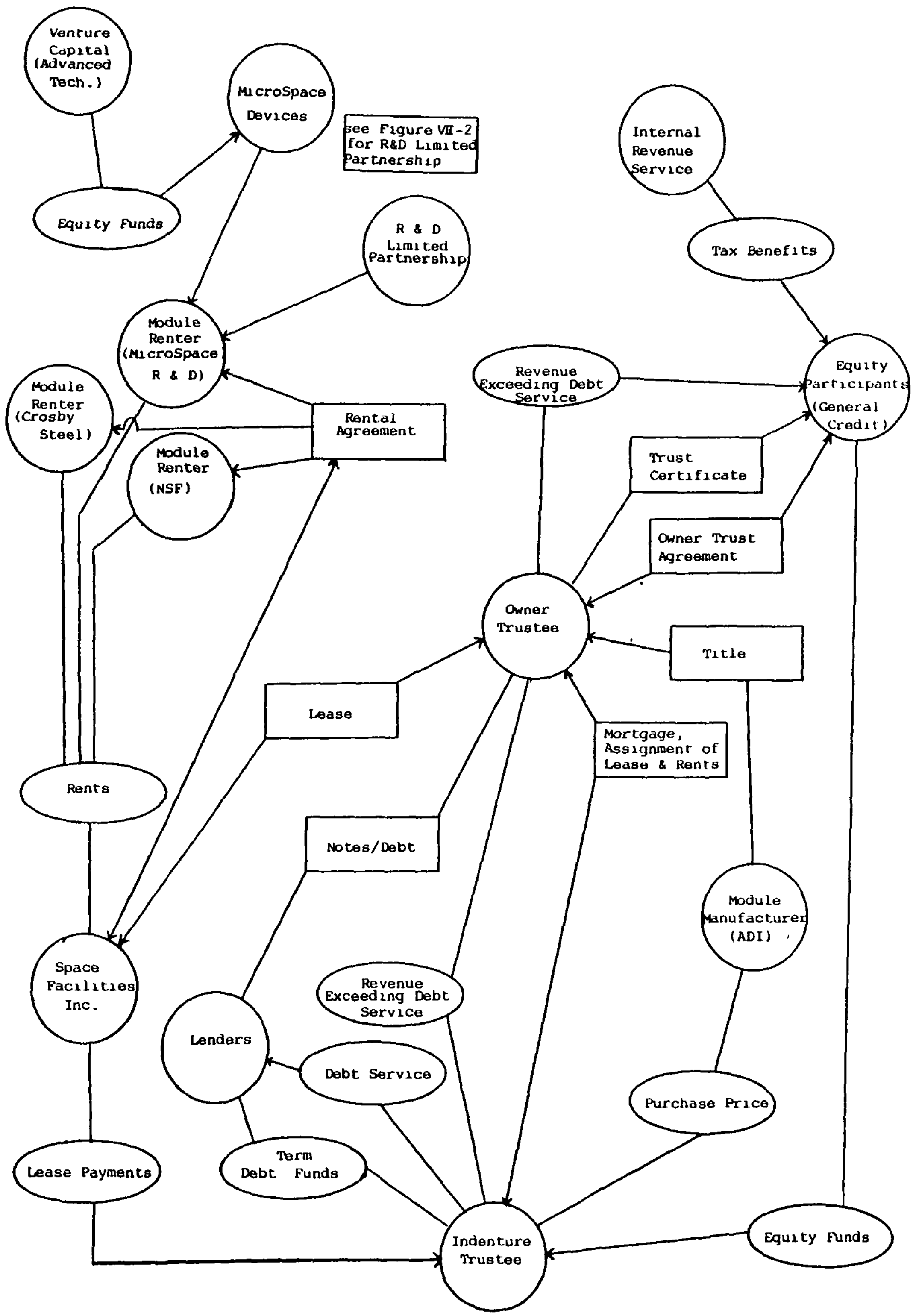
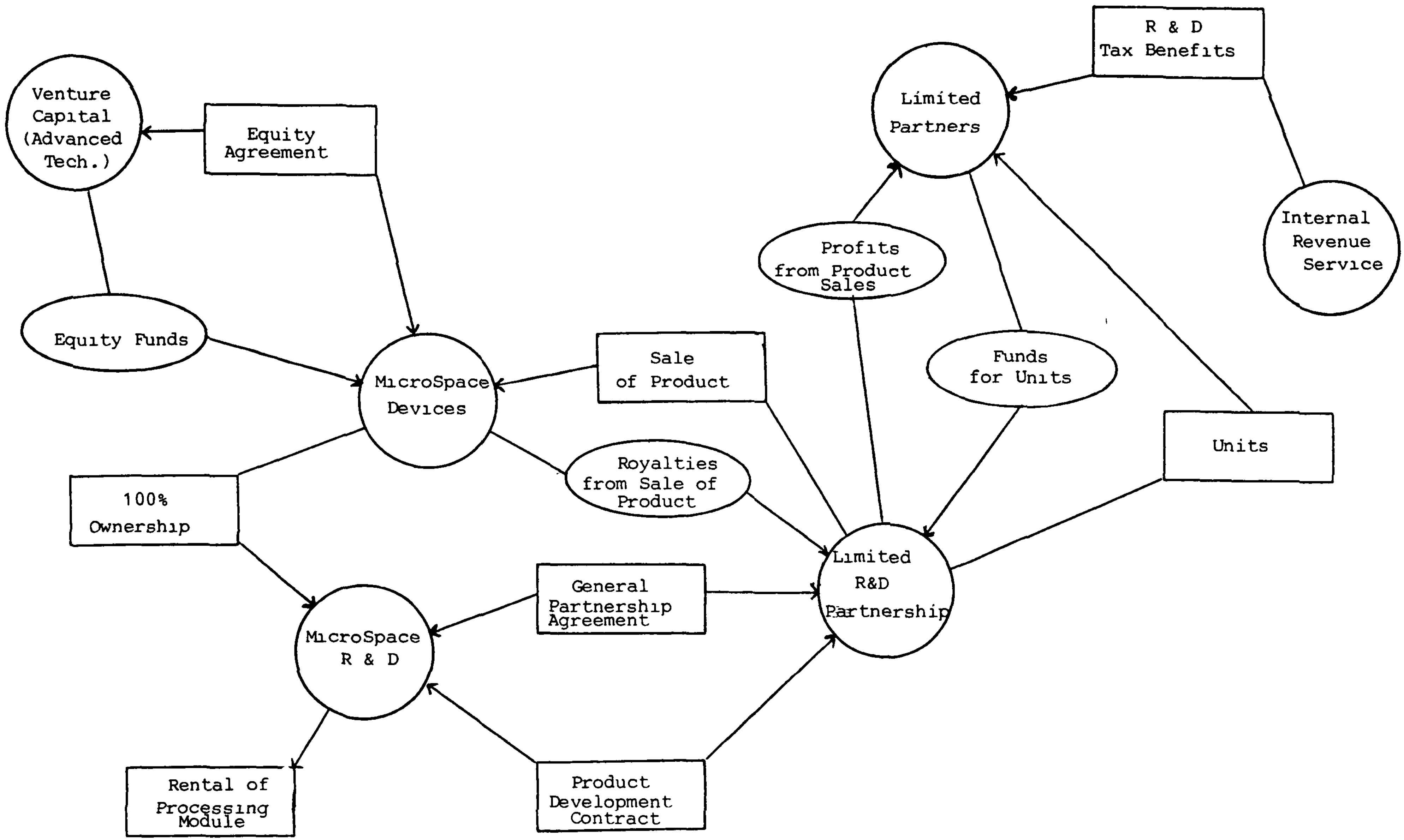


