Center for Space Law and Policy

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A Study of Factors
Related to Commercial Space
Platform Services

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By

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Table of Contents

Participants ........................................ 2
Preface ............................................. 3
Executive Summary ................................. 4-12

SECTION ONE
IDENTIFICATION OF FACTORS

Organization of the Report ................. 13

I. Introduction .................................. 13

II. Background .................................. 15

A. MMS Heritage ................................. 15

B. Initial Stages of Fairchild's Leasecraft 16

C. NASA-Fairchild Memorandum of Understanding 17

D. Fairchild's Early Marketing Assessment 17

E. NASA-Fairchild Joint Endeavor Agreement 19

F. Fairchild's Unsolicited Proposal 20

G. NASA Request for Proposal for Commercial Space Platform Services 22
III. Factors Affecting Commercial Development of Space Platform Services

A. Market Aspects
   1. Pharmaceuticals
   2. Crystals
   3. Glasses and Ceramics
   4. Metal Alloys and Composites
   5. Other Market Possibilities
   6. Summary of Market Aspects

B. Insurance and Risk of Loss

C. Tax Related Factors

D. Space Transportation

E. Termination Liability
   1. Under JEA
   2. Under Unsolicited Proposal
   3. Under NASA RFP

F. Institutional Barriers
   1. Source Evaluation Board Process
   2. Funding Procedures

G. Procurement Laws and Regulations

IV. Summary - Section One
SECTION TWO
RECOMMENDATIONS

I. Introduction to Recommendations.................45

A. Market Risk 45
B. Insurance and Risk of Loss 46
C. Tax Treatment 47
D. Space Transportation 48
E. Schedule Uncertainty 49
F. Termination Liability 49
G. Institutional Barriers 50
H. Procurement Laws and Regulations 51
I. Funding Procedures 52
J. Financing 52

II. Conclusion........................................53

Appendix 1
Chronology of Events

Appendix 2
NASA-Fairchild MOU

Appendix 3
NASA-Fairchild JEA

Appendix 4
Leasecraft Mission Scenario

Appendix 5
Select Abstracts

Appendix 6
Explanatory Charts
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PREFACE

The Center for Space Law and Policy is an interdisciplinary enterprise based at the University of Colorado, Boulder. The Center seeks to promote research and education across a wide variety of disciplines related to space law, business, economics, and policy.

This study, "A Study of Factors Related to Commercial Space Platform Services," was made possible through a grant from the National Aeronautics and Space Administration's Office of Commercial Programs (NAGW-884). The Center would like to express its gratitude and appreciation to personnel at NASA Headquarters; NASA Goddard Space Flight Center; Fairchild Industries; McDonnell Douglas; RCA; Ball Aerospace Systems Division; The Center for Space and Advanced Technology, Inc.; Dr. John Naugle; Johnson & Johnson; and the many others who contributed to the final report.
EXECUTIVE SUMMARY

In the past four years, the issue of the commercial development of space has come to the forefront of U.S. national space policy. Though the Administration, Congress and NASA have all shown strong support for encouraging the private sector to become more actively involved in the commercial utilization of space, the question remains whether they must do more - at least at these early beginnings - to foster the creation and development of a viable U.S. commercial space industry.

This study was made possible through a grant from the National Aeronautics and Space Administration's Commercial Programs Office (NAGW-884). Section I focuses on the identification of specific factors which hindered the development of commercial space platform services and, in particular, Fairchild's Leasecraft program. Section II of the study contains general and specific policy recommendations addressing common concerns voiced by personnel within industry and NASA.

SUMMARY OF FACTORS IDENTIFIED IN SECTION ONE

The NASA-Fairchild Memorandum of Understanding (MOU), NASA-Fairchild Joint Endeavor Agreement (JEA), and NASA Request for Proposal (RFP) for commercial space platform services can be seen as three separate yet interrelated attempts to develop a commercially owned and operated space platform system. Some of the factors identified here were apparent in each of the three phases while others were unique to one or two of the phases.

A. Market Aspects

The high costs of getting to space and risks associated with activities in space significantly limit the range of products that can be profitably produced in space. The few existing products which have the high cost per unit rate yields and sufficient market demand to warrant consideration as candidates for space processing are certain pharmaceutical products; particularly high grade, defect free crystals; exotic glasses and ceramics; and possibly some metal alloys and composites. Beyond NASA, the market for commercial space platform services is equally as narrow, consisting of a wide variety of "potential users" but, as of yet, no paying users.
From the initiation of the NASA-Fairchild MOU in 1982, through NASA’s RFP for competitive procurement in 1985, the only company that had made a substantial investment and developed a comprehensive plan to produce a product in space was McDonnell Douglas. With MDAC’s withdrawal from negotiations with Fairchild there was no private sector market for commercial platform services, leaving NASA as the only customer for commercial platform services. With neither Fairchild nor RCA able to obtain a commercial customer, both companies set their price to NASA in response to the RFP at a level exceeding the cost of the Government conducting separate missions. The extremely narrow market for commercial space processing materials had a substantial and negative impact on the prospects for success for both the Leasecraft program as well as the RFP for commercial space platform services.

B. Insurance and Risk of Loss

Following a series of satellite losses, the capacity in the insurance market declined precipitously. When insurance was available, rates reached levels in excess of 20% in 1985. The sharp rise in rates, more stringent restrictions on coverage, and general unavailability of insurance led both RCA and Fairchild in their response to NASA’s RFP to request that the Government become the "insurer of last resort". Though the Government generally self-insures under standard procurements for NASA owned platforms, it was unprepared to assume the same risk for a commercial platform. At the time of NASA’s request for best and final offers, Fairchild was unable to obtain a commitment from underwriters for insurance. Without insurance, Fairchild concluded that the risks were simply too high to justify continuance of the Leasecraft program under the terms of the RFP.

The absence of an assured source of insurance or risk of loss protection substantially impacted the prospects for a successful development of a commercially owned and operated space platform.

C. Tax Related Factors

No evidence was found that suggested that tax considerations played a major role in the failure to commercialize space platform services. However, it can be argued that Internal Revenue Code provisions in existence at the time served to discourage, rather than encourage, commercial investment in space.

The applicable Treasury regulations adopt a "physical location" test for determining whether a property is used
predominantly inside the U.S. and thus qualified for an investment tax credit (ITC) or accelerated depreciation (ACRS). Under this test, non-communication space-based assets are excluded. The absence of an applicable investment tax credit [ITC] or an accelerated depreciation provision [ACRS] for non-communication, space-based assets results in an unfavorable internal rate of return for non-communication space-based investments when compared to alternative ground-based investment opportunities. This, in turn, has an adverse impact on the market for space platform services since higher investment costs result in higher platform service fees.

The tax laws also do not allow the establishment of tax deductible reserves for casualty losses for a commercial business, thus requiring the purchase of insurance to cover damage to, or loss of, the asset, facility, or product.

In sum, tax factors did not play a major role however, under similar circumstances in the future and unless changed, they will continue to discourage extensive commercial investment in space.

D. Space Transportation

A predominate factor influencing the failure to develop commercial platform services was, and still is, the high cost of transportation to and from space and the high cost of providing utilities in space.

Initial free shuttle flights as provided in the RFP did serve to lessen the financial risks to the contractor. However, for the space platform services contractor as well as potential commercial customers, platform services fees and product prices had to be calculated according to estimated transportation costs over five to ten years, after the free flights were used.

To date, transportation to and from space costs approximately 20,000 times the cost of ground transportation. In a similar vein, the provision of utilities in space costs approximately 16,000 times. Both of these figures serve to narrow the market for platform services to products with extremely high per unit yields with an estimated market demand in excess of $100 million. Unless the cost of space transportation drops dramatically over the next decade, the prospects for extensive and profitable commercial investment in materials processing in space or space facilities supporting such an industry are discouraging.
E. Termination Liability

Termination liability can best be described as the obligation of the buyer of the product or services to pay damages to the seller if, for any reason, the buyer terminates performance under the contract for the purchase of such goods or services. Termination liability was present in each of the three phases.

It is evident that termination did not create a barrier in the negotiation of the NASA-Fairchild JEA. Fairchild assumed the entire risk that it might not obtain the free shuttle launches agreed to by NASA.

Under the terms of Fairchild's unsolicited proposal, termination presented two problems. First, the proposal included a clause enabling Fairchild to "trigger" NASA's otherwise unilateral termination for convenience clause, in the event that Fairchild lost its first non-NASA customer and could not find another customer. Second, it was NASA's view that the proposal did not permit them to exercise a default termination, but instead granted NASA limited rights for "outage" penalties (i.e., a reduction in the price to be paid as a result of failure to provide contract services). Both of these conditions, in addition to the procurement problems associated with an unsolicited proposal, led NASA to decline consideration of the unsolicited proposal.

NASA's RFP for the competitive procurement for space platform services contained the standard Government termination for convenience clause. In addition to a quarterly schedule outlining the cumulative maximum liability the Government would incur in the event of a termination for convenience, the RFP stated that nothing in the RFP or contract should be construed as making the Government liable for any amount exceeding actual appropriations in relevant program areas or for the lack of appropriations sufficient to fund such liability.

NASA expected the contractors to assume the risk of obtaining additional customers other than NASA - whether Government or commercial - and based upon this assumption of risk, NASA would receive appropriate credit (or equity) in the termination schedule.

Neither Fairchild nor RCA proposed any equity value in their termination schedule and, from NASA's point of view, both proposers sought termination liability limits exceeding what the Government was prepared to offer.

Though the termination issue did present a formidable obstacle to the success of the RFP, there appears to have been a willingness on the part of at least one of the
proposers to negotiate a mutually acceptable resolution to the termination problem by assuming a significant portion of termination liability.

**F. Institutional Barriers**

No evidence was found that the composition of the Source Evaluation Board (SEB), its location at Goddard, or Goddard's previous experience with the Tracking and Data Relay Satellite System (TDRSS), influenced the objectivity of the Board or resulted in a selection process prejudicial to the development of commercial space platform services.

The Office of Commercial Programs played little or no role throughout the three phases to develop a commercially owned and operated space platform. This is largely due to the fact that the Office had only recently been established. However, in the future, it must play a major role in similar endeavors if it is to succeed in its stated mission.

Uncertainty in Government funding (i.e., termination "mid-stream" in a project), availability of funding for termination liability, and the restraint imposed by current Congressional and NASA procedures for authorization and appropriations on a fiscal year basis will continue to hinder substantial commercial investment in space.

Also working against the development of a commercially owned and operated platform was NASA's unwillingness to view the long run value that developing a commercial space platform would have on encouraging and fostering future commercialization initiatives by the private sector. In addition, the contractors' unwillingness to assume the risk of obtaining non-NASA customers to offset the cost to NASA for the platform services had a negative impact on the prospects for a successful commercial space platform.

**G. Procurement Laws and Regulations**

A final barrier rests with existing procurement laws, regulations and procedures. In contrast to the flexibility afforded NASA under Section 203 (c) (5) of the National Aeronautics and Space Act, procurement laws, regulations and procedures require - with very limited exceptions - full and open competition. P.L. 83-36, 98-525 and 98-577 recently enacted by Congress have made it more difficult for NASA to accept unsolicited proposals or to make sole source awards.

Using the procurement process is time consuming as well as inflexible. The procurement laws have been interpreted and applied so as to require NASA and other Government
agencies to set forth technical requirements in great detail. Once proposals have been submitted there is little room for innovative ideas or approaches which deviate from the RFP requirements but may be more beneficial to the Government.

The requirement for competitive selection where there is a known Government requirement discourages companies from identifying space facilities that could be developed by the private sector. It makes no financial sense for a company to expend its funds to design a facility only to have the Government then decide to proceed with a competitive procurement. It is unrealistic, to expect the private sector to fully initiate a program of research leading to final design and development with the prospect of competitive selection enforced in the final stages.

**SUMMARY OF RECOMMENDATIONS CONTAINED IN SECTION TWO**

The Administration, the Congress and NASA all publicly support the concept of space commercialization. If space commercialization is to succeed, there must be tangible evidence that all three entities will support the concept with clear objectives and commitments. On the industry side, the private sector must be willing to make the capital investment and to assume or share with the Government some of the risks associated with the development of a new industry and new markets.

The recommendations contained in this section and those that follow are directed to the Administration, Congress, and to NASA.

**A. The Market Risk**

There may be occasions when NASA should be willing to share the market risk with the supplier of goods and services to promote the early development of a commercially financed and operated space facility that would be used by other government agencies or by the private sector. For this to happen however, it may be necessary for the Administration, Congress and NASA to approve funds for this purpose over and above the basic NASA budget request. Any such "equity" or "commercial value" would be recouped by NASA from non-NASA sales by the commercial developer to other private sector entities or other Government agencies as was proposed in the space platform services procurement.
B. Insurance and Risk of Loss

Because of the high capital investment required for the commercial development of a space facility, the risk of loss during launch or on orbit is substantial and, unless resolved in some fashion by the space insurance industry, the Administration, Congress or NASA, it will continue to be a major barrier to the development of commercial activities in space. One alternative is to allow commercial entities to establish tax deductible reserves to cover casualty losses or damage to space assets.

The possibility of sharing the risk of loss in the space platform services procurement was never explored. In the future, and as part of these recommendations, in some instances NASA should share risk of loss with the commercial developer. This option should be explored more thoroughly.

C. Tax Treatment

Private sector initiative directed at the commercial development of space should receive equal, if not preferential, treatment under the tax laws and regulations.

D. Space Transportation

Congress and NASA should explore the question of reduced transportation costs with the materials processing industry, focusing on what effect, if any, a reduction of transportation costs would have on expanding the market. Another approach would be to expand the use of Space Services Development agreements with materials processing concerns as well as others who offer to develop commercial facilities. This approach, rather than being a direct form of subsidy, would require repayment, whole or in part, of the launch services furnished by NASA; in effect creating a partnership between those industries and the Government.

E. Schedule Uncertainty

The solution may again be a sharing of the risk of delay in commercial space initiatives.

F. Termination Liability

The recommendations outlined in the areas of sharing the market risk and the risk of loss, are equally applicable to sharing termination liability.
G. Institutional Aspects

0 NASA as an organization must fully support commercialization the effort. That includes the Administrator, the Associate Administrators and the Center Directors. When a potential commercial development is identified by NASA or proposed by industry, it is important that the Administrator, Program Directors, Associate Administrators and Center Directors review their programs to identify potential Government participation through the purchase of services or product by those organizations.

H. Procurement Laws and Regulations

0 When a Joint Endeavor Agreement or an unsolicited proposal proposes a product or service that could be used by both Government and non-Government users, and after identifying the Government uses in accordance with the previous recommendation, NASA should negotiate a contract with such offeror for the procurement of the Government services assuming agreement on price can be reached.

0 Where NASA has identified a facility, product or service that can be used by NASA and other non-Government customers, NASA should seek expressions of interest from the private sector for the commercial development of such a facility, product or service. Rather than employing the standard NASA procurement procedures, NASA should develop procedures permitting greater flexibility in stating its requirements, negotiating final agreements, and reducing the lead time for a contract award. NASA developed the Announcement of Opportunity procedures to meet its unique needs for experiment selection. Commercialization of space is sufficiently unique so as not to lend itself to the normal NASA procurement process. Pending the establishment of such procedures and pending clarification of NASA's authority under the Space Act, NASA should review its selection criteria and SEB scoring system recognizing the importance of space commercialization.

0 Where other major non-Government customers have been identified who would use the service or buy the product, NASA - with the permission of the supplier - should contact such non-governmental customers to negotiate as a team with the supplier in those situations where it is highly unlikely that the commercialization effort could proceed without the Government and the non-Government purchase of the goods or services. This provides the opportunity for the three parties to allocate and share the substantial risk involved in space commercialization.
The General Counsel's office should review the authority of NASA to carry out the above recommendations under the authority of the Space Act, Section 203 (C) (5), taking into account the decision interpreting that section in the case of AFGE vs. Paine. In the event the General Counsel determines that NASA lacks the authority, then it is recommended that Congress enact legislation to grant NASA the authority to implement this recommendation.

I. Funding Procedures

Congress, in concert with the Administration and NASA, should review the funding procedures normally used for NASA projects to see whether, as a matter of policy, those procedures should be changed to encourage and support space commercialization activity. Specifically, all three entities should consider granting NASA authority relieving them of the requirement to obligate funds for the contingent liability of a convenience termination. Also, NASA projects associated with a commercialization effort should be fully funded through appropriations and authorization rather than on a fiscal year basis.

J. Financing

The Congress may wish to reconsider HR7412 introduced to the 96th Congress Second Session, to establish a Space Industrial Corporation to promote, encourage, and assist in the development of new products, processes, services, and industries using the properties of the space environment and in the use of space technology. H.R. 7412 was introduced on May 21, 1980.

CONCLUSION

In view of the recognized importance of space commercialization, the U.S. Government should at least be willing to share and reduce the risks involved in commercial space activities at this stage in its development.
SECTION I

IDENTIFICATION OF FACTORS
ORGANIZATION OF THE REPORT

This report is divided into two sections. Section I focuses on the identification of specific factors which affected the full development of commercial space platform services and, in particular, Fairchild's Leasecraft program. A substantial portion of Section I of the study is directed towards a description and analysis of three phases to commercialize space platform services: the NASA-Fairchild Memorandum of Understanding (MOU) and Joint Endeavor Agreement (JEA); Fairchild's unsolicited proposal to NASA; and, NASA's Request for Proposal (RFP) for Commercial Space Platform Services. Each of these phases represents a separate attempt to move the concept of a commercially owned and operated space platform off the drawing boards and into space. Without an understanding of the underlying requirements, constraints, and conditions inherent in each phase, the factors subsequently identified as impediments or barriers cannot be adequately understood. Some of the barriers identified are present in each phase, while others are present in only one or two.

Section II of the study focuses on general and specific policy recommendations, addressing issues of mutual interest to NASA and industry. Appendices to the study include a chronology of events; the NASA-Fairchild Memorandum of Understanding and Joint Endeavor Agreement; explanatory charts; and a series of select abstracts related to the commercial development of space.

I. INTRODUCTION

In the past four years, the issue of commercial uses of space has come to the forefront of U.S. national space policy. The Administration, Congress and NASA have all shown strong support for encouraging the private sector to become more actively involved in the commercial utilization of space.

The President's National Space Policy issued on July 4, 1982, stated "the United States Government will provide a climate conducive to expanded private sector investment and involvement in space and space-related activities."

In December, 1983, an industry commercial space group formed to advise the White House on how provide such a climate stated in its report that "commercial activities in space by private enterprise need to begin now if our nation is to retain leadership in science and technology and advantages in international trade."
In his January, 1984, State of the Union Address the President stated: "We will soon implement a number of executive initiatives to promote private sector investment in space."

Finally, in 1984, the House and the Senate decided to amend the National Aeronautics and Space Act of 1958 as follows: "The Congress declares that the general welfare of the United States requires that the National Aeronautics and Space Administration seek and encourage, to the maximum extent possible, the fullest commercial use of space."

Still later in 1984, NASA issued its own Commercial Space Policy declaring that "NASA is encouraging free enterprise to participate in space by inviting industries and other private entities to finance and conduct business in space."

NASA has made a significant and substantial effort to implement the Administration's policy and Congressional mandate through the implementation of the NASA Commercial Space Policy. In late 1984, NASA established the Office of Commercial Programs to serve as an advocate and focal point for the commercial development of space. In addition, several Centers for Commercial Space Development, which utilize the expertise of industry, academia and NASA, have been funded. In 1985 NASA selected five such centers and, depending on the availability of funding, has plans for additional centers.

NASA has also developed and offered various types of industry-NASA agreements intended to assist and encourage the commercial exploitation of space. Through Joint Endeavor Agreements, NASA has offered the private sector free shuttle flights, representing an expenditure by NASA of millions of dollars. The same is true for the Space Services Development Agreement where, in effect, NASA delays the repayment of flight costs until a revenue stream results from the operation of the developed space facility. In addition, NASA also supports basic university and industry research that could lead to the development of new products in space.

Despite NASA's current efforts, and the high level of policy support for private commercial initiatives in space, little has been accomplished towards meeting overall U.S. commercial objectives in space. The high risks and costs associated with space activities have proven to be difficult obstacles for the private sector to overcome. In telecommunications satellites, the private sector has found a profitable means by which to exploit the commercial potential of space. Private sector initiatives in launch vehicles,
materials processing in space, and space-based facilities have not yet experienced the same degree of opportunity and prosperity. This has led some observers to become overly critical of the "hype" associated with commercial opportunities in space and, in turn, critical of the Government's implementation of commercial objectives in space.

The question still remains whether the Administration, Congress, and NASA must do more to foster at these early beginnings the creation and development of a viable commercial space industry.

The subject of this report, the development of commercial space platform services - and in particular the Leasecraft free-flying platform - touches nearly all aspects of the commercialization issue. Though the Leasecraft free-flyer and the NASA procurement for commercial space platform services both failed to materialize, the lessons that can be learned should prove valuable.

II. BACKGROUND OF COMMERCIAL SPACE PLATFORM SERVICES PROGRAM

The principal players in the attempt to develop commercial platform services, and in particular the Leasecraft program, were Fairchild Industries, McDonnell Douglas Astronautics Company (MDAC), NASA Goddard Space Flight Center, NASA Headquarters, Johnson & Johnson, and RCA. Each entity, over the several years of study and research into the organization and feasibility of the concept played a role in the course of events that ultimately led to the termination of the NASA RFP in 1985. A condensed chronology of key events appears in Appendix 1.

Because of their significance as separate yet interrelated attempts to commercialize the platform services, the NASA-Fairchild MOU and JEA, Fairchild's unsolicited proposal, and NASA's RFP are examined in detail. The NASA-Fairchild MOU and JEA can be found in Appendix 2 and 3 of this report.

A. The MMS Heritage

In 1981, the Goddard Space Flight Center conducted a study to assess the feasibility and capability of developing a Multi-mission Modular Spacecraft to support McDonnell
Douglas' (MDAC) free-flyer Electrophoresis Operations in Space (EOS). McDonnell Douglas had begun their EOS experimentation, employing a continuous-flow process, around 1977. The results of the Goddard study, and a separate study conducted by Fairchild on the potential market for MMS operations, concluded that Goddard's initial MMS design could not supply sufficient power for EOS and that a modified version of the MMS, which more efficiently used the shuttle's capability, could compete more effectively for NASA and DOD business in the shuttle era. More specifically, the MMS system could only supply 1 kilowatt of power, while McDonnell Douglas' (MDAC) initial EOS design required at least 3.5 kilowatts of power.

B. Initial Stages of Fairchild's Leasecraft System

In the fall of 1982, Fairchild decided to pursue the idea of a modified MMS, seeing a potential market for a small, commercially owned and operated space platform that could service commercial and Government payloads. The concept was relatively simple. The shuttle would deploy the first Leasecraft system in orbit, complete with experiments housed in detachable modules. For a revisit, the shuttle would load new payload modules into the bay and return to orbit, rendezvousing with the Leasecraft system. During rendezvous, the remote manipulator arm would latch on to the Leasecraft system, and bring it back to the bay to exchange the new payload modules for the old payload modules. The shuttle would then redeploy the Leasecraft system - complete with new modules - and bring the old modules back to earth for product delivery or for observation, analysis, and testing. A typical mission scenario appears in Appendix 4 of this report.

Technically, the Leasecraft system would be capable of carrying two or more payloads at once, or carry different payloads in sequence through on-orbit payload exchanges using the shuttle. The platform was also designed to supply up to 7.5 kw of power, thereby satisfying MDAC's requirements as well as other potential users. Essential to the Leasecraft concept however, was the objective that the program be an entire operating system which included an extensive ground based component as well as the platform in orbit. The Leasecraft platform was to have its own operational control center, logistics system of spare modules and ground support equipment, servicing equipment, and staff for operations and marketing.
C. NASA - Fairchild Memorandum of Understanding

Fairchild Industries recognized early on that Leasecraft would require NASA's "whole-hearted" support and, in August 1982, sought and obtained a Memorandum of Understanding (MOU) with NASA. The MOU states: "NASA is, therefore, interested in a commercial firm opting to design, develop, and provide such a platform to users through lease or purchase." In addition, the MOU notes "NASA and Fairchild Industries, having a mutual interest in the development and commercial availability of a small space platform, and associated services, based upon MMS technology, agree to explore the feasibility of an agreement on a joint endeavor to bring such a platform into being, demonstrate its capability in 1986 and have it commercially available for Governmental and commercial users for at least 10 years beginning in 1986."

Under the terms of the MOU, the endeavor was to proceed in three phases. First, a feasibility and preliminary design phase in FY 1982. Second, a developmental phase extending from CY 1983 through CY 1986, with a six-month in-orbit demonstration in CY 1986. And third, an operational phase from CY 1987 through CY 1996. No exchange of funds between NASA and Fairchild Industries would be expected in phases 1 or 2.

D. Fairchild's Early Market Assessment

By February 1983, Fairchild had established the Fairchild Space Operations Company to oversee the Leasecraft program. During the previous year, Fairchild held extensive discussions with a host of potential users. From these discussions, Fairchild concluded that the Leasecraft market consisted of two segments - materials processing, and data collection and transmission.

These two markets indicated that two technical versions of Leasecraft would be needed. The materials processing configuration would be a high power system with coarse pointing and stabilization, while the data collection version would be a low power system, with fine pointing and low jitter capable of high data rates. Both systems were to be operationally ready for an "early 1987 launch". In addition, Fairchild narrowed the list of potential users to three "major customers"; NASA, DOD, and McDonnell Douglas. MDAC in collaboration with Johnson & Johnson had made a substantial investment in their EOS facility and had developed a comprehensive plan for the manufacture and marketing of space-processed pharmaceuticals.
According to Fairchild's assessment, NASA was "interested" and believed the Leasecraft concept to be sound. From Fairchild's point of view, NASA wanted to help Fairchild "succeed through lowering technical and financial risks, but not by providing Fairchild with an overt monopoly position for Government business". Further, Fairchild believed that NASA "might be willing to make Leasecraft a standard shuttle service", though the "cost per hour of observation in the shuttle/sortie is of grave concern". Lastly, Fairchild's assessment of NASA's status in early 1983 noted that "current spacecraft procurement requires very early NASA funding."

Fairchild's 1983 assessment of DOD as a major user describes DOD as "very interested" and "if the Leasecraft technical concept is satisfactory, DOD will fund further efforts."

The assessment of McDonnell Douglas' status as a major user noted that MDAC "wants to be operational by 1987 but wants to keep their options open for either their own spacecraft, an RFP to industry, sole source with Fairchild, or using shuttle sorties." Fairchild and MDAC had already signed an MOU and had agreed to conduct a joint study on EOS and Leasecraft.

As of February 1983, Fairchild set an overall marketing strategy to effectively deal with each of its intended major customers. On the NASA side, Fairchild set the objective of obtaining a Joint Endeavor Agreement with NASA to establish Leasecraft's credibility and obtain a bankable agreement in 1983 for a four year lease of one Leasecraft beginning in late 1987 with NASA to provide technical services and two free launches to lower Fairchild's technical and financial risk.

Fairchild's strategy with MDAC was to conduct a joint study with MDAC to develop their confidence in the Leasecraft and ensure compatibility of EOS with Leasecraft. Within that context, Fairchild was willing to offer MDAC an exclusive role for the provision of Leasecraft power and propulsion modules, and a free EOS launch, with six months service and a revisit. In return, Fairchild hoped to gain an agreement in 1983 from MDAC to use the Leasecraft system in commercial operations.

Within DOD, Fairchild had targeted DARPA as a customer base and was prepared to offer one Leasecraft and standard services for four years, starting in the fourth quarter of 1987, payable at a rate of $4 million per month (1983 dollars) per month of service. This offer was to be on the condition that DARPA agree to sign a "bankable" agreement and provide $100 thousand earnest money on or before October 1,
1983, and to provide launch services for the initial Leasecraft launch and one revisit for refurbishment during a four year lease and for DOD payload changeouts.

E. NASA - Fairchild Joint Endeavor Agreement

In August 1983, Fairchild obtained a Joint Endeavor Agreement with NASA. Under the terms of the agreement, Fairchild would develop the Leasecraft platform as a commercial venture, with no transfer of funds between NASA and Fairchild. NASA would supply an initial test flight and a revisit together with associated launch services.

Although the JEA provided that no funds would change hands, it was recognized that NASA might wish to use the Fairchild platform for one or more of its programs. Accordingly, NASA and Fairchild also signed a separate "Letter of Agreement" attached to the JEA, pledging both parties to "jointly and expeditiously" examine the technical compatibility and economic suitability of the Fairchild platform for the performance of one or more NASA missions.

Phase 1 of the JEA called for feasibility studies and preliminary design work, including the preliminary design of Leasecraft, market surveys of potential users and economic analysis, and preliminary schedules for the program. Phase 2 called for program development and flight testing, including research, design, development, and manufacture of the test vehicle and associated ground hardware and software; and planning with NASA and other users for the operational period.

In accordance with the JEA, Fairchild initiated a market survey to further identify and document potential commercial and government users. Their survey included over 200 briefings with potential Government and commercial users; identification of candidate technologies for manufacturing in space; and estimates of the market for new pharmaceutical products and for one crystal product (gallium arsenide).

The results of Fairchild's marketing survey revealed little that Fairchild had not already anticipated. Pharmaceutical products were judged to be the most promising product market, with EOS being the most promising process by which to produce commercially marketable pharmaceuticals in space. McDonnell Douglas, then in collaboration with Johnson & Johnson, was the only entity engaged in EOS activity, attempting to produce a large glycoprotein molecule - erythropoietin - which stimulates the production of red blood cells. MDAC had estimated a domestic annual sales figure in excess of $100 million dollars for erythropoietin.
Alongside the potential market for pharmaceuticals, Fairchild identified the preparation of ultra-pure, defect-free crystals as another promising space processing activity. Gallium arsenide (GaAs), cadmium telluride (CdTe), indium phosphide (InP) and mercuric iodide (HgI₂) were cited as particular candidates for space processing. Sales projections for these crystals were set at $10-20 million, marginal to be a Leasecraft customer. According to Fairchild's marketing survey, no organization had demonstrated a process, a product or a market that could justify the commercial production of crystals in space. Fairchild did, however, see the potential for military production of these crystals where profit considerations would not weigh as heavily as in industry.

Also, in accordance with the separate Letter of Agreement, Fairchild submitted in 1984 a Mission Suitability Report to document the technical compatibility of Leasecraft with a number of NASA missions, including the EUVE, XTE, STARLAB, SIRTF and LANDSAT missions.

F. Fairchild's Unsolicited Proposal

In early 1984, Fairchild set about the task of reaching a firm agreement with their two most promising customers - NASA and McDonnell Douglas. In April 1984, Fairchild submitted an unsolicited proposal to NASA to provide three years of service for the Extreme Ultraviolet Explorer, the X-ray Timing Explorer, and a materials processing experiment. Fairchild also submitted a firm fixed price proposal to MDAC to provide five years of service to support MDAC's EOS program.

Fairchild's decision to submit an unsolicited proposal to NASA in 1984 can be viewed from two perspectives. From Fairchild's point of view, the unsolicited proposal was intended to document, for NASA's benefit, the economic suitability of the Leasecraft system. The contract provisions in the unsolicited proposal were intended to serve as model provisions for the purpose of discussion.

From NASA's point of view, the unsolicited proposal raised the more complex procurement issue of competition versus sole-source procurement. In July 1984, NASA received a request from the House Science and Technology Committee pertaining to the "Selection of Support Platforms for Payloads". The Committee (House Report 98-629) noted that "it is necessary to establish guidelines for determining when it makes sense to put payloads on either a free-flyer, unmanned platform, the Space Station, or Spacelab." The Committee directed NASA "to develop selection criteria for
each available support platform" and submit the guidelines to
the Committee by January 1, 1985.

Already in receipt of Fairchild's proposal, the request
from the Committee placed NASA in an awkward position. As
one NASA source stated at the time:

It seems to me we are obligated to
assess how the Leasecraft proposal meshes or
fails to mesh with this obligation to the Hill.
We should be careful not to prejudge the study
results prematurely, in other words, should the
Leasecraft proposal drive the study results or
should it be the other way around?

Even without selection criteria established at the time
Fairchild submitted the proposal, NASA was keenly aware that
any acceptance of the proposal "raised the over-arching
procurement consideration of competition versus sole source".
The relevant statute governing procurement, Title 10 U.S.
Code Sec. 2304 (g) provides that:

In all negotiated procurements in excess
of $25,000 in which rates or prices are not
fixed by law or regulation and in which time of
delivery will permit, proposals, including
price, shall be solicited from the maximum
number of qualified sources consistent with the
nature and requirements of the suppliers or
services procured...

Any exception to this legal requirement would have to be
explained and justified by NASA, thus raising two questions
First, can or should NASA accept an unsolicited proposal?
Second, if NASA did accept Fairchild's proposal, could a
defensible justification for non-competitive procurement
(JNCP) be argued?

In the case of the former, NASA believed it could not
accept Fairchild's proposal where there was a known
government requirement (i.e., the EUVE and XTE missions).
The second option, a defensible JNCP for Fairchild, was not
judged to be in NASA's interest. As one NASA official put it:

The extent of other private sector interests
in competing for Explorer requirements is
unknown; however, the thrust of all
congressional policy and current legislation is
unmistakably in the direction of the reliance
upon private sector competition to determine
the lowest cost to the Government.
The questionable success of a JNCP, combined with the recent request for clear-cut guidelines for the selection of platforms from the House Science and Technology Committee, led NASA to determine that Fairchild's unsolicited proposal was inappropriate for consideration.

Having reviewed Fairchild's unsolicited proposal and Mission Suitability Report, NASA decided that it was interested in procuring the services of a commercially owned and operated platform. In September 1984, NASA decided to procure such services by competition, declined Fairchild's proposal, and issued an RFP for Space Platform Services.

Fairchild's firm fixed price proposal to MDAC did not fare much better than their experience with NASA. Negotiations over the proposal were suspended in December 1984 and reinstated for a short period in 1985.

G. NASA RFP for Commercial Space Platform Services

On January 23, 1985, NASA held a preproposal conference which was attended by 15 organizations interested in the basic firm fixed price contract for mission services. The award date was planned for September 1985. From the award date to September 30, 1988 the selected contractor would complete the platform development. Starting on October 1, 1988, through September 30, 1995, the contractor would perform 60 months of on orbit platform services. The contractor would receive payment upon delivery of acceptable service which would be sometime after October 1, 1988, thus requiring private sector financing for platform development prior to receiving any NASA funds.

The statement of work for 60 months of on orbit platform services included:

- Performing all tasks necessary to analytically integrate the payload module into the platform/space transportation/tracking data systems;
- Arranging for launch services;
- Arranging for tracking and data acquisition services;
- Providing physical integration of payload module with the platform (on the ground or on orbit);
- Conducting operations by a contractor's platform operations control center;
0 Retrieving data and returning to users;
0 Returning the payload to the ground following completion of the mission.

Candidate missions specified in the RFP were the Extreme Ultraviolet Explorer (EUVE), the X-Ray Timing Explorer (XTE), and the Microgravity Science capability mission. In addition, the RFP requested 17 months of unallocated time for either a mission extension and/or a fourth mission. The payload modules were not part of the procurement, and the platform services contractor would provide mission unique services under a separate contract.

The RFP was unique in several aspects from the usual NASA Request for Proposal. First, it required the contractor to privately finance, own, and operate the system, and demonstrate the capability to manufacture and place the platform in service without resorting to government financing. The normal NASA procurement contract provides for progress payments during the manufacture of the payload or product being procured by NASA. NASA's previous procurements were almost always either fixed price contracts with progress payments, or a cost reimbursement form of contract - either fixed price incentive, cost plus incentive, or cost plus award fee - where the contractor receives reimbursement for cost incurred during development and for costs incurred after the start of services.

A second difference between the Platform Services RFP and normal NASA procurement practice was that the RFP specified the contractor would be fully responsible for system reliability and for performance of the platform. There would be no government technical monitoring and, if there was a failure of performance, no payments would be made. In assuming this responsibility, the contractor would perform the contract in a commercial manner and not be subject to the complex reporting and data requirements that are normally imposed under a government contract. Following this commercial approach, the production cost of the platform should have been lower since additional cost burdens associated with the normal procurement process would have been avoided.

The contract also contained a standard termination for convenience clause in the event the Government would terminate the contract for any reason whatsoever. Again, unlike a normal NASA procurement contract, the contract contained a termination liability schedule keyed to funds available out of the Explorer program.
The RFP stated the procurement was intended to encourage contractors to propose pricing policies that would motivate NASA and the contractor toward mutually beneficial operations such as co-occupancy with other payloads (NASA or commercial), and extended service at lower rates.

The RFP resulted in the submission of two proposals, one from Fairchild heading a team of subcontractors; and one from the RCA Corporation which also included a team of subcontractors. In accordance with NASA procurement procedures, a Source Evaluation Board (SEB) was established to review the proposals in accordance with predetermined criteria. The Selection Official was to be the Associate Administrator for the Office of Space Science and Applications.

The SEB established evaluation criteria, ground rules for a recommended service fee, and other factors that should influence the procurement. The ground rules for recommended service fee, which were not reviewed by Senior Management at NASA Headquarters, were:

- The service fee must be lower than the cost of the traditional expendable approach;
- The service fee must be comparable with the cost of a newly developed Government platform with appropriate consideration for additional platform capability, commercial rebate potential, and guaranteed service offers and proposals.
- In comparing the traditional expendable approach with the platform services approach, the comparisons should not, at this time, include consideration for the value of fostering commercialization of space.
- Funding for the service fee should come from the Code E (Space Science and Applications) and T (Tracking and Data) program offices to support activities traditionally funded at the Program Office level rather than funded from Center funds;
- Funding from the Code E and T program offices should not exceed what they otherwise would have paid under the development of a new government platform;
- The lowest cost alternative of using a refurbished Solar Maximum Mission (SMM) should only be used as a basis for comparison with a service fee if NASA is willing to let the platform services contractor have access to the same capital assets used by the Government.
Other factors that were to be applied in evaluating the service fee, but not given a designated dollar value, were:

0 Flexibility to obtain extended operations with the candidate missions through the co-occupant payload capability;

0 Flexibility to accommodate additional missions at very low costs;

0 Potential revenue to the Government from commercial use of the platform;

0 Domestic capability for U.S. commercial space R&D enterprises, and overall U.S. posture in "first to the market" space infrastructure.

Aside from these unique features, the RFP followed the normal procedures for a standard NASA competitive procurement.

III. FACTORS AFFECTING COMMERCIAL DEVELOPMENT OF SPACE PLATFORM SERVICES

A. Market Aspects

Marketing any new product or service requires that a commercial enterprise identify potential customers and whether there is a real need for the product or service offered. In addition, several equally important considerations come into play, such as pricing strategy; the extent of the existing customer base and the potential for future growth; projected revenues and operating and development costs; the extent of the competition; and whether projected returns on investment are commensurate with the risk environment.

The market for space platform services consisted of potential use by commercial concerns interested in materials processing in space and a Government market - civil and military - for observations from space.
The high costs of getting to space and the risks associated with space activity had led Fairchild to conclude that products produced in space on their platform must be of a high cost per unit rate and must have potential annual sales of at least $100 million. The few existing products which fit that description are the production of pharmaceutical products, crystals, precious metals, glasses and ceramics, metal alloys and deposits, and some specialty products. An overview of these products is presented below.

1. Pharmaceuticals

To date, the most promising commercial space processing activity appears to be the production of pharmaceutical products by the separation or purification of hormones and cells through continuous flow electrophoresis (EOS). By some estimates, the application of electrophoresis operations in space (EOS) to proteins and cells could result in yields 400 to 700 times than could be gained on the ground, as well as an improvement in resolution by about a factor of four.

MDAC began development of their EOS program employing the continuous flow process in 1977. Early shuttle flights in the 1982 to 1984 time period demonstrated the capability of the equipment to perform as predicted. With successful completion of their November 1985 flight, MDAC had the material to start the Food and Drug Administration clearance procedure for their first product. If they had been able to fly their commercial systems as planned in late 1986, by early 1987 they would have been in a position to draw final conclusions about the commercial potential and profitability of their first product, most likely erythropoietin. If the FDA had approved the product and it was demonstrated that it could be produced in sufficient quantities, domestic annual sales in excess of a $100 million were projected by MDAC.

2. Crystals

Production of ultra pure, defect-free crystals was another promising space processing activity identified by Fairchild in their early marketing analysis. Fairchild identified four crystals that might be suitable for space manufacture. The first was gallium arsenide [GaAs] for use in microwave circuits and high speed processing. For the 1988 to 1995 time period, annual sales projections - based on the sale of five to forty kilograms at a price range of $250,000 to $600,000 per kilogram - were estimated at between $3 million to $10 million. Gallium arsenide would qualify as a potential space product on a price per unit weight basis, but not on the size of the projected annual sales (i.e below the $100 million mark).
Cadmium telluride [CdTe] for use in infrared detector rays; indium phosphide [InP] for use in high speed single processing in fiber optic emitters and detectors; and mercuric iodide [HgI₂] for use in gamma ray detectors were also identified as potential candidates for space processing. Like gallium arsenide, these crystals would all meet the requirement of price per unit weight, but would fall short of the $100 million profitability mark, producing projected revenues in the $5 to $20 million annual sales range.

Research conducted on large organic crystals also suggests that they may be a potential candidate for space processing.

3. Glasses and Ceramics

Examples of three high grade glass products that cannot be made on earth today are 1) high efficiency laser rod glass; 2) low impurity laser rod glass; and 3) pure fluoride glass fibers for communications. However, the extent of the market for these products is unknown.

4. Metal Alloys and Composites

In a gravity present environment, metal alloys of different density are difficult to mix. This is because the heavier metal tends to separate from the lighter metal, thus resulting in an unequal distribution of the metals in the resultant solid. In a gravity free environment (10⁻⁶g), the density factor is removed, thus enabling metal alloys to be compounded into homogeneous mixtures. In theory, this process could result in extremely strong, yet light weight metal alloys of a type that cannot be found or produced on earth. Some possibilities include special catalysts, supermagnets, and high performance turbine blades. Again, no reliable market projections exist.

5. Other Market Possibilities

One space manufactured product that is well advanced and has already produced sales is mono-dispersed latex spheres. Fifteen grams of ten micrometer polystyrene spheres have been produced on the STS-6 mission and are currently being offered for sale by the National Bureau of Standards. Production of the spheres however, is a rapid process, discounting the need for extended flight times such as that provided by Fairchild's Leasecraft platform.

Government use of a commercial space platform, as identified in the NASA RFP, represented a considerable
element of the market for such services. Several missions, including two Explorer missions, the EUVE and XTE missions, a microgravity science mission, and a yet to be determined fourth mission were identified as candidate NASA missions in the RFP. The platform could also have been used as a test bed for sensor development, for land remote sensing, ocean remote sensing, meteorological satellites, Air Force projects, and some Strategic Defense Initiative projects.

In discussions with NASA and industry personnel, there is no question that many commercial firms were, and still are, interested in research in space. Their interest stems primarily from a desire to better understand the fundamental behavior of materials processes in space with the hope of improving ground-based manufacturing processes. From the initiation of the Fairchild Leasecraft MOU through the competitive procurement with RCA and Fairchild, MDAC was the only company with a comprehensive plan to produce a product in space. While several promising and potential commercial markets could be identified for a commercially owned and operated space platform, none of them—aside from MDAC's operations—fit the existing and present need for near term profitable operations.

6. Summary of Market Aspects

Fairchild and RCA attempted to negotiate firm agreements with McDonnell Douglas as a major commercial customer for their respective space platforms. The negotiations with McDonnell Douglas were unsuccessful. In August 1985, Johnson & Johnson, the partner with McDonnell Douglas in the electrophoresis project, withdrew their participation, having found that a competing technology (genetic engineering) could produce the desired product on the ground at a price that would permit the early marketing. In 1985, MDAC decided they could meet their foreseeable processing requirements using the shuttle and was therefore no longer a near-term space platform services customer.

It is evident from the proposals submitted by both RCA and Fairchild that neither company had identified any commercial customer then willing to enter into any agreement for their respective space platform services, and both priced their services to NASA accordingly. Both companies proposed that if a commercial customer or other non-NASA Government program made use of their platform, NASA would be credited under formulas proposed by the contractors with revenues resulting from such uses. The lack of other non-NASA customers, whether commercial or Government, combined with the ground rule requiring the cost of the NASA procurement not be significantly greater than the traditional NASA method for carrying out the missions identified in the
RFP, substantially impacted the prospects of a successful price negotiation with either contractor.

B. Insurance and Risk of Loss

Unlike the U.S. Government which acts as a self-insurer, commercial concerns generally obtain insurance against risks that may result in either claims against the company, or loss or damage to a revenue producing asset. The types of coverage planned for the proposed space platform services would have related to damage to, or loss of, the space platform during construction, transportation, or pre-ignition. The availability of insurance prior to launch has generally not been a problem. In addition to the pre-launch coverage, insurance against losses that might result during a shuttle launch, or while the platform is on orbit, is generally required by industry to protect its investment, or required by the financial institution providing financing for the development of the platform. In the past, insurance coverage has been provided through the space insurance market.

At the time of the NASA-Fairchild Joint Endeavor Agreement, and for a short period thereafter, insurance could have been obtained in the marketplace. In the 1983 time frame, shuttle launch and on orbit insurance rates ranged from 5 - 7% and could have been obtained at the time financing was being arranged for construction of the satellite. As a result of a series of communication satellite losses, the capacity in the market declined precipitously, particularly in 1985. Assuming coverage could be obtained in the amounts required (if obtained at all), coverage for launch and on orbit insurance increased to rates in excess of 20%. More importantly, coverage was not available until shortly before the scheduled launch - well after substantial investment had been made.

The sharp rise in insurance rates, restrictions, and availability led both RCA and Fairchild in their response to NASA's RFP to request that the Government become the insurer of last resort. This, in effect, shifted the risk of loss from the contractors to the Government. If insurance was available prior to launch the contractors would obtain it, but would expect the cost to be included in the contract price for services. At the time of NASA's request for best and final offers on the RFP, Fairchild was unable to obtain a commitment from underwriters for insurance.

If the RFP had been a standard NASA procurement for a NASA owned platform, the Government would have assumed the
risk of loss, thus eliminating the impediment imposed by insurance. In comparing the costs associated with the space platform services contract to the cost of carrying out the standard NASA approach of separate missions, the cost of insurance was not included in latter, though the imputed cost of money (interest) was. This had the net effect of inflating the commercial platform cost compared to a standard Government owned platform procurement.

Risk of loss, combined with the lack of a commercial market or other non-NASA government market, had a substantial impact on the prospects for a commercially owned and operated space platform.

C. Tax Related Factors

Tax reform is currently under consideration in Congress and could have a major impact on private sector opportunities and initiatives in space. In addition, an Administration Interagency Working Group is also considering tax impediments to the commercial development of space. This section focuses on the impact of the tax laws from the time of the Fairchild - NASA MOU to the termination of the NASA RFP for commercial space platform services.

Rather than providing an incentive for private sector investment in space (particularly commercial facilities that would be used in space), Internal Revenue Code provisions in existence during the period identified served to discourage commercial investment in space when compared to other projects competing for capital investment. There is no investment tax credit [ITC] or accelerated depreciation [ACRS] available for assets used predominantly outside the United States. The applicable Treasury regulations adopt a "physical location" test for determining whether property is used predominantly outside the U.S., thus excluding assets used in space. In the case of communication satellites, there have been exceptions to this rule through IRS rulings and statutory amendments. Inclusion of non-communication, space-based assets however, would require legislative action.

A project's internal rate of return is seriously affected by tax provisions which require capitalizing certain costs that other projects can deduct. For example, the provision that permits current deductions of all research and development costs "in the year incurred" will generally permit a business to expense the cost of a prototype or pilot model of its planned product or asset. Reuseable spacecraft and space-based assets are so expensive, and the number of units in a program so small, that no commercial endeavor can
afford to build a prototype purely for test purposes. Typically, all of the design changes and improvements discovered in testing will be incorporated into the prototype and will generally be used either as a flight unit or spare. In such cases, the prototype hardware expenses must be capitalized and recovered over a period which commences when the asset is placed in service. If that date is five to seven years away, the internal rate of return of the commercial space venture will suffer when compared to a land-based investment rate of return.

Even the R&D tax credit passed by Congress in the Economic Recovery Tax Act of 1981 is of little or no benefit to the commercial space business. The Act requires that a company must already be in the space business to qualify, making it difficult for non-space businesses - such as the pharmaceutical industry - to qualify for credit. This, in turn, has an adverse impact on the the market for space platform services R&D. The Act also denies the credit to businesses that lease or license the results of their research to other firms, thus penalizing entrepreneurs that may lack the ability to bring a new space product to market.

Current tax laws do not allow the establishment of reserves for casualty losses for a commercial business, thus requiring the purchase of insurance to cover damage to, or loss of, the asset facility or product. While the tax code permits a business to take a yearly tax deduction for depreciation to provide funds for replacement of an asset, no similar yearly tax deduction is permitted to establish reserves for replacement due to casualty loss or damage to the asset. If tax deductible reserves could be established, they would be available for the replacement of a lost platform or other space facility thereby reducing the risk and financial impact of a loss in the event insurance was not available at any price. Insurance premiums for such coverage are tax deductible in the year incurred.

Though no evidence was found that tax considerations played a major role in causing the space platform services commercialization effort to flounder, existing tax disincentives make private investment in space activities less attractive than alternative opportunities.

D. Space Transportation

A predominant factor limiting the commercial platform market potential was, and still is, the high cost of transportation and cost of providing utilities in space. Both the platform operator and potential users must also have an assured source of transportation to and from space, and timely availability and reliability of transportation.
The RFP provision of initial free launch services was intended to assist the selected platform operator and commercial customers with entry into their respective markets by lowering their initial costs. However, for the space platform services contractor and potential commercial customers to establish prices and estimate the size of their respective markets, both had to consider transportation costs over a period of five to ten years.

From the contractor's point of view, pricing had to account for the cost of placing platforms in orbit, servicing them from time to time, and carrying, installing, and removing customer payloads. In the case of a materials processing manufacturer or commercial customer, transportation costs for raw materials or other payloads to and from the platform had to be included in the product or service pricing strategy. Once the initial free flights had been utilized, both the platform operator and customers had to plan on paying for transportation services at the rates NASA was likely to charge.

Transportation to the 260 nautical mile (NMi) orbit proposed by Fairchild as the nominal orbit for their platform varies from $15,000 per pound for a 2,000 pound payload, to $1,837 per pound for a 52,000 pound payload. Using the cost of transporting a 20,000 per pound payload, the cost of transportation can be calculated in more common terms.

It costs approximately $64 million to transport ten tons approximately 300 miles (260 NMi), or about $21,000 per ton-mile. Ground-based transportation, on the other hand, costs less than $1 per ton-mile. In simple terms, transportation to and from space costs about 20,000 times the cost of ground transportation.

Although solar energy in space is free, the cost of transporting hardware to space to convert solar energy into electrical power is extremely high. Because of the large consumer base, electrical power on earth costs less than 0.10/KWH whereas on a space platform it costs about $1,600/KWH. Or in the same simple terms, electrical power in space costs 16,000 times the cost of electrical power on the ground. Since electrical power is the principal utility required by a space manufacturer, the full cost of space platform services is significantly higher than a ground based facility producing the same product. Seen in this light, the high cost of transportation services to and from space had an negative influence on the potential market for space platform services.

The efficiency of a space-based manufacturing process, and its relationship to transportation costs, is another factor which impacts the market for platform services.
One measurement of the efficiency of an operation may be considered as the ratio of the weight of saleable products to the weight of the raw materials which must be carried into space to produce the product. For example, an inefficient system might be a small "purification" system which yields a 1% ratio of the weight of saleable products to the weight of the raw material needed to produce that product. Conversely, an efficient system might be a large "transformation" system capable of yielding an 80% ratio of the weight of saleable products to the weight of the raw material needed to produce the product. Another measurement of efficiency is the amount of power required to produce a given amount of material. An efficient system would be one that uses the full power capability of the platform, while an inefficient system would use only a portion of the platform's capability. A third measurement of efficiency is the amount of shuttle payload capacity utilized. An efficient system would use the full payload capacity, while an inefficient system would use only a fraction of the shuttle's capacity.

Under these assumptions, an efficient system would be the large "transformation" system (80%) which uses the full capacity of the platform and the full capacity of the shuttle for each launch. An inefficient system would be the small "purification" system (1%) which uses only a fraction of the platform capability and a fraction of the shuttle's payload capacity.

Assuming a platform customer requires the services of half a platform for a five metric ton processor (1% purification system), and the processor annually separates 1 pound of saleable products from 100 pounds of raw material, the annual transportation cost would be about $20 million and platform lease and utilities about another $25 million. The user with a small inefficient purification system has to pay a premium for operational costs when only a portion of the capacity of the shuttle and the platform are used. To break even with such a system, the customer must have an annual market of at least $45 million for a product whose transportation and utility costs are over $400,000 per pound.

In the case of a platform user with a highly efficient "transformation" system that uses the full capacity of the shuttle and the platform, the results are much different.

Assuming the user annually "transforms" 80,000 pounds of material into 64,000 pounds of saleable product (80% efficiency), the annual transportation costs would be $140 million and the annual facility bill about $50 million. The efficient user must have an annual market in excess of $190 million for a product whose production costs are more than $3,000 per pound.
Under both the inefficient and efficient scenarios, the impact of transportation and utility costs on potential customers (from the platform operator's view) and products (from the potential user's viewpoint) is to significantly narrow the range of market opportunities, both in terms of users and products.

Another way of analyzing the transportation costs is in terms of different platform operational altitudes. Table 1 shows the cost of transportation to and from 160 nautical miles (NMi), while Table 2 shows the cost of transportation to and from 260 nautical miles (NMi). Both tables appear on the following pages. It should be noted that the space station plans to operate at 260 nautical miles.
### TABLE 1
LAUNCH COSTS TO 160 NM ORBIT

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<tr>
<td>65,000</td>
<td>93.63</td>
<td>97.38</td>
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</tbody>
</table>

**NOTE:** These prices are base transportation cost. To these must be added the price for optional services, a planning charge of $1.5 million per mission, and the cost of any upper stages.

- **EOS** = MDAC Electrophoresis Operation
- **LC** = Leasecraft Platform
- **PRICE** = \( \frac{4}{3} \cdot \frac{W}{65,000} \cdot (\$74M) \cdot (1.04) \)
- **EOS** = Price in 1982 dollars of dedicated shuttle flight
- **Y** = Average annual rate of inflation over period 1982 - 1990
- **Y** = Fiscal year of launch, prices in millions of dollars

35
TABLE 2
LAUNCH COSTS TO 260 NMi ORBIT

<table>
<thead>
<tr>
<th>W Pounds</th>
<th>Launch Costs By Fiscal Year</th>
<th>Cost Per Pound</th>
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<td>52,700</td>
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<td>99.35</td>
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</table>

EOS 22,500 68.74 71.48 74.34
LC 17,000 58.17 60.50 62.92

NOTE: These are the base transportation costs. To these must be added the price for optional services and the cost of any upper stage.

EOS = MDAC Electrophoresis Operation
LC = Leasecraft

PRICE = ($1.5M + 4/3 * (W + 12,300) / 65,000 * ($74M)) * (1.04)
$74M = Price in 1982 dollars of dedicated shuttle flight
$1.5M = Cost of planning a mission
$10,800 = Weight penalty for lost tariff from 160 to 260 NMi
1,500 = Weight of additional fuel required for higher orbit
1.04 = Average annual rate of inflation over period 1982 - 1990
Y = Fiscal year launch. Prices in millions of 1982 dollars.
Clearly, the cost of transportation plays a critical role in shaping the size of the potential market for platform users and products. In addition, shuttle availability and schedule certainty are important. Interviews with industry personnel universally identified delay as a barrier to market entry since delayed launches, whether resulting from availability or schedule, impose an additional risk on both the space platform services operator and the space manufacturer. Under the terms of the RFP, NASA refused to accept the risk of liability for shuttle delay, imposing this risk on the space platform services contractor and its potential customers.

The lack of a replacement for Challenger will exacerbate the problems that have already been encountered while the shuttle was operating.

E. Termination Liability

Termination liability can be generally described as the obligation of the buyer of the services or product to pay damages to the seller of the services or product if, for any reason, the buyer terminates performance under the contract.

In Government contracting, there are two forms of termination -- termination for the convenience of the Government, and termination for default. Under the standard termination for convenience clause, the Government, without explanation but acting in good faith, can terminate the contract. In doing so, the Government is liable for the payment of all incurred costs or liabilities arising out of the performance of the contract to the date of the termination notice, plus a reasonable profit for work performed, taking into consideration the percentage of work already accomplished.

Termination for default is a termination arising out of either the contractor or seller notifying the Government it will not perform, or the failure of the contractor or seller to perform in accordance with the terms and conditions of the contract. In a default termination the Government is relieved of any payments for any costs incurred by the contractor or seller and, in some cases, the contractor or seller may be liable for damages to the Government arising out of a reprocurement at a higher price for the same services or product.

In a standard Government procurement contract, unless funds are fully obligated, the contract usually includes a "Limitation of Funds" clause. This is the standard procedure in most NASA contracts performed beyond a fiscal year where multi-year funding would be required for
full performance of the contract. The Limitation of Funds clause requires a contractor to stop work at the point in performance where costs incurred by the contractor would exceed the funds obligated to the contract. The contractor assumes liability for costs of continuing performance after reaching this limit until such time as additional funds are obligated by the Government on the contract.

1. Termination under the JEA

The NASA-Fairchild JEA contains a termination article covering both Phase 1 and 2 of the agreement and was a specially crafted article not found in a standard government procurement contract. In Phase 1, neither Fairchild nor NASA would have been entitled to any compensation as a result of termination. Neither party would have been required to transfer any data information, patents, or other results of work accomplished or in progress other than those agreed upon as a result of negotiations. In Phase 2, Fairchild could have terminated unilaterally for any reason by giving NASA written notice. In the event of a termination, NASA would be entitled to purchase and take title of all flight hardware, related software, and support equipment - completed or in process - at the cost incurred by Fairchild together with any license rights to any patents and data that might be required. Under very limited circumstances, NASA had the right to unilaterally terminate the agreement. If NASA did choose to terminate, they would not be obligated to reimburse Fairchild for costs incurred.

In light of the Challenger accident, it is important to note that NASA agreed that it would not terminate the agreement for reasons beyond NASA's control unless there was a resulting cessation of shuttle launches for commercial purposes for a substantial period of time. NASA did, however, agree that as an option to terminating the agreement it would consider postponing a payload launch.

Termination did not create a barrier in the negotiation of the Joint Endeavor Agreement and Fairchild assumed the entire risk that it might not obtain the free launches agreed to by NASA. In the JEA, however, NASA did not agree to procure platform services. Any such procurement would have been in a form of a standard procurement contract containing the usual termination for convenience and default clauses.

2. Termination under the Unsolicited Proposal

Though the unsolicited proposal submitted by Fairchild never went beyond the preliminary discussion
stage, there was a termination liability clause included in the proposed contract for services.

Under the provisions of the proposal, NASA, in the event of a unilateral termination, assumed termination liability under a fixed payment schedule in fixed amounts extending over the period of the agreement. The proposed termination agreement provided that a NASA convenience termination could be triggered by Fairchild if its first commercial customer (presumably MDAC) terminated its contract with Fairchild and Fairchild could not find another customer. Under the latter provision, Fairchild was attempting to shift the market risk for commercial customers to NASA. Similar to a standard procurement termination, the termination for convenience clause in the unsolicited proposal required Fairchild to transfer title, and turn over all hardware and works in process and any data that generated by the performance of the contract.

It was NASA's view that the unsolicited proposal did not permit NASA to exercise a default termination but, instead, granted NASA limited rights for what would be called "outage" penalties, (i.e., a reduction in the price to be paid as a result of failure to fully provide contract services).

3. Termination under the RFP

The RFP set forth an outline of quarterly schedules establishing the cumulative maximum liability the Government would incur in the event of a termination for convenience. The schedule provided for a maximum termination liability for each undelivered service month and stated, notwithstanding any amounts listed, nothing in the RFP or contract should be construed as making the Government liable for any amount exceeding actual appropriations in relevant program areas or for appropriations sufficient to fund such liability. NASA's best estimate of the amount that would be available to fund termination liability was promised to all offerors before the time of the final proposal. Because the contract was a procurement of services and not hardware, the Government would not automatically get title to platform parts and materials since they would not have been acquired specifically for a NASA service, but, instead, were being acquired to provide services to NASA as well as other commercial customers and/or other Government agencies. Since NASA would not obtain title in the event of a NASA termination for convenience, NASA did not expect the contractor to propose NASA pay all costs associated with the entire effort, or to propose termination liability based on a 100% of all incurred costs. NASA did expect the contractor to propose an "equity" factor in the termination
proposal schedule. In other words, NASA expected the contractors to assume the risk of obtaining additional customers other than NASA - whether Government or commercial - and based upon this assumption of risk, NASA would receive appropriate credit in the termination schedule.

Neither Fairchild nor RCA proposed an "equity" value in their termination schedule, preferring instead to leave the issue of credits NASA would receive towards its termination payments open to future negotiations. In the event such termination would occur, other factors, such as the date of termination and the circumstances at the time, would come into play.

As no final proposal was submitted or final negotiations conducted on the RFP, it is impossible to project what the outcome of the termination issue might have been. However, based on interviews conducted in the course of this study, and an analysis of the proposals as well, there appears to have been a willingness on the part of one of the contractors to propose a significant "equity" factor enabling a resolution of the termination issue that would have been satisfactory to both NASA and the contractor.

F. Institutional Barriers

1. The Source Evaluation Board Process

An examination of the Source Evaluation Board (SEB) documentation, composition of the SEB and its committees, and interviews with participants in the selection process, leads to the conclusion that any prejudice against using a space platform services contract - as opposed to the use of individual Explorer missions - had been minimized to the maximum extent possible.

The platform services approach represented a change in the way previous Explorer programs had been run. In the past, an Explorer mission would normally continue operation until its performance degraded at no additional cost to the Government except the cost of operation. Under the platform services concept, operation of a mission would terminate at the end of the service contract or NASA would have to purchase additional services from the platform operator. The possibility of institutional resistance to that change was real; however, the selection process served admirably in minimizing any such prejudice.

A related institutional concern is whether the difficulties that occurred during the administration of the Tracking and Data Relay Satellite System procurement (TDRSS)
might have negatively influenced attitudes at Goddard in proceeding with another mixed Government / commercial facility. The standard Goddard procurement normally includes "in-house" technical direction and influence on the design or manufacture of a spacecraft. Such technical direction was lacking in the TDRSS contract and would have been lacking in the space platform services contract. The lack of ability to technically direct the TDRSS contractor was a major cause of conflict during the performance of that procurement. Based on a review of related documents and interviews, it is clear that any such impact in the platform procurement had been minimized through the selection of the SEB members and committee members well as the manner in which the SEB evaluation had been conducted. In addition, it is evident that every effort was made to run a fair and proper evaluation of the proposals including detailed analysis of the relative costs and advantages of separate Explorer missions versus the use of the space platform services contract.

The ground rules utilized in the SEB selection process were not reviewed by Senior Management at NASA Headquarters. More careful review of the ground rules may have avoided the inconsistency concerning whether or not the reviewers were to consider the value of fostering future commercial endeavors as part of the selection criteria. One ground rule explicitly states that the SEB was not to consider this aspect while another states that "domestic capability for U.S. commercial space R&D enterprises, and overall U.S. posture in 'first to the market' space infrastructure" should be considered within the context of the evaluation.

The Office of Commercial Programs played no role throughout the attempts to develop a commercially owned and operated space platform service. This was either because the Office was not established at the time (the Office was established in November, 1984), or in the case of the competitive procurement, it was too far along and the Office was too new to substantially participate in the activity. If the Office is to be an effective advocate for the commercialization of space and to be charged with implementing the policies announced by the Administration, Congress and NASA, it must play a major role in commercialization efforts in coordination with any affected Program Office or Center.

2. Funding Procedures

Funding procedures followed by NASA and Congress can be viewed as barriers to commercialization where the Government is either the first customer or prime customer for the commercial goods or services.
The lack of certainty of government funding for the entire contract period makes it difficult, if not impossible, to market the platform to potential commercial users, particularly when the market is limited and the platform would be the only extended stay facility until the space station became operational. A company interested in space manufacturing requiring such long stay time would require some assurance that the space platform would be developed and constructed irrespective of whether the Government terminates or not. Such a customer would not be interested in making any large capital investment without such assurances. A space platform manufacturer would not give those assurances because, if the Government was to terminate mid-stream, there would not be sufficient revenues flowing from the other customers to justify the continuation of the project. More than likely, any contract with a potential commercial customer would contain a provision that if the Government were to terminate its program, then the space platform manufacturing contractor could terminate its contract with a commercial customer without any liability for the payment of damages to the commercial customer. The reason why such a clause was included in the unsolicited proposal by Fairchild was that the price being offered to NASA was based on continued revenue from McDonnell Douglas. The lack of such revenue from McDonnell Douglas would have made the unsolicited proposal unprofitable for Fairchild. Thus, the uncertainty that, at some stage, a program might be discontinued and the government contract terminated for the convenience of the Government, tends to act as a negative factor in stimulating commercialization of space.

Current NASA funding and Congressional procedures make no provision for the value of a private sector company providing a commercial, privately financed space facility for use by both the Government and other commercial customers. The ground rules for the procurement of platform services required the cost or price of the platform services to be less than, or equal to, the funding available or anticipated from approved projects or anticipated new starts. There was no willingness on NASA's part to place a dollar amount on the value that developing a commercial space platform would have on encouraging the development of a space manufacturing industry. Just as the contractor's refusal to accept a substantial portion of the market risk negatively impacted the commercial platform concept, so did the Government's refusal to recognize the value of seeing the project through in relation to future commercialization initiatives by the private sector. If the development was successful and other commercial customers began to use such a facility, in the long run the Government would have recovered that value through lower prices. The only way that additional funds could be made available to fund commercialization initiatives - as initiatives with a recognized value beyond short term

42
returns - would be from other NASA programs. At a time of tight budget constraints within NASA, there is an inherent institutional barrier to NASA transferring funds from other approved programs to new programs which are deemed to have a value in fostering commercialization of space. Compounding this problem is the fact that under current Congressional and NASA procedures, authorizations and appropriations done on a fiscal year basis do not fully fund NASA's programs.

G. Procurement Laws and Regulations

Another barrier rests with existing procurement laws, regulations and procedures. In contrast to the flexibility afforded NASA under Section 203 (c) (5) of the National Aeronautics and Space Act, procurement laws, regulations and procedures require - with very limited exceptions - full and open competition. Public Law 83-36, 98-525 and 98-577 recently enacted by Congress have made it more difficult for NASA to accept unsolicited proposals or to make sole source awards.

NASA, in a report to the Chairman of the House Committee on Science and Technology (August 29, 1985) stated:

In view of this, we are not aware of procurement authority which would, per se, authorize, in the selection process, a preference for commercial ventures or the encouragement of such ventures. Thus, NASA's promotion of commercial ventures in the procurement context has been necessarily constrained.

Using the procurement process is time consuming as well as inflexible. The procurement laws have been interpreted and applied so as to require NASA and other Government agencies to set forth technical requirements in great detail. Once proposals have been submitted, and without reopening the competition, there is little room for innovative ideas or approaches which deviate from the RFP requirements but may be more beneficial to the Government.

The requirement for competitive selection where there is a known Government requirement discourages companies from identifying space facilities that could be developed by the private sector. It makes no financial sense for a company to expend its funds to design a facility only to have the Government then decide to seek a competitive procurement. It is unrealistic, to expect the private sector to fully initiate a program of research leading to final design and development with the prospect of competitive selection enforced in the final stages.

43
Any one or more of the factors outlined above can be cited as a reason why the commercial development of space platform services failed. Based on interviews and a review of the documentation, two salient factors "doomed" the commercial space platform concept. Both of these factors were beyond the control of either NASA, Fairchild, or RCA.

The first was the lack of an existing non-Government market and, in particular, the withdrawal of McDonnell Douglas, the one commercial concern well along in the development of space manufacturing of pharmaceuticals. With MDAC's withdraw from the market, NASA was the sole customer for what was to be a primarily commercially oriented venture.

The second factor was the reduction in available insurance resulting from catastrophic losses occurring in the space insurance market in 1984 and 1985. Both of these factors, and NASA's position that it would not assume the risk of loss of the space platform during launch or on orbit, resulted in a situation where the expected costs to NASA of procuring commercial space platform services substantially exceeded the cost of conducting its missions as individual and separate missions. From the contractor's point of view, the substantial investment required could not be justified in terms of the risks. In simple terms, the space platform services procurement was viewed both by NASA and the contractors as a "bad deal".
SECTION II

RECOMMENDATIONS
I. INTRODUCTION TO RECOMMENDATIONS

No set of recommendations - including those presented here - can be applied in each instance to each and every commercialization effort. In some cases, all that may be required is the support currently being provided by NASA under the various forms of agreements that already exist. For example, in the case of the commercial development of the Payload Assistance Module - Delta (PAM-D), all that was required was some technical assistance and permission to use government property. Or, in the case of the Payload Assistance Module - Atlas (PAM-A), the purchase of several units was required. In other cases however, more extensive forms of assistance - such as free shuttle flights - may be in order. The recommendations contained in this section and those that follow are directed to the Administration, Congress and NASA.

A. The Market Risk

While final negotiations did not take place with either Fairchild or RCA on the competitive procurement, NASA would not have entered into a contract with either corporation at the prices initially proposed. The prices offered by both contractors far exceeded the cost of separate missions. It is apparent from a review of the documentation and interviews, that neither company was willing to assume the market risk of acquiring additional non-Government or other Government agency customers who would use platform services. This lack of confidence by the proposers that there was neither an existing market nor a near-term potential market for platform services other than NASA, was sufficient reason for NASA not to proceed with this procurement. In interviews with senior personnel of one of the contractors this was accepted as a valid reason for NASA not proceeding with the commercialization effort.

There may be occasions when NASA should be willing to share the market risk with the supplier of goods and services to promote the early development of a commercially financed, owned, and operated space facility that would be used by other government agencies or by the private sector. This may require the Administration, Congress and NASA to approve funds for this purpose over and above the basic NASA budget request. Any such "equity" or "commercial value" would be recouped by NASA from non-NASA sales by the commercial developer to other private sector entities or other Government agencies.
B. Insurance and Risk of Loss

The lack of insurance coverage clearly prevents entrepreneurs from entering the space commercialization market whether it be the development of space platforms, communication satellites, or other space facilities. It is also part of a broader problem affecting many other industries in the United States. The simple, straightforward solution that has been proposed by the contractors that were involved in the space platform services procurement, as well as others, is for the Government to become the insurer of last resort. It has done so in the past on many occasions. Some examples are flood insurance, crop insurance, and the Price-Anderson Act applicable to the nuclear industry, to name just a few. Congress could pass legislation to provide coverage for commercial activities in space or such coverage could be provided in a broader bill covering other industries as well.

The Administration or Congress could also change the tax laws to permit the establishment of tax deductible reserves for damage or loss of property. Such reserves would be tax deductible during the construction of the space facility. The reserve would be reduced, once the asset was put into use, by the amounts deducted for depreciation in subsequent years. Insurance premiums are currently an allowable business expense.

Such reserves could be established only upon a showing to the Internal Revenue Service that insurance coverage was either unavailable or was available at a premium which would be unreasonable in light of the prior claim experience of the company.

The two previous solutions that have been suggested are so broad and involve so many policy considerations that they could not be adopted in the near term. There is however, a potential solution for the narrow case illustrated by the space platform services commercialization effort. It deals with the situation in which NASA is the predominant customer for the space services or goods that are being commercially developed, or where NASA is the initial customer but has determined that future commercial markets for such goods or services would develop.

It is the general policy of the U.S. Government to self insure its activities and its property. Based on this policy, when NASA procures an asset for its own use through the procurement process, it assumes the entire risk of loss after completion of the contract and delivery. In the case of the procurement of a separate platform for an Explorer
mission, under normal procurement procedure NASA would assume the risk of a satellite being damaged or lost during launch or on orbit. In the case of TDRSS, and in accordance with the policy of self insurance, NASA directed the contractor not to insure that portion of spacecraft cost that was attributed to government use. The contractor was free to insure the portion of the investment in the spacecraft that was dedicated to commercial use. The reason for this was that NASA was following the policy of self-insurance and did not wish the cost of insurance for the government portion of the program to be included in the price for the services to be rendered after launch and when the TDRSS was on orbit. There is evidence to suggest that NASA's sharing of the risk in the TDRSS case was linked to a high level of interest within senior NASA management levels in the success of the venture. Neither the Challenger, the TDRSS on board, nor other government satellites and property on board the orbiter were insured against loss or damage.

Because of the high capital investment required for the commercial development of a space facility, the risk of loss during launch or on orbit is substantial and, unless resolved by the insurance industry, the Administration, Congress or NASA, it will continue to be a major barrier to the development of commercial activities in space. The possibility of sharing the risk of loss in the space platform services procurement was never explored. In the future, and as part of these recommendations, in some instances NASA should share risk of loss with the commercial developer. This option should be explored more thoroughly. If there are one or more non-NASA customers for the facility that is to be commercially developed, the risk of loss could be shared by NASA, the proposer of the commercial facility and one or more of the additional customers, whether they be private sector or other Government agencies.

C. Tax Treatment

The unequal treatment of space commercialization investments received under the tax laws and regulations is a disincentive to industry to invest in the commercial space initiatives.

If a company must choose between two investment opportunities - one being a space commercialization facility project and the other an asset based within the territorial limits of the United States - and both projects are of an equal amount and equal market potential, the current tax laws give preference to the ground-based investment. The tax reforms under current consideration may result in equality of treatment at least in the areas of incentive tax credits
and accelerated depreciation. The lack of an R&D credit will remain a disincentive for businesses wishing to enter space commercialization industry.

Private sector initiatives aimed at the commercial development of space should receive equal, if not preferential, treatment under the tax laws and regulations.

D. Space Transportation

The JEA provision of free flights represented a very substantial financial incentive to the commercial development of the Leasecraft Platform proposed by Fairchild. In order to equalize the opportunity for competition, NASA decided to include the free flights in the competitive RFP. However, the approximate $2,000 cost per pound for transportation had (and still has) a significant effect in limiting the market available for commercial use by materials processing concerns.

The recent National Commission on Space report recognized the need to reduce the cost of transportation if the exploration and exploitation of space for commercial and other purposes is to be achieved. The Commission recommended that the cost of space transportation be reduced from the approximate $2,000 per pound to $100 per pound. All forms of transportation in this country have received and are continuing to receive some form of government support. Rail transportation received rights-of-way and mail subsidies. Air transportation receives air traffic control as well as having received mail subsidies. Water transportation, both for inland and ocean faring transport, receives Government support. On a comparative basis, at a minimum, space transportation should be given equal consideration and receive such support.

Congress and NASA should explore the question of reduced transportation costs with the materials processing industry, focusing on what effect, if any, a reduction of transportation costs would have on expanding the market. Another approach would be to expand the use of Space Services Development agreements with materials processing concerns as well as others who offer to develop commercial facilities. This approach, rather than being a direct form of subsidy, would require repayment, whole or in part, of the launch services furnished by NASA; in effect creating a partnership between those industries and the Government.
E. Schedule Uncertainty

Schedule uncertainty is a risk that has been identified by industry as a major barrier in determining whether to invest corporate funds in space commercialization.

The standard Launch Services Agreement relieves NASA for any delays, and the communications satellite industry has accepted it. The communications satellite industry, however, is a well-established industry with a well-established market and, in most cases, delay does not have a major impact on the revenue flow. In the past, the communications satellite industry could obtain satellite life insurance which further minimized this risk. The reason for the adoption of this policy by NASA as applied to commercial communications satellites is if NASA were to be liable for damages caused by delay, then those damages would have to be paid for out of other NASA programs or by additional Congressional appropriations - thus creating another institutional barrier to the acceptance of such a risk.

However, NASA does assume the risk of delay when it is a standard government procurement for goods or services to be provided to NASA as the sole customer, whether the contract is a cost reimbursement or fixed price contract contract. NASA did pay for shuttle delays that impacted the TDRSS program and it is currently paying for delays brought about by the cessation of government launches in such programs such as Galileo, the Space Telescope and others. The situation is therefore the same as exists for termination liability and risk of loss.