Figure VII-1: ADI Space Station Module Project Financing.



The MicroSpace R & D Partnership

Figure VII-2

VIII. LEASE VS. BUY: NASA HAS A CHOICE

In the previous sections, it was assumed that NASA would be the prime instigator in establishing a space station for commercial or any other purpose. Supposedly, this would mean that the government would own the space station and, through NASA, would lease facilities and thus provide services for a fee. Conceivably, one could ask whether, on earth, the government should be in the business of building industrial parks and leasing these facilities to the private sector. In reality, although the government does own a large number of the office buildings and laboratories which it utilizes, it also leases a considerable number of buildings from private owners and real estate developers.

It could be argued that a space station is nothing more than an industrial park in space -- in essence, orbiting real estate. Should NASA be doing a lease vs. buy analysis in determining its best utilization of government funds? Perhaps yes. Is there something so overwhelmingly governmental about space that the private sector should not be given the opportunity to take the initiative? Perhaps no. Definitely, the military's requirements for secure facilities may preclude their operation by civilians. If this factor is an overriding consideration in our future space programs, then the government should take the lead in developing appropriate facilities for its own use.

However, if military applications do not represent the primary reason for being in space, the lease vs. buy decision should certainly be considered, particularly if the concept of space commercialization is to be taken seriously. Why? For the reasons brought up initially in Section II. Can NASA guarantee its customers continuity of prices and policy through changes of administration and fluctuations in the attitude of a Congress that continually revises budget priorities? It is extremely unlikely. On the other hand, NASA could lease all or part of a space station from a private financial institution and expect that contract to remain in tact through the lifetime of the facility. That is the reality of law and the art of writing a good contract.

What about the cost? Here, there are tradeoffs that must be considered. In favor of leasing: deferred vs. upfront payment, tax revenues generated by leasing profits, and interest dollars saved if deficit financing is involved. In favor of buying: elimination of tax deductions associated with depreciation and potential revenues gained from leasing facilities to nongovernment customers. A sensitivity analysis could be run to analyze the effect of various tax considerations and interest rates on this type of tradeoff analysis. However, a more appropriate and perhaps less easily answered question would be -- what levels of efficiency and economy could be achieved by an appropriate private space station operator as compared to a government agency? Would private lenders backing a private space station operator impose greater discipline on the contracting and facilities management process thus promoting more efficient operations? Would the construction and operation of a private space station be comparable to the manufacture and operation of airliners -- delivered on schedule for the contracted amount, operated and maintained according to strict guidelines motivated by legal, liability, and profit considerations? Would the economies achieved through business and legal discipline reduce NASA's flexibility in accomplishing its stated mission, specifically, leading edge research and development in aerospace applications?

Of course, there is the middle road. The government through NASA could finance the core facilities -- the solar panels, docking ports, cooling and radiation devices, and telemetry facilities -- while the private sector would own and finance its own manufacturing and processing modules.

To a great extent, the answers to the above questions go beyond economics and enter the arena of establishing and perhaps rewriting government policy. However, it should be realized that the investment community will more readily interface with a system that it understands and respects, namely, a system of binding contracts and economic incentives. NASA's commitment to space commercialization may be judged on the basis of NASA's willingness to play by those rules. The commitment of private dollars to a commercial space station project will be impacted accordingly.

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