The solution may again be a sharing of the risk of delay in commercial space initiatives. In addition, and to the maximum extent possible, NASA must exert its efforts to shorten the time period between when a request for a Joint Endeavor or a unsolicited proposal is submitted, and an when an agreement for the procurement of the Government services or product is reached.

F. Termination Liability

A proposer of a commercial development facility should be willing to assume a portion of the termination liability. Such was the case in TDRSS where NASA only assumed the termination liability for the Government's portion of the spacecraft. Whether the sharing ratio should be the same for market risk, risk of loss, and termination liability is a question worthy of a more in depth study. A provision could be negotiated that in the event non-NASA use of the facility increases - thus reducing the percentage of NASA use of the
facility - adjustments could be made reducing the NASA liability for termination or risk of loss. It would stand to reason that by initially sharing the market risk, as the market expands, NASA would benefit through the reduction of costs for the services being performed for NASA.

The recommendations outlined in the areas of sharing the market risk and the risk of loss, are equally applicable to sharing termination liability.

G. Institutional Barriers

One institutional barrier of prime importance is the priority to be afforded in the Administration, Congress, and within NASA to the commercial development of space. The importance of NASA senior level involvement in the commercialization effort can best be illustrated by the TDRSS experience. The TDRSS request for proposal and resulting contract was the first effort by NASA to obtain commercial services that would be available to both NASA and to non-Government users. The TDRSS procurement is not without controversy. It is used here only to illustrate what can be accomplished when a program receives senior level management attention, direction and support.

The TDRSS procurement received the attention, direction and strong support of the then Administrator of NASA, other senior officials at NASA headquarters, and the Goddard Space Flight Center Director. Most of the factors on which agreement could not be reached between NASA and the contractors in the space platform services procurement were satisfactorily resolved during negotiations with Western Union, the successful proposer on TDRSS. The same degree of senior level NASA support will be needed if future commercial initiatives are to succeed. Currently, the Office of Commercial Programs is the organization in NASA responsible for, stimulating, encouraging, and supporting commercial initiatives in space. It cannot, however, do the job alone.

NASA, as an organization, must fully support the commercialization effort. That includes the Administrator, the Associate Administrators and the Center Directors. When a potential commercial development is identified by NASA or proposed by industry, it is important that the Administrator, Program Directors, Associate Administrators and Center Directors review their programs to identify potential Government participation through the purchase of services or product by those organizations.
Another barrier is the application of the procurement statutes and regulations to commercialization proposals submitted to NASA either through a request for a Joint Endeavor Agreement or the submission of an unsolicited proposal. The Competition in Contracting Act and the regulations implementing that act make it extremely difficult for NASA to go sole source or accept an unsolicited proposal for a government requirement. Congress amended the NASA Act declaring that the general welfare of the United States requires that NASA "seek and encourage, to the maximum extent possible, the fullest commercial use of space." If NASA is to carry out that mandate, it is absolutely necessary that when an innovative commercialization idea is presented to NASA - by way of a Joint Endeavor or an unsolicited proposal - NASA is free to identify potential government uses and not be unconditionally bound by competitive procurement subsequent to the presentation of the idea. To do otherwise, will discourage the development of innovative commercialization approaches.

When a Joint Endeavor Agreement or an unsolicited proposal proposes a product or service that could be used by both Government and non-Government users, and after identifying the Government uses in accordance with the previous recommendation, NASA should negotiate a contract with such offeror for the procurement of the Government services assuming agreement on price can be reached.

Where NASA has identified a facility, product or service that can be used by NASA and other non-Government customers, NASA should seek expressions of interest from the private sector for the commercial development of such a facility, product or service. Rather than employing the standard NASA procurement procedures, NASA should develop procedures permitting greater flexibility in stating its requirements, negotiating final agreements, and reducing the lead time for a contract award. NASA developed the Announcement of Opportunity procedures to meet its unique needs for experiment selection. Commercialization of space is sufficiently unique so as not to lend itself to the normal NASA procurement process. Pending the establishment of such procedures and pending clarification of NASA's authority under the Space Act, NASA should review its selection criteria and SEB scoring system recognizing the importance of space commercialization.

Where other major non-Government customers have been identified who would use the service or buy the product, NASA - with the permission of the supplier - should contact such non-governmental customers to negotiate as a team with the supplier in those situations where it is highly unlikely
that the commercialization effort could proceed without the
Government and the non-Government purchase of the goods or
services. This provides the opportunity for the three
parties to allocate and share the substantial risk involved
in space commercialization.

The General Counsel's office should review the
authority of NASA to carry out the above recommendations
under the authority of the Space Act, Section 203 (C) (5),
taking into account the decision interpreting that section
in the case of AFGE vs. Paine. In the event the General
Counsel determines that NASA lacks the authority, then it is
recommended that Congress enact legislation to grant NASA
the authority to implement this recommendation.

I. Funding Procedures

A major complaint voiced by industry was the
uncertainty of NASA's annual funding process. While full
funding would not, in and of itself, prevent the termination
of the NASA project by either the Administration or
Congress, it does provide greater assurance to industry
investing its own funds in commercialization efforts.

Congress, in concert with the Administration and NASA,
review the funding procedures normally used for NASA projects
to see whether, as a matter of policy, those procedures
should be changed to encourage and support space
commercialization activity. Specifically, all three entities
should consider granting NASA authority relieving NASA of the
requirement to obligate funds for the contingent liability of
a convenience termination. Also, NASA projects associated
with a commercialization effort should be fully funded
through appropriations and authorization rather than on a
fiscal year basis.

J. Financing

Congress may wish to consider the advisability of
providing such financing or guarantee to entrepreneurs.
Such financial assistance would encourage small
entrepreneurs and non-aerospace companies to consider
investment in commercial space initiatives.

The Congress may wish to reconsider HR7412 introduced to
the 96th Congress Second Session, to establish a Space
Industrial Corporation to promote, encourage, and assist in
the development of new products, processes, services, and
industries using the properties of the space environment and
II. CONCLUSION

The commercial development of space is within its infancy and in some cases in its gestation period. It is an area of activity that requires high capital investment and high risk, while other competing ground based investment opportunities offer significantly lower risk. It is an area that, at present, offers a only a limited or even unknown market potential. Also, it is an area with no industry experience base or proven "track record". Lastly, it is an area that, in many cases, will require the development of new technologies but in doing so will contribute to United States leadership in space and new technologies.

The Administration, the Congress and NASA all publicly support the concept of space commercialization. If space commercialization is to succeed, there must be tangible evidence that all three entities will support the concept with clear objectives and commitments. On the industry side, the private sector must be willing to make the capital investment and to assume or share with the Government some of the risks associated with the development of a new industry and new markets. The Government cannot and should not assume all the risks of space commercialization. Considering the risk involved and the current status of space commercialization, a contractor cannot and will not assume all the risks in order to enter the market. The Administration, Congress, and NASA can remove some of the institutional and other barriers that inhibit the commercialization of space. Other nations appear willing to support their industry in one way or another either through subsidies or through entering into equity relationships with their industry.

In view of the recognized importance of space commercialization, the U.S. Government should at least be willing to share and reduce the risks involved in commercial space activities at this stage in its development.
APPENDIX 1

CHRONOLOGY OF EVENTS
## Chronology of Events

<table>
<thead>
<tr>
<th>DATE</th>
<th>EVENT</th>
</tr>
</thead>
<tbody>
<tr>
<td>1977</td>
<td>McDonnell Douglas flies Electrophoresis (EOS) Experiment on STS.</td>
</tr>
<tr>
<td>1981</td>
<td>FC and Goddard independently conduct feasibility studies on possibility of using MMS for EOS experiments. Conclude that power requirements and cost of compatibility with STS warrant new system.</td>
</tr>
<tr>
<td>1982</td>
<td>Fairchild establishes Space Operations Company to market services of Leasecraft.</td>
</tr>
<tr>
<td>8/82</td>
<td>NASA and Fairchild sign MOU with Letter of Agreement attached.</td>
</tr>
<tr>
<td>8/83</td>
<td>NASA and Fairchild sign JEA.</td>
</tr>
<tr>
<td>4/84</td>
<td>Fairchild submits unsolicited proposal to NASA for services of Leasecraft.</td>
</tr>
<tr>
<td>9/84</td>
<td>Fairchild submits firm fixed price contract to MDAC for services of Leasecraft and begins negotiations for services.</td>
</tr>
<tr>
<td>12/84</td>
<td>MDAC and Fairchild suspend negotiations.</td>
</tr>
<tr>
<td>9/84</td>
<td>NASA declines Fairchild's unsolicited proposal. Decides to procure services through competition.</td>
</tr>
<tr>
<td>11/84</td>
<td>RFP Pre-release.</td>
</tr>
<tr>
<td>12/84</td>
<td>Procurement plan approved.</td>
</tr>
<tr>
<td>1/85</td>
<td>Source Evaluation Board (SEB) appointed.</td>
</tr>
<tr>
<td>1/85</td>
<td>NASA issues RFP 5-14000/357 for Space Platform Services.</td>
</tr>
<tr>
<td>1/85</td>
<td>Preproposal conference attended by 15 companies.</td>
</tr>
</tbody>
</table>
Amendments 1 and 2 to the RFP issued.

Amendment 1 revised payload module power loads and Section L of RFP; deleted requirements for unpriced elements of cost; and responded to submitted questions.

Amendment 2 revised delivery schedule in Article F-1, the Technical Proposal Instructions, the Specification for Platform Services; updated requirements for Micro-Gravity Science Mission; added EUVE data requirements.

Amendment 3 to the RFP issued, revising the proposal due date and packaging.

Fairchild and RCA respond to RFP.

Initial proposal evaluation completed.

Competitive range determination. RCA judged to be outside competitive range

Orals held by NASA.

Fairchild resumes discussions with MDAC.

MDAC notifies Fairchild that they have no foreseeable future need for Leasecraft services.

NASA issues letter requesting best and final proposals.

Fairchild declines to submit a final proposal.

NASA formally terminates the RFP.

Fairchild submits a report to NASA on a "Survey of the Market for the Services of Small Privately Owned Space Platforms (LC 085-01)."

* Approximate date
APPENDIX 2

NASA - FAIRCHILD MEMORANDUM OF UNDERSTANDING
THE NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
CONCERNING THE DEVELOPMENT AND COMMERCIAL
AVAILABILITY OF A SMALL SPACE PLATFORM

PREAMBLE

The National Aeronautics and Space Act of 1958, declares that the aeronautical and space activities of the United States shall be conducted so as to contribute to the preservation of the role of the United States as a leader in aeronautical and space science and technology and their application to the conduct of peaceful activities within and outside the atmosphere. The furtherance of these activities may be substantially enhanced by the early availability of a shuttle-launched and supported mobile mini space platform furnishing the necessary utilities (space, power, stabilization and communication) for these activities. The Administration and NASA are committed to a reliance on the private sector for the supply of needed commercial products and services whenever possible. NASA is, therefore, interested in a commercial firm opting to design, develop, and provide such a platform to users through lease or purchase.

Fairchild Space and Electronics Company (FSEC) believes there is an increasing number of commercial institutions moving toward the use of space and space technology for the production of goods and services for profit. Fairchild wishes to create a commercial entity to lease to governmental and commercial users a variety of space systems, spacecraft, and space platforms launched, serviced, and retrieved by the Shuttle. Such a commercial entity could also supply a variety of technical and administrative services such as the integration of the user's hardware with the spacecraft or platform, integration of such a spacecraft or platform with the Shuttle, and provision of the necessary documentation and technical support to the user and to NASA for the launch, operation, services and retrieval of the users' products and/or hardware. Fairchild recognizes the need for a substantial investment to create such an entity and its shuttle-compatible hardware and the investment will be at a considerable risk for a number of years. Fairchild believes that the possible returns from the already planned governmental and commercial space activities, together with the coming industrialization of space justify much of that risk. Fairchild believes that its experience with the shuttle-compatible Multimission Modular Spacecraft (MMS) places it in a unique position to assure the technical success of such an enterprise, and to succeed in this respect of the commercialization of the Shuttle.
THE UNDERSTANDING

NASA and Fairchild Industries, having a mutual interest in the development and commercial availability of a small space platform, and associated services, based upon MMS technology, agree to explore the feasibility of an agreement on a joint endeavor to bring such a platform into being, demonstrate its capability in 1986 and have it commercially available for Governmental and commercial users for at least 10 years beginning in 1986.

It is expected that any such endeavor would proceed in three (3) phases: (1) a feasibility and preliminary design phase in FY 1982; (2) a development phase extending from CY 1983 through CY 1986, with a six-month in-orbit demonstration in CY 1986; and (3) an operational phase from CY 1987 through CY 1996. No exchange of funds between NASA and Fairchild Industries would be expected in Phases 1 and 2.

It is further expected that such a small space platform would be capable of supporting appropriate scientific and space applications missions.

NASA and Fairchild each agree to designate an individual to be responsible for pursuing the agreements reached in this Memorandum of Understanding.

The undersigned agree to review jointly the status of the endeavor no later than September 1, 1982. While pursuing this endeavor representatives of NASA and Fairchild will agree on procedures regarding publicity and the maintenance of proprietary information where necessary and appropriate.

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

APPROVED:  
James M. Beggs  
Administrator

FAIRCHILD INDUSTRIES, INC.

APPROVED:  
Edward G. Uhl  
Chief Executive Officer

DATE:  AUG 27 1982
APPENDIX 3

NASA FAIRCHILD JOINT ENDEAVOR AGREEMENT

AND

SEPARATE LETTER OF AGREEMENT

ORIGINAL PAGE IS OF POOR QUALITY
AGREEMENT BETWEEN THE
NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
AND
FAIRCHILD INDUSTRIES, INCORPORATED
FOR A JOINT ENDEAVOR CONCERNING THE
RESEARCH AND DEVELOPMENT OF A SMALL
SPACE PLATFORM FOR COMMERCIAL OPERATIONS
LETTER AGREEMENT BETWEEN NASA AND FAIRCHILD
REGARDING THE NASA/FAIRCHILD JOINT ENDEAVOR AGREEMENT

The purpose of this Letter Agreement is to record actions which must be jointly taken by NASA and Fairchild in order to carry out the intent of the Joint Endeavor Agreement (JEA) and help establish the commercial viability of Fairchild's Leasecraft venture. These actions are not part of the NASA/Fairchild Joint Endeavor Agreement JEA proper because they relate to possible commitments which may extend beyond the term of the JEA. However, action to resolve these issues must be taken during the term of the JEA and decisions taken on the schedule indicated.

A. Fairchild and NASA shall jointly and expeditiously examine the technical compatibility and economic suitability of Leasecraft for the performance of one or more NASA missions (not limited to the attached payload mentioned in the JEA) beginning with calendar year 1987. 10/1/83

B. NASA will establish a pricing policy which will apply to the retrieval and return of spacecraft, such as Leasecraft, or payloads therefrom. NASA will work toward establishing this policy by the date indicated and will provide Fairchild periodic status reports. 1/1/84

C. NASA and Fairchild will seek to negotiate arrangements for short leadtime scheduling and/or manifesting of small payloads and/or on-orbit operations. 6/1/84

D. NASA will consider the use of Fairchild employees as payload specialists on Leasecraft flights to assist in the operation and servicing of Leasecraft equipment, under terms and conditions to be established in subsequent launch services agreements. 1/1/84

E. NASA will work with Fairchild for the operational flights of Leasecraft by providing STS launch and TDRSS communication services consistent with charge policies, and use its best efforts to meet scheduling requirements of Leasecraft and reduce overall transportation costs.

F. NASA will continue to notify Fairchild of any changes to STS pricing policies in advance of the effectivity of the changes.

Fairchild Industries, Inc.

Edward G. Uhl
Chairman and Chief Executive Officer

Date: August 23, 1983

National Aeronautics and Space Administration

James M. Beggs
Administrator

Date: August 23, 1983
AGREEMENT BETWEEN THE
NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
AND
FAIRCHILD INDUSTRIES, INCORPORATED
FOR A JOINT ENDEAVOR CONCERNING THE
RESEARCH AND DEVELOPMENT OF A SMALL
SPACE PLATFORM FOR COMMERCIAL OPERATIONS

Fairchild Industries, Inc.
Approved by:
Edward G. Uhl
Chairman and Chief Executive Officer
Date: August 23 1983

National Aeronautics and Space Administration
Approved by:
James M. Beggs
Administrator
Date: August 23 1983
# TABLE OF CONTENTS

<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>PREAMBULE</td>
<td>1</td>
</tr>
<tr>
<td>ARTICLE I APPOACH.</td>
<td>3</td>
</tr>
<tr>
<td>II FAIRCHILD RESPONSIBILITIES.</td>
<td>6</td>
</tr>
<tr>
<td>III NASA RESPONSIBILITIES.</td>
<td>9</td>
</tr>
<tr>
<td>IV RELEASABLE INFORMATION.</td>
<td>13</td>
</tr>
<tr>
<td>V SPACE SYSTEM EXCLUSIVITY.</td>
<td>14</td>
</tr>
<tr>
<td>VI TERM OF AGREEMENT.</td>
<td>15</td>
</tr>
<tr>
<td>VII TERMINATION.</td>
<td>16</td>
</tr>
<tr>
<td>VIII CONSIDERATION AND RIGHTS.</td>
<td>18</td>
</tr>
<tr>
<td>IX PROGRAM MANAGEMENT AND CONTROL.</td>
<td>20</td>
</tr>
<tr>
<td>X SAFETY AND INTERFACE REQUIREMENTS.</td>
<td>23</td>
</tr>
<tr>
<td>XI RESOURCES AND AVAILABILITY OF APPROPRIATED FUNDS.</td>
<td>24</td>
</tr>
<tr>
<td>XII DATA RIGHTS.</td>
<td>25</td>
</tr>
<tr>
<td>XIII RECORDS AND ASSOCIATED DATA.</td>
<td>28</td>
</tr>
<tr>
<td>XIV PROPERTY RIGHTS IN INVENTIONS.</td>
<td>29</td>
</tr>
<tr>
<td>XV ASSIGNMENT AND SUBCONTRACT.</td>
<td>31</td>
</tr>
<tr>
<td>XVI SERVICES CONSISTENT WITH UNITED STATES OBLIGATIONS, LAWS AND PUBLISHED POLICY.</td>
<td>33</td>
</tr>
<tr>
<td>XVII AUTHORIZATION AND CONSENT AND PATENT INDEMNITY.</td>
<td>34</td>
</tr>
<tr>
<td>XVIII MUTUAL OBSERVATION OF THE RULES.</td>
<td>35</td>
</tr>
<tr>
<td>XIX UNITED STATES GOVERNMENT OFFICIALS NOT TO BENEFIT.</td>
<td>36</td>
</tr>
<tr>
<td>XX RIGHTS OF FAIRCHILD TO DELAY, SUSPEND, POSTPONE OR ACCELERATE A LAUNCH OR PLACE A HOLD ON PRELAUNCH ACTIVITIES.</td>
<td>37</td>
</tr>
<tr>
<td>XXI RIGHTS OF FAIRCHILD TO DEFER OR CANCEL A PAYLOAD OPERATION.</td>
<td>38</td>
</tr>
<tr>
<td>XXII RIGHTS OF NASA TO DELAY AND TO SUSPEND OR POSTPONE AN AGREED UPON LAUNCH.</td>
<td>39</td>
</tr>
<tr>
<td>XXIII RIGHTS OF NASA TO DEFER OR CANCEL PAYLOAD OPERATIONS OR JETTISON A PAYLOAD.</td>
<td>41</td>
</tr>
<tr>
<td>XXIV ALLOCATION OF CERTAIN RISKS.</td>
<td>42</td>
</tr>
<tr>
<td>XXV REVISIONS.</td>
<td>52</td>
</tr>
<tr>
<td>XXVI APPLICABLE LAW.</td>
<td>53</td>
</tr>
<tr>
<td>XXVII DISPUTES.</td>
<td>54</td>
</tr>
<tr>
<td>XXVIII NOTICES.</td>
<td>55</td>
</tr>
<tr>
<td>APPENDIX A.</td>
<td>56</td>
</tr>
</tbody>
</table>
AGREEMENT BETWEEN THE
NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
AND
FAIRCHILD INDUSTRIES, INCORPORATED,
FOR A JOINT ENDEAVOR CONCERNING THE
RESEARCH AND DEVELOPMENT OF A SMALL SPACE PLATFORM
FOR COMMERCIAL OPERATIONS

PREAMBLE

The National Aeronautics and Space Act of 1958 declares that the aeronautical and space activities of the United States shall be conducted so as to contribute to the preservation of the role of the United States as a leader in aeronautical and space science technologies and their application to the conduct of peaceful activities within and outside the atmosphere. The furtherance of these activities may be substantially enhanced by the early availability of a shuttle-launched and supported mobile, unmanned space platform furnishing the necessary utilities (volume, power, stabilization and communication) for these activities. The Administration and NASA are committed to a reliance on the private sector for the supply of needed commercial products and services whenever available. NASA is, therefore, interested in a commercial firm willing to use their own resources to design, develop, and provide such a platform to users through lease or purchase.

Fairchild Industries believes that there are an increasing number of companies moving toward the use of space and space technology for the profitable production of goods and services. Fairchild wishes to create a commercial entity to lease to government and commercial users a variety of space systems, spacecraft, and space platforms that are launched, serviced and retrieved by the Shuttle. Such a commercial entity could also supply a variety of technical and administrative services, such as the integration of the users hardware with the spacecraft or platform, integration of such a spacecraft or platform with the Shuttle, provision of the necessary documentation and technical support to the user and to NASA for the launch,
operational services, and retrieval of the users products and/or hardware. Fairchild recognizes that it will incur substantial expenses to create such an entity and its shuttle-serviceable hardware, and that these operations may not return profit for a number of years. Fairchild believes that the possible returns from the already planned government and commercial space activities, together with the coming industrialization of space, justify much of that risk. Fairchild believes that its experience with the shuttle-compatible Multimission Modular Spacecraft (MMS) places it in a unique position to assure the technical success of such an enterprise, and to succeed in this aspect of the commercialization of space.

Accordingly, this agreement is made and entered into this 23rd day of August 1983, by and between Fairchild Industries which is a corporation organized and existing under the laws of the State of Maryland, whose principal offices are at Germantown, Maryland, and the United States of America, represented by the National Aeronautics and Space Administration. It delineates the joint endeavor that the parties will undertake and sets forth the terms and conditions therefore. Now, therefore, it is agreed as follows:
ARTICLE 1 - APPROACH

A. The Fairchild Leasecraft system is a shuttle-tended, mobile, unmanned space platform supported by ground-based systems and services. The space segment will be spacecraft providing a platform in low earth orbit for scientific, commercial, and government users on a leased or service-contract basis. (While not the intended approach, Leasecraft will be made available for purchase to customers who can be served best in that way.) The user's payload may consist of scientific instruments, material processing equipment or remote sensors carried on a user-supplied or Fairchild-provided payload support structure. Secondary payloads, e.g., instruments, electronics, or other equipment of limited volume and power dissipation, can also be accommodated. Secondary payloads may be mounted in standard MMS module boxes or by other means. The payload will be carried to a rendezvous orbit by the Space Transportation System (STS). The Leasecraft and payloads are subsequently mated on orbit. The spacecraft operate in orbits that are accessible from nominal Shuttle orbits. The configuration can support experimental, pre-operational, and operational programs.

The operational system will consist of one or more spacecraft, spare MMS modules and components, a Ground Support System, a Flight Support System, on-orbit servicing equipment, an Operations Control Center, and associated software and services. The Fairchild Leasecraft system will be responsible for providing to NASA the information to mate the payloads to Leasecraft (typically on-orbit), orbital operations, data and/or product retrieval, and payload demating and return to Shuttle orbiter cargo bay. Leasecraft will also provide payload integration and test services as a user option. Additional technical description is provided in Appendix A.

B. In this joint endeavor, NASA and Fairchild each will be responsible for specific portions of the total venture wherein each party separately and independently provides the resources required to accomplish its portion of the endeavor.
C. This Joint Endeavor will proceed in two sequential phases. The phases are generally defined as follows:

1. Phase 1 - Feasibility Studies and Preliminary Design

Phase 1 will begin with the signing of this document. By that time, NASA and Fairchild will each have designated a Joint Endeavor Manager (JEM) to carry out the terms of this JEA.

Phase 1 consists primarily of a research and engineering effort to establish requirements and to initiate the preliminary design of Leasecraft. In addition, market surveys of potential users and economic analyses will be made. Preliminary schedules for the program will be developed as well as overall flight planning, including the identification of STS, tracking, data acquisition, mission control and other data operations services required for flights. During this phase, a decision will be made as to the payload(s) for the test flights and agreements will be signed with the user(s). Completion of Phase I and entry into Phase II will be determined jointly by the Joint Endeavor Managers.

2. Phase 2 - Program Development and Flight Tests

This phase includes the research, design, development, and manufacture of the test vehicle for the Leasecraft system and the provision of the flight and ground hardware along with its associated software for the test flights. It is expected that the first launch will be scheduled for the second quarter of calendar year 1987, followed by a revisit service flight approximately six months later. Notwithstanding any other provision of the Agreement, the Fairchild payload (which includes the Leasecraft, Leasecraft payloads and all other property to be flown aboard the Shuttle for Leasecraft) will not exceed 360 inches along the keel of the Shuttle and will not exceed 35,000 pounds for the first launch and will not exceed 360 inches along the keel of the Shuttle and will not exceed 32,500 pounds for the service flight. Fairchild shall be eligible for Standard Shuttle Services, and such
optional services as mutually agreed to and documented in the PMP
required to accomplish the missions objectives including power,
cooling and crew operation consistent with the load factor for the
Fairchild payload, unless the parties otherwise agree. Also during
this phase, planning will be accomplished with NASA and users for the
operational period. Flight schedules, launch services, and associated
rates will be established with NASA through Launch Services Agreements
for the operational flights to follow.

D. The parties to this Agreement are cooperative participants. (Neither party
is regarded to be the leader or superior party with respect to the joint
activities contemplated by this Agreement.) Fairchild and NASA will each
appoint and so designate a Joint Endeavor Manager who shall have
responsibility for assuring that the respective parties' responsibilities
are satisfied. In this capacity, the NASA JEM and the Fairchild JEM will
serve as the sole interface for management and control of commitments
regarding this joint endeavor. The parties recognize that actions and
decisions by one party can significantly affect the other's work under
this endeavor, and therefore they agree to maintain frequent
communications with regard to progress, status of approvals, potential
problems, and schedule changes. It is also understood that the respective
JEMs may authorize the establishment of direct technical channels for
implementation of this Agreement, as well as channels for data and
information flow between parties. The parties further recognize that, in
the course of the programmatic and technical exchanges and reviews that
will occur under this endeavor, representatives from the respective
organizations may provide advice and comments on the approach and merits
of the work being conducted by the other. Such advice and comments are
not to be construed by either party as direction or control of the work
being performed. Further, a party's use of such advice and comments is at
its own discretion and risk.
ARTICLE II - FAIRCHILD RESPONSIBILITIES

A. With the goal of substantially supporting the commercialization of space, Fairchild will use its best efforts to design and develop a mobile, unmanned space platform and associated facilities and services for use by a wide range of commercial and government users of space.

Consistent with this goal and in accordance with the overall approach described in ARTICLE I, Fairchild shall, at no cost to NASA:

1. Phase I

   a. Develop the requirements for and initiate preliminary design of a mobile, unmanned space platform, including ground and flight support equipment and software, based on MMS technology, which will have the capability of supporting a variety of commercial, scientific and experimental users.

   b. Conduct market surveys to identify potential commercial and government users of the Fairchild Leasecraft system.

   c. Develop preliminary pricing policies, criteria, prices, and business procedures for lease of Fairchild's Leasecraft, facilities, and services by users.

   d. Define the requirements and develop preliminary plans to successfully demonstrate Leasecraft operations and payload changeout to be conducted with the STS during Phase II.

   e. Identify technical data and services required by NASA to conduct flights of Leasecraft.

   f. Develop jointly with NASA a Program Management Plan (PMP) in accordance with ARTICLE IX.
g. Provide NASA with information from which NASA can determine the suitability of Leasecraft for NASA missions.

2. Phase II

a. Design, develop, test and verify the compatibility of Leasecraft, together with its payload, with the STS, certify the flight readiness and provide the flight hardware and related ground and flight support equipment and software necessary for the test flights. As part of this effort, Fairchild will conduct the necessary design and flight readiness reviews, with NASA participation as defined in the PMP, to ensure compatibility with the existing STS configuration and to meet safety requirements.

b. Develop detailed plans with NASA for the initial test flight by the second quarter of calendar year 1987 and the re-visit flight approximately six months thereafter.

c. Support NASA's integration and launch operations of the Leasecraft with its payload into the STS and provide any unique ground and flight support equipment as specified in the PMP.

d. Provide personnel and Leasecraft-unique equipment and related software for a NASA provided operations control center for space operations during the test flights.

e. Conduct the free-flight operations of the Leasecraft and its payload during the test flights, except that the conduct of the Leasecraft operations during the service flight shall be agreed upon in the PMP.

f. Establish agreements with users and determine pricing arrangements, launch schedules, and other Fairchild services required for the follow-on operational flights.
g. Jointly with NASA, share Fairchild MMS-compatible test equipment, flight support and ground support equipment and software, to be specified in the PMP, as available on a non-interference basis with Fairchild's activities and only during the term of this agreement.

h. If NASA exercises its option to provide an attached payload, as described in Article III, paragraph 1.h, mount such attached payload onto the Initial Leasecraft flight article and conduct the necessary pre-flight functional testing, with NASA support.

i. At NASA's option, provide services to NASA, as defined in Article III.2.b, on the service flight covered by this Agreement. If NASA does not retrieve its attached payload(s) on the service flight, or if NASA changes out its attached payload(s) on the service flight, NASA will not be charged for the use of Leasecraft services for the term of this Agreement for such attached payloads. If the NASA attached payload(s) is not retrieved during the term of this Agreement, the parties shall seek to negotiate a separate appropriate agreement for the use of Leasecraft services after the term of this Agreement.
ARTICLE III - NASA RESPONSIBILITIES

With the goal of making a significant contribution to technological innovation and U.S. leadership in space by making facilities and services available to users on a lease basis, NASA will use its best efforts, on a non-interference basis with NASA activities, to provide the technical assistance, flight time on the STS, and available general purpose equipment and/or facilities needed to support the research and development effort to permit the commercial availability of the Leasecraft System.

Consistent with the purpose stated herein, and in consideration for the contribution that Fairchild agrees to make to develop and produce the Leasecraft system, NASA shall, at no cost to Fairchild:

1. Phase I

a. Make available to Fairchild releasable applicable designs, software and procedures from the NASA/GSFC Flight Projects Directorate and other NASA sources for possible use in designing and developing the Leasecraft system, this availability to continue through Phase II.

b. Conduct the necessary planning, scheduling, manifesting and budgeting to provide STS flights, related services, and available general purpose equipment to successfully complete the Leasecraft test and service demonstration flights in Phase II.

c. Furnish to Fairchild design criteria related to safety of flight, as well as interface, integration and test, and checkout requirements as applicable to Leasecraft and its payloads, this effort to continue through Phase II.

d. Develop jointly with Fairchild a Program Management Plan (PMP) in accordance with ARTICLE IX.
e. Provide design review support to Fairchild, as agreed to by NASA, from the NASA/GSFC System Review Office, and consulting support from NASA technical experts, this support to continue through Phase II.

f. Permit Fairchild access, on a non-interference basis with NASA activities, to NASA centers under "contractor" designation to meet its responsibilities under this agreement, this privilege to continue through Phase II.

g. Jointly with Fairchild, identify any requirements for training of NASA personnel that will use Fairchild equipment, facilities or services, this effort to continue through Phase II.

h. At NASA's option, NASA will designate an attached payload, generally the size of an MMS Box, or operational test for each test flight of the Leasecraft demonstration. NASA may designate additional payload(s) or operational test(s) if Fairchild agrees. The operation of the payload or operational test will be, with Fairchild's concurrence, compatible with test flight objectives. Such attached payloads will be provided to Fairchild fully assembled, self-contained, flight-ready, and compatible with Leasecraft interfaces.

i. With respect to NASA attached payload(s), at NASA's option, NASA will select the services, as defined in Article III.2.b., that will be performed on the service flight covered by this Agreement.

2. Phase II

a. To begin space testing of the Leasecraft system, provide pre-launch and launch services, including optional services normally provided to STS payloads, for an STS payload consisting of a Leasecraft and a Leasecraft payload, both to be designated by Fairchild, the latter with NASA concurrence. Fairchild shall provide NASA with written notice of its Leasecraft payload designation for this space test at least 18 months prior to the
scheduled launch date for the STS payload described. If no NASA objection to Fairchild's designation of such Leasecraft payload is received by Fairchild within 45 days of its written notification to NASA of such designation, then such designation will be approved.

b. In order to complete testing of the Leasecraft system, within approximately six months of the initial launch, provide a service flight and perform on-orbit servicing of a Leasecraft and its payload(s), including appropriate pre-launch, launch and landing support. Servicing means payload changeout or resupply, or the return of a Leasecraft and/or its payload to earth or other servicing as agreed to by the parties. Following the successful completion of this test program, NASA will verify the extent to which the operation of the Leasecraft system has met the joint Fairchild-NASA test objectives and is compatible with the Space Transportation System.

c. Provide support of the Multi-Satellite Operations Control Center and Missions Operations Room at Goddard Space Flight Center that is comparable to that provided to a NASA mission, for the flights covered under this agreement, and as agreed upon in the PMP. Fairchild to make best efforts to minimize NASA's out-of-pocket expenses for this item.

d. Provide an agreed upon level of service of the Tracking and Data Relay Satellite System in accordance with NASA Management Instruction as published in The Federal Register under Title 14, Chapter V, Part 1215 48 FR 9845-9849, March 9, 1983, with designation as a NASA payload/spacecraft and as agreed upon in the PMP.

e. Make available, on a non-interference basis with NASA activities, NASA test facilities, as may be agreed upon in the PMP.
f. Periodically furnish to Fairchild, upon request, applicable data on relevant NASA programs that might use Fairchild's facilities and services for the operational flights.

g. Consider the use of Leasecraft for NASA missions compatible with its capability and, as they are identified by either party, opportunities for joint development of new or expanded Leasecraft system capabilities that would be mutually beneficial.

h. Jointly with Fairchild, share NASA MMS-compatible test equipment, flight support and ground support equipment and software, to be specified in the PMP, as available on a non-interference basis with NASA's activities and only during the term of this Agreement.

i. Refer all inquiries regarding the use of Leasecraft to Fairchild.

j. If NASA exercises its options to provide an attached payload(s), as described in Article III, paragraph 1.h., or payload change out or re-supply as described in Article III, paragraph 1.i. deliver such payload to Fairchild in fully assembled, flight ready and operational form together with all necessary ground and flight support equipment, test and operational software, on a schedule to be determined in the PMP.
ARTICLE IV - RELEASABLE INFORMATION

It is recognized that from time to time the parties may desire to release to
the public and appropriate government organizations information about the
endeavor. Release of public information regarding the endeavor may be made by
NASA and Fairchild as to their participation and activities as desired and
insofar as the participation and activities of the other is involved, after
suitable consultation. In the release of such information, the parties agree
to exercise reasonable discretion, considering the nature of this endeavor and
the need to keep the public informed. In addition, it is agreed that the
following listed technical information, to be furnished by Fairchild to NASA
may be released to the public without consultation:

A. The contents of this agreement.

B. Overall system descriptions, including external dimensions, of Fairchild
   systems, but excluding design details.

C. General information on potential applications of the Fairchild Leasecraft
   Program.

D. Data as may be needed for STS interface verification, payload integration
   and checkout.

E. General performance data of the Leasecraft, and its payloads, and other
devices flown on board Leasecraft, excluding detail design information and
trade secrets.
ARTICLE V - SPACE SYSTEM EXCLUSIVITY

A. During the period from the signing of this Agreement through December 31, 1986, NASA will not use appropriated funds to develop in-house or procure a platform similar to Fairchild's Leasecraft Platform nor enter into an international cooperative agreement to develop a platform similar to Fairchild's Leasecraft Platform.

B. For purposes of this Article, a similar space platform would be an unmanned spacecraft, STS-deployed and left in orbit, whose payloads would be changed or serviced in space, which would be replenished and repaired as necessary by subsequent STS visits and that provides maximum continuous power to a payload of no more than 12.5 kw. This does not include specific designs for a single purpose or mission, one of a kind spacecraft, where the spacecraft components are a tightly integrated part of the space system. Rather, it is directed to restricting the development, at Government expense, of self-sustaining free flying platforms that would compete with Fairchild's Leasecraft.

C. Nothing in this Agreement shall preclude NASA from selling launch and associated services or other services to an organization on a reimbursable basis in accordance with NASA charge policies.
ARTICLE VI - TERM OF AGREEMENT

This Agreement shall be in force until six months after the successful completion of the flight test program and data evaluation, culminating in NASA verification that the test flight objectives have been met, or December 31, 1989, whichever comes first. This term is extendable by mutual written agreement of signatories of this Agreement.
ARTICLE VII - TERMINATION

A. Termination during Phase I

At the end of Phase I either party may elect to terminate this Agreement. It is expected that any such decision to terminate would be made following the completion of a scheduled review specified in Article IX of this Agreement and would be based on the data, information and assessments developed for or resulting from that review. In the event of such termination, the parties agree to negotiate in good faith the disposition of data, information, patents and other results of work accomplished or in progress, arising from or performed under this Agreement.

Neither party shall be entitled to any compensation due to such termination and neither party will be required to transfer any data, information, patents or other results of work accomplished or in progress other than as agreed to in such negotiations.

B. Termination during Phase II

1. Fairchild may elect to terminate unilaterally this Agreement for any reason by giving NASA written notice not less than 90 days prior to the desired termination date. In the event of such termination, NASA shall be entitled to purchase and take title to all flight hardware and related software and support equipment completed or in process at the cost incurred by Fairchild. NASA shall have the license rights in and to all patents and data as set forth in ARTICLES XII and XIV.

2. NASA shall have the right to terminate unilaterally this Agreement (i) upon declaration of war by the United States, (ii) upon declaration of a national emergency by the Congress of the United States, (iii) upon the failure of the Congress of the United States to provide NASA adequate appropriations, as indicated in Article XI of this Agreement, or (iv) upon a determination in writing that NASA is required to terminate the Launch and Associated Services for Reasons Beyond NASA's Control. If practical,
prior to terminating NASA shall consult with Fairchild for the purpose of reviewing the available evidence which requires NASA to terminate. NASA will consider Postponing a Payload launch before considering terminating its commitment, in whole or in part, under the authority in this Subparagraph B.2. For purpose of this Subparagraph B.2., "Reasons Beyond NASA's Control" include, but are not limited to, acts of God or of the public enemy; acts of the United States Government other than NASA, in either its sovereign or contractual capacity; fires, floods; epidemics; quarantine restrictions; strikes; freight embargoes or unusually severe weather which make impractical NASA's or its contractor's or subcontractor's performance of Launch and Associated Services. NASA agrees that it will not terminate this Agreement for "Reasons Beyond NASA's Control" unless there is a resulting cessation of Shuttle launches for commercial purposes for a substantial period of time.
ARTICLE VIII - CONSIDERATION AND RIGHTS

A. In discharging its responsibilities per ARTICLE III, NASA's primary interests are in stimulating and accelerating the transition from research and development to commercial availability of necessary facilities, utilities, and services at a reasonable cost to potential users of space, thereby increasing taxable revenue from space activities. In discharging its responsibilities per ARTICLE II, Fairchild is concerned with making a fair return on its research and development effort considering the high and long-term technological and economic risks it has undertaken by execution of this Joint Endeavor Agreement. Fairchild contemplates making significant expenditures for several years under circumstances where the outcome of the endeavor is highly speculative due to technical and market uncertainties. During the earlier years, when the risk is highest, Fairchild will expend substantially more in its part of the endeavor than NASA. Fairchild will also make available for use under this endeavor valuable intellectual property in the form of proprietary data and patent rights, as well as skills related to space platforms and MMS technology.

B. It is the intent of both parties that this joint endeavor will result in commercial sales. Fairchild will exert its best efforts to make results of this joint endeavor available to the United States public on reasonable terms and conditions. The reasonableness of the terms and conditions shall include a fair return to Fairchild and associated third parties. Parallel to the development and demonstration of commercially available facilities, utilities, and services to support the initial test flights of Leasecraft, Fairchild, at its option, will make such equipment and services available to others via lease or purchase. Subject to the rights reserved to the Government under ARTICLES XII or XIV of this Agreement, Fairchild shall exclusively have the right to enter into agreements with others for the provision of Leasecraft hardware, software and services, without concurrence of NASA except as otherwise specified herein. Operational flights with commercial users will be on a fully reimbursable basis to NASA in accordance with STS pricing policies and specific launch service agreements executed for that purpose.
C. In consideration for the risks undertaken, effort expended, and cost incurred by the parties, the rights under this agreement are apportioned in accordance with ARTICLES V, XII and XIV, respectively entitled "Space System Exclusivity," "Data Rights," and "Property Rights in Inventions."
ARTICLE IX - PROGRAM MANAGEMENT AND CONTROL

A. Management Structure

The parties to this agreement shall be separately responsible for establishing the necessary management and work elements structure within their respective organizations, which shall have both the scope and capacity required to discharge their respective responsibilities as set forth in ARTICLE II and III hereof and in accordance with the Program Management Plan (PMP).

B. Management and Control Documents

This Agreement provides for two levels of management control as follows:

1. Level I

   Level I encompasses the basic understanding between the two organizations and is documented by this Agreement. This Agreement is the controlling document and any other agreements, understandings and documentation relating to it are deemed subordinate.

2. Level II

   a. Level II controls the implementing and operating interface between the two organizations and includes measurable performance objectives and milestones for progress assessments and decisions. The Program Management Plan (PMP) is the basic Level II document and will be approved by the respective JEMs. The parties understand and recognize that the STS services (Shuttle Standard and Optional) to be furnished by NASA shall be specifically defined for each Phase in the PMP and limited to: (i) normal, relevant services provided by NASA to Shuttle payloads, (ii) STS general purpose equipment and available facilities, (iii) common operational research equipment as available and (iv) such support equipment and software to be agreed to under Article III. 2.h.
b. A Program Management Plan will be mutually developed by the two parties and shall serve as the Level II technical and programmatic baseline for this Endeavor. The PMP shall detail the plans and requirements needed for the parties to fulfill their respective responsibilities under this Agreement, including measurable objectives and milestones, and shall be the baseline against which progress will be assessed at the periodic reviews. It shall include, but not be limited to, the following:

(1) Program objectives and approach
(2) Technical performance requirements
(3) Design and development plans, including plans for verification of safety and interface requirements developed in accordance with ARTICLE X
(4) Delineation of the hardware, software, facilities, data, and services to be furnished by the respective parties, including definition of launch and associated services
(5) Delineation of services for tracking, data acquisition, mission control and other data operations.
(6) Schedules

C. Reviews and Meetings

1. The parties will consult periodically, as determined to be appropriate by the JEMs, to exchange technical, programmatic and other information needed to assess progress of this endeavor and make timely decisions. The JEMs shall call upon other individuals from their respective organizations, including contractors and consultants, to participate as necessary and appropriate in such consultations.

2. The parties shall meet periodically, as determined by the respective JEMs, for a formal review of planning, progress and problems. At the initial review, each party shall present its respective portion of the PMP and supporting documentation for discussion, possible revision and
subsequent agreement. The reviews shall include such items as accomplishments, plans and problems related to technical progress, schedule considerations, manpower allocations, risk assessments and such other items as may be required to facilitate a mutual understanding of the status of the Leasecraft program and to make timely decisions.
ARTICLE X - SAFETY AND INTERFACE REQUIREMENTS

A. Safety

The Leasecraft system design, development and operations shall comply with the NASA safety requirements in NHB 1700.7, Safety Policy and Requirements for Payloads Using the Space Transportation System (STS).

B. Interface Requirements

As early in Phase I as practical, the parties shall cooperatively develop documentation to assure the electrical, structural, functional and operational compatibility of the Fairchild equipment (hardware and software) with NASA's ground and flight equipment and procedures. Interface documentation will be approved by the JEMs on behalf of the parties. During this Agreement NASA may update interface specifications and other design and operations restraints in providing for the compatibility of the payload with the Shuttle. NASA will use its best efforts to find a solution to interface problems that minimize the resulting efforts and costs.

C. Reliability

Fairchild and NASA agree to apply their best efforts to assure that all equipment, hardware and software will function reliably for its intended purposes and use, provided, however, that Fairchild and NASA respectively disclaim any warranties or representations to the other with respect to such equipment, hardware and software.
ARTICLE XI - RESOURCES AND AVAILABILITY OF APPROPRIATED FUNDS

A. NASA, subject to the limitations set forth in Paragraph B below, and Fairchild shall provide funding and all other resources required to fulfill their respective responsibilities set forth in this agreement. There will be no exchange of funds between Fairchild and NASA under this agreement.

B. NASA's ability to perform its obligations under this Agreement is subject to the availability of appropriated funds. If adequate appropriations are not forthcoming, this shall be construed as a unilateral termination by NASA under Paragraph B of ARTICLE VII of this Agreement. However, NASA shall use its best efforts to obtain needed funding.
ARTICLE XII - DATA RIGHTS

A. Data means recorded information, such as but not limited to writings, drawings, recordings and pictorial representations, regardless of form or the media on which it may be recorded.

B. All data furnished to NASA included in the list contained in ARTICLE IV of this Agreement shall be furnished with unlimited rights (the right to use, reproduce, disclose in any manner and for any purpose whatsoever), and without restrictive legend. Recognizing that the requirements for, and the need for protection of, data may change during different phases of this Agreement, NASA and Fairchild may from time to time, upon mutual agreement, change the listing of data to be furnished pursuant to ARTICLE IV.

C. Other than as provided in Paragraph B above, NASA will use its best effort to assure that any data required to be furnished, or in fact furnished under this Agreement will be used, reproduced, and disclosed by the Government only for the purpose of carrying out its responsibilities under this agreement. In the event the data qualifies as a trade secret and the originator of such data desires to maintain trade secret rights therein, such data shall be marked with the following (and no other) notice and the Government will thereafter treat the data in accordance with the Notice:
NOTICE

This data is a trade secret of ___________ and is submitted in confidence to NASA under Joint Endeavor Agreement, No. _______ dated __________, 1983. NASA agrees that the data will not, without permission of Fairchild be duplicated, used or disclosed by NASA or its contractors for any purpose other than as necessary to carry out NASA's obligations under this Agreement. If required by such contractors, the data will only be furnished after the contractors have agreed with NASA in writing to protect the data from unauthorized use, duplication and disclosure. This notice shall be marked on any reproduction of the data, in whole or part.

D. Notwithstanding any other provisions of this Agreement, data owned by Leasecraft customers need not be furnished to NASA except as required by NASA for safety, integration and compatibility with other payloads and the Shuttle and as may be required by Articles IV, XV and XVI of this Agreement.

E. Fairchild or any party in privity therewith agrees to furnish data first produced in carrying out Fairchild's responsibilities under Article II of this Agreement to responsible parties designated by NASA or to NASA and Fairchild further agrees that NASA itself may furnish such data to responsible parties if the NASA Administrator or his/her designee determines such action is necessary (i) because Fairchild has not taken, or is not expected to take within a reasonable time, effective steps to achieve commercial utilization of the results demonstrated or to be demonstrated under this Agreement, or (ii) to enable the practice of any license rights to patents or inventions acquired by NASA pursuant to ARTICLE XIV of this Agreement, or (iii) in the event of a unilateral termination in accordance with ARTICLE VII, Paragraph B.1. Any of the above determinations by the NASA Administrator or his/her designee shall be in accordance with the provisions of Paragraph C of ARTICLE XIV of this Agreement. Data
(other than unlimited rights data under ARTICLE XII) when furnished as agreed above will be royalty free, under protective conditions, for use by NASA, or responsible parties acting on NASA's behalf, to complete the objectives of the Agreement if such is necessary, and for the practice of any license rights to patents and inventions under ARTICLE XIV. All other use of the data will be under terms and conditions reasonable under the circumstances.
ARTICLE XIII - RECORDS AND ASSOCIATED DATA

Fairchild and NASA agree to maintain technical records, documents and other associated data pertaining to the design, development, manufacture, test integration and operation of Fairchild hardware and software. These records and documents shall be of sufficient detail and completeness that, in the event of determinations made under ARTICLE XII or ARTICLE XIV or termination by one party, the other can continue the program if it so desires. Upon request, the NASA JEM or a mutually agreed designee shall have access to Fairchild generated records at all reasonable times during regular business hours. All data reviewed under this Article which qualifies as a trade secret shall be treated as trade secrets in accordance with ARTICLE XII, Paragraph C entitled "DATA RIGHTS". The records, documents and other associated data identified above shall be preserved for a period of at least seven years from the date of termination of this Joint Endeavor Agreement.
ARTICLE XIV - PROPERTY RIGHTS IN INVENTIONS

A. Except for the rights reserved by NASA in Paragraph B below, and those rights provided pursuant to ARTICLE VII entitled "Terminations," Fairchild and any party in privity therewith shall retain all right, title and interest to any invention conceived or first reduced to practice in carrying out its responsibilities under this agreement as described in ARTICLE II of this agreement.

B. With respect to any invention subject to Paragraph A above, the following will apply:

1. NASA shall have a contingent royalty-free license to practice or have practiced such inventions by or on behalf of the Government for any Governmental purpose. The contingent royalty-free license is a nonexclusive paid-up license to all inventions contained in Paragraph A above, and all data and patents necessary to practice or have practiced such inventions, which data will be furnished to NASA, and will become effective if the NASA Administrator or his/her designee determines such action is necessary: (i) because Fairchild or any party in privity therewith has not taken, or is not expected to take within a reasonable time, effective steps to achieve commercial utilization of the invention; or (ii) in the event of a unilateral termination in accordance with ARTICLE VII, Paragraph B.1.

2. If a determination is made by the NASA Administrator or his/her designee that action is necessary as a result of (i) or (ii) in Paragraph B.1. above, NASA has the right to require the granting of a license to responsible parties, upon terms and conditions reasonable under the circumstances, or to so grant such a license itself, if in the judgement of the NASA Administrator or his/her designee that Fairchild or its parties in privity have not effectively taken steps or have been unsuccessful in licensing to satisfy the requirements of (i) and (ii) above.

C. Prior to the making of a determination by the NASA Administrator or
his/her designee under Paragraph B above, NASA shall give Fairchild sixty
days written notice of intention to make such determination and provide
findings in support thereof and shall afford Fairchild an opportunity to
be heard and offer evidence in support of its position. Any determination
will be subject to ARTICLE XXVII, "DISPUTES."

D. Fairchild shall, at the request of NASA, provide NASA with a brief
description of any invention subject to Paragraph A above, and of any
action taken to obtain patent protection thereon, and of the final
disposition of such action. Any brief description so provided shall be
subject to protection from disclosure under the provision of Paragraph C
of ARTICLE XII, "DATA RIGHTS" until a patent is issued thereon or the
patent application is otherwise made available to the public.
ARTICLE XV - ASSIGNMENT AND SUBCONTRACT

A. This Agreement shall not be assignable by Fairchild without the prior written consent of NASA, except that it may be assigned without such consent to a United States Person or Entity which is (i) a successor of Fairchild, (ii) a firm or corporation acquiring all or substantially all of the business and assets of Fairchild relating to the Leasecraft System, (iii) a wholly-owned subsidiary corporation of Fairchild, or (iv) a partnership affiliated with Fairchild or a wholly-owned subsidiary of Fairchild formed for the purpose of financing Fairchild's responsibilities and obligations to be performed under this Agreement. No assignment of this Agreement shall be valid until and unless all the terms and conditions of this Agreement have been assumed by the assignee and NASA consents in writing that the assignee is technically qualified and financially capable of fulfilling the Agreement, which consent will not be unreasonably withheld. When duly assigned in accordance with the foregoing, this Agreement shall be binding upon and shall inure to the benefit of the assignee. In the event of assignment as specified in (iii) or (iv), Fairchild will also, in addition to the assignee, remain obligated to NASA under all the terms and conditions of this Agreement, and the assignment will set forth the party or parties as mutually agreed upon between Fairchild, the assignee and NASA with whom NASA is to interface under the Agreement with regard to technical, financial, and scheduled matters.

B. Fairchild may subcontract parts of its work to be performed under this Agreement without obtaining the consent of NASA.

C. Fairchild may provide services or lease the Leasecraft to users subject to the following limitations:

   (i) Fairchild shall notify NASA in writing of the identity of its users whom Fairchild believes may not be a United States Person or Entity and who are to provide Leasecraft payloads to Fairchild to be flown on board the Shuttle; and within thirty days following receipt of notice from Fairchild, NASA shall have the right to disapprove in writing to Fairchild
the flight of the Leasercraft payload on board the Shuttle for any user who is not a United States Person or Entity.

(ii) With respect to each user Fairchild shall provide the identity of the user and a description of the payload and its general performance for purposes of receiving NASA's concurrence referenced to in Article III.2.a.
ARTICLE XVI - SERVICES CONSISTENT WITH UNITED STATES' OBLIGATIONS, LAW AND PUBLISHED POLICY

NASA shall furnish launch and associated services under this Agreement to the extent consistent with the United States' obligations (including any intergovernmental memorandum of understanding entered into by NASA and the User), United States' Law and United States' published policy.
ARTICLE XVII - AUTHORIZATION AND CONSENT AND PATENT INDEMNITY

NASA hereby gives its authorization and consent to Fairchild and any party in privity therewith for all use and manufacture of any invention or process described in and covered by a patent of the United States in carrying out its responsibilities set forth in ARTICLE II of this Agreement. Fairchild agrees to indemnify the Government for any costs incurred by the Government as a result of the unlicensed use (infringement) of privately owned U.S. patents to the extent that any such costs are attributable to the responsibilities set forth in ARTICLE II of this Agreement.

Such costs shall include, but are not limited to, administrative claims against NASA for infringement of such patents, as well as costs incurred by the Government in the form of a judgment against the U.S. by a court of competent jurisdiction. Fairchild shall be given an opportunity as is afforded by applicable laws, rules, or regulations to participate in the defense of such suits, and no settlement of any such claim or suit will be made without Fairchild's written consent other than as required by final decrees of a court of competent jurisdiction.
ARTICLE XVIII - MUTUAL OBSERVATION OF THE RULES

In the performance of this Agreement, Fairchild and NASA will be required to visit and work at the other's installation/plant facilities, and therefore each party agrees to observe the safety, security and plant operating rules while on the other's property.
ARTICLE XIX - UNITED STATES GOVERNMENT OFFICIALS NOT TO BENEFIT

No member of or delegate to the United States Congress, or resident commissioner, shall be admitted to any share or part of this agreement, or to any benefit that may arise therefrom, but this provision shall not be construed to extend to this agreement if made with a corporation for its general benefit.
ARTICLE XX - RIGHTS OF FAIRCHILD TO DELAY, SUSPEND, POSTPONE OR ACCELERATE A LAUNCH OR PLACE A HOLD ON PRELAUNCH ACTIVITIES

A. Unless the parties otherwise mutually agree, the rights of Fairchild to delay a launch shall consist of the right to delay liftoff of the Shuttle, exclusive of NASA's right to delay, for a period not in excess of a total of seventy-two hours beyond the time of scheduled liftoff on the previously agreed launch date with NASA's concurrence. NASA's concurrence will not unreasonably be withheld. Fairchild agrees to exercise this right in a reasonable manner with reasonably prompt notification to NASA. This right to delay will be reduced or terminated to the extent that other users on the same Shuttle flight as Fairchild have in the aggregate used part or all of the seventy-two hours. Fairchild shall effect such a delay (i) only after the NASA-specified time for delivery of the payload or any portion thereof to the cargo integration facility, unless NASA otherwise agrees, and (ii) by giving written notification to NASA specifying the circumstances of the request for delay. Fairchild shall have no other right to postpone, suspend or accelerate a launch except as otherwise mutually agreed between the parties.

B. Fairchild shall have the right, with NASA's concurrence, to interrupt any prelaunch activity involving the payload if Fairchild has reason to believe that continuation of the activity would adversely affect the success of Fairchild's payload mission (hereinafter called "hold"). At the time a hold is placed by Fairchild, or as soon thereafter as practical, the NASA JEM and the Fairchild JEM, or their designees, shall document in writing the circumstances that necessitated the hold and the resulting launch schedule impact of the hold. A hold will result in a delay if the scheduled time of liftoff of the Shuttle is impacted by the hold.
ARTICLE XXI - RIGHTS OF FAIRCHILD TO DEFER OR CANCEL A PAYLOAD OPERATION

Fairchild, in the person of the JEM, shall have the right to defer or cancel all or a portion of the planned payload operations after the liftoff of the shuttle, so long as NASA can safely halt such operations, by notifying the NASA Mission Manager, or his designee, who will in turn notify the NASA Flight Director of the decision to defer or cancel. The payload operations may be rescheduled later in the shuttle flight at the request of Fairchild, if NASA so agrees.
ARTICLE XXII - RIGHTS OF NASA TO DELAY AND TO SUSPEND OR POSTPONE AN AGREED UPON LAUNCH

The rights of NASA to delay and to suspend or postpone a launch shall be exercised by NASA in a reasonable manner and with reasonably prompt notification to Fairchild and shall consist of:

A. The right to delay a liftoff of the Shuttle, after the NASA specified time for delivery of Fairchild's payload, another payload on the same Shuttle flight as the Fairchild payload, or any portion of the Fairchild payload or other such payloads to the cargo integration facility, exclusive of Fairchild and any other user's right to delay, for a period not in excess of a total of seventy two hours beyond the time of scheduled liftoff on the agreed upon date and the right to further delay liftoff beyond the seventy two hour period, after consulting Fairchild and all other users on the same Shuttle flight. In the event of delays beyond seventy two hours, NASA will consult and cooperate with Fairchild in rescheduling the launch, considering the loss of revenue to Fairchild caused by the launch delay.

B. The right to suspend or postpone a payload launch, after consulting Fairchild, if the agreed upon date is delayed beyond seventy two hour period defined in ARTICLE XX above as a direct result of one or more requests by Fairchild for such delay.

C. The right to suspend or postpone a launch of a Fairchild payload if Fairchild fails to meet any significant obligation under this Agreement, including its obligation to provide, on the schedule specified in the PMP, payload hardware and software that are operationally compatible with the STS and related payload checkout and integration functions.

D. The right to suspend or postpone a launch or on-orbit service of Fairchild's payload if major or untimely modification or rework, as determined by NASA, would be required to the Shuttle hardware, software, or procedures as a result of proposed changes by Fairchild to the interface and/or mission requirements set forth in the PMP. It shall be the responsibility of Fairchild to ascertain from NASA the impact of
requested changes prior to giving written request to NASA for such
changes. On a timely basis, upon request of Fairchild, NASA shall consult
with Fairchild in evaluating the impact of the proposed changes and
provide relevant, readily available information to Fairchild.

E. The right to suspend or postpone a launch or on-orbit service of
Fairchild's payload if NASA determines that it would be necessary because,
in NASA's judgement, the safety or probable success of the launch would be
affected due to unfavorable weather conditions, equipment malfunctions,
delay in the availability of necessary Shuttle services, including the
flight crew or payload specialists, or other similar reasons, or for
reasons beyond NASA's control. This right to suspend or postpone shall
apply also to a launch delay that is directed by the Commander, United
States Air Force Eastern Space and Mission Center.

F. The right to suspend or postpone a launch of a Fairchild payload in order
to maintain the sequence of Shuttle flights or if NASA is faced with a
conflict between the agreed upon launch date of a payload and that desired
(e.g., launch window) for another payload. In such a case (i) the payload
launch will be dealt with on the same basis as would any other comparable
payload launch, (ii) each payload launch shall be treated in terms of its
own requirements, including consideration of the financial and other
consequences such as suspension or postponement would cause and (iii) NASA
shall consult with Fairchild and with all other affected parties in order
to arrive at an equitable solution.
ARTICLE XXIII - RIGHTS OF NASA TO DEFER OR CANCEL PAYLOAD

OPERATIONS OR JETTISON A PAYLOAD

A. NASA shall have the right to defer all or a portion of the planned payload operations if, in NASA's judgement, start or continuation of such payload operations would adversely affect the safety or planned objectives of the Shuttle flight. The payload operations will be rescheduled later in the Shuttle flight following satisfactory resolution of the cause for deferral, as determined by NASA, if NASA can accommodate such a rescheduling. NASA shall reasonably exercise its judgement to defer the planned payload operations based upon the data available at the time such decision is made and will consult with Fairchild to the extent practicable in making such decision. In any event, NASA will immediately advise Fairchild of its decision in this regard.

B. NASA shall have the right to cancel all or a portion of the planned payload operations if, in NASA's judgement, the payload operations would adversely affect the safety or planned objectives of the Shuttle flight or would require an extension in the planned duration of the Shuttle flight. NASA shall reasonably exercise its judgement to cancel the planned payload operations based upon the data available at the time such decision is made and will consult with Fairchild to the extent practicable in making such decision.

C. NASA shall have the right to jettison a payload after liftoff of the Shuttle if, in NASA's judgement, the payload presents an immediate or unresolvable danger to human life, another payload or the Shuttle flight. Such action shall be taken by NASA only after reasonable effort to place the payload in a safe configuration and, circumstances permitting, only after consultation with Fairchild.
ARTICLE XXIV - ALLOCATION OF CERTAIN RISKS

A. General

1. Certain risks of liability, as defined below, arising out of the launch and associated services to be provided by the United States Government and its contractors and subcontractors under this Agreement shall be allocated between Fairchild and the United States Government as set forth in this ARTICLE XXIV. To the extent that a risk of damage, as defined below, is not dealt with expressly in this Agreement, the United States Federal Law shall govern the allocation of such risk between Fairchild and the United States Government.

2. For purposes of this Agreement, the following definitions shall be applicable:

   a. "Liability" shall include payments made pursuant to United States' treaty, any judgement by a court of competent jurisdiction, administrative and litigation costs, and, after consultation with Fairchild, settlement payments.

   b. "Damage" shall mean bodily injury to or death of any person, damage to or loss of any property, and loss of revenue or profits or other direct, indirect or consequential damages arising therefrom.

B. Third Party Liability

1. Fairchild shall obtain, at no cost to NASA, insurance protecting Fairchild and the United States Government from any third party liability for damage arising out of the performance of this Agreement during the risk period (as defined herein).

   a. The "risk period" for Fairchild begins at the start of the physical attachment by bolt or other device of the Leasecraft or Leasecraft payload to the Orbiter.
b. The "risk period" for Fairchild after launch of a Leasecraft or Leasecraft payload ends upon the landing of the particular Orbiter without causing damage to third parties or, if a Leasecraft or Leasecraft payload is jettisoned, when the Leasecraft or Leasecraft payload impacts the earth without causing damage to third parties, whichever occurs last. If third parties are damaged, the "risk period" ends immediately after all such damage occurs.

c. The "risk period" for Fairchild ends prior to launch of a Leasecraft or Leasecraft payload upon completion of removal of the Leasecraft or Leasecraft payload from the orbiter for any reason and shall begin again upon start of physical attachment as described in Subparagraph B.I.a above.

2. Fairchild shall obtain, at no cost to NASA, insurance protecting Fairchild and the United States Government from any third party liability for any damage resulting from a deployable Leasecraft or Leasecraft payload element following deployment. A Leasecraft or Leasecraft payload that remains tethered to the Orbiter shall not be considered to have been deployed.

3. The insurance policy may take into account the agreement by NASA, Fairchild and other identified persons, in Paragraph C below, not to make a claim for damage under the conditions described therein. The insurance policy shall provide for the right of the United States Government to settle reasonably a claim for damage after consultation with Fairchild.

4. The amount of insurance and terms and conditions of such insurance to be purchased pursuant to this Paragraph B. shall be agreed to by Fairchild and NASA in view of the insurance available in the world market at a reasonable premium. Notwithstanding such agreement by NASA, Fairchild shall have the responsibility to meet the requirements in Subparagraphs B.1 and B.2 above. Although NASA may agree to an
insurance policy, such agreement shall not result in Fairchild being relieved of its obligation to protect the United States Government by an enforceable insurance policy in the amount agreed upon without exclusions or other limitations which reduce or eliminate the protection of the United States Government, except that the Policy need not protect the United States Government for Liability that falls within the following standard exclusions, but only to the extent NASA agreed in writing to the wording of these standard exclusions: (i) war-risk, (ii) nuclear risks, (iii) Shuttle-caused pollution, (iv) Shuttle-caused interference with radio frequencies, and (v) Worker's compensation, unemployment compensation, death or disability benefits law or equal opportunity laws. As to any individual customer, such insurance shall not be required in an amount in excess of 500 million dollars (U.S.). Where multiple customers are on the same Shuttle flight and are named insureds under a single policy, such insurance shall not be required in an amount in excess of one billion dollars (U.S.). However, if Fairchild or multiple customers obtain insurance in excess of that amount, the United States Government and other insureds shall be protected by the total amount of insurance. Fairchild shall provide to NASA a copy of the executed insurance policy (or policies), or other evidence thereof satisfactory to NASA, within a reasonable time before the Firm Launch Date.

5. a. Under section 308 of the National Aeronautics and Space Act of 1958, as amended by Public Law 96-48, for purposes solely of Subparagraph B.I above, if NASA determines that it is not feasible for Fairchild to obtain adequate insurance, or if NASA determines that Fairchild is unable to obtain adequate insurance, NASA may provide Fairchild insurance and/or indemnification for a reasonable fee to be agreed upon by Fairchild and NASA.

b. Under Section 308, NASA agrees to indemnify Fairchild, at no additional cost, for liability incurred by Fairchild solely under subparagraph B.I above, but only to the extent it is in
excess of the maximum dollar limitation on insurance coverage stated in the insurance policy purchased by or provided to Fairchild. However, if a standard exclusion agreed to by NASA pursuant to subparagraph B.4 (iii) and B.4 (iv) above is applicable to the claim, NASA agrees to indemnify Fairchild at no additional costs, for the liability incurred by Fairchild solely under subparagraph B.1 above. For purposes of this subparagraph B.5.b, "Liability" shall not include payments made by Fairchild:

(1) which are within the deductible amounts of Fairchild's insurance policy, or

(2) which are not covered by insurance because of a limitation or exclusion in the insurance policy, except for (i) the maximum dollar limitation on coverage stated in the insurance policy, or (ii) a standard exclusion agreed to by NASA pursuant to subparagraphs B.4 (iii) and B.4 (iv) above, or

(3) to Fairchild's contractor or subcontractor for liability incurred by that contractor or subcontractor, or

(4) as settlement payments, unless such payments are agreed to by the United States Government.

c. (1) No payment shall be made by the United States Government under this Subparagraph B.5 unless the NASA Administrator's designee certifies that the amount is just and reasonable.

d. Fairchild shall (i) promptly notify the General Counsel of NASA of any claims or suit against Fairchild for the death, bodily injury, or loss of or damage to property which reasonably may be expected to involve indemnification under this Subparagraph B.5, (ii) furnish evidence or proof of any
claim, suit or damage covered by this Subparagraph 8.5 in the manner and form required by the United States Government, and (iii) immediately furnish to the United States Government copies of all pertinent papers to such claim or suit received by Fairchild.

e. The United States Government, at its election, may control or assist in the settlement or defense of any such claim or suit. The United States Government may discharge its obligation under this Subparagraph 8.5 by making payments to Fairchild or directly to persons to whom Fairchild may be liable.

C. Damage to Persons or Property Involved in STS Operations

1. For purposes of this paragraph C., the following definitions shall be applicable:

a. "STS Operations" shall mean:

(1) All Space Transportation System activity;
(2) All payload activity;
(3) All tangible personal property (including ground support, test, training and simulation equipment) related to (1) and (2) above;
(4) Research, design, development, test, manufacture, assembly, integration, transportation, or use of any materials related to (1), (2) or (3) above.
(5) Performance of any services related to (1) through (4) above.

b. "Protected STS Operations" shall mean a period of time during which STS Operations are being performed as follows:

(1) Beginning with the signature of an Agreement or Arrangement with NASA for Space Transportation System services and (a) when any employee, payload or property arrives at a United States Government Installation, or (b) during transportation
of such to the installation by a United States Government conveyance or (c) at ingress of such into an Orbiter, for the purpose of fulfilling such Agreement or Arrangement, whichever occurs first.

(2) Ending with regard to any employee when the employee departs
(a) a United States Government Installation, or (b) the Orbiter if it lands at other than such Installation, or (c) a United States Government conveyance which transports the employee from such Installation or Orbiter, whichever occurs last.

(3) Ending with regard to a payload or property, not jettisoned or deployed, under the same conditions as set forth in subparagraph C.1.(b.) above.

(4) Ending with whichever occurs last with regard to a deployed or jettisoned payload or property (a) after such impacts the Earth; or (b) if retrieved by the Orbiter, under the same conditions set forth in subparagraph C.1.b.(2) above.

2. NASA and Fairchild (the parties) will respectively utilize their property and employees in STS Operations in close proximity to one another and to others. Furthermore, the parties recognize that all participants in STS Operations are engaged in the common goal of meaningful exploration, exploitation and uses of outer space. In furtherance of this goal, the parties hereto agree to a no-fault, no-subrogation, inter-party waiver of liability pursuant to which each party agrees not to bring a claim against or sue the other party or other customers and agrees to absorb the financial and any other consequences for Damage it incurs to its own property and employees as a result of participation in STS Operations during Protected STS Operations, irrespective of whether such Damage is caused by NASA, Fairchild, or other customers participating in STS Operations, and regardless of whether such Damage arises through negligence or otherwise. Thus,
the parties, by absorbing the consequences of damage to their property and employees without recourse against each other or other customers participating in STS Operations during Protected STS Operations, jointly contribute to the common goal of meaningful exploration of outer space.

3. The parties agree that this common goal will also be advanced through extension of the inter-party waiver of liability to other participants in STS Operations. Accordingly, the parties agree to extend the waiver as set forth in subparagraph C.2 above to contractors and subcontractors at every tier of the parties and other customers, as third party beneficiaries, whether or not such contractors or subcontractors causing damage bring property or employees to a United States Government installation or retain title to or other interest in property provided by them to be used, or otherwise involved, in STS Operations. Specifically, the parties intend to protect these contractors and subcontractors from claims, including "products liability" claims, which might otherwise be pursued by the parties, or the contractors or subcontractors of the parties, or other customers or the contractors or subcontractors of other customers. Moreover, it is the intent of the parties that each will take all necessary and reasonable steps in accordance with subparagraph C.4 below to foreclose claims for Damage by any participant in STS Operations during Protected STS Operations, under the same conditions and to the same extent as set forth in subparagraph C.2 above, except for claims between Fairchild and its contractors or subcontractors and claims between the United States Government and its contractors and subcontractors.

4. The parties intend that the inter-party waiver of liability set forth in subparagraph C.2 and C.3 above be broadly construed to achieve the intended objectives.

5. NASA will require all Space Transportation System customers entering into Launch and Associated Services Agreements with NASA
after December 1, 1982, to agree to the inter-party waiver of liability as set forth in subparagraphs C.2 and C.3 above. Fairchild, and each other customer, will require the following to agree to the waiver of liability set forth in subparagraph C.3 above: (a) all persons and entities to whom it assigns all or part of its right to Launch and Associated Services; (b) any person or entity to whom it has sold or leased or otherwise agreed, prior to the completion of NASA's launch services for a particular Payload, to provide all or any portion of its Payload or Payload services; (c) all its prime contractors; and (d) all its subcontractors who will have persons or property involved in STS Operations during Protected STS Operations. NASA will require all the following to agree to the waiver of liability set forth in subparagraph 3.c above: (a) all its prime contractors; and (b) all its subcontractors who will have persons or property involved in STS Operations during Protected STS Operations. Furthermore, NASA has required all STS customers entering into Launch and Associated Services Agreements prior to December 1, 1982, to agree to a more limited waiver of liability, a copy of which is available from NASA upon request. Failure of any party or contractor or subcontractor to obtain a waiver agreement required above shall not affect such party's or contractor's or subcontractor's right to the protection otherwise provided by this paragraph C.

D. **Fairchild Claims Against the United States Government and Its Contractors**

Without affecting the right of Fairchild to pursue the procedure under the Disputes provision set forth in Article XXVII of this Agreement, Fairchild shall not make any claim against the United States Government or the United States Government's contractors and subcontractors for Damage or other relief for any delay (including a Deferral, Delay, Suspension or Postponement) in the provision of any Launch and Associated Services or for the non-performance or improper performance of Launch and Associated Services, including, but not limited to, the performance of the United States Government or the United States Government's contractors and
subcontractors of research, design, development, test, manufacture, assembly, integration, transportation or use of any materials related to STS Operations or in the performance of other services related to STS Operations, except that Fairchild may make a claim for such costs or liquidated damages that may be payable as expressly provided for in the contracts entered into by the United States Government and its contractors and subcontractors for services performed for Fairchild. Except to the extent Fairchild is compensated by insurance or otherwise for Damage, this Paragraph D shall not prevent a claim from being brought by Fairchild (i) against the United States Government or its contractors and subcontractors if Fairchild suffers Damage caused by failure of the United States Government or its contractors and subcontractors to fulfill their obligation to incorporate Paragraph C above, or its equivalent, in an Agreement, Arrangement or Contract, as provided for in Paragraph C above, or (ii) against the United States Government if Fairchild suffers Damage caused by failure of the United States Government or its contractors and subcontractors to fulfill their obligation to protect Fairchild data as specified in Article XII of this Agreement.

E. Limitation of United States Government and Fairchild Liability

Notwithstanding Subparagraph A.2.b above, to the extent that a risk of damage is not dealt with expressly in this Agreement, the United States Government's liability to Fairchild and Fairchild's liability to the United States Government arising out of this Agreement, whether or not arising as a result of an alleged breach of this Agreement, shall be limited to direct damages only and shall not include any loss or revenue, profits or other indirect or consequential damages.

F. Damage to the Payload or Associated Property

The United States Government shall not be responsible for damage to the Payload or associated property of Fairchild, any party in privity therewith, Fairchild's users, or their contractors or subcontractors, which property is provided pursuant to this Joint Endeavor. Fairchild
agrees to indemnify the United States Government for any liability incurred by the United States Government as a result of such damage.

G. Product Liability

Fairchild agrees to indemnify the Government for any costs incurred by the Government as a result of damage caused by a process, material, service or other product of a Leasecraft payload, which may arise out of this Agreement.
This agreement may be modified, in whole or in part, by mutual agreement between the parties. Only the signatories of this agreement or their designees shall have the authority to execute any such amendments to this Agreement.
ARTICLE XXVI - APPLICABLE LAW

Fairchild Industries, Germantown, Maryland, and the National Aeronautics and Space Administration (NASA) hereby designate the United States Federal Law to govern this Agreement for all purposes, including but not limited to determining the validity of this Agreement, the meaning of its provisions and the rights, obligations and remedies of the parties.
ARTICLE XXVII - DISPUTES

A. Any dispute arising under this Agreement which is not disposed of by agreement of the two JEMs shall be submitted jointly to the signatories of this Agreement. A joint decision of the signatories or their designees shall be the disposition of such dispute.

B. With respect solely to claims that may be made against NASA or its contractors or subcontractors, pursuant to subparagraph D. of Article XXIV, if within a reasonable period of time (120 days) after submission of a dispute for resolution the signatories of this agreement are unable to jointly resolve a dispute, the dispute will be considered to have become a "claim" within the meaning of the "Contract Disputes Act of 1978" (P.L. 95-563); and the parties agree to be bound by the provisions thereof. In this regard, the parties expressly recognize the opportunity for such claims to be pursued either before the NASA Board of Contract Appeals or the United States Court of Claims, at the election of Fairchild.

C. Pending the resolution of any dispute or claim pursuant to this ARTICLE XXVII, the parties agree that performance of all obligations shall be pursued diligently in accordance with the direction of the NASA signatory.
ARTICLE XXVIII - NOTICES

Any notice to be given hereunder shall be in writing and shall be sent by registered or certified mail, postage prepaid, to the parties at the following addresses or at such addresses as the respective parties may from time to time designate in writing:

National Aeronautics and Space Administration
Attention: Administrator
Washington, D. C. 20546

Fairchild Industries, Inc.
Attention: Chairman and Chief Executive Officer
Germantown, MD 20874
FAIRCHILD LEASECRAFT GENERAL DESCRIPTION

This section presents a brief description of the standard Farichild Leasecraft (FLC) spacecraft. The vehicle as shown in Figure A-1 is made up of the following items.

1. Spacecraft structure with interfaces for payload and at least 8 modules of the Multi-mission Modular spacecraft type

2. Up to 5 Power Modules (MPS)

3. 1 - Communications & Data Handling Module (C&DH)

4. 1 - Modular Attitude Control System (MACS)

5. 1 - Special Function Module

6. 1 - TDRSS Antenna Assembly

7. 1 - Payload Module

Four of the MPS modules can be replaced with Payload Modules. The structure internally supports a propulsion module based on the Mark II, 4-tank hydrazine propulsion system. FLC also has a modularized solar array which can be incrementally deployed. The solar array is sized at 1320 ft² in a symmetric deployment about the roll axis. At least one panel of the array can be double-gimballed to support earth-pointing or inertial-reference missions.

A summary of the FLC functional requirements is presented in Figure 2. The general performance requirements are summarized in Figure A-3. The system electrical block diagram is shown in Figure A-4.
Some of the key operational features of the Leasecraft system are shown in Figure A-5, while Figure A-6 summarizes some of its unique cost-saving and service features.

Leasecraft, without payload is approximately 15 feet long, 15 feet wide and 14.5 feet high and weighs 20,000 pounds loaded.
FAIRCHILD LEASECRAFT CONCEPTUAL DESIGN

PRIMARY PAYLOAD MOUNTING SURFACE (93 x 138 INCHES)

UNDEPLOYED SOLAR ARRAY

STRUCTURE

PROPULSION MODULE (INTERIOR)

SECONDARY PAYLOAD LOCATIONS: UP TO 4 MMS MODULE BOXES (OR EQUIVALENT FOOTPRINTS) AVAILABLE FOR SECONDARY PAYLOADS

TDRSS ANTENNA

Figure A-1. Fairchild Leasecraft Space Vehicle
• UP TO 7,300 WATTS OF ELECTRICAL POWER IN FIVE INCREMENTS
• TWO-WAY TRANSFER 20,000 LBS. TO 360 N. MILES; 4,000 LBS. TO 600 N.
  MILES
• TDRSS, STDN OR SGLS COMPATIBLE COMMUNICATION LINKS
• ATTITUDE ERROR < .01° WITH ATTITUDE RATE < .002°/SEC
• AUTONOMOUS OPERATION
• DUAL REDUNDANT (NO SINGLE POINT FAILURES)
• CAPABLE OF BEING LAUNCHED & RETRIEVED BY STS
• DIRECT SPACEFRAME ATTACHMENT TO STS LONGERON & KEEL
  FITTINGS
• UTILIZE STANDARD MMS MODULES
• ALL MODULES & MAJOR SUB-ASSEMBLIES EXCHANGEABLE IN SPACE
  ENVIRONMENT
• LEASECRAFT MATED TO PAYLOAD IN ORBIT
• MATING, DEPLOYMENT, RETRIEVAL & CHANGEOUT TIMELINE’S
  MINIMIZED
• MAXIMUM USE OF RMS FOR SERVICE OPERATIONS

Figure A-2. Leasecraft Functional Requirements
PAYLOAD WEIGHT CAPABILITY

- Primary payload up to 14,500 kg (32,000 lbs)
- Secondary payloads: up to 1,000 kg (2,200 lbs)

APPROXIMATE TYPES OF MISSIONS

- Stellar, solar, Earth pointed, or special purpose missions
- Low Earth orbits, inertial pointed, or payload pointed

OPERATING ORBITAL ALTITUDE

- Low Earth orbits, all inclinations ≥ 28.5 deg

LIFE EXPECTANCY/REDUNDANCY

- All critical elements redundant, all subsystems replaceable
- In orbit no single point failure to prevent resupply or retrieval by Shuttle

LAUNCH VEHICLE

- Space Shuttle for launch, service, and retrieval

COMMUNICATIONS AND DATA HANDLING SUBSYSTEM

- Transponder 5-band STDN/TDRSS, transponder output power at module interface 0.8, 2.0, 4.0 watts, selectable at manufacture
- Command rates 2 KBPS (Shuttle/STDN). 125 and 1 KBPS selectable (TDRSS)
- Real-time telemetry rates 1, 2, 4, 8, 16, 32, 64 KBPS
- Telemetry formats 2 selectable prior to launch, plus in-orbit programmable capability. All formats contain 890 data word maximum
- Stored data dump/mission data source 2.048 MBPS maximum. 1.024 MBPS coded data up to 100 MBPS in optional wideband data module
- On-board computer 18 bits per word 32K words of memory. Baseline expandable to 64K words 5 microsecond add time
- Data storage 10^8 or 10^9 bit tape recorders

ATTITUDE CONTROL SYSTEMS

- Type 3-axis stabilized, zero momentum
- Attitude reference (without payload sensor) Stellar (Inertial)
- Pointing error (one sigma) without payload sensor < 10^-2 deg
- With payload sensor (ideal) < 10^-4 deg
- Pointing stability (one sigma) average rate < 10^-4 deg/sec
- Jitter without payload sensor < 6 x 10^-4 deg (20 minute period)
- With payload sensor (ideal) < 10^-6 deg
- Slew rate Maximum 1.6°/sec with standard inertial reference unit

POWER SUBSYSTEM (BASELINE - 1 MODULE - UP TO 5 MODULES AVAILABLE)

- Voltage output 28 ± 7 VDC
- Power to payloads (max) 1,000, 2,600, 4,200, 5,700, 7,300 watts (1 - 5 power modules)
- Batteries Two 20-ampere-hour batteries to three 60-ampere-hour batteries per power module

MK II 4-TANK HYDRAZINE SYSTEM CAPABLE OF CARRYING 2700 kg (6000 LBS) 4-445N (100 LB) ORBIT ADJUST THRUSTERS. 12-22.2N (5 LB) RCS THRUSTERS

PROPULSION SYSTEM

MK II 4-TANK HYDRAZINE SYSTEM CAPABLE OF CARRYING 2700 kg (6000 LBS) 4-445N (100 LB) ORBIT ADJUST THRUSTERS. 12-22.2N (5 LB) RCS THRUSTERS

Figure A-3. Leasecraft Performance Summary
NOTE: REDUNDANCY IS NOT SHOWN IN THIS DIAGRAM

Figure A-4. Fairchild Leascraft System Block Diagram
• DESIGNED FOR SHUTTLE TENDING

• SPACECRAFT PERMANENTLY IN ORBIT - RETURNS TO SHUTTLE FOR SERVICING & PAYLOAD CHANGEOUTS; AVOIDS ADDED LAUNCH COSTS

• USES ALREADY-DEVELOPED SHUTTLE SERVICING TECHNIQUES AND HARDWARE; TO BE PROVEN ON SMM REPAIR MISSION

• SYSTEM INCLUDES:
  - SPACECRAFT CONTROL SEGMENT
  - DATA OR PRODUCT TRANSFER TO USER
  - PAYLOAD HANDLING AT CAPE & IN ORBIT
  - OPTIONAL SERVICES, HARDWARE, SOFTWARE FOR SPECIAL USES
  - COMPANY-EMPLOYED MISSION-SPECIALIST CREW

• APPLICABLE TO MAJOR PAYLOADS; DEDICATED FLIGHTS AND TO MULTIPLE-PAYLOADS; SHARED FLIGHTS

Figure A-5. Leasecraft System - Key Features
LOW COST
• COMMERCIALLY PRODUCED HARDWARE AND SERVICES
• MINIMUM COST THROUGH ON-GOING PRODUCTION OF STANDARD SPACECRAFT ELEMENTS
• PAYLOAD CHANGEOUT AND REPAIR ON ORBIT
• MOBILITY TO AND FROM SHUTTLE PARKING ORBIT

SERVICES
• GUARANTEED SERVICES PAID FOR AS THE CUSTOMER RECEIVES IT
• COMPLETE "PORTAL TO PORTAL" SERVICE

CAPABILITIES
• HIGH POWER, HEAVY PAYLOAD, FINE POINTING
• CONVERTIBLE CONFIGURATIONS ON GROUND OR IN SPACE

Figure A-6. Unique Features of the Leasecraft Concept
Figure A-1. Fairchild Leasecraft Space Vehicle
• Up to 6,600 watts of electrical power in 1650W increments
• Two-way transfer 20,000 lbs. to 360 n. miles; 4,000 lbs. to 600 n. miles
• TDRSS, STDN or SGLS compatible communication links
• Attitude error < .01° with attitude rate < .002°/sec
• Autonomous operation
• Dual redundant (no single point failures)
• Capable of being launched & retrieved by STS
• Cost-effective utilization of STS cargo bay (1,100 lb./ft.)
• Direct spaceframe attachment to STS longeron & keel fittings
• Utilize standard MMS modules
• All modules & major sub-assemblies exchangeable in space environment
• Leasecraft mated to payload in orbit
• Matimg, deployment, retrieval & changeout timeline's minimized
• Maximum use of RMS for service operations

Figure A-2. Leasecraft Functional Requirements
PAYLOAD WEIGHT CAPABILITY

PRIMARY PAYLOAD: UP TO 14,500 kg (32,000 LBS.)
SECONDARY PAYLOADS: UP TO MMS MODULE CAPABILITY

TYPES OF MISSIONS

STEellar,Solar,Earth pointed, or special purpose missions. Low Earth orbits. Inertial pointed or payload pointed.

OPERATING ORBITAL ALTITUDE

LOW Earth orbits, all inclinations.

LIFE EXPECTANCY/REDUNDANCY

ALL CRITICAL ELEMENTS REDUNDANT; REPLACEABLE IN ORBIT.
NO SINGLE POINT FAILURE TO PREVENT RESUPPLY OR RETRIEVAL BY SHUTTLE WITHIN 6 MONTHS.
FULLY SHUTTLE COMPATIBLE FOR LAUNCH, SERVICE, AND RETRIEVAL.

LAUNCH VEHICLE

COMMUNICATIONS AND DATA HANDLING SUBSYSTEM

TRANSPONDER

5-BAND STDN/DRRSS, TRANSPONDER OUTPUT POWER AT MODULE INTERFACE 0.8, 2.0, 4.0 WATTS, SELECTABLE AT MANUFACTURE.

COMMAND RATES

2 KBPS (SHUTTLE/STDN). 125 AND 1 KBPS SELECTABLE (TDRSS).

REAL-TIME TELEMETRY RATES

1, 2, 4, 8, 16, 32, 64 KBPS.

TELEMETRY FORMATS

2 SELECTABLE PRIOR TO LAUNCH. PLUS IN-ORBIT PROGRAMMABLE CAPABILITY: ALL FORMATS CONTAIN 890 DATA WORD MAXIMUm.

STORED DATA DUMP/MISSION DATA SOURCE

2.048 MBPS MAXIMUM. 1.024 MBPS CODED DATA. UP TO 80 MBPS IN OPTIONAL WIDEBAND DATA MODULE.

ON-BOARD COMPUTER

18 BITS PER WORD. 32K WORDS OF MEMORY. BASELINE EXPANDABLE TO 64K WORDS. 5 MICROSECOND ADD TIME.

DATA STORAGE

STANDARD OPTION OF 10^5 AND 10^6 BIT TAPE RECORDERS.

ATTITUDE CONTROL SYSTEMS

TYPE

3-AXIS STABILIZED, ZERO MOMENTUM

ATTITUDE REFERENCE (WITHOUT PAYLOAD SENSOR)

STEellar (INERTIAL)

< 10^-2 Deg.
< 10^-5 Deg.
< 10^-6 Deg./Sec.
< 6 x 10^-4 Deg. (20 MINUTE PERIOD)
< 10^-6 Deg.

MAXIMUM 1.6°/SEC WITH STANDARD INERTIAL REFERENCE UNIT

POWER SUBSYSTEM (BASELINE - 1 MODULE - UP TO 3 MODULES AVAILABLE)

VOLTAGE OUTPUT

+28 ± 7 VDC COARSeLY REGULATED

1650 WATTS AVERAGE (1250W AVAILABLE TO USER). UP TO 6600 WATTS

POWER OUTPUT

TWO 20-AMPERE-HOUR BATTERIES AS BASELINE. UP TO THREE 50-AMPERE-HOUR BATTERIES MAXIMUM.

BATTERIES

MK II 4-TANK HYDRAZINE SYSTEM CAPABLE OF CARRYING 2700 kg (6000 LBS)
4-445N (100 LB.) ORBIT ADJUST THRUSTERS. 12-22.2N (5 LB.) RCS THRUSTERS.

PROPULSION SYSTEM

Figure A-3. Leascraft Performance Requirements
Note: Redundancy is not shown in this diagram.

Figure A-4. Fairchild Leasecraft System Block Diagram
• DESIGNED FOR SHUTTLE TENDING

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• USES ALREADY-DEVELOPED SHUTTLE SERVICING TECHNIQUES AND HARDWARE; TO BE PROVEN ON SMM REPAIR MISSION

• SYSTEM INCLUDES:
  - SPACECRAFT CONTROL SEGMENT
  - DATA OR PRODUCT TRANSFER TO USER
  - PAYLOAD HANDLING AT CAPE & IN ORBIT
  - OPTIONAL SERVICES, HARDWARE, SOFTWARE FOR SPECIAL USES
  - COMPANY-EMPLOYED PAYLOAD-SPECIALIST CREW

• APPLICABLE TO MAJOR PAYLOADS; DEDICATED FLIGHTS AND TO MULTIPLE-PAYLOADS; SHARED FLIGHTS

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• CONVERTIBLE CONFIGURATIONS ON GROUND OR
  IN SPACE

Figure A-6. Unique Features of the Leasercraft Concept
APPENDIX 4

LEASECRAFT MISSION SCENARIO
An operational Leasecraft retracts its solar array as it descends and maneuvers toward the shuttle. The Remote Manipulator System (RMS) arm locks on to the platform.

Once a Leasecraft satellite is locked in the shuttle bay, the RMS removes the payload/experiment, stows it, and replaces it with a new unit.

Prior to re-deployment, the platform and the new payload undergo interface verification. When it is fully checked out, the RMS arm releases the platform, which returns to its orbit.

The shuttle returns to Earth after completing its mission, with the payload materials and equipment safely berthed aboard.
APPENDIX 5

SELECT CITATIONS AND ABSTRACTS

To compliment the preceding study, the Center has compiled a collection of database abstracts dealing with various aspects of space commercialization. The following abstracts were reprinted with the permission of the copyright owners. Each section is preceded by a cover sheet detailing copyright restrictions on the material. Reproduction of this material is prohibited without the express written authorization of the copyright owner.
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- STAR: Scientific and Technical Aerospace Reports
  Published by NASA's Scientific and Technical Information Branch.

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New York, NY 10019
212-582-4901 or 247-6500
Satellite leasing - Cheap access to space

MAHAN, R. (RCA, Astro-Electronics Div., Princeton, NJ)
Publication Date: Feb. 1986
Language: English
Country of Origin: United States
Country of Publication: United Kingdom
Document Type: JOURNAL ARTICLE

The role of satellite leasing arrangements in marketing commercial ventures in space is considered. The most recent examples of leased space platforms are described, including Leasat: ESA’s EURECA; Omnistar; and Leasecraft. It is shown that because of NASA Shuttle pricing policies, leasing room for commercial payloads on board space platforms will become an increasingly attractive way of financing space ventures in which capital investments are often at risk. The development of the first large-scale commercial space platform for the Electrophoresis in Space (EDS) program is also discussed. (I.H.)

Source of Abstract/Subfile: AIAA/TIS
Descriptors: *LEASING; *SPACE COMMERCIALIZATION; *SPACE PLATFORMS; *SPACE PROCESSING; MARKETING; SPACE TRANSPORTATION SYSTEM

The importance of microgravity environment in material processing in space (MPS) is discussed. The features that make microgravity useful for MPS, which are the reduction of buoyancy-driven convection, containerless processing, and the elimination of sedimentation, are described. A comparison of the operating characteristics of the Space Shuttle, Space Station, EURECA, and Leasecraft microgravity support systems is provided. The calculation of the proper MPS spacecraft geometry which minimizes microgravity contamination is described, and microgravity acceleration values for the spacecraft studied are given. The effect of atmospheric drag and crew operations on the quality of microgravity is investigated. An example revealing the importance of the proper microgravity environment is presented. (I.F.)

Source of Abstract/Subfile: AIAA/TIS

Descriptors: *EARTH ORBITAL ENVIRONMENTS; *MICROGRAVITY APPLICATIONS; *SPACE PROCESSING; *SPACE STATIONS; AERODYNAMIC FORCES; CONTAINERLESS MELTS; CORIOLIS EFFECT; MATERIALS SCIENCE; SOLAR WIND

Subject Classification: 7512 .Astronautics-General (1975-)

Leasecraft power system

CHETTY, P. R. K. (Fairchild Space Co., Germantown, MD)
Publication Date: May 1985
Language: English
Country of Origin: United States
Country of Publication: United States
Document Type: JOURNAL ARTICLE

A detailed description is presented of the power system of Leasecraft, a satellite platform for low earth orbit missions to facilitate commercial development of space. Typical spacecraft power systems are first briefly reviewed, and the results of tradeoff studies are reported which led to the selection of a decentralized regulation concept utilizing a nondissipative unregulated main bus approach to the Leasecraft power system. The need for modularity is addressed, and the modular power system is addressed, including the power regulator unit, power control unit, bus protection assembly, signal conditioning assembly, storage batteries, remote interface unit, and heaters. (C.D.)

Source of Abstract/Subfile: AIAA/TIS
Descriptors: *COMMERCIAL SPACECRAFT; *POWER CONDITIONING; *SATELLITE DESIGN; *SOLAR ARRAYS; *SPACE PLATFORMS; *SPACECRAFT POWER SUPPLIES; BUS CONDUCTORS; POWER CONVERTERS; POWER EFFICIENCY; SPACECRAFT MODULES; TRADEOFFS

Subject Classification: 7520 .Astronautics--General (1975-)

Leasecraft - A commercial space platform

BUNNEMANN, O. R. (Fairchild Space Co., Germantown, MD)
Publication Date: 1984
Language: English
Country of Origin: United States
Country of Publication: United States
Document Type: CONFERENCE PAPER
NASA program concerned with the identification of new approaches to spacecraft design. A mandatory requirement regarding the MMS was flexibility to accommodate a wide variety of payloads. MMS derived subsystems will provide a platform in low orbit for scientific, commercial, and government users on a leased or service contract basis. The payload may consist of scientific instruments, material processing equipment, or remote sensors. Secondary payloads may be mounted in standard MMS module boxes. The platform forms a part of the 'Leasecraft' system, which was developed by an American aerospace company. Attention is given to the Leasecraft vehicle, details regarding the Leasecraft platform, and payload accommodations and Leasecraft missions. (G.R.)

Source of Abstract/Subfile: AIAA/TIS
Descriptors: •COMMERCIAL SPACECRAFT; •LEASING; •MULTIMISSION MODULAR SPACECRAFT; •PAYLOADS; •SPACE COMMERCIALIZATION; •SPACE PLATFORMS; •ATTITUDE CONTROL; •EARTH ORBITS; •NASA PROGRAMS; •REMOTE SENSORS; •SOLAR MAXIMUM MISSION
Subject Classification: 7515 :Launch Vehicles & Space Vehicles (1975-)

The economics of mapping with space data
DOLGE, F. J. (U.S. Geological Survey, Reston, VA)
Publication Date: 1984
Language: English
Country of Origin: United States
Country of Publication: Netherlands

Document Type: JOURNAL ARTICLE
Most documents available from AIAA Technical Library
Journal Announcement: IAA8414

The Leasecraft system has been developed by an American aerospace company with the objective to further the industrialization of space with its significant business potential. This system comprises a low orbit space platform, an operation control center, user accommodations, and services such as payload interfaces, documentation, and ground support equipment and procedures. Potential applications of Leasecraft considered are related to the processing of pharmaceuticals and materials, satellite-aided search and rescue, data collection, and support of NASA's astrophysics programs. The Leasecraft space vehicle will accommodate up to five secondary payloads, including a communications and data handling module, a modular attitude control subsystem, a special function module, two alternative solar array assemblies, a tracking and data relay satellite system antenna assembly, a propulsion module, and optional primary and secondary payload modules. (G.R.)

Source of Abstract/Subfile: AIAA/TIS
Descriptors: •COMMERCIAL SPACECRAFT; •SPACE COMMERCIALIZATION; •SPACE PLATFORMS; •SPACECRAFT DESIGN; •EARTH ORBITS; •NASA PROGRAMS; •REMOTE SENSORS; •SOLAR MAXIMUM MISSION
Subject Classification: 7515 :Launch Vehicles & Space Vehicles (1975-)

Remote manipulators in space
MATTHEWS, P. S.; HILL, B. R. (Spar Aerospace, Ltd., Remote Manipulator Systems Div., Toronto, Canada); WAGNER-BARTAK, C. G.
Publication Date: 1983
Language: English

Subject Classification: 7515 :Launch Vehicles & Space Vehicles (1975-)

1284836 A84-22336
Remote manipulators in space
MATTHEWS, P. S.; HILL, B. R. (Spar Aerospace, Ltd., Remote Manipulator Systems Div., Toronto, Canada); WAGNER-BARTAK, C. G.
Publication Date: 1983
Language: English
The role of manipulators in space and the major design challenges of the current Remote Manipulator System (RMS) are treated. The RMS, operated by both man-in-the-loop and preprogrammed control, manipulates a maximum 30,000 kg payload, 18.3 m in length and 4.5 m in diameter. End point accuracy is in the order of + or - 5 cm and + or - 1 deg when automatically controlled and better than + or - 1/2 cm when operator controlled. RMS functions discussed include the future deployment of on-orbit, Shuttle tended platforms such as Eureca and Leasecraft, where robotic technology will exploit the constant microgravity environment for manufacturing processes. In the future, control systems will only be provided with tasks; manipulators will effect obstacle-avoiding, automatic interfacing of tools and spacecraft with fully sensoric hands that include force and visual/proximity sensing. (C.M.)

Source of Abstract/Subfile: AIAA/TIS

Descriptors: MANIPULATORS; REMOTE MANIPULATOR SYSTEM; ROBOTICS; SPACE MANUFACTURING; SPACE TRANSPORTATION SYSTEM; SYSTEMS ENGINEERING; TOOLS

Subject Classification: 7516 SPACE TRANSPORTATION (1975-)

1284835 A84-22335

The Fairchild Leasecraft - A low orbit satellite manufacturing facility

RAAB, B.; DESKOVITCH, J.; BRODSKY, N. T. (Fairchild Space Co., Germantown, MD)


Publication Date: 1983

Language: English


Document Type: CONFERENCE PAPER

Most documents available from AIAA Technical Library

While using the standard modules of the NASA Multi-Mission Modular Spacecraft, the Leasecraft extends the on-orbit service and module-exchange capability to all of the major subsystems of the spacecraft and to the payload as well. Besides this, a relatively large integral liquid propulsion system is included in order to enhance the spacecraft's mobility. The on-board inertial guidance and computer systems will be used by the propulsion system to effect orbit modification and the principal rendezvous maneuvers. It is pointed out that a multiplex command and data bus simplifies the accommodation of different payloads through a set of standard mechanical and electrical connectors and remote interface units. As designed, the platform can provide as much as seven kilowatts of power for materials-processing or other uses in a high-power configuration. Also available is a low-power version for scientific and remote sensing missions. (C.R.)

Source of Abstract/Subfile: AIAA/TIS

Descriptors: MULTIMISSION MODULAR SPACECRAFT; SPACE COMMERCIALIZATION; SPACE MANUFACTURING; SPACE TRANSPORTATION SYSTEM; SATELLITE ANTENNAS; SPACE PLATFORMS; SPACE SHUTTLE PAYLOADS; SPACECRAFT CONFIGURATIONS; SPACECRAFT MODULES

Subject Classification: 7512 Astronautics-General (1975-)

1274273 A84-11773

The Fairchild Leasecraft system - A commercially-operated platform for science and business in space

RAAB, B. (Fairchild Space Co., Germantown, MD)


Publication Date: Oct. 1983

Report No.: IAF PAPER 83-232

Language: English


Document Type: PREPRINT

Most documents available from AIAA Technical Library

Design features and mission profiles for the Leasecraft free-flying platforms are described. The Leasecraft would use multimission modular spacecraft (MMS) configured for launch by the Shuttle, transfer to 28.5 deg polar sunsynchronous inclination orbits, and return for later retrieval with the RMS arm, changeout of the payload, and return to the sunsynchronous orbit. The Leasecraft would have two optional solar power panels, an attitude control subsystem, a special function module, and a TDRSS antenna, as well as a propulsion subsystem that would also be refueled during Orbiter rendezvous. Payloads would be categorized as primary or secondary, with the former claiming priority on the spacecraft attitude, mission modes, and revisit intervals. An example of a primary mission would be the Advanced X-ray Astrophysics Facility, while secondary payloads could include materials processing experiments and search and rescue transponders. Primary services are expected to cost $2.4 million/month, while secondary services run $0.5-1 million/month. (M.S.K.)

Source of Abstract/Subfile: AIAA/TIS

Descriptors: SPACE PLATFORMS; SPACE SHUTTLE PAYLOADS; SPACE TRANSPORTATION SYSTEM; DATA ACQUISITION; SPACE PROCESSING; SPACECRAFT CONFIGURATIONS; SPACECRAFT MODULES; TDR SATELLITES

Subject Classification: 7515 Launch Vehicles & Space Vehicles (1975-)

1274274 A84-13342

The Fairchild Leasecraft - A low orbit satellite manufacturing facility

RAAB, B. (Fairchild Space Co., Germantown, MD)


Publication Date: 1983

Language: English


Document Type: PREPRINT

Most documents available from AIAA Technical Library

A comparative study is made of four methods of manufacturing spacecraft components in space. The Leasecraft is based on the Eureca spacecraft, and enhances the onboard manufacturing capability. Options include a medium capacity actuated manipulator system, a high capacity manipulator system, and a remote manipulator system, each with different payloads and applications. A system is outlined to allow both on-orbit and on-ground testing. (C.R.)
"Page missing from available version"

Pgs. 79 - 83
NASA centers will stimulate Industry R & D

DOOLING, D. (Essex Corp., Huntsville, AL)

Commercial Space (ISSN 8756-4831), vol. 1, Fall 1985, p. 95-98

Publication Date: 1985
Language: English

Document Type: JOURNAL ARTICLE

Most documents available from AIAA Technical Library
Journal Announcement: IAA8609

Four prototype centers supported by NASA in order to stimulate research and development, and encourage individual investment in space are described. The crystallography program of the Center for Macromolecular Crystallization is examined; the center will grow the crystals in space and analyze the usefulness of the products. The benefits and problems of these protein experiments are investigated. The Consortium for Materials Development is to study the applications of physical chemistry and material transport through fluids in space. The processes by which metals, alloys, ceramics, and glasses are formed will be analyzed by the Center for Space Processing of Engineering Materials in order to improve production on earth.

The interpretation and commercialization of Landsat data is conducted at the Space Remote Sensing Center. The production of materials which will be easily commercialized, such as piezoelectric transducers and glass microspheres, is the objective of the Multi-Phase Materials Center. (I.F.)

Source of Abstract/Subfile: AIAA/TIS
Descriptors: "REMOTE SENSING; "RESEARCH AND DEVELOPMENT; "SPACE COMMERCIALIZATION; "SPACE PROCESSING; "SPACEBORNE EXPERIMENTS; CONTRACTS; CRYSTAL GROWTH; LANDSAT SATELLITES; PROTEINS; SATELLITE IMAGERY

Subject Classification: 7581 .Administration & Management (1975-)

Space Industries is making plans with NASA for a space facility

EGAN, J. J. (Coopers and Lybrand, Space Consulting Div., Washington, DC)

Commercial Space (ISSN 8756-4831), vol. 1, Summer 1985, p. 62, 63, 65, 66

Publication Date: 1985
Language: English

Document Type: JOURNAL ARTICLE

Most documents available from AIAA Technical Library
Journal Announcement: IAA8609

The economic factors governing the development of space processing techniques are discussed. Emphasis is given to the potential benefits of new processes for zero-g production of pharmaceuticals, protein crystals, advanced metals, and semiconductor materials. It is shown that a vigorous joint effort by government and industry to lower the costs of launching and maintaining space-based materials processing platforms is required before the economic benefits of space processing can be accrued. A pie graph showing the costs of space-processed semiconductor chips is provided. (I.H.)

Source of Abstract/Subfile: AIAA/TIS
Descriptors: "ECONOMIC ANALYSIS; "SPACE COMMERCIALIZATION; "SPACE INDUSTRIALIZATION; "SPACE PROCESSING; "SPACECRAFT DESIGN; MEDICINE; ORGANIC MATERIALS; SEMICONDUCTORS (MATERIALS)

Subject Classification: 7583 .Economics & Cost Analysis (1975-)

Washington broadens its efforts to aid small business

MANN, P.

Commercial Space (ISSN 8756-4831), vol. 1, Summer 1985, p. 21, 24, 25.

Publication Date: 1985
Language: English

The development of a privately funded space facility as the basis of operation for commercial space projects is examined. The 35 foot long and 14.5 foot wide facility is to contain automatic material processing equipment, which will be periodically serviced by the Shuttle crew. The benefits of NASA's deferred payment agreement, which will allow the facility to be established with no payment required until revenue is generated by the project, are described. The building and assembly of the industrial space facility, and the design of the docking module are analyzed. Potential projects for the facility include: (1) the development of organic films that use light to carry information, (2) the manufacturing of semiconductor materials, and (3) a biological space medicines processing system. (I.F.)

Source of Abstract/Subfile: AIAA/TIS
Descriptors: "ECONOMIC ANALYSIS; "SPACE COMMERCIALIZATION; "SPACE INDUSTRIALIZATION; "SPACE PROCESSING; "SPACECRAFT DESIGN; MEDICINE; ORGANIC MATERIALS; SEMICONDUCTORS (MATERIALS)

Subject Classification: 7583 .Economics & Cost Analysis (1975-)

What's the payoff? Pluses and minuses of space processing (space processing)

Washington broadens its efforts to aid small business

MANN, P.

Commercial Space (ISSN 8756-4831), vol. 1, Summer 1985, p. 21, 24, 25.

Publication Date: 1985
Language: English

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Source of Abstract/Subfile: AIAA/TIS
Descriptors: "ECONOMIC ANALYSIS; "SPACE COMMERCIALIZATION; "SPACE INDUSTRIALIZATION; "SPACE PROCESSING; "SPACECRAFT DESIGN; MEDICINE; ORGANIC MATERIALS; SEMICONDUCTORS (MATERIALS)

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Subject Classification: 7583 .Economics & Cost Analysis (1975-)

Washington broadens its efforts to aid small business

MANN, P.
Document Type: JOURNAL ARTICLE
Most documents available from AIAA Technical Library

A general description of the Materials Processing In Space (MPS) program at NASA/ Marshall is given. The three main components of the MPS program are outlined, including: R&D to improve terrestrial processes; R&D leading to space production for later terrestrial sales; and technology transfer. The development of second generation processing facilities for protein crystal growth, inorganic crystal growth, and gallium arsenide crystal growth on board Shuttle is discussed in detail. Color photographs of space-grown mercury iodide and triglycine sulfate crystals are provided. (I.H.)

Source of Abstract/Subfile: AIAA/TIS
Descriptors: *MATERIALS SCIENCE; *SPACE COMMERCIALIZATION; *SPACE INDUSTRIALIZATION; *SPACE PROCESSING; CRYSTAL GROWTH; REDUCED GRAVITY; RESEARCH AND DEVELOPMENT: SPACE SHUTTLE PAYLOADS; SPACELAB PAYLOADS
Subject Classification: 7512 Astronautics-General (1975-)

Publication Date: 1985
Language: English
Document Type: JOURNAL ARTICLE
Most documents available from AIAA Technical Library

Satellite leasing - Cheap access to space MAEH, R. (RCA, Astro-Electronics Div., Princeton, N.J)
Publication Date: Feb. 1986
Language: English
Country of Origin: United States Country of Publication: United Kingdom
Document Type: JOURNAL ARTICLE
Most documents available from AIAA Technical Library

The role of satellite leasing arrangements in marketing commercial ventures in space is considered. The most recent examples of leased space platforms are described, including Leasat: ESA's EURECA; Omnistar; and Leasecraft. It is shown that because of NASA Shuttle pricing policies, leasing room for commercial payloads on board space platforms will become an increasingly attractive way of financing space ventures in which capital investments are often at risk. The development of the first large-scale commercial space platform for the Electrophoresis in Space (EOS) program is also discussed. (I.H.)

Source of Abstract/Subfile: AIAA/TIS
Descriptors: *LEASING; *SPACE COMMERCIALIZATION; *SPACE PLATFORMS; *SPACE PROCESSING; MARKETING; SPACE TRANSPORTATION SYSTEM
Subject Classification: 7581 Administration & Management (1975-)

Publication Date: Feb. 1985
Language: English
Country of Origin: United States Country of Publication: United Kingdom
Document Type: JOURNAL ARTICLE
Most documents available from AIAA Technical Library

The U.S. Space Station program is described. The objectives of the present national space policy are reviewed. International involvement and commercial use of space are the two strategies involved in the development of the Space Station. The Space Station is to be a multifunctional, modular, permanent facility with manned and unmanned platforms. The functions of the Space Station for space research projects, such as material processing and electrophoresis, are examined. The infrastructure required for commercialization of space is analyzed. NASA's space policy (cont. next page)
The commercial value of material processing in space is discussed. In order for material processing to be profitable, the items produced in space must not be price sensitive. The potential processing costs to be incurred by companies which will manufacture in space are examined. The application of space processing to computer chips, electrophoresis, and metal manufacturing are described. (I.F.)

Source of Abstract/Subfile: AIAA/TIS

Descriptors: SPACE COMMERCIALIZATION; SPACE INDUSTRIALIZATION; SPACE STATIONS; INTERNATIONAL COOPERATION; POLICIES; UNITED STATES

Subject Classification: 7512.Astronautics-General (1975-)

1425058 A86-17320

Human roles in future space systems

WOLBERS, H. L. (McDonnell Douglas Astronautics Co., Huntington Beach, CA)


Publication Date: 1985 6 Refs.

Report No.: AAS PAPER 84-117

Language: English


Document Type: CONFERENCE PAPER

Most documents available from AIAA Technical Library

Journal Announcement: IAA8606

Space (ISSN 0267-954X), vol. 1, Sept. 1985, p. 64-67.

Publication Date: Sep. 1985

Language: English

Country of Origin: United Kingdom Country of Publication: United Kingdom

Document Type: JOURNAL ARTICLE

Most documents available from AIAA Technical Library

Journal Announcement: IAA8606

A fortune in orbit

PARKER, I.

Space (ISSN 0267-954X), vol. 1, Sept. 1985, p. 64-67.

Publication Date: Sep. 1985

Language: English

Country of Origin: United Kingdom Country of Publication: United Kingdom

Document Type: JOURNAL ARTICLE

Most documents available from AIAA Technical Library

Journal Announcement: IAA8606
Among additional topics discussed are: Space Station platform thermal control; environmental control and life support for an evolving capability manned Space Station; and the commercial prospects of the Space Station. (E.H.)

Source of Abstract/Subfile: AIAA/TIS

Descriptors: *CONFERENCES; ORBITAL SPACE STATIONS; SPACE STATIONS; ELECTROPHORESIS; ENVIRONMENTAL CONTROL; EXTRAVEHICULAR ACTIVITY; METALLURGY; REUSABLE SPACECRAFT; SPACE COMMERCIALIZATION; SPACE PLATFORMS; SPACE PROCESSING; SPACEBORNE EXPERIMENTS; SPACECRAFT POWER SUPPLIES; TEMPERATURE CONTROL

Subject Classification: 7512 .Astronautics--General (1975-)

1425050 A86-17312

The potential of materials processing using the space environment


Publication Date: 1985

Language: English


Document Type: ANALYTIC OF COLLECTED WORK

Most documents available from AIAA Technical Library

Journal Announcement: IAA8605

The scientific, economic, structural, and political problems and advantages of material processing in space (MPS) are discussed. The microgravity environment provides the setting for new developments in biological materials, metal alloys and composites, and semiconductor crystals and glasses. The benefits of the Space Shuttle for MPS are described. A review of the history of MPS in the U.S. and abroad is presented. The electrophoresis operations in space (EOS) project is examined; the problems encountered with static electrophoresis and continuous flow electrophoresis are examined; and the increases in concentration, flow rate, and purity provided by EOS are studied. The economic and commercial advantages possible by conducting EOS and MPS within the Space Station are investigated. (I.F.)

Source of Abstract/Subfile: AIAA/TIS

Descriptors: *ELECTROPHORESIS; *SPACE COMMERCIALIZATION; *SPACE PROCESSING; CONVECTION CURRENTS; HISTORIES; PHARMACOLOGY; SPACE TRANSPORTATION SYSTEM

Subject Classification: 7512 .Astronautics--General (1975-)

1423070 N86-13352

EURECA: An introduction to Europe's free-flying retrievable cargo system

LONGDON, N., comp.

European Space Agency, Paris (France).

(cont. next page)
The European Retrievable Carrier (EURECA) is a reusable platform launched by the Shuttle, released in a free-flying mode for 6 months or more, and then retrieved by the Shuttle Orbiter and returned to Earth. Payload capacity is up to 1000 kg. The first EURECA payload is primarily dedicated to material and life sciences which benefit from the microgravity environment. The versatility of the system is demonstrated by the fact that a quarter of the payload weight is taken up by space science and technological experiments. The EURECA provides an excellent test bed to demonstrate in-flight technologies such as direct data relay from low Earth orbits via geostationary satellites to a central operations center, rendezvous and docking, and in-orbit servicing. Earth observation possibilities, and commercial applications (new materials, crystal growth, proteins, and pharmaceutical products) are numerous. (Author (ESA))

The role of the government and private industries in the commercialization of space is investigated. The government needs to provide funding, stimulate research and development, and establish regulations, and industries need to develop areas which will provide profitable investments. The three phases of the evolution of space activities, which are high tech R and D, the development of infrastructure, and the establishment of the industry, are described. The relationship between NASA's policies, the joint endeavor agreement, and the stages of the evolution of space activities is analyzed; a balance between investment and profit needs to be established. Examples of existing space commercialization, the American commercial Landsat venture, and developments in the low altitude commercial platforms for material processing and scientific missions are presented. (I.F.)

The problems encountered and areas of developments in space commercialization in the U.S are analyzed. Developments such as, reductions in projected payoffs from space commercialization, the incurred losses and increased cost to a business for space activities, the slow development of material processing in space, and the limited areas for investment, which have led to reduced interest and investment in space commercialization, are discussed. Emphasis must be placed on the process of developing the research base and infrastructure required for commercialization of space. The future use of the Space Shuttle and its pricing in space commercialization is discussed. The incorporation of the proper requirements into a Space Station is studied. The establishment of an Office of Commercial Programs to direct and control NASA's space commercialization policies is discussed. (I.F.)

The problems encountered and areas of developments in space commercialization in the U.S are analyzed. Developments such as, reductions in projected payoffs from space commercialization, the incurred losses and increased cost to a business for space activities, the slow development of material processing in space, and the limited areas for investment, which have led to reduced interest and investment in space commercialization, are discussed. Emphasis must be placed on the process of developing the research base and infrastructure required for commercialization of space. The future use of the Space Shuttle and its pricing in space commercialization is discussed. The incorporation of the proper requirements into a Space Station is studied. The establishment of an Office of Commercial Programs to direct and control NASA's space commercialization policies is discussed. (I.F.)
Commercialization of space activities

GILLAM, L. T., IV
Publication Date: Oct. 1985 6 Refs.
Report No.: IAF PAPER 85-428
Language: English
Country of Origin: International Organization
Publication: International Organization
Document Type: PREPRINT

Most documents available from AIAA Technical Library

Journal Announcement: IAA8604

COMMERCIALIZATION; COMMUNICATIONS SATELLITES; SPACE TECHNOLOGY UTILIZATION

142709 A86-15899

Space Station redesigned for larger structural area

COVAULT, C.
Publication Date: Oct. 1985
Language: English
Country of Origin: United States
Country of Publication: United States

Document Type: JOURNAL ARTICLE

Most documents available from AIAA Technical Library

Journal Announcement: IAA8602

SPACE STATIONS; SPACE TECHNOLOGY UTILIZATION

Subject Classification: 7512 .Astronautics--General (1975-)

Subject Classification: 7518 .Spacecraft Design. Testing

The present article is concerned with a redesign of the U.S. Space Station by NASA. The redesign has the objective to provide a better zero-gravity platform for materials processing and to obtain more structure on which to mount experiments, telescopes, and upper-stage hardware. Instead of a long, tall station, the redesign will feature a wide, boxlike permanently manned structure. The changes were made in response to the concerns of science and commercial users, whose support is needed if the Space Station project is to succeed. Attention is given to the new U.S. Space Station dual keel design, safety considerations, an evaluation of development versus operating costs, station operations concepts, and operations management. (G.R.)

Source of Abstract/Subfile: AIAA/TIS

Descriptors: DESIGN ANALYSIS; NASA PROGRAMS; ORBITAL SPACE STATIONS; SPACE STATIONS; SPACECRAFT DESIGN; SPACE DESIGN ANALYSIS; ORBITAL SERVICING; SPACE MANUFACTURING; SPACE PLATFORMS

Subject Classification: 7518 .Spacecraft Design. Testing & Performance (1975-)

and discussed in the context of past and current experiment programs. The capabilities of NASA to support future research and development, and to engage in cooperative risk sharing programs with Industry are discussed. Meetings were held with several biotechnology and pharmaceutical companies to provide data for an analysis of the attitudes and perceptions of these industries toward the use of the space environment. Recommendations are made for actions that might be taken by NASA to facilitate the marketing of the use of the space environment, and in particular the Space Shuttle, to the biotechnology and pharmaceutical Industries. (Author)

Descriptors: BIOTECHNOLOGY; PHARMACOLOGY; RESEARCH AND DEVELOPMENT; SPACE MANUFACTURING; AEROSPACE ENVIRONMENTS; DRUGS; MEDICAL SCIENCE; SPACE SHUTTLES; TECHNOLOGY UTILIZATION

Subject Classification: 7512 .Astronautics--General (1975-)

CODATI Code: 22A .Astronautics

1416623 A86-11954
Utilization of Space Shuttle External Tank materials by melting and powder metallurgy

CHERN, T. S. (California, University, Scripps Institution of Oceanography, La Jolla, Calif.) Scripps Institution of Oceanography, La Jolla, Calif.

Publication Date: Sep. 1985  6 Refs.
Contract No.: NASA-35037
Language: English
Country of Origin: United States
Country of Publication: United Kingdom

Document Type: JOURNAL ARTICLE
Most documents available from AIAA Technical Library
Journal Announcement: IAA86020

The Crucible Melt Extraction Process was demonstrated to convert scraps of aluminum alloy 2219, used in the Space Shuttle External Tank, into fibers. The cast fibers were then consolidated by cold welding. The X-ray diffraction test of the cast fibers was done to examine the crystallinity and oxide content of the fibers. The compressive stress-strain behavior of the consolidated materials was also examined. Two conceptual schemes which would adapt the as-developed Crucible Melt Extraction Process to the microgravity condition in space were finally proposed. (Author)

Source of Abstract/Subfile: AIAA/ITIS
Descriptors: *EXTERNAL TANKS; *METAL FIBERS; *POWDER METALLURGY; *SPACE MANUFACTURING; *SPACE SHUTTLES; *SPACECRAFT CONSTRUCTION MATERIALS; FIBER COMPOSITES; MELTING; REUSE; SCRAP; STRESS-STRAIN RELATIONSHIPS; X RAY DIFFRACTION
Subject Classification: 7512 .Astronautics-General (1975-)

Development of materials processing systems for use in space on low-g simulation devices

ALDRICH, B. R.; WHITT, W. D.
National Aeronautics and Space Administration, Marshall Space Flight Center, Huntsville, Ala.

Publication Date: May 1985
Language: English
Country of Origin: United States
Country of Publication: United States

Document Type: REPORT

Most documents available from AIAA Technical Library
Journal Announcement: STAR8601

Advanced. furnace systems are being developed for use in space. Systems are being tested for current experiment applications and modified for future experiment requirements. Future projects are: (1) fabrication and testing of the Advanced Automated Directional Solidification Furnace (AADSF) flight hardware; (2) development of a Heat Pipe Furnace (HPF) for use in space; and (3) the AADSF furnaces will be modified and tested to operate at temperatures up to 1700 C in the heated cavity. This will be accomplished by developing a new hot and heating module and insulation package for the existing AADSF. The DTF can operate at temperatures up to 1700 C. The sample size will be approximately 3/8 in. dia. x 5/8 in. long. Design improvements for the General Purpose Rocket Furnace (GPRF) for use in the Material Experiment Assembly (MEA) are to be accomplished. (F.M.R.)

Source of Abstract/Subfile: NASA STIF
Descriptors: *CAVITIES; *DROP TOWERS; *FURNACES; *HEAT PIPES; *MATERIALS HANDLING; *REDUCED GRAVITY; *SPACE MANUFACTURING

Space sciences: Perspectives of commercial utilization for the German Industry

WELTRAUMFORSCHUNG: PERSPEKTIVEN DER KOMMERZIELLEN NUTZUNG FUER DIE DEUTSCHE INDUSTRIE
JORDAN, H. L.
Bundesinstitut fuer Forschung und Technologie, Bonn (West Germany)

Publication Date: Jan. 1985
Presentation Note: Presented at BDI Ausschuss fuer Forsch.- u. Wissenschaftspolitik, Bonn, 19 Oct. 1984
Language: German
Country of Origin: Germany

Document Type: CONFERENCE PAPER
Most documents available from AIAA Technical Library
Journal Announcement: STAR8601

Space sciences and their possible utilization by industry are presented. The development of astronautics and applications in observation techniques, communication, and navigation are reviewed. Utilization of reduced gravitational force effects: diffusion phenomena, crystal growth, production process for metals and composite materials, biotechnology, and biologie sciences are considered. (Author (ESA)) Source of Abstract/Subfile: ESA
Descriptors: *AEROSPACE INDUSTRY; *AEROSPACE SCIENCES; *REDUCED GRAVITY; *SPACE COMMERCIALIZATION; *SPACE TECHNOLOGY; *BIOCHEMISTRY; *BIOTECHNOLOGY; *COMMUNICATION COMPOSITE MATERIALS; CRYSTAL GROWTH; EARTH OBSERVATIONS (FROM SPACE); SPACE NAVIGATION; SPACE PROCESSING

Subject Classification: 7581 .Administration & Management (1975-)

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Descriptors: *AEROSPACE INDUSTRY; *AEROSPACE SCIENCES; *REDUCED GRAVITY; *SPACE COMMERCIALIZATION; *SPACE TECHNOLOGY; *BIOCHEMISTRY; *BIOTECHNOLOGY; *COMMUNICATION COMPOSITE MATERIALS; CRYSTAL GROWTH; EARTH OBSERVATIONS (FROM SPACE); SPACE NAVIGATION; SPACE PROCESSING

Subject Classification: 7581 .Administration & Management (1975-)

Development of materials processing systems for use in space on low-g simulation devices

ALDRICH, B. R.; WHITT, W. D.
National Aeronautics and Space Administration, Marshall Space Flight Center, Huntsville, Ala.

Publication Date: May 1985
Language: English
Country of Origin: United States
Country of Publication: United States

Document Type: REPORT

Most documents available from AIAA Technical Library
Journal Announcement: STAR8601

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Source of Abstract/Subfile: NASA STIF
Descriptors: *CAVITIES; *DROP TOWERS; *FURNACES; *HEAT PIPES; *MATERIALS HANDLING; *REDUCED GRAVITY; *SPACE MANUFACTURING

Space sciences: Perspectives of commercial utilization for the German Industry

WELTRAUMFORSCHUNG: PERSPEKTIVEN DER KOMMERZIELLEN NUTZUNG FUER DIE DEUTSCHE INDUSTRIE
JORDAN, H. L.
Bundesinstitut fuer Forschung und Technologie, Bonn (West Germany)

Publication Date: Jan. 1985
Presentation Note: Presented at BDI Ausschuss fuer Forsch.- u. Wissenschaftspolitik, Bonn, 19 Oct. 1984
Language: German
Country of Origin: Germany

Document Type: CONFERENCE PAPER
Most documents available from AIAA Technical Library
Journal Announcement: STAR8601

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Descriptors: *AEROSPACE INDUSTRY; *AEROSPACE SCIENCES; *REDUCED GRAVITY; *SPACE COMMERCIALIZATION; *SPACE TECHNOLOGY; *BIOCHEMISTRY; *BIOTECHNOLOGY; *COMMUNICATION COMPOSITE MATERIALS; CRYSTAL GROWTH; EARTH OBSERVATIONS (FROM SPACE); SPACE NAVIGATION; SPACE PROCESSING

Subject Classification: 7581 .Administration & Management (1975-)

Development of materials processing systems for use in space on low-g simulation devices

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Most documents available from AIAA Technical Library
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Source of Abstract/Subfile: NASA STIF
Descriptors: *CAVITIES; *DROP TOWERS; *FURNACES; *HEAT PIPES; *MATERIALS HANDLING; *REDUCED GRAVITY; *SPACE MANUFACTURING
Current plans for the ESA Columbus Space Station (SS) co-orbit are reviewed. A manned laboratory pressure module is intended to be attached to the SS to share power and living quarters. A Resource Module will be added 10 yr later and permit autonomy in co-orbit. The configuration would be accompanied by free-flying platforms, either co-orbiting or polar-orbiting, and a service vehicle. Initiatives are under way to generate commercial and scientific participation in the Columbus project by providing access to low-g laboratories and documentation, and by developing expert systems to assist payload users. Materials science and pharmaceuticals experiments are receiving the greatest industrial attention at present. It is not yet known whether the ownership of the SS will be in the form of a condominium or a commune. (M.S.K.)

Source of Abstract/Subfile: AIAA/TIS

Descriptors: *EUROPEAN SPACE AGENCY; *INTERNATIONAL RELATIONS; ORBITAL WORKSHOPS; SPACE LABORATORIES; CRYSTAL GROWTH; ITALIAN SPACE PROGRAM; SPACE MANUFACTURING

Subject Classification: 7518 .Spacecraft Design, Testing & Performance (1975-)

Scientific foundations of space manufacturing (Book)
AVDEEVSKII, V. S.; GRISHIN, S. D.; LESKOV, L. V.; POLEZHAEV, V. I.; SAVICHEV, V. V.

A review is given of Soviet efforts to develop platforms and techniques for materials processing in outer space. Consideration is given to the physical conditions on board a space-based materials processing platform, including the fluid mechanics of microgravity; dynamic weightlessness; and transport phenomena. Thermodynamic and kinetic aspects of phase transitions in microgravity are discussed, with emphasis on solidification and heat transfer, the distribution of impurities, and the formation of structural defects in materials (metals, semiconductors and glasses) which are processed in space. Techniques for modeling the reactions of materials and material processes to microgravity are also described based on experimental data collected during the Soyuz and Salyut missions. (I.H.)

Source of Abstract/Subfile: AIAA/TIS

Descriptors: *AEROSPACE SCIENCES; *LOW GRAVITY MANUFACTURING; *MICROGRAVITY APPLICATIONS; *REDUCED GRAVITY; *SPACE MANUFACTURING; SPACE PLATFORMS; FLUID MECHANICS; HEAT TRANSFER; MASS TRANSFER; MATHEMATICAL MODELS; PHASE TRANSFORMATIONS; SOLIDIFICATION

Subject Classification: 7512 .Astronautics--General (1975-)

NASA approves fly-now, pay-later plans for orbiting industrial facility
COVAULT, C.

In a continuing effort to foster the commercialization of space, NASA has entered into an agreement with Space Industries, Inc. to furnish that company with two STS launches which will be paid for in the form of 12 percent of the revenues from the first five years of operation. The payload will be a Shuttle-tended unmanned module for materials processing. NASA also plans to benefit from access to the module and docking facility technologies which will be developed by the commercial organization. This will avoid in-house development costs for NASA. The first module will be 35 ft long and 14.5 ft wide and will cost from $250-500 million to develop. The initial launch is scheduled for 1992. Module power will be furnished by 100-ft long solar cell masts rated at 12 kW. The orbit will be selected to allow operations in concert with the Space Station orbit, thereby facilitating Orbiter visits. (M.S.K.)

Source of Abstract/Subfile: AIAA/TIS

Descriptors: *NASA PROGRAMS; SPACE INDUSTRIALIZATION; SPACE PROCESSING; SPACE SHUTTLE PAYLOADS; SPACE COMMERCIALIZATION; SPACECRAFT DESIGN; SPACECRAFT MODULES

Subject Classification: 7518 .Spacecraft Design, Testing & Performance (1975-)

Information Services, Inc.
The issue is leadership (Space Station program)

BEGGS, J. M. (NASA, Washington, DC)
National Aeronautics and Space Administration, Washington, D.C.
Corp. Source Code: NC452981
Aerospace America (ISSN 0740-722X), vol. 23, Sept. 1985, p. 44-47.

Publication Date: Sep. 1985
Language: English

Document Type: JOURNAL ARTICLE
Most documents available from AIAA Technical Library
Journal Announcement: IAA8552

Four NASA Phase B centers (NASA-Johnson, NASA-Marshall, NASA-Goddard, and NASA-Lewis) are responsible for construction, assembly, servicing, habitat, and other particular tasks and functions of the Space Station. The project has been joined by the aerospace programs of Canada, Japan, and the European Space Agency, ensuring technological and financial support, and cooperative use by the participants. Some of the future uses of the Space Station include biomedical research and applications; experiments in solar-terrestrial physics and astronomy; building, maintaining, and launching of space instruments and planetary missions; manufacturing and processing of materials that call for the conditions of microgravity and weightlessness; supporting communication operations; and improving earth and atmospheric observations. The political significance of the Space Station as a symbol of leadership and of friendly cooperation is noted. (I.S.)

Source of Abstract/Subfile: AIAA/TIS
Descriptors: "NASA PROGRAMS; "ORBITAL SPACE STATIONS; "SPACE STATIONS; COST ANALYSIS; SPACE LABORATORIES; SPACE MAINTENANCE; SPACE MANUFACTURING; SPACE PROCESSING"
Subject Classification: 7512 .Astronautics--General (1975-)

1386936 N85-34538

Commercial use of space - The space business era

GRIFFIN, G. D. (NASA, Johnson Space Center, Houston, TX)
National Aeronautics and Space Administration, Lyndon B.
Corp. Source Code: NC452981


Report No.: NASA-TM-77657; NAS 1.15:77657

Contract No.: NASW-4004
Language: English
Country of Origin: Germany, Federal Republic of Country of Publication: United States
Document Type: PREPRINT
Most documents available from AIAA Technical Library
Journal Announcement: IAA85518

A Space Station will create new opportunities for commercial investment. This paper explores two of the most promising areas: materials processing in space, and the servicing and launching of communications satellites. Risks to commercial investors are identified. Recommendations are offered for providing incentives to private sector companies to invest in a Space Station. (Author)

Source of Abstract/Subfile: AIAA/TIS
Descriptors: "ORBITAL SERVICING; "ORBITAL SPACE STATIONS; "SPACE COMMERCIALIZATION; "SPACE PROCESSING; COMMUNICATION SATELLITES; MARKET RESEARCH; MATERIALS SCIENCE; ORBITAL LAUNCHING; RISK; WEIGHTLESSNESS"
Subject Classification: 7512 .Astronautics--General (1975-)

1386936 A85-34538

Commercialization of a Space Station

SHESKIN, T. J. (Cleveland State University, Cleveland, OH)

Publication Date: Dec. 1984 10 Refs.
Report No.: ASME PAPER 84-WA/TS-3
Language: English
Document Type: PREPRINT
Most documents available from AIAA Technical Library
Journal Announcement: IAA85518

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Source of Abstract/Subfile: AIAA/TIS
Descriptors: "ORBITAL SERVICING; "ORBITAL SPACE STATIONS; "SPACE COMMERCIALIZATION; "SPACE PROCESSING; COMMUNICATION SATELLITES; MARKET RESEARCH; MATERIALS SCIENCE; ORBITAL LAUNCHING; RISK; WEIGHTLESSNESS"
Subject Classification: 7512 .Astronautics--General (1975-)

1396072 A85-39930

Commercialization of a Space Station

SHESKIN, T. J. (Cleveland State University, Cleveland, OH)

Publication Date: Dec. 1984 10 Refs.
Report No.: ASME PAPER 84-WA/TS-3
Language: English
Document Type: PREPRINT
Most documents available from AIAA Technical Library
Journal Announcement: IAA85518

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Source of Abstract/Subfile: AIAA/TIS
Descriptors: "ORBITAL SERVICING; "ORBITAL SPACE STATIONS; "SPACE COMMERCIALIZATION; "SPACE PROCESSING; COMMUNICATION SATELLITES; MARKET RESEARCH; MATERIALS SCIENCE; ORBITAL LAUNCHING; RISK; WEIGHTLESSNESS"
Subject Classification: 7512 .Astronautics--General (1975-)

1398563 N85-29979

International space research perspectives of commercialization for German Industry

JORDAN, H. L.
National Aeronautics and Space Administration, Washington, D.C.
Corp. Source Code: NC452981
Publication Date: Jul. 1985 31P.
Translation Note: Transl. into ENGLISH of "Weltumsumongung - perspektiven der kommerziellen nutzung fur die deutsche industri" Linder Hoehe, West Germany, 19 Oct. 1984 16 p.

Report No.: NASA-TM-77657; NAS 1.15:77657

Contract No.: NASW-4004
Language: English
Country of Origin: Germany, Federal Republic of Country of Publication: United States
Document Type: REPORT; CONFERENCE PAPER; TRANSLATION
Most documents available from AIAA Technical Library
Other Availability: NTIS HC AO3/MF AO1
Journal Announcement: STAR8519

A brief overview of space flight activities is presented. West German contributions to satellite mapping, communication satellites, navigation, Spacelab, diffusion under weightlessness, crystal growth in space, metal bonding, and biochemistry are described. The future of the research in the space station is analyzed. (B.W.)

Source of Abstract/Subfile: NASA STIF
Descriptors: "COMMUNICATION SATELLITES; "DIFFUSION; "SPACE COMMERCIALIZATION; "SPACE MANUFACTURING; "SPACE STATIONS; "SPACELAB; "WEST GERMANY; BIOCHEMISTRY; CRYSTAL GROWTH; SATELLITE IMAGERY"
Subject Classification: 7512 .Astronautics--General (1975-)

CosatI Code: 22A .Astronautics
Progress and avenues being explored by NASA to hasten the commercialization of space are described. A task force has recommended that the effort begin at once, that bureaucratic barriers to commercial space activities be removed, and that a partnership between government and industry be seriously explored. The government role is to establish links with private industry, invest in high-leverage technologies and space facilities which will be attractive to commercial ventures, and contribute to commercial enterprises where risks are high and significant economic benefits can be foreseen. The government/industry relationship can be legally evidenced by MOUs, joint endeavor agreements, technical exchange agreements and industrial guest investigator arrangements. The Space Station is the first step in that it allows Americans to live and work in space. It is expected that international participation in Space Station development and utilization will accelerate the space business era. (M.S.K.)

Although the interest in commercial space projects is increasing, the investment community shows caution and hesitancy regarding a commitment to such projects. The caution is a result of the particular situation which exists with respect to space-related commercial projects. They require generally a large amount of capital, the potential return on investment may be years off, and the risks, compared with other potential investments, appear greater. There are, however, a number of entrepreneurial companies which are finding capital for commercial space projects. One is developing Space Shuttle upper stages and vehicles to be used for space launch satellites, while another is concerned with the growing of crystals in space. A third company is developing a free-flying manned laboratory platform to be used for materials processing and other activities. Attention is also given to a number of Fortune 500 companies which are getting involved in commercial space projects. (G.R.)

Astronauts balance enthusiasm for new market against risk potential

An astronaut's look at commercial space opportunities

The commercial opportunities provided by space are related to the unique qualities of the space environment. These qualities are discussed, taking into account weightlessness, a practically perfect vacuum, the continuous supply of solar energy, the charged particles, good visibility, absence of noise, the practically infinite size of space, and the high costs of gaining access to it. These qualities make possible the production of very precise spheres for calibration purposes, and the manufacture of ultra-pure glass and other materials. The production of rare pharmaceuticals in space is likely to have an early payoff, while the production of gallium-arsenide crystals for electronic devices is also very promising. However, the great risks involved in space ventures together with long payback times required by investments exert a retarding influence on space commercialization. Attention is given to the role of the government in space and opportunities provided by the Space Station. (G.R.)
Evolving government policy eases way for space ventures.

Commercial Space (ISSN 8756-4831), vol. 1, Spring 1985, p.

14-18.

Publication Date: 1985

Language: English

Country of Origin: United States

Document Type: JOURNAL ARTICLE

Evolving government policy eases way for space ventures. Co-sponsored by NASA and U.S. domestic concerns, for performing materials processing in research and pre-commercial investigations, as an orbital facility for developing, and implementing hardware and procedures, Commerce Lab can enhance space station development and hasten space platform production capability. Tasks considered include: (1) synthesis of user requirements and identification of common element and voids; (2) definition of performance and infrastructure requirement and alternative approaches; and (3) carrier, mission model, and infrastructure development.

Source of Abstract/Subfile: NASA STIF

Descriptors: *REDUCED GRAVITY; *SPACE COMMERCIALIZATION; SPACE LABORATORIES; SPACE PROCESSING; SPACE SHUTTLE PAYLOADS; USER REQUIREMENTS; GOVERNMENT/INDUSTRY RELATIONS; INTERFACES; MISSION PLANNING; PAYLOAD INTEGRATION PLAN; SPACEBORNE EXPERIMENTS; TRADEOFFS

Subject Classification: 7512 .Astronautics--General (1975-)

1363400 A85-20512

Astrobusiness: A guide to the commerce and law of outer space (Book)


Publication Date: 1985 89 Refs.

Language: English

Country of Origin: United States

Document Type: BOOK

This book documents the commercialization of outer space by the incredible growth of space-related opportunities for the private sector. The commercial use of space is related to communications, remote sensing, space manufacturing, and energy. Possibilities of a manufacture in space are considered for pharmaceuticals, electronics, glass, and metallurgy. Structure for a space discussed include space platforms, the Space Station, and space structures in geostationary orbit, a high orbit between the earth and the moon, and on the moon itself. Attention is also given to space transportation services, space risks and liabilities, questions regarding the financing of business in space, the national space law, international space law, and the militarization of space. An outlook is provided regarding future commercial space business opportunities. (G.R.)

Source of Abstract/Subfile: AIAA/TIS

Descriptors: *COMMERCIAL SPACECRAFT; *SPACE COMMERCIALIZATION; SPACE INDUSTRIALIZATION; SPACE LAW; COMMUNICATION SATELLITES; EARTH OBSERVATIONS (FROM SPACE); FINANCIAL MANAGEMENT; GOVERNMENT/INDUSTRY RELATIONS; LEGAL LIABILITY;

(continues on next page)
MILITARY SPACECRAFT; ORBITAL SPACE STATIONS; SPACE MANUFACTURING; SPACE PLATFORMS; SPACE TRANSPORTATION
Subject Classification: 7512 .Astronautics-General (1975-)

1357647 A76-46105
Economy of in-orbit manufacturing and processing
GEBER, G. (Bundesministerium fuer Forschung und Technologie, Bonn, West Germany)
Publication Date: Oct. 1976 7 Refs.
Report No.: IAF PAPER A-76-25
Language: English
Document Type: CONFERENCE PAPER

Most documents available from AIAA Technical Library
Journal Announcement: IAA7623

Manned orbital systems will, for the first time, enable technological basic research to be carried out which allows long-term development under space conditions. But space technology will not be able to avail itself of this opportunity of making an important contribution to increasing industrial efficiency and competitiveness unless a convincing breakthrough can be made towards greater economy of space flight operations. The present paper discusses selected examples of materials research and process engineering which show such approaches. Furthermore, it reports on considerations made and measures envisaged by the German space program to establish the necessary prerequisites for economic operation. (Author)

Descriptors: +ECONOMIC FACTORS; +METALLURGY; +MICROELECTRONICS; +SPACE MANUFACTURING; EUROPEAN SPACE PROGRAMS; NETWORK SYNTHESIS; PAYLOADS; TECHNOLOGICAL FORECASTING; TURBINE BLADES
Subject Classification: 7512 .Astronautics-General (1975-)

1343898 A76-32356
Space processing - Status, prospects and problems: 1975
STEIG, L.; MCCREIGHT, L. R. (GE Space Sciences Laboratory, Philadelphia, Pa.)
Publication Date: 1975 22 Refs.
Language: English
Country of Origin: United States Country of Publication: Japan
Document Type: CONFERENCE PAPER
Journal Announcement: IAA7615

In the past decade, several ideas have been advanced for utilizing the prolonged low gravity available on spacecraft to process materials for use on earth. The validity of a few of these have been demonstrated on the Apollo flights and on Skylab. In particular, some crystals grown by solidification techniques on Skylab have provided indications that the predicted improvements in perfection can be gained under minimal gravity induced convection and sedimentation conditions. The far greater capabilities of the space shuttle for extending the range and quantities of experiments are now being awaited. In the interim, the Apollo Soyuz Test Project, sounding rocket flights to provide a few minutes of microgravity experimental time and numerous ground-based experiments and studies are being performed or planned. These are briefly reviewed in this paper. (Author)

Descriptors: +LOW GRAVITY MANUFACTURING; +MATERIALS SCIENCE +SPACE MANUFACTURING; +TECHNOLOGY ASSESSMENT; AEROSPACE SCIENCES; APOLLO SOYUZ TEST PROJECT; CRYSTAL GROWTH; EXPERIMENT DESIGN; GRAVITY; SOUNDRockets; TECHNOLOGICAL FORECASTING
Subject Classification: 7512 .Astronautics-General (1975-)

1343911 A76-32369
An orbital chemical plant for production of propellant and structural materials
NAGATOMO, M. (Tokyo, University, Tokyo, Japan); KANZAWA, A. (Tokyo Institute of Technology, Tokyo, Japan)
Publication Date: 1975
Language: English
Country of Origin: Japan Country of Publication: Japan
Document Type: CONFERENCE PAPER
Journal Announcement: IAA7615

The large payload capability of the launch system like Space Shuttle will make it possible, not only to carry great amount of consumables and structural materials for the use in orbit, but also to construct a plant or a factory to produce such necessaries in space. Such a facility in orbit is advantageous from two points. The first one is that the massive materials can be carried in the most suitable form as the cargo of the launch vehicle, and the second is that the propellent available on the earth orbit as energy source for materials processing. In the present paper, concept of a chemical plant is shown which produces propellant for orbital rocket vehicle and structural materials for constructing space stations. The chemical process discussed here is thermal dissociation of hydrocarbon Into hydrogen and carbon black in a solar energy furnace. The orbital chemical plant consists of the furnace with an acceptor, a hydrogen liquefier and a carbon material processing facility. (Author)

Descriptors: +CHEMICAL ENGINEERING; +CONSTRUCTION MATERIALS +HYDROCARBON FUEL PRODUCTION; +ORBITAL WORKSHOPS; +SPACE MANUFACTURING; METHANE; ORBITAL ASSEMBLY; PYROLYSIS; SPACE SHUTTLES; SPACECRAFT MODULES
Subject Classification: 7512 .Astronautics-General (1975-)

VHINTS

DIALOG Flic 108: AEROSPACE - 82-88/ISS09

1041190 N85-14439
Bioprocessing in space
BLOHRING, S. L.
Nijmegen Univ. (Netherlands). Dept. of Biochemistry.
Corp. Source Code: N1473382
In ESA Life Sci. Res. In Space p 75-78 (SEE N85-14425 05-51)
Publication Date: Aug. 1984
Language: English
Document Type: CONFERENCE PAPER
Most documents available from AIAA Technical Library
Other Availability: NTIS HC A14/MF A01
Journal Announcement: STAR8505
The technical, biological, and financial aspects of bioprocessing with continuous free-flow electrophoresis (CFE) are discussed. Specifications for a CFE apparatus are suggested. Candidate materials, e.g., erythropoietin for anemia and pancreas beta cells for diabetes, are listed. (Author (ESA))
Source of Abstract/Subfile: ESA
Descriptors: *BIOPROCESSING; *BIOSYNTHESIS; *ELECTROPHORESIS; *PHARMACOLOGY; *SPACE PROCESSING; ECONOMIC FACTORS; FUNCTIONAL DESIGN SPECIFICATIONS; SPACE MANUFACTURING
Subject Classification: 7551 Life Sciences--General (1975-)

1335300 A85-13142
Activities in Germany for the commercialization of space
KLEBER, P. (Deutsche Forschungs- und Versuchsanstalt fuer Luft- und Raumfahrt, Cologne, West Germany)
Publication Date: Oct. 1984
Report No.: IAF PAPER 84-222
Language: English
Country of Origin: Germany Country of Publication: International Organization
Document Type: PREPRINT
Most documents available from AIAA Technical Library
Journal Announcement: IAA8505
NASA's approach to the commercial use of space
GILLAM, I. T., IV (NASA, Washington, DC)
National Aeronautics and Space Administration, Washington, D. C.
Corp. Source Code: NC452981
Publication Date: Oct. 1984
Report No.: IAF PAPER 84-217
Language: English
Document Type: PREPRINT
Most documents available from AIAA Technical Library
Journal Announcement: IAA8505
NASA planning activities in the areas of commercial development of space resources are reviewed. Examples of specific types of commercial space ventures are given, according to three different categories: new commercial high-technology ventures; new commercial application of existing space technology, and commercial ventures resulting from the transfer of existing space programs to the private sector. Basic objectives for reducing technical, financial and institutional risks for commercial space operations are considered. Attention is given to the cooperative work environment encouraged by Joint Endeavor Agreements (JEAs) and Technical Exchange Agreements (TEAs) between industrial organizations in the development of space systems. Benefits of the commercial development of space resources include the production of new pharmaceuticals for the treatment of cancer, kidney diseases, and diabetes; and the development of ultra-pure semiconductor crystals for use in next generation electronic equipment. (J.H.)
Source of Abstract/Subfile: AIAA/TIS
Descriptors: *AEROSPACE INDUSTRY; *GOVERNMENT/INDUSTRY RELATIONS; *NASA PROGRAMS; *SPACE COMMERCIALIZATION; *SPACE INDUSTRIALIZATION: COMMERCIAL SPACECRAFT; ECONOMIC FACTORS; RISK
Subject Classification: 7512 Astronautics--General (1975-)

The benefits space has to offer to industrial concerns are discussed with an eye to methods of arousing greater industrial participation. Future technological development hinges on exploitation of the microgravity environment, particularly the free fall produced by blanking the spacecraft velocity against the centripetal force. Preliminary experimentation growing single crystals, studying diffusion in materials, the growth of living cells, etc., must be expanded upon by inducing further trials by more industrial investigators. Interest can be heightened through media advertising, direct mailing, personal contacts, and exhibits at industrial fairs. Industrial interest is most likely in the fields of metallic materials, electronics, chemistry, pharmaceuticals, and basic research. The promotions should be targeted at raising executive-level awareness of the possibilities space offers. (M.S.K.)
Source of Abstract/Subfile: AIAA/TIS
Descriptors: *REDUCED GRAVITY; *SPACE COMMERCIALIZATION; *SPACE INDUSTRIALIZATION; *SPACE MANUFACTURING; *SPACE PROCESSING: CHEMISTRY; ELECTRONICS; LOW GRAVITY MANUFACTURING
MATERIALS: SCIENCE; PHARMACOLOGY; WEST GERMANY
Subject Classification: 7512 Astronautics--General (1975-)

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Source of Abstract/Subfile: AIAA/TIS
Descriptors: *REDUCED GRAVITY; *SPACE COMMERCIALIZATION; *SPACE INDUSTRIALIZATION; *SPACE MANUFACTURING; *SPACE PROCESSING: CHEMISTRY; ELECTRONICS; LOW GRAVITY MANUFACTURING
MATERIALS: SCIENCE; PHARMACOLOGY; WEST GERMANY
Subject Classification: 7512 Astronautics--General (1975-)

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Opportunities for commercial organizations

Abstract Only

VARDMAN, W. K.; ATKINS, H.; TAYLOR, K. R.
National Aeronautics and Space Administration, Marshall Space Flight Center, Huntsville, Ala.

Corporation Source Code: ND736801

In Its 2nd Symp. on Space Industrialization p 369 (SEE NBS-11011 02-12)

Publication Date: Oct. 1984

Language: English


Document Type: CONFERENCE PAPER

Most documents available from AIAA Technical Library

Other Availability: NTIS I.C A19/MF A01

Journal Announcement: STAR8502

The possible applications of technology of materials processing in low gravity is discussed. A special office established by NASA to familiarize commercial organizations with materials processing in low gravity is described. This office provides information on present research and will, if requested, hold a seminar to present the technological and business aspects of joint investigations and joint endeavors to interested organizations. Arrangements can be made for visits to laboratories where ground based research is in progress. (M.A.C.)

Source of Abstract/Subfile: NASA STIF

Descriptors: INFORMATION DISSEMINATION; SPACE COMMERCIALIZATION; TECHNOLOGY ASSESSMENT; TECHNOLOGY TRANSFER; GOVERNMENT/INDUSTRY RELATIONS; PROJECT MANAGEMENT; REDUCED GRAVITY

Subject Classification: 7581 Administration & Management

COSATI Code: 5A .Administration & Management

Advances in electrophoretic separations

Abstract Only

SNYDER, R. S.; RHODES, P. H.
National Aeronautics and Space Administration, Marshall Space Flight Center, Huntsville, Ala.

Corporation Source Code: ND736801

In Its 2nd Symp. on Space Industrialization p 368 (SEE NBS-11011 02-12)

Publication Date: Oct. 1984

Language: English


Document Type: CONFERENCE PAPER

Most documents available from AIAA Technical Library

Other Availability: NTIS I.C A19/MF A01

Journal Announcement: STAR8502

Free fluid electrophoresis is described using laboratory and space experiments combined with extensive mathematical modeling. Buoyancy driven convective flows due to thermal and concentration gradients are absent in the reduced gravity environment of space. The elimination of convection in weightlessness offers possible improvements in electrophoresis and other separation methods which occur in fluid media. The mathematical modeling suggests new ways of doing electrophoresis in space and explains various phenomena observed during past experiments. The extent to which ground based separation techniques are limited by gravity induced convection is investigated and space experiments are designed to evaluate specific characteristics of the fluid/particle environment. A series of experiments are proposed that require weightlessness and apparatus is developed that can be used to carry out these experiments in the near future. (M.A.C.)

Source of Abstract/Subfile: NASA STIF

Descriptors: ELECTROPHORESIS; EXPERIMENT DESIGN; MATHEMATICAL MODELS; SPACE COMMERCIALIZATION; TECHNOLOGY ASSESSMENT; FLUID DYNAMICS; FLUID FLOW; TECHNOLOGICAL FORECASTING; WEIGHTLESSNESS

Subject Classification: 7525 Inorganic & Physical Chemistry

COSATI Code: 70 .Physical Chemistry

Opportunities for space bioprocessing

BIER, M.
Arizona Univ., Tucson, Biophysics Technology Lab.

Corporation Source Code: AX852975

In NASA, Marshall Space Flight Center 2nd Symp. on Space Industrialization p 60-64 (SEE NBS-11011 02-12)

Publication Date: Oct. 1984

Language: English


Document Type: CONFERENCE PAPER

Most documents available from AIAA Technical Library

Other Availability: NTIS I.C A19/MF A01

Journal Announcement: STAR8502

The need for improved purification technologies, the role of electrophoresis, and isoelectric focusing are discussed in the context of space bioprocessing. (R.S.F.)

Source of Abstract/Subfile: NASA STIF

Descriptors: BIOPROCESSING; BIOTECHNOLOGY; ELECTROPHORESIS; PURIFICATION; SPACE PROCESSING; GENETIC ENGINEERING; PH FACTOR; REDUCED GRAVITY; SPACE COMMERCIALIZATION; SPACE TRANSPORTATION SYSTEM 11 FLIGHT

Subject Classification: 7512 Astronautics--General (1975-)

COSATI Code: 22A .Astronautics

Financial issues for commercial space ventures: Paying for the dreams

EGAN, J. J.
Coopers and Lybrand, Washington, D.C.

(cont. next page)
The probability of success of future materials development efforts in the materials processing area: the current state of business planning and financial developments, what is needed for enhanced industrialization are discussed. Particular emphasis is placed on the role of space carriers and a space station in space industrialization. (R.S.F.)

Materials processing in space - Plenty of prophets, but what about profits?

BULLOCH, C. (USDA/Agriculture Research Service, Beltsville, MD) Descriptors: *COMMERCIAL SPACECRAFT; *LEASING; *MULTIMISSION MODULAR SPACECRAFT; *PAYLOADS; *SPACE COMMERCIALIZATION; *SPACE PLATFORMS; ATTITUDE CONTROL; EARTH ORBITS; NASA PROGRAMS; REMOTE SENSORS; SOLAR MAXIMUM MISSION

Subject Classification: 7515 : Launch Vehicles & Space Vehicles (1975-)

Agriculture: Budgets; Crystal Growth; Drop Towers; Electrolysis; Eureca (ESA); European Space Agency; Gallium Arsenides; Glass; Iron; Landsat Satellites; Latex; Manned Orbital Research Laboratories; NASA Programs; Satellite Imagery; Solidification; Space Manufacturing; Space Platforms; Space Shuttle Payloads; Spacecraft Maintenance; Technology Assessment; Technology Utilization

Subject Classification: 7512 : Astronautics-General (1975-)

Burrowbridge, D. R. (Fairchild Space Co., Germantown, MD) Descriptors: *SPACE COMMERCIALIZATION; *SPACE PROCESSING; *SPACE PROCESSING: INVESTMENTS; *SPACE PROCESSING: LIFE CYCLE COSTS; *SPACE PROCESSING: RISK

Source of Abstract/Subfile: NASA STIF

Subject Classification: 7583 : Economics & Cost Analysis (1975-)

COSATI Code: SC : Economics

1320848 A84-41224 Materials processing in space - Plenty of prophets, but what about profits?

Bulloch, C. (U.S. Department of Agriculture, Beltsville, MD) Descriptors: *COMMERCIAL SPACECRAFT; *COMMERCIAL SPACECRAFT: LEASING; *MULTIMISSION MODULAR SPACECRAFT; *PAYLOADS; *SPACE COMMERCIALIZATION; *SPACE PLATFORMS; ATTITUDE CONTROL; EARTH ORBITS; NASA PROGRAMS; REMOTE SENSORS; SOLAR MAXIMUM MISSION

Subject Classification: 7515 : Launch Vehicles & Space Vehicles (1975-)

1328769 A84-49146 Leasecraft - A commercial space platform

Burrowbridge, D. R. (Fairchild Space Co., Germantown, MD) Descriptors: *SPACE COMMERCIALIZATION; *SPACE PROCESSING; *SPACE PROCESSING: INVESTMENTS; *SPACE PROCESSING: LIFE CYCLE COSTS; *SPACE PROCESSING: RISK

Source of Abstract/Subfile: NASA STIF

Subject Classification: 7583 : Economics & Cost Analysis (1975-)

COSATI Code: SC : Economics

1331475 N85-11011 Second Symposium on Space Industrialization (space commercialization)

Jernigan, C. M., ed.
National Aeronautics and Space Administration, Marshall Space Flight Center, Huntsville, Ala.
Corporation Source Code: NMS
Publication Date: Oct. 1984 427P.
Publication Note: Sponsored in cooperation with AIAA and Alabama Univ.
Language: English

Document Type: CONFERENCE PAPER

Most documents available from AIAA Technical Library

COSATI Code: 5C : Economics

Language: English

Publication Date: Jul. 1984

1326067 A84-49035 Spacecraft processing equipment - The need for product identification

Riccoboni, C. A.; Johnson, M. E. (ORI, Inc.) Descriptors: *SPACE COMMERCIALIZATION; *SPACE PROCESSING; *SPACE PROCESSING: INVESTMENTS; *SPACE PROCESSING: LIFE CYCLE COSTS; *SPACE PROCESSING: RISK

Source of Abstract/Subfile: NASA STIF

Subject Classification: 7583 : Economics & Cost Analysis (1975-)

COSATI Code: SC : Economics

1326067 A84-49131 The Multimission Modular Spacecraft (MMS)

Burrowbridge, D. R. (Fairchild Space Co., Germantown, MD) Descriptors: *SPACE COMMERCIALIZATION; *SPACE PROCESSING; *SPACE PROCESSING: INVESTMENTS; *SPACE PROCESSING: LIFE CYCLE COSTS; *SPACE PROCESSING: RISK

Source of Abstract/Subfile: NASA STIF

Subject Classification: 7512 : Astronautics-General (1975-)

COSATI Code: 22A : Astronautics

Language: English

Publication Date: Oct. 1984

1331475 N85-11011 Second Symposium on Space Industrialization (space commercialization)

Jernigan, C. M., ed.
National Aeronautics and Space Administration, Marshall Space Flight Center, Huntsville, Ala.
Corporation Source Code: NMS
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COSATI Code: 5C : Economics

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Source of Abstract/Subfile: NASA STIF

Subject Classification: 7583 : Economics & Cost Analysis (1975-)

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Source of Abstract/Subfile: NASA STIF

Subject Classification: 7512 : Astronautics-General (1975-)

COSATI Code: 22A : Astronautics

Language: English

Publication Date: Oct. 1984
The economics of space processing, the benefits of manufacturing in space and the technologies most likely to succeed in terms of yielding commercially viable products are surveyed. One estimate indicated that space-processed substances must be worth $10,000-100,000/lb to turn a profit on earth. Space offers high vacuum, low gravity, and an infinite 'heat-sink' for experiments and manufacturing. Melt, solution and float zone growth of semiconductor crystals is being examined. Turbine blades could be flown to space, remelted to introduce reinforcing composite whiskers and resolidified for return to earth. Electrophoretically separated biological materials have been 5-7 times as pure if produced in space instead of on earth, and may lead to manufacturing Beta cells, pituitary cells, urokinase and interferon. Chief impediments to rapid progress in space commercialization could be the present tax structure, which inhibits high-risk ventures, and industrial ignorance of space manufacturing capabilities. (M.S.K.)

Source of Abstract/Subfile: AIAA/TIS
Descriptors: *LOW GRAVITY MANUFACTURING; *SPACE MANUFACTURING; *SPACE PROCESSING: COST EFFECTIVENESS; CRYSTALS; DRUGS; MATERIALS RECOVERY; METALLURGY; RESEARCH AND DEVELOPMENT; SPACE INDUSTRIALIZATION; WEIGHTLESSNESS
Subject Classification: 7512 .Astronautics--General (1975-)

Overview of the Industrialization of Space
PARDOE, G. K. C. (General Technology Systems, Ltd., Brentford, Middx., England)
Publication Date: 1984
Language: English
Country of Origin: United Kingdom Country of Publication: United Kingdom
Document Type: JOURNAL ARTICLE; CONFERENCE PAPER
Most documents available from AIAA Technical Library
Journal Announcement: IAA8418
The present status of space industrialization is reviewed with attention given to the role played by satellites in education, mobile communications on land, navigation, earth observations and meteorology. Space transportation for the injection of satellites into orbit, and more recently the process of recovering them, is shown to be an area of considerable commercial opportunity and projected as an area of vast importance in the future. The recent flight of Spacelab is considered, along with the deployment of SPAS from a Shuttle in September 1983 and its retrieval by the RMS. SPAS and its onboard observation package MOMS is noted to represent an important operational facility for the future. International industrial collaboration may play an essential role in the consideration of other projects among which the Space Station figures prominently. In conclusion, it is noted that because of its potential for industrialization and extensive commercial activities, space has become an expensive business and there is therefore a need for the interest of nonaerospace industries, particularly in the pharmaceutical sector to get involved. (J.P.)

Source of Abstract/Subfile: AIAA/TIS
Descriptors: *AEROSPACE SCIENCES; *SPACE INDUSTRIALIZATION; TECHNOLOGY ASSESSMENT; COMMUNICATION SATELLITES; INTERNATIONAL COOPERATION; SPACE TRANSPORTATION SYSTEM; SPACELAB; TECHNOLOGICAL FORECASTING
Subject Classification: 7512 .Astronautics--General (1975-)

1318687 A84-39063

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Source of Abstract/Subfile: AIAA/TIS
Descriptors: *AEROSPACE SCIENCES; *SPACE INDUSTRIALIZATION; TECHNOLOGY ASSESSMENT; COMMUNICATION SATELLITES; INTERNATIONAL COOPERATION; SPACE TRANSPORTATION SYSTEM; SPACELAB; TECHNOLOGICAL FORECASTING
Subject Classification: 7512 .Astronautics--General (1975-)

Overview of the Industrialization of Space
PARDOE, G. K. C. (General Technology Systems, Ltd., Brentford, Middx., England)
Publication Date: 1984
Language: English
Country of Origin: United Kingdom Country of Publication: United Kingdom
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Journal Announcement: IAA8418
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Interspace of commercial space activities
PEDERSEN, K. S. (NASA, International Affairs Div., Washington, DC)


International aspects of commercial space activities is underwriting the development of up to six
MANAGEMENT: SPACE PROCESSING; SPACEBORNE EXPERIMENTS; SPACELAB
MATERIALS RECOVERY; MILITARY SPACECRAFT; POLICIES; PROJECT
cooperation. It will interfere with research carried out by the U.S.
rise in space budgets in many countries is cited as an indication of the growing importance being placed on space
activities. It is also pointed out that these nations are emphasizing areas which hold promise for eventual commercial payoff. Developing countries are also paying greater attention to space. As part of the European Space Agency's development programs, it is undergoing the development of up to six
multisatellite facilities dedicated to microgravity research; these
including furnaces and thermostats for processing metallurgical
samples and for crystal growth and botanical investigations. Competition from Europe is seen as a spur to efficiency.

Attention is also given to problems in international cooperation that will arise if NASA proceeds with a Space Station. The rise in space budgets in many countries is cited as an indication of the growing importance being placed on space activities. It is also pointed out that these nations are emphasizing areas which hold promise for eventual commercial payoff. Developing countries are also paying greater attention to space. As part of the European Space Agency's development programs, it is undergoing the development of up to six
multisatellite facilities dedicated to microgravity research; these
including furnaces and thermostats for processing metallurgical
samples and for crystal growth and botanical investigations. Competition from Europe is seen as a spur to efficiency.

International cooperation will interfere with research carried out by the US
foreseeable purposes. (C.R.)

The 21st century in space
MUELLER, G. (International Academy of Astronautics, Paris, France)

Aerospace America (ISSN 0740-722X), vol. 22, Jan. 1984, p. 84-88.

An attempt is made to forecast the space systems scenario of the early 21st century in terms of trends rather than items on a specific timetable, assuming that the militarization of space does not preclude further development of scientific and commercial systems either directly, or indirectly through absorption of government funding. Further assuming that the pertinent legal issues will be resolved, satellite communications beyond the year 2000 will allow beaming to any spot on the globe at very low cost. This communications capability will strongly affect the advertising and distribution of consumer goods. Lunar solar power stations may be able to supply a significant portion of the earth's electrical energy. A second generation Space Shuttle will allow the volume of microgravity environment-processed materials to grow into a major commercial field. The prospects for further searches for extraterrestrial intelligence are noted. (O.C.)

Satellite communications and industrial enterprises related to it are already gaining large revenues, while potential businesses based on space manufacturing, space transportation, navigation, remote sensing, and ground servicing have been identified. Space transportation capacity is currently far greater than demand, and will remain so for at least a decade. Satellite communications demand is still growing rapidly at 20 and 30 percent. This market is, however, already being actively developed by major corporations. Real business prospects regarding remote sensing are difficult to quantify and may very well prove to be illusory, at least in the near term. The biggest long-term potential return lies in exploiting the wholly new materials-processing environment created in an orbiting satellite. However, profits are not expected to appear until perhaps 1988 at best. (G.R.)

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Subject Classification: 7512 .Astronautics--General (1975-)  
1284827 A84-22327  
Manufacturing in space; Proceedings of the Winter Annual Meeting, Boston, MA, November 13-18, 1983  
KOPS, L., ED. (McGill University, Montreal, Canada)  
Meeting sponsored by the American Society of Mechanical Engineers. New York, American Society of Mechanical Engineers (Production Engineering Symposia Series. PED Volume 11), 1983, 223 p.  
Publication Date: 1983  
Language: English  
Country of Publication: United States  
Document Type: CONFERENCE PROCEEDINGS  
Journal Announcement: IAA8408  
Processes, facilities, and issues related to manufacturing in outer space are addressed. The subjects discussed include: NASA, European, and Japanese projects on materials processing in space; gravitational effects in dendritic growth; space research impact on semiconductor crystal growth technology; simulation prior to space manufacturing; hardware for materials processing in space; containerless science and technologies; a low orbit satellite manufacturing facility; remote manipulators in space; automation, robotics, and machine intelligence systems in space manufacturing. Also considered are: manufacturing space systems in space; electrophoresis operations in space; rationale for commercial activities in space; Space Shuttle, private enterprise, and intellectual properties in space manufacturing; manufacturers' liability for space products; economics and profitability of space manufacturing; and international cooperation and competition in materials processing in space. For individual items see A84-22328 to A84-22346 (C.D.) (cont. next page)
Space station - A Canadian perspective

Doeckel, K. H. (National Aeronautical Establishment, Ottawa, Canada)


Publication Date: Oct. 1983
Report No.: IAF PAPER 83-55

Language: English
Country of Origin: Canada
Country of Publication: Canada

Document Type: PREPRINT

Most documents available from AIAA Technical Library
Journal Announcement: IAAB402

Canada's potential role in the development and operation of a space-station infrastructure is discussed, reporting the results of a survey of industrial, university, and government users and/or suppliers conducted in 1982-1983. In response to a NASA request, interest is found in applications from the fields of remote sensing, communications, materials processing, science, technology, medicine, and biology; while Canadian industry could contribute to such aspects as space construction and maintenance, large-solar-array design, flexible-structure design and control, and sensor-system development. It is suggested that most Canadian needs can be served by a combination of polar-orbit platforms for remote sensing, a low-inclination, low-earth-orbit, permanently or intermittently manned research and development laboratory, and a local-orbit maneuvering vehicle to assemble and service them. A block diagram of space infrastructures and graphs of the survey responses are provided. (T.K.)

Source of Abstract/Subfile: AIAA/ISS

Descriptors: *LOW GRAVITY MANUFACTURING

Subject Classification: 7512 Astronautics-General (1975-)

Most documents available from AIAA Technical Library
Journal Announcement: IAAB402

Commercialization of opportunities for materials processing in low gravity

Brown, W. S.; Nixon, S. R.

Corp. Source Code: B1723032

Government attempts to increase the participation of private enterprise in the commercialization of space are explored. The electrophoresis experiments on the Shuttle have progressed sufficiently far to give the sponsoring company a flight, as well as clinical testing of the product. Government policy hampered by encouraging private sector participation is in line with the concept that competition and profit motives produce better service at a lower price. Proposals to transfer the Landsat and MetSat systems to private concerns have failed to lead to swift action. Similarly, leasing launch rights to expendable boosters has been inhibited by the presence of direct competition with government subsidized launch services like the Shuttle and the Ariane. Industrialists have encouraged the government-supported development of a space station and unmanned, reusable launch vehicles that are less costly than the Shuttle. NASA, meanwhile, is entering into joint development contracts with industries for experimenting with prototype production systems, e.g., the electrophoretic pharmaceuticals and GaAs semiconductors grown in space. (M.S.K.)

(cont. next page)
The world in space: A survey of space activities and issues (Book)
CHIPMAN, R., ED.

Language: English
Country of Publication: United States
Document Type: COLLECTED WORK
Journal Announcement: IAA8321

Materials presented at the UNISPACE 82 conference are provided. The current state of space science is summarized and discoveries in the future are projected, including geoscience and materials processing experiments in near-earth space. The support technologies in existence and necessary for an expansion of space capabilities are described, and the relevance of space missions for monitoring earth resources and the environment is discussed. The physical impact of space activities on the atmosphere, human life, the orbital environment, and on astronomical observations is assessed. Attention is devoted to the compatibility and complementarity of meteorological, communications, and remote sensing satellite systems, and to the feasibility of using satellites for educational purposes. Efficiency in geostationary orbit use is considered, as are the social and economic aspects of space technology, with note taken of the relevance to developing nations. Finally, international cooperation in space is explored in terms of roles of intergovernmental, United Nations, and nongovernmental organizations in space activities. No individual items are abstracted in this volume.

M.S.K.

Source of Abstract/Subfile: AIAA/TIS
Descriptors: *AEROSPACE SCIENCES; *SPACE EXPLORATION; *TECHNOLOGY UTILIZATION; *UNITED NATIONS; *ARTIFICIAL SATELLITES; *ASTRONOMY; *COMMUNICATION SATELLITES; ECONOMIC DEVELOPMENT; ENVIRONMENT EFFECTS; GEOSYNCHRONOUS ORBITS; INTERNATIONAL COOPERATION; ORBIT SPECTRUM UTILIZATION; REMOTE SENSING; SATELLITE OBSERVATION; SPACE MANUFACTURING

Subject Classification: 7512 .Astronautics--General (1975-)

1229808 A83-15663
Space Industrialization - An International perspective
MAYUR, R. (Futurology Commission, Bombay, India)

Publication Date: 1982
Language: English
Country of Origin: India
Country of Publication: Italy
Document Type: CONFERENCE PAPER
Journal Announcement: STAR8320

Space Industrialization is seen as an inexorable step following the development of automation, which demands thorough cost-benefit analyses before undertaking any new initiatives in space. Industrialized countries are predicted to benefit in areas of medicine, tourism, new products, electronic mail, and electronics during the near-term from space activities, while lesser developed countries will gain advantages in agriculture and education. The entire world will experience gains in energy, communications, transportation, disaster prevention, environmental monitoring, materials processing, resource assessments, and the development of new materials.

M.S.K.

Source of Abstract/Subfile: AIAA/TIS
Descriptors: *AEROSPACE SCIENCES; *SPACE EXPLORATION; *TECHNOLOGY UTILIZATION; *UNITED NATIONS; ARTIFICIAL SATELLITES; *ASTRONOMY; *COMMUNICATION SATELLITES; ECONOMIC DEVELOPMENT; ENVIRONMENT EFFECTS; GEOSYNCHRONOUS ORBITS; INTERNATIONAL COOPERATION; ORBIT SPECTRUM UTILIZATION; REMOTE SENSING; SATELLITE OBSERVATION; SPACE MANUFACTURING

Subject Classification: 7512 .Astronautics--General (1975-)

1218736 N83-31640
Japanese program review of material processing in space
SAWAGA, A.
Tokyo Inst. of Tech. (Japan).
Corp. Source Code: T1204219
In: ESA Mater. Sci. under Microgravity p 23-27 (SEE N83-31637
20-12)
Publication Date: Jun. 1983
Language: English
Country of Origin: Japan
Country of Publication: Japan
International Organization: 
Document Type: CONFERENCE PAPER

Most documents available from AIAA Technical Library
Other Availability: NTIS HC A19/MF AOI: ESA, Paris FF 140
Journal Announcement: IAA83O4

Ground based simulations of material processing in space, the specifications of the TT 500A rocket for material processing experiments, Japanese participation in the Spaceplab program, and research into the creation of materials in microgravity are outlined. The TT 500A electric furnace can heat a 35 mm x 10 mm sample to 1500 C within 2 min and cool it from 1500 to 800 C in 2 min, with ± 150 C accuracy.

Author (ESA)

Source of Abstract/Subfile: ESA
Descriptors: *JAPANESE SPACE PROGRAM; *SPACE MANUFACTURING;

(cont. next page)
Natural convection in a spherical container with cooling at the center was numerically simulated using the Lockheed-developed General Interpolants Method (GIM) numerical fluid dynamic computer program. The numerical analysis was simplified by assuming axisymmetric flow in the spherical container, with the symmetry axis being a sphere diagonal parallel to the gravity vector. This axisymmetric spherical geometry was intended as an idealization of the proposed Spacelab furnaces for growing experiments to be performed on board Spacelab. Results were obtained for a range of Rayleigh numbers from 25 to 10,000. For a temperature difference of 10°C from the cooling sting at the center to the container surface, and a gravitational loading of 0.000001 g, a computed maximum fluid velocity of about 2.4 x 0.00001 cm/sec was reached after about 250 sec. The computed velocities were found to be approximately proportional to the Rayleigh number over the range of Rayleigh numbers investigated. (Author)

Descriptors: \textsuperscript{-}COMPUTATIONAL FLUID DYNAMICS; \textsuperscript{-}COMPUTER PROGRAMS; \textsuperscript{-}COMPUTERIZED SIMULATION; \textsuperscript{-}CRYSTAL GROWTH; \textsuperscript{-}SPACE MANUFACTURING; \textsuperscript{-}AXISYMMETRIC FLOW; \textsuperscript{-}CIRCULAR CYLINDERS; \textsuperscript{-}CONVECTION; \textsuperscript{-}COOLING; \textsuperscript{-}FLOW VELOCITY; \textsuperscript{-}GRAVITATION; \textsuperscript{-}RAYLEIGH NUMBER; \textsuperscript{-}SPACELAB

Subject Classification: 7512 -Astronautics-General (1975-1983)

Language: English

Country of Origin: United States

Country of Publication: United States

Document Type: REPORT

Most documents available from AIAA Technical Library

Journal Announcement: AIAA2224

Space manufacturing is defined, and potential processes and product types are discussed. Five basic processes are involved, including crystal growth, purification/separation, mixing/condensation, and processes in fluids. A three-phase timetable for the space manufacturing is described, and major issues and considerations that apply to various points of the timetable are addressed, including the products and services most likely to be exploited, the assessment of proprietary data, and handling of proprietary data. It is concluded that pharmaceuticals, electronic devices, optical products, and advanced alloys seem to hold the most promise for space manufacturing. (C.D.)

Source of Abstract/Subfile: AIAA/TIS

Descriptors: \textsuperscript{-}MARKET RESEARCH; \textsuperscript{-}SPACE MANUFACTURING; \textsuperscript{-}TECHNOLOGY ASSESSMENT; \textsuperscript{-}ALLOYS; \textsuperscript{-}ELECTRONIC EQUIPMENT; \textsuperscript{-}OPTICAL EQUIPMENT; \textsuperscript{-}SPACE PROCESSING; \textsuperscript{-}USER REQUIREMENTS

Subject Classification: 7512 -Astronautics-General (1975-1983)

Language: English

Country of Origin: United States

Country of Publication: United States

Document Type: CONFERENCE PAPER

Journal Announcement: IAA82224

Space factories a long way off

WATTS, C.


Language: English

Country of Publication: United States

Document Type: JOURNAL ARTICLE

Most documents available from AIAA Technical Library

Journal Announcement: IAA82224

Experimentation and prospects of materials processing on-board the Shuttle as a prelude to future space manufacturing facilities are assessed. Space-based research into specific heats, diffusivity, surface tension, and viscosity has applications in earth-based industry, although the related products cannot be more effectively made in orbit.

Biological experimentation is promising due to the contamination-free, near vacuum conditions in space. Continuous flow electrophoresis is unhindered by gravitational effects in space, and Shuttle experiments have demonstrated separation of six proteins producing purities of 40%, while the same process on Earth would yield 0.1% purity. The absence of convection and gravitational effects is partially offset by the presence of Marangoni convection in liquids. Finally, use of a wake-shield extended by a boom from the side of the Orbiter to carry out experimentation in ultrahigh vacuum conditions is described, as is the development of a 200-lb furnace with 37 compartments for testing alloy resolidification on board the Orbiter. (M.S.K.)

Source of Abstract/Subfile: AIAA/TIS

Descriptors: \textsuperscript{-}MATERIALS SCIENCE; \textsuperscript{-}SPACE INDUSTRIALIZATION;

(cont. next page)
Various aspects of space manufacturing are discussed, including the use of the Bridgman furnace, powder-metallurgical processes, crystal growth and volume crystallization in a universal furnace during the Morava experiment, and the Sirena experiment on Salyut-6-Soyuz. The conducting of biomedical experiments in space is discussed, and the repair and maintenance of space stations is considered. (B.J.)

Source of Abstract/Subfile: AIAA/TIS
Descriptors: +ORBITAL SPACE STATIONS; +SOVIET SPACECRAFT; +SPACE MANUFACTURING; +SPACE MAINTENANCE; +SPACE RESEARCH; +SPACE SHUTTLE ORBITERS; +SPACEBORNE EXPERIMENTS; BRIDGMAN METHOD; COMPOSITE MATERIALS; CRYSTAL GROWTH; EXOBIOLOGY; LONG DURATION SPACE FLIGHT; METALLURGY
Subject Classification: 7512 .Astronautics--General (1975-)

Publication Date: 1980 17 Refs.
Language: Russian
Country of Publication: Yugoslavia
Document Type: JOURNAL ARTICLE
Journal Announcement: IAA8220

The transition from exploration to commercial exploitation of space and space technology is considered in terms of legal issues defined by international and national laws, the Outer Space Treaty and the Moon Treaty, and liability and regulatory topics. The shift of emphasis of government funding for the Shuttle Is regarded as encouraging early commercial use for Shuttle-launched materials processing in space. Communications and earth resources satellites have already begun showing commercial success, and resources assessment from space offers an aid to developing nations in need of mineral and energy sources. Legal issues are projected to include the delineation of the boundaries of outer space, GEO, the legal definition of space transportation systems, the access of states, institutions, and enterprises to natural resources in celestial bodies, and the transfer of space technology. (Author)

Descriptors: +INTERNATIONAL RELATIONS; +LEGAL LIABILITY; +SPACE INDUSTRIALIZATION; +SPACE LAW; +SPACE PROCESSING; ECONOMIC FACTORS; INTERNATIONAL LAW; OUTER SPACE TREATY; SPACE TRANSPORTATION SYSTEM; TECHNOLOGY TRANSFER
Subject Classification: 7584 .Law & Political Science (1975-)

Publication Date: 1982 49 Refs.
Report No.: IAF 81-SL-02
Language: English
Country of Origin: Germany, Federal Republic of Germany
Document Type: CONFERENCE PAPER
Journal Announcement: IAA8212

Space manufacturing is discussed in regard to international and legal considerations, social sciences, novel concepts, materials resources and processing, and space stations and habitats. Particular topics discussed include the military implications of a satellite power system; a self-replicating, growing lunar factory; the supply of lunar oxygen to low earth orbit; a small-scale lunar launcher for early lunar material utilization; a decision-analytic evaluation of the SPS program; powder metallurgy in space manufacturing; and United States and Soviet life sciences factors in long-duration space flight. (B.U.)

Source of Abstract/Subfile: AIAA/TIS
Descriptors: +CONFERENCE: +SPACE MANUFACTURING; +ELECTROMAGNETIC ACCELERATION; HUMAN BEHAVIOR; INTERNATIONAL COOPERATION; INTERNATIONAL LAW; LARGE SPACE STRUCTURES; LAUNCHERS; LIFE SCIENCES; LUNAR SOIL; MASS DRIVERS (PAYLOAD DELIVERY); POLICIES; POLITICS; POWDER METALLURGY; SOLAR POWER SATELLITES; SPACE LAW; SPACE STATIONS
Subject Classification: 7512 .Astronautics--General (1975-)

In: Conference sponsored by Princeton University and American Institute of Aeronautics and Astronautics, September 18-21, 1981. Proceedings. (A82-35602 to A82-35641) New York, American Institute of Aeronautics and Astronautics, 1981. 464 p. (For individual items see A82-35602 to A82-35641)
Publication Date: 1981 17 Refs.
Language: English
Country of Publication: United States
Document Type: CONFERENCE PROCEEDINGS
Journal Announcement: IAA8217

In: Conference sponsored by Princeton University and American Institute of Aeronautics and Astronautics, New York, American Institute of Aeronautics and Astronautics, 1981. 464 p. (For individual items see A82-35602 to A82-35641)
Publication Date: 1981 17 Refs.
Language: English
Country of Publication: United States
Document Type: CONFERENCE PROCEEDINGS
Journal Announcement: IAA8217
Modular Spacecraft (MMS) are discussed. The MMS is designed to carry payloads by the Shuttle and later retrieved, returned to Earth, and fitted with another payload. The modules can also be detached, repaired, or replaced in space by simple, standardized procedures. The use of the MMS as the base for space factories, such as for electrophoresis to produce beta cells, interferon, and the enzyme alpha-trypsin in solution, and for a possible rescue mission by the Shuttle to retrieve or repair the first MMS, the Solar Maximum Mission, which has experienced a number of instrument malfunctions.

After a brief historical review of the economics of expendable-boosters, commercial-payload operations to date, and a description of the Space Shuttle system's design, operational capabilities, and mission profile, the payload flight assignments, materials processing experiments, and Spacelab I material science experiment are detailed. Among the Materials Processing in Space (MPS) fields for investigation are metal growth from vapor and solution, the production of magnetic composites and metal foams, laser host glasses and metallic glasses, non-buoyancy-driven convections, unidirectional solidification of eutectics, and the solidification of inconspicuous alloys. Emphasis is put on long-term, commercial usefulness of such studies, with attention to historical precedents such as the Skylab, Apollo, and Apollo-Soyuz programs.

Source of Abstract/Subfile: AIAA/TIS
Descriptors: MULTIMISSION MODULAR SPACECRAFT; NASA PROGRAMS; REUSABLE SPACECRAFT; SPACE MANUFACTURING; SPACE PLATFORMS; INSTRUMENT PACKAGES; MILITARY SPACECRAFT; RESCUE OPERATIONS; SCIENTIFIC SATELLITES; SPACE SHUTTLES; STEEL STRUCTURES

Subject Classification: 7515 Launch Vehicles & Space Vehicles (1975-)

Space Shuttle - A new era in transportation
DUNBAR, B. D. (NASA, Johnson Space Center, Houston, TX)
National Aeronautics and Space Administration, Lyndon B. Johnson Space Center, Houston, Tex.
Corp. Source Code: ND052615
Publication Date: Nov. 1981 26 Refs.
Language: English

Document Type: JOURNAL ARTICLE
Most documents available from AIAA Technical Library
Journal Announcement: IAA8204

Issues affecting space-based production of goods and services for earth-based use are discussed. Research, development, and operations define the technical phases leading to production, and fields open to space processing are listed as earth observations, communications, materials processing (high-volumetric ratio interactions), and energy beaming. It is noted that space activities which have entered an operations phase do so at a cost and quality which is superior to the same service rendered from earth-based facilities. The possibilities for a utility type institution to handle Shuttle traffic as a replacement for NASA are considered, and additional fields of outer space enterprises, such as earth resources management, land mobile communications systems, and applications for a worldwide emergency communications network are explored. (M.S.K.)

Source of Abstract/Subfile: AIAA/TIS
Descriptors: ECONOMIC FACTORS; LOW GRAVITY MANUFACTURING; RESEARCH AND DEVELOPMENT; SPACE INDUSTRIALIZATION; SPACE TRANSPORTATION; COST EFFECTIVENESS; DATA COLLECTION PLATFORMS; DATA PROCESSING; DATA TRANSMISSION; RESOURCES MANAGEMENT

Subject Classification: 7583 Economics & Cost Analysis (1975-)

Economic factors of outer space production
MILLER, B. P. (ECON, Inc., Princeton, NJ)
Publication Date: 1980 17 Refs.

Language: English

Document Type: ANALYTIC OF COLLECTED WORK
Journal Announcement: IAA8204

Issues affecting space-based production of goods and services for earth-based use are discussed. Research, development, and operations define the technical phases leading to production, and fields open to space processing are listed as earth observations, communications, materials processing (high-volumetric ratio interactions), and energy beaming. It is noted that space activities which have entered an operations phase do so at a cost and quality which is superior to the same service rendered from earth-based facilities. The possibilities for a utility type institution to handle Shuttle traffic as a replacement for NASA are considered, and additional fields of outer space enterprises, such as earth resources management, land mobile communications systems, and applications for a worldwide emergency communications network are explored. (M.S.K.)

Source of Abstract/Subfile: AIAA/TIS
Descriptors: ECONOMIC FACTORS; LOW GRAVITY MANUFACTURING; RESEARCH AND DEVELOPMENT; SPACE INDUSTRIALIZATION; SPACE TRANSPORTATION; COST EFFECTIVENESS; DATA COLLECTION PLATFORMS; DATA PROCESSING; DATA TRANSMISSION; RESOURCES MANAGEMENT

Subject Classification: 7583 Economics & Cost Analysis (1975-)

Space Shuttle - A new era in transportation
DUNBAR, B. D. (NASA, Johnson Space Center, Houston, TX)
National Aeronautics and Space Administration, Lyndon B. Johnson Space Center, Houston, Tex.
Corp. Source Code: ND052615
Publication Date: Nov. 1981 26 Refs.
Language: English

Document Type: JOURNAL ARTICLE
Most documents available from AIAA Technical Library
Journal Announcement: IAA8204

After a brief historical review of the economics of expendable-boosters, commercial-payload operations to date, and a description of the Space Shuttle system's design, operational capabilities, and mission profile, the payload flight assignments, materials processing experiments, and Spacelab I material science experiment are detailed. Among the Materials Processing in Space (MPS) fields for investigation are metal growth from vapor and solution, the production of magnetic composites and metal foams, laser host glasses and metallic glasses, non-buoyancy-driven convections, unidirectional solidification of eutectics, and the solidification of inconspicuous alloys. Emphasis is put on long-term, commercial usefulness of such studies, with attention to historical precedents such as the Skylab, Apollo, and Apollo-Soyuz programs.
The construction of factories making use of lunar materials on the surface of the moon is discussed. Advantages of, on the one hand, the use of extraterrestrial materials for manufacturing and, on the other, the low gravity and abundant solar energy of space for materials processing operations are pointed out, and it is noted that initially, such factories making use of lunar materials would be located in earth orbit.

The ultimate transfer of orbiting space factories to the lunar surface is considered, and the types of manufacturing processes that would be suitable for use on the moon are examined, including hydrofluoric acid leaching and electrophoresis as separation techniques, and powder materials processing for metals and ceramics. Consideration is also given to the self-replication of automated lunar factories resembling the proposed space operations center, and to NASA plans for materials processing experiments on the Shuttle, which have suffered significant budget decreases. Finally, the use of lunar-products on the moon is discussed. Advantages of, on the one hand, the low gravity and abundant solar energy of space for materials processing operations are pointed out, and it is noted that initially, such factories making use of lunar materials would be located in earth orbit.


A scenario is presented for the retrieval of lunar materials sent into lunar orbit to be used as raw materials in space manufacturing operations. The proposal is based on the launch of material from the lunar surface by an electromagnetic mass driver and the capture of this material in low lunar orbit by a fleet of mass catchers which ferry the material to processing facilities when full. Material trajectories are analyzed using the two-body equations of motion, and intercept requirements and the sensitivity of the system to launch errors are determined. The present scenario is shown to be superior to scenarios that place a single mass catcher at the L2 libration point due to increased operations flexibility, decreased mass driver performance requirements and centralized catcher servicing. (A.L.W.)

Source of Abstract/Subfile: AIAA/TIS
Descriptors: *CATCHERS; *LUNAR ORBITS; *MASS DRIVERS (PAYLOAD DELIVERY); *MATERIALS HANDLING; *SPACE PROCESSING; *TRAJECTORY ANALYSIS; CAPTURE EFFECT; ECONOMIC ANALYSIS; EQUATIONS OF MOTION; ORBITAL ELEMENTS; ORBITAL LAUNCHING; SPACE MANUFACTURING
Subject Classification: 7512 .Astronautics--General (1975-)


A summary is given of the advantages that the large cargo bay of the Space Shuttle will offer. Also discussed are four space-manufacturing activities deemed especially promising: pharmaceuticals, electronic devices, glass products, and advanced alloys. It is noted that the weightlessness of space eliminates the need for containers, a major source of impurities and surface irregularities in manufacturing. The fact that the commercial development of space requires few scientific breakthroughs - only a great deal of engineering - to establish technical, economic, and environmental viability is stressed. (C.R.)

Source of Abstract/Subfile: AIAA/TIS
Descriptors: *LOW GRAVITY MANUFACTURING; *SPACE MANUFACTURING; *SPACE PROCESSING; *SPACE SHUTTLE PAYLOADS; *WEIGHTLESSNESS; ALLOYS; ECONOMIC FACTORS; GLASS; IMPURITIES; NASA PROGRAMS; PHARMACOLOGY; SPACECRAFT ELECTRONIC EQUIPMENT; VARIABILITY
Subject Classification: 7512 .Astronautics--General (1975-).
establishing legal and management mechanisms to share cost and risk of early commercial ventures. (D.L.G.)

Source of Abstract/Subfile: AIAA/TIS

Descriptors: *AEROSPACE ENVIRONMENTS; *LOW GRAVITY MANUFACTURING; *NASA PROGRAMS; *SPACE INDUSTRIALIZATION; *SPACE PROCESSING; *COST INCENTIVES; CRYSTAL GROWTH; DIRECTIONAL SOLIDIFICATION (CRYSTALS); *ECONOMIC FACTORS; PRODUCT DEVELOPMENT; TECHNOLOGY ASSESSMENT

Subject Classification: 7512 .Astronautics--General (1975-)

1094073 A81-35539

Materials Experiment Carrier - An approach to expanded space processing capability


National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, Ala.

Corp. Source Code: ND738801


Publication Date: Oct. 1980 14 Refs.

Report No.: AAS PAPER 80-249

Contract No.: NASA-33688

Language: English


Document Type: CONFERENCE PAPER

Most documents available from AIAA Technical Library

Journal Announcement: IAA8114

Wide consideration is given the range of technological and economic factors affecting the planning and implementation of commercial Materials Processing in Space (MPS). Emphasis is put on the early, 1980-95 research and development period, during which will be conducted the research necessary to identify economically attractive space-based processing concepts and products for 1995 and beyond. Among the topics discussed are: MPS user motivation, business and legal aspects of MPS, government funding, the roles to be played by government and the aerospace and commercial industries. MPS programs in the Soviet Union, West Germany, France and Japan, suggested incentives for MPS commercialization, and the promotion of work of NASA's Commercial Applications Office. A list of companies actively investigating the possibilities of MPS is given, along with their concerns about risk capital, priorities and rights in space, and patent rights in the course of collaboration with a federal agency like NASA. (O.C.)

Source of Abstract/Subfile: AIAA/TIS

Descriptors: *COMPOSITE MATERIALS; *LOW GRAVITY MANUFACTURING; *SEMICONDUCTORS (MATERIALS); *SPACE PROCESSING; *SPACE SHUTTLE PAYLOADS; *TECHNOLOGY ASSESSMENT; ALLOYS; ECONOMIC ANALYSIS; LONG TERM EFFECTS; MAGNETIC MATERIALS; MATERIALS SCIENCE; SPACE INDUSTRIALIZATION; TECHNOLOGICAL FORECASTING; U.S.S.R. SPACE PROGRAM

Subject Classification: 7583 .Economics & Cost Analysis (1975-)

1093751 A81-20817

Is there business in space - Outlook for commercial space materials processing

WALTZ, D. M. (TRW, Inc., Redondo Beach, Calif.)


Publication Date: May 1981 19 Refs.

Report No.: AIAA PAPER 81-0891

Language: English


Document Type: CONFERENCE PAPER

Most documents available from AIAA Technical Library

Journal Announcement: IAA8114

Wide consideration is given the range of technological and economic factors affecting the planning and implementation of commercial Materials Processing in Space (MPS). Emphasis is put on the early, 1980-95 research and development period, during which will be conducted the research necessary to identify economically attractive space-based processing concepts and products for 1995 and beyond. Among the topics discussed are: MPS user motivation, business and legal aspects of MPS, government funding, the roles to be played by government and the aerospace and commercial industries. MPS programs in the Soviet Union, West Germany, France and Japan, suggested incentives for MPS commercialization, and the promotion of work of NASA's Commercial Applications Office. A list of companies actively investigating the possibilities of MPS is given, along with their concerns about risk capital, priorities and rights in space, and patent rights in the course of collaboration with a federal agency like NASA. (O.C.)

Source of Abstract/Subfile: AIAA/TIS

Descriptors: *COMPOSITE MATERIALS; *LOW GRAVITY MANUFACTURING; *SEMICONDUCTORS (MATERIALS); *SPACE PROCESSING; *SPACE SHUTTLE PAYLOADS; *TECHNOLOGY ASSESSMENT; ALLOYS; ECONOMIC ANALYSIS; LONG TERM EFFECTS; MAGNETIC MATERIALS; MATERIALS SCIENCE; SPACE INDUSTRIALIZATION; TECHNOLOGICAL FORECASTING; U.S.S.R. SPACE PROGRAM

Subject Classification: 7583 .Economics & Cost Analysis (1975-)

1072185 A81-11351

Hardhat in space

HAISE, F. W., JR. (Grumman Aerospace Corp., Bethpage, N.Y.)


Publication Date: 1980

(cont. next page)
The near-term potential of manufacturing in space

FRIITIS, E.; BYROADE, A.

General Accounting Office, Washington, D. C.

In ESA Mater. Sci. In Space p 427-432 (SEE N80-13069 04-12)

Publication Date: Jun. 1979

Language: English

Country of Origin: United States
Country of Publication: International Organization

Document Type: CONFERENCE PAPER

Most documents available from AIAA Technical Library

Subject Classification: 7512 ;Astronautics--General (1975-)

Included. Three hundred and thirty three citations are included. (GRA)

Descriptors: *AEROSPACE ENVIRONMENTS; *BIBLIOGRAPHIES; *SPACE MANUFACTURING; CRYSTAL GROWTH; SPACE LABORATORIES; SPACE PROCESSING; WEIGHTLESSNESS

Subject Classification: 7512 ;Astronautics--General (1975-)

CODAT Code: 13H ;Industrial Processes

1049978 N80-13125

The near-term potential of manufacturing in space

FRIITIS, E.; BYROADE, A.

General Accounting Office, Washington, D. C.

In ESA Mater. Sci. In Space p 427-432 (SEE N80-13069 04-12)

Publication Date: Jun. 1979

Language: English

Country of Origin: United States
Country of Publication: International Organization

Document Type: CONFERENCE PAPER

Most documents available from AIAA Technical Library

Subject Classification: 7512 ;Astronautics--General (1975-)

Included. Three hundred and thirty three citations are included. (GRA)

Descriptors: *AEROSPACE ENVIRONMENTS; *BIBLIOGRAPHIES; *SPACE MANUFACTURING; CRYSTAL GROWTH; SPACE LABORATORIES; SPACE PROCESSING; WEIGHTLESSNESS

Subject Classification: 7512 ;Astronautics--General (1975-)

CODAT Code: 13H ;Industrial Processes

1047985 N80-11112

Evaluation criteria for commercially oriented materials processing in space proposals

Final Report

MOORE, W. F.; McDOWELL, J. R.

Battelle Columbus Labs., Ohio.

In ESA Mater. Sci. In Space p 427-432 (SEE N80-13069 04-12)

Publication Date: Jun. 1979

Language: English

Country of Origin: United States
Country of Publication: United States

Document Type: REPORT

(cont. next page)
Most documents available from AIAA Technical Library
Document Type: JOURNAL ARTICLE
Country of Origin: United Kingdom
Country of Publication: United Kingdom
Language: English
Publication Date: May 1980

MINOS - A space system for the Industrial production of materials in orbit

MINOS - Systeme spatial pour la production industrielle de materiaux en orbite

SERRADEIL, R (Centre National d'Etudes Spatiales, Paris, France); TOROSSIAN, R (Societe Nationale Industrielle Aeronautique et Spatiale, Paris, France); DOMAULAM, M. (MATRA, S.A., Velizy-Villacoublay, Yvelines, France)

L'Aeronautique et Astronautique, no. 82, 1980, p. 3-10. In French.

Publication Date: 1980
Language: French
Country of Origin: France
Country of Publication: France
Document Type: JOURNAL ARTICLE
Most documents available from AIAA Technical Library

The MINOS (French acronym for Modules for Space Industry and Observation) system approach to an automatic orbital station for the industrial production of materials in space is presented. Consideration is given to the possible materials to be processed by the station and associated system requirements, and the results of baseline studies concerning the functions and subsystems determining the orbit and configuration of the system are outlined. The components of the proposed system are then described, with attention given to the service module, which fulfills the functions of stabilization, energy and communications, and the shuttle vehicle, to be launched by Ariane and be responsible for returning products to earth. The design of a multimission MINOS system is then considered, with attention given to the modular design, shuttle vehicle, standard modules and the arrangement of the modules, and areas requiring further technical development are indicated. (A.L.W.)

Source of Abstract/Subfile: AIAA/TIS

Descriptors: +FRENCH SPACE PROGRAMS; +ORBITAL SPACE STATIONS; +SPACE MANUFACTURING; +DESIGN ANALYSIS; +MODULES; +SPACE MISSIONS; +SPACE SHUTTLES; +SPACE TRANSPORTATION; TECHNOLOGY UTILIZATION

Subject Classification: 7512 .Astronautics--General (1975-)

1040471 A80-47670

MINOS - A space system for the industrial production of materials in orbit

MINOS - Systeme spatial pour la production industrielle de materiaux en orbite

SERRADEIL, R (Centre National d'Etudes Spatiales, Paris, France); TOROSSIAN, R (Societe Nationale Industrielle Aeronautique et Spatiale, Paris, France); DOMAULAM, M. (MATRA, S.A., Velizy-Villacoublay, Yvelines, France)

L'Aeronautique et Astronautique, no. 82, 1980, p. 3-10. In French.

Publication Date: 1980
Language: French
Country of Origin: France
Country of Publication: France
Document Type: JOURNAL ARTICLE
Most documents available from AIAA Technical Library

The MINOS (French acronym for Modules for Space Industry and Observation) system approach to an automatic orbital station for the industrial production of materials in space is presented. Consideration is given to the possible materials to be processed by the station and associated system requirements, and the results of baseline studies concerning the functions and subsystems determining the orbit and configuration of the system are outlined. The components of the proposed system are then described, with attention given to the service module, which fulfills the functions of stabilization, energy and communications, and the shuttle vehicle, to be launched by Ariane and be responsible for returning products to earth. The design of a multimission MINOS system is then considered, with attention given to the modular design, shuttle vehicle, standard modules and the arrangement of the modules, and areas requiring further technical development are indicated. (A.L.W.)

Source of Abstract/Subfile: AIAA/TIS

Descriptors: +FRENCH SPACE PROGRAMS; +ORBITAL SPACE STATIONS; +SPACE MANUFACTURING; +DESIGN ANALYSIS; +MODULES; +SPACE MISSIONS; +SPACE SHUTTLES; +SPACE TRANSPORTATION; TECHNOLOGY UTILIZATION

Subject Classification: 7512 .Astronautics--General (1975-)

1040471 A80-47670

MINOS - A space system for the industrial production of materials in orbit

MINOS - Systeme spatial pour la production industrielle de materiaux en orbite
of commercially based communications satellites in the 1960s. Also examined is the growth of industrialization and the commercial implications of earth observation satellites, in-orbit material processing, orbital antenna farm, and space power system. Finally, it is concluded that the current reluctance of sectors of industry to innovate must be reversed since the solving of future problems will require a more revolutionary approach. (M.E.P.)

Source of Abstract/Subfile: AIAA/TIS
Descriptors: *SPACE INDUSTRIALIZATION; *TECHNOLOGY UTILIZATION; ANTENNAS; COMMUNICATION SATELLITES; DEFENSE PROGRAM; EARTH OBSERVATIONS (FROM SPACE); ELECTRIC GENERATORS; ENERGY TECHNOLOGY; MILITARY TECHNOLOGY; SOLAR POWER SATELLITES; SPACE PROCESSING
Subject Classification: 7512 .Astronautics-General (1975-)

1007572 ABO-14771
Congress sponsored by the Canaveral Council of Technical Societies. Cocoa Beach, Fla., Canaveral Council of Technical Societies, 1979. 325 p (For individual items see ABO-14777 to ABO-14793)
Publication Date: 1979
Language: English
Country of Publication: United States
Document Type: CONFERENCE PROCEEDINGS
Journal Announcement: IAA8003

Papers are presented on such areas as Shuttle update, DOD initiatives in space, Spacelab, payload planning, space commercialization, and technology transfer. Particular consideration is given to the Shuttle orbital flight test, leased military space communication systems, Spacelab flight operations, commercialization of materials processing in space, and medical applications of aerospace technology. (B.J.)

Source of Abstract/Subfile: AIAA/TIS
Descriptors: *AEROSPACE TECHNOLOGY TRANSFER; *CONFERENCES; *SPACE MISSIONS; *SPACE TRANSPORTATION SYSTEM; *TECHNOLOGY UTILIZATION; DEFENSE PROGRAM; EXTERNAL TANKS; FLIGHT OPERATIONS; GROUND SUPPORT SYSTEMS; LANDSAT SATELLITES; MEDICAL SCIENCE; OPTICAL COMMUNICATION; SOCIOLOGY; SOLAR POWER SATELLITES; SPACE INDUSTRIALIZATION; SPACE SHUTTLE ORBITERS; SPACE SHUTTLE PAYLOADS; SPACE SURVEILLANCE (SATELLITE); SPACE TRANSPORTATION SYSTEM FLIGHTS; SPACELAB PAYLOADS; TECHNOLOGY ASSESSMENT
Subject Classification: 7512 .Astronautics-General (1975-)

0982963 N79-14120 Nonterrestrial material processing and manufacturing of large space systems
VONTIENSHAUSEN, G. F.
National Aeronautics and Space Administration, Marshall Space Flight Center, Huntsville, Ala.
Corp. Source Code: ND736801
Publication Date: Nov. 1978 31P.
Report No.: NASA-TM-78207
Language: English
Country of Origin: United States
Country of Publication: United States
Document Type: REPORT
Journal Announcement: STAR7905

Most documents available from AIAA Technical Library
Other Availability: NTIS HC AO3/MF AO1

It was calculated that an FeBO3B203 glass-ceramic containing only 1 mole% FeBO3 would be equivalent for magnetooptical application to a YIG crystal of equal thickness. An FeBO3B203 composition containing 2 mole% FeBO3 equivalent (98B) could be converted largely to a dense green, though opaque, FeBO3 glass-ceramic through suitable heat treatments. However, phase separation (and segregation) and Fe3+ reduction could not be entirely avoided with the various procedures that were employed. From light scattering calculations, it was estimated that about 100 A to allow 90% light transmission through a 1 cm thick sample. However, the actual FeBO3 crystallite sizes obtained in 98B were of the order of 1 micron or greater. (Author)

Descriptors: *BORATES; *IRON COMPOUNDS; *SPACE MANUFACTURING; *CERAMICS; *GLASS; *HEAT TREATMENT; *LIGHT SCATTERING
Subject Classification: 7512 .Astronautics-General (1975-)
COSATI Code: 22A .Astronautics
process. Several options for chemical processing of lunar materials are well within the state of the art of applied chemistry and chemical engineering to begin development based on the extensive knowledge of lunar materials. (S.D.)

The paper highlights recent work on the general problem of processing lunar materials. The discussion covers lunar source materials, refined products, motivations for using lunar materials, and general considerations for a lunar or space processing plant. Attention is given to chemical processing materials, and general considerations for a lunar or space materials handling system. Various techniques, including electrolysis of molten silicates, carbothermal/silicothermal reduction, carbo-chlorination process, and HF acid-leach process. Several options for chemical processing of lunar materials are well within the state of the art of applied chemistry and chemical engineering to begin development based on the extensive knowledge of lunar materials. (S.D.)

Subject Classification: 7512.Astronautics-General (1975-)

Descriptors: *CHEMICAL ENGINEERING; *LUNAR ROCKS; *LUNAR SOIL; *SPACE MANUFACTURING; BENEFICIATION; CHLORINATION; ELECTROLYSIS; HYDROFLUORIC ACID; LEACHING; MATERIALS HANDLING SPACE INDUSTRIALIZATION

The present paper deals with the orbiting Minos station intended for processing materials in space, whose design and specifications are being developed to match the capabilities of the Ariane booster. The structure of the spacecraft is described along with the solar panels, energy storage, control system, communications, telemetry, and on-board computer system. (V.P.)

Source of Abstract/Subfile: AIAA/TIS

Descriptors: *FRENCH SPACE PROGRAMS; *ORBITAL SPACE STATIONS; *SPACE MANUFACTURING; *SPACE PROCESSING; ARIANE LAUNCH VEHICLE; *FREE FLIGHT; GUYANA; *REENTRY VEHICLES; *RENDEZVOUS SPACECRAFT; *SERVICE MODULES; SPACECRAFT POWER SUPPLIES; SPACECRAFT STRUCTURES

Subject Classification: 7512.Astronautics- General (1975-)

Alloys out of weightlessness (space manufacturing of semiconductors)

Some results of technological experiments on board the Salut-6/Soyuz space laboratory are reviewed. X-ray photographs of an aluminum-tungsten alloy and an aluminum-bismuth alloy and their terrestrial counterparts are given and discussed. Study of the microstructure shows suppression of liquation and a more uniform phase distribution than in terrestrial samples. Also, the primary crystals are larger with a more perfect faceting. Under terrestrial conditions, the components of the aluminum-bismuth alloy are distributed in two separate rows, whereas under space conditions they are mixed. (V.P.)

Source of Abstract/Subfile: AIAA/TIS

Descriptors: *CADMIUM TELLURIDES; *MERCURY TELLURIDES; *SEMICONDUCTORS (MATERIALS); *SPACE MANUFACTURING; *WEIGHTLESSNESS; *ALLOYS; *CRYSTALLIZATION; *GLASS; MICROSTRUCTURE; X-RAY SPECTROSCOPY

Subject Classification: 7526.Metallic Materials (1975-)

Post-Apollo revisited


(cont. next page)
will be flown to the space manufacturing facility (SMF), where together with supplementary terrestrial materials, they will be final processed and fabricated into space communication systems, solar cell blankets, radio frequency generators, and electrical equipment. Satellite Power System (SPS) materials requirements and lunar material availability and utilization are detailed, and the SMF processing, refining, fabricating facilities, material flow and manpower requirements are described. (A.T.)

Source of Abstract/Subfile: AIAA/TIS
Descriptors: *EXTRATERRESTRIAL RESOURCES; *LARGE SPACE STRUCTURES; *LUNAR ROCKS; *SPACE MANUFACTURING; *SPACE INDUSTRIALIZATION

Subject Classification: 7512 .Astronautics--General (1975-)

0967630 A79-43247
Nonterrestrial material processing and manufacturing of large space systems


Corp. Source Code: M9738001


Publication Date: 1979 8 Refs.
Language: English

Document Type: CONFERENCE PAPER
Journal Announcement: IAA7918

Nonterrestrial processing of materials and manufacturing of large space system components from preprocessed lunar materials at a manufacturing site in space is described. Lunar materials mined and preprocessed at the lunar resource complex...
The advantages of manufacturing in space are discussed, together with a detailed description of the materials to be processed aboard the Spacelab of NASA's Shuttle. Gravity includes convection currents which lead to unpredictable and undesirable structural and composition differences in solids, tending to separate the different materials contained in a liquid, with the resulting solid lacking uniformity. Most such problems disappear in the weightlessness of outer space making thus possible the production of higher quality materials, as for example metals displaying self-lubricating properties of superconducting qualities. Further, studies show that there are more than 400 alloys that cannot be made on earth because of the gravitational pull. In the microgravity of an orbiting Spacelab NASA will be able to produce crystals, alloys, and medicines (e.g. pure interferon, endorphines, and erythropoietin) never seen on earth. (A.A.)

The book discusses the prospects for carrying out various types of industrial processes in space. The physical conditions prevailing in space are reviewed, phenomena such as convection, diffusion, and surface tension under zero-gravity conditions are discussed, experimental methods of simulating weightlessness, are briefly described, and results of first technological experiments in space on Soyuz 6, Skylab, and the Salyut series of spacecraft are summarized. Possibilities for producing hollow spheres in space or for producing foam metal are discussed. Schemes for crystal growing, electrophoresis, using the sun as heat source, and other technologies for space are studied. (P.T.H.)
kinetics of nucleation and the elimination of crystals, and the elimination of unirregularity in glass growth. Rapid heat transfer is also important in glass forming: the special conditions of heat transfer in space processing must be carefully controlled for successful melting of easily crystallized glasses. Fining and homogenization are important problems in making glasses, but they present no special problems for glass melting in space.

Descriptors: "glass; space processing; bubbles; crystallization; homogeneity; melting; nucleation; reaction kinetics; space manufacturing; supercooling; weightlessness."

Subject Classification: 7512. Astronautics-General (1975-)

A baseline of logistic and power requirements for full-scale manufacturing of metallic materials in earth orbit.

Bloom, H. (General Electric Co., Space Div., Valley Forge, Pa.)


Publication Date: 1978 13 Refs.

Language: English

Country of Origin: International Organization Country of Publication: Netherlands

Document Type: JOURNAL ARTICLE

Most documents available from AIAA Technical Library

Journal Announcement: IAA7820

Various material-science experiments which may be performed under near-weightlessness in space are outlined. Two methods of electrophoretic separation are described: free-flow electrophoresis, and static-zone electrophoresis. Attention is given to the production of isotropic composite materials, the production of two-phase alloys by solidification with a miscibility gap in the liquid state, the production of foamed metals, the preparation of defect-free single crystals and aligned eutectics, and levitation melting. Space-grown crystals are outlined with reference to their use as elementary semiconductors and compound semiconductors. Studies in fluid physics and fluid dynamics in near-zero-gravity conditions are evaluated. (S.C.S.)

Source of Abstract/Subfile: AIAA/TIS

Descriptors: "Materials science; space manufacturing; space processing; space labor; aerospace environments; Alloys; Biophysics; ceramic composite materials; crystallography; electrophoresis; fluid dynamics; metallurgy; microstructure; particle motion; semiconductors (materials); space shuttles; weightlessness."

Subject Classification: 7512. Astronautics-General (1975-)

AEROSPACE - 62-86/ISS09
A number of preliminary surveys have been carried out to identify potential space-processed materials that might be of sufficient worth in earth-based applications to warrant their further production in space. From these surveys, this paper extracts those quantities of materials to be transported and stored, physical parameters of production equipment and facilities, on-orbit operating needs, crew needs, and power requirements that are upper limits of space processing requirements. These data are then developed into a representative baseline of the logistics and power requirements of a future mature space manufacturing program.

Source of Abstract/Subfile: AIAA/TIS
Descriptors: *ENERGY REQUIREMENTS; *ENERGY SOURCES; *LOGISTICS MANAGEMENT; *MATERIALS HANDLING; *METALS; *SPACE MANUFACTURING; EARTH ORBITS; ENERGY TECHNOLOGY; PRODUCTION ENGINEERING; RESEARCH FACILITIES; SATELLITE ORBITS; SPACE INDUSTRALIZATION; SPACE PROCESSING; SPACECRAFT POWER SUPPLIES; TECHNOLOGICAL FORECASTING; TECHNOLOGY UTILIZATION
Subject Classification: 7512 .Astronautics--General (1975-)

Material sciences in space. I - Review of space experiments to date
SEIBERT, G. (ESA, Paris, France)
Publication Date: 1978 5 Refs.
Language: English
Country of Origin: International Organization Country of Publication: Netherlands
Document Type: JOURNAL ARTICLE

The advantages of a processing of materials in space are related to the presence of the low-gravity environment, the vacuum conditions, and the readily available solar energy.

Five basic types of processes envisioned are related to crystal growth, purification/separation, mixing, solidification, and processes in fluids. Potential space products are listed in a table. Electronic products considered include semiconductors, integrated circuits, magnetic switches, relays, magnetic detectors, ultrasonic and optical frequency filters, superconductors, and X-ray targets. Optical and biological products envisaged are related to large diameter crystals, uniformly doped crystals, high-index of refraction glasses, IR-transmitting glasses, improved fiber optics, holographic storage devices, high-purity biologicals for use in making vaccines, human cell purification, enzyme isolations, and protein purification and production. Materials for structural uses comprise better turbine blade materials, high-strength composites, and high-purity materials.

A description is presented of the development of space manufacturing, beginning from flight research phase (1965-1984), the product and process development phase (1982-1990), and the industrial utilization phase (1990-2000). (G.R.)

Source of Abstract/Subfile: AIAA/TIS
Descriptors: *EXTRATERRESTRIAL RESOURCES; *LOW GRAVITY MANUFACTURING; *PRODUCT DEVELOPMENT; *SOLAR ENERGY; *SPACE MANUFACTURING; *VACUUM EFFECTS; CRYSTAL GROWTH; DOPED CRYSTALS; DRUGS; ELECTRONIC EQUIPMENT; GOVERNMENT/INDUSTRY RELATIONS; LEGAL LIABILITY; SPACE PROCESSING; SPACE STATIONS; TECHNOLOGY UTILIZATION; WEIGHTLESSNESS
Subject Classification: 7512 .Astronautics--General (1975-)

Planning for materials processing in space
BARKSDALE, W. J. (South Carolina, University, Columbia, S.C.); GROGGER, P. K. (Colorado, University, Colorado Springs, Colo.); LUEG, R. E. (Alabama, University, University, Ala.).
The concept of space-based manufacturing facilities

Kingsbury, J. E. (NASA, Marshall Space Flight Center, Huntsville, Ala.)

National Aeronautics and Space Administration, Marshall Space Flight Center, Huntsville, Ala.

A theoretical discussion concerning the development of space-based manufacturing facilities is presented. The space-habitat concept, i.e., an in-space self-supporting technological civilization built on rotating pressure vessels is discussed. The development of a solar-powered lunar-materials transporter is proposed, noting various possible configurations. Factors involved in materials processing in space are reviewed along with procedures for the maintenance of an in-space workforce. Attention is also given to human tolerance to rotation as it concerns space-habitat development cost, and to the construction of maximum-strength, minimum-mass structures for such applications. (S.C.S.)

Source of Abstract/Subfile: AIAA/115

Descriptors: *MATERIALS HANDLING; *SPACE MANUFACTURING; *SPACE STATIONS; CILUNAR SPACE; CLOSED ECOLOGICAL SYSTEMS; EXTRATERRESTRIAL RESOURCES; HUMAN TOLERANCES; LAGRANGIAN EQUILIBRIUM POINTS; LIBRATION; LUNAR ROCKS; PAYLOADS

Subject Classification: 7512 .Astronautics-General (1975-)

8072647 A78-15930

Systems analysis of space manufacturing from nonterrestrial materials

Driggers, G. W. (Science Applications, Inc., Huntsville, Ala.)

A theoretical discussion concerning the development of space-based manufacturing facilities is presented. The space-habitat concept, i.e., an in-space self-supporting technological civilization built on rotating pressure vessels is discussed. The development of a solar-powered lunar-materials transporter is proposed, noting various possible configurations. Factors involved in materials processing in space are reviewed along with procedures for the maintenance of an in-space workforce. Attention is also given to human tolerance to rotation as it concerns space-habitat development cost, and to the construction of maximum-strength, minimum-mass structures for such applications. (S.C.S.)

Source of Abstract/Subfile: AIAA/115

Descriptors: *MATERIALS HANDLING; *SPACE MANUFACTURING; *SPACE STATIONS; CILUNAR SPACE; CLOSED ECOLOGICAL SYSTEMS; EXTRATERRESTRIAL RESOURCES; HUMAN TOLERANCES; LAGRANGIAN EQUILIBRIUM POINTS; LIBRATION; LUNAR ROCKS; PAYLOADS

Subject Classification: 7512 .Astronautics-General (1975-)

80873901 A78-17184

The concept of space-based manufacturing facilities

ONEILL, G. K. (Princeton University, Princeton, N.J.)

In: Space-based manufacturing from nonterrestrial materials. (A78-17183 05-12) New York, American Institute of Aeronautics

A theoretical discussion concerning the development of space-based manufacturing facilities is presented. The space-habitat concept, i.e., an in-space self-supporting technological civilization built on rotating pressure vessels is discussed. The development of a solar-powered lunar-materials transporter is proposed, noting various possible configurations. Factors involved in materials processing in space are reviewed along with procedures for the maintenance of an in-space workforce. Attention is also given to human tolerance to rotation as it concerns space-habitat development cost, and to the construction of maximum-strength, minimum-mass structures for such applications. (S.C.S.)

Source of Abstract/Subfile: AIAA/115

Descriptors: *MATERIALS HANDLING; *SPACE MANUFACTURING; *SPACE STATIONS; CILUNAR SPACE; CLOSED ECOLOGICAL SYSTEMS; EXTRATERRESTRIAL RESOURCES; HUMAN TOLERANCES; LAGRANGIAN EQUILIBRIUM POINTS; LIBRATION; LUNAR ROCKS; PAYLOADS

Subject Classification: 7512 .Astronautics-General (1975-)

8067261 A78-19544

New works in space (Space Shuttle based manufacturing and services)

Kingsbury, J. E. (NASA, Marshall Space Flight Center, Huntsville, Ala.)

National Aeronautics and Space Administration, Marshall Space Flight Center, Huntsville, Ala.

A theoretical discussion concerning the development of space-based manufacturing facilities is presented. The space-habitat concept, i.e., an in-space self-supporting technological civilization built on rotating pressure vessels is discussed. The development of a solar-powered lunar-materials transporter is proposed, noting various possible configurations. Factors involved in materials processing in space are reviewed along with procedures for the maintenance of an in-space workforce. Attention is also given to human tolerance to rotation as it concerns space-habitat development cost, and to the construction of maximum-strength, minimum-mass structures for such applications. (S.C.S.)

Source of Abstract/Subfile: AIAA/115

Descriptors: *MATERIALS HANDLING; *SPACE MANUFACTURING; *SPACE STATIONS; CILUNAR SPACE; CLOSED ECOLOGICAL SYSTEMS; EXTRATERRESTRIAL RESOURCES; HUMAN TOLERANCES; LAGRANGIAN EQUILIBRIUM POINTS; LIBRATION; LUNAR ROCKS; PAYLOADS

Subject Classification: 7512 .Astronautics-General (1975-)

8067267 A78-15930

Systems analysis of space manufacturing from nonterrestrial materials

Driggers, G. W. (Science Applications, Inc., Huntsville, Ala.)

A theoretical discussion concerning the development of space-based manufacturing facilities is presented. The space-habitat concept, i.e., an in-space self-supporting technological civilization built on rotating pressure vessels is discussed. The development of a solar-powered lunar-materials transporter is proposed, noting various possible configurations. Factors involved in materials processing in space are reviewed along with procedures for the maintenance of an in-space workforce. Attention is also given to human tolerance to rotation as it concerns space-habitat development cost, and to the construction of maximum-strength, minimum-mass structures for such applications. (S.C.S.)

Source of Abstract/Subfile: AIAA/115

Descriptors: *MATERIALS HANDLING; *SPACE MANUFACTURING; *SPACE STATIONS; CILUNAR SPACE; CLOSED ECOLOGICAL SYSTEMS; EXTRATERRESTRIAL RESOURCES; HUMAN TOLERANCES; LAGRANGIAN EQUILIBRIUM POINTS; LIBRATION; LUNAR ROCKS; PAYLOADS

Subject Classification: 7512 .Astronautics-General (1975-)

8067267 A78-15930

Systems analysis of space manufacturing from nonterrestrial materials

Driggers, G. W. (Science Applications, Inc., Huntsville, Ala.)
The components of a general system for obtaining nonterrestrial material and processing it to a finished product are described conceptually. A chemical process system for lunar materials is schematically portrayed, and parameters of the system are estimated. Scenarios for the implementation of the manufacturing facility and production of the early ground operations are discussed, noting SPA equipment with regard to the user community which will be primarily supported by NASA. The development of a series of low-gravity processing experiments (including crystal growth, solidifications, and processes in fluids) is described along with the program requirements for such research. Spacelab/SPA ground operations are discussed, noting SPA equipment integration into subsystems, and prelaunch/post landing data handling and processing. A review is presented of an eight-month Space Processing Payload Equipment study which defines and investigates SPA payloads for the Space Shuttle, and which includes studies of SPA payload design criteria, mission planning, and analyses regarding costs and scheduling. Areas of immediate challenges are identified, such as the creation of an apparatus inventory, the definition of alternatives in payload design studies, and cost analyses.
The technical and business aspects of space manufacturing are discussed, advantages of space factories and of the low-gravity environment in space are summarized, and five basic types of space processes are examined: crystal growth, purification and separation of various materials, mixing of immiscible and composite materials, solidification and process in fluids concerned with chemical reactions and reaction rates or physical and thermodynamic phenomena. Steps in the evolution of a space-manufacturing program are outlined, and previous experiments in space processing are described along with proposed Space Transportation System/Space lab space-processing payloads. Three case studies representative of future commercial space-processing activities are reviewed, some practical features of a space factory are considered, and the reality of the space-factory concept formed the basis of a study of construction concepts and operations. Design implications imposed on the SPS satellite as a consequence of in-orbit assembly operations, and related attitude control requirements during assembly in LEO or GEO environments, were also evaluated. Results are presented indicating that complete assembly of an operational SPS in LEO, followed by transport to GEO, does not appear technically desirable. The best mix, however, of LEO versus GEO construction activity remains to be resolved. (Author)

Descriptors: \*ASSEMBLIES; \*MICROWAVE ANTENNAS; \*SATELLITE ORBITS; \*SOLAR ARRAYS; \*SPACE MANUFACTURING; \*SPACECRAFT POWER SUPPLIES; \*ANTENNA DESIGN; \*EARTH ORBITS; \*ELECTRIC POWER SUPPLIES; \*POINTING CONTROL SYSTEMS; \*SATELLITE ANTENNAS; \*STATIONARY ORBITS; \*STRUCTURAL DESIGN; \*TRUSSES

Subject Classification: 7512 .Astronautics--General (1975-)}
The prospect of experiments under microgravity has stimulated considerable interest in the FRG. Presently 150 experiments have been proposed. Most of them are aimed at gaining new insight into material processes such as nucleation or solidification, or at obtaining improved data of material properties. The program includes experiments in the fields of metallurgy, crystal growth, chemistry, physical chemistry, fluid dynamics, and it relates even to biology and biophysics. Experiments have been conducted aboard Apollo-Soyuz and NASA rockets. More rocket flights are planned over the next years.

Descriptors: CHALLENGE; ELECTROPHORESIS; FREE CONVECTION; GRAVITATIONAL EFFECTS; MEDICAL EQUIPMENT; MOLECULAR BIOLOGY; SPACE MANUFACTURING

Subject Classification: 7512. Astronautics-General (1975-)

The paper examines the general conditions for the static capillary equilibrium of a fluid interface and for the stability of such equilibrium. Attention is given to capillary phenomena in microgravity in general, and to the utilization of capillary phenomena on Spacelab for space processing, in particular. The maintenance of stable molten zones during crystal growth experiments is considered. (B.J.)

Source of Abstract/Subfile: AIAA/TIS

Descriptors: CAPILLARY FLOW; LOW GRAVITY MANUFACTURING; PROCESSING; MATERIALS SCIENCE; SPACE MANUFACTURING; TECHNOLOGY UTILIZATION

Subject Classification: 7512. Astronautics-General (1975-)

Electrophoresis (in microgravity environment)

BIER. M. (U.S. Veterans Administration Hospital, Tucson, Ariz.)

Veterans Administration Hospital, Tucson, Ariz.
crystals, glass fibers, silicon ribbon, laser glass, and electrophoretic isolation of biological cells. (R.D.V.)

Source of Abstract/Subfile: AIAA/TIS

Descriptors: *INDUSTRIAL PLANTS; *LARGE SPACE STRUCTURES; *LOW GRAVITY MANUFACTURING; *SPACE MANUFACTURING; COST ESTIMATES; EXTRATERRESTRIAL RESOURCES; OPTICAL EQUIPMENT; SPACE SHUTTLES; SPACE STATIONS; SPACELAB; WEIGHTLESSNESS

Subject Classification: 7512 .Astronautics--General (1975-)

How do U.S. companies view space industrialization

DULA, A. M. (Butler, Bilton, Rice, Cook and Knapp: Houston, University, Houston. Tex.)
   Publication Date: Apr. 1977
   Language: English
   Country of Origin: United States

Document Type: JOURNAL ARTICLE

Results from a questionnaire on space industrialization sent to chief executive officers of 378 American companies are discussed. Twenty percent of the companies returned the questionnaire completed. The average company responding to the questionnaire had annual gross sales of $2.5 billion. Some 30% of the respondents were aware of and interested in the possibility of solar power satellites and communication satellites. Forty-seven percent of the respondents felt that there was some probability of both their industries and their companies becoming involved in a Shuttle-based program. (A.Y.)

Source of Abstract/Subfile: AIAA/TIS

Descriptors: *INDUSTRIES; *SPACE MANUFACTURING; *SPACE PROCESSING; COMMUNICATION SATELLITES; CRYSTAL GROWTH; ECONOMIC FACTORS; GOVERNMENT/INDUSTRY RELATIONS; METALLURGY; SATELLITE SOLAR POWER STATIONS; SPACE SHUTTLES

Subject Classification: 7580 .Social Sciences--General (1975-1)
Space processing applications - Designing the initial space transportation payload equipment

R. L. Hammel (TRW Systems, Redondo Beach, Calif.)


The principal results are discussed of a summer study conducted in 1976 at the NASA Ames Research Center. The study had been concerned with the key technical problems which would have to be resolved to make a space manufacturing of lunar materials feasible. Attention is focused on the mass driver as a means of transporting large quantities of lunar materials to a precise point in space, three-body calculations are also considered along with the utilization, of earth-approaching asteroids as raw materials for space manufacturing.

Possibilities of manufacturing, and of scientific research in the space environment, and effective realization thereof (literature study)

R. L. Hammel (TRW Systems, Redondo Beach, Calif.)


A description is presented of the U.S. Space Processing Applications program which has been established under the auspices of NASA. Material processes considered are related to crystal growth, purification/separator, mixing, solidification, and processes in fluids. Program requirements are examined, taking into account fundamentals, research and development payload equipment design efforts, facility summarizer, design payloads, and a mission model. It is pointed out that Spacetab sortie flights offer the opportunity to initiate a comprehensive research and development phase in the exploitation of near weightless conditions for processing materials.

Descriptors: *PROCESSING; *SPACE MANUFACTURING; SPACECRAFT CONSTRUCTION MATERIALS; *ASTEROIDS; *CERAMICS; *ENERGY TECHNOLOGY; FEASIBILITY ANALYSIS; SPACE COLONIES; SPACE TUGS

Subject Classification: 7512 .Astronautics--General (1975-)

The construction of satellite solar power stations from non-terrestrial materials

B. Oleary (Princeton University, Princeton, N.J.)


Publication Date: Jan. 1977 8 Refs.

The construction of satellite solar power stations from non-terrestrial materials is examined. The materials are discussed which can be used, and some of the processes for which space manufacture appears to be particularly interesting.

Descriptors: *INSTRUMENT PACKAGES; *MISSION PLANNING; *NASA PROGRAMS; *SPACE PROCESSING; *SPACE SHUTTLES; FURNACES; PAYLOADS; *RESEARCH AND DEVELOPMENT; SATELLITE-BORNE INSTRUMENTS; SPACE MANUFACTURING

Subject Classification: 7512 .Astronautics--General (1975-)

0810064 A77-18759

0809564 A77-18259
Zero-G processing of magnets experiment MA-070

LARSON, D. J., JR.
Grumman Aerospace Corp., Bethpage, N.Y.
Corporal Source Code: G69I9090

In NASA, Lyndon B. Johnson Space Center Apollo-Soyuz Test Project 13 P (SEE N76-23074 13-88)
Publication Date: Feb. 1976
Language: English

Solidification of magnetic materials in the low gravity orbital environment was studied. The magnetic compounds under study, manganese bismuth and copper cobalt cerium ((Cu, Co)5Ce), both have the potential for the development of high coercive strength. Preliminary results indicate that static fluid configurations, in the absence of the gravitational body force, differ substantially from the documented terrestrial behavior. Chemical homogeneity is substantially enhanced on a macroscopic and microscopic level. Single crystal matrices have been grown in the coordinated growth regions of the flight samples. Primary crystals one order of magnitude greater than those grown terrestrially have been noted and are limited in size by the ampoule dimensions. (Author)

Descriptors: *APOLLO SOYUZ TEST PROJECT; *MAGNETIC MATERIALS; *REDUCED GRAVITY; *SPACE MANUFACTURING; BISMUTH ALLOYS; COPPER ALLOYS; MANGANESE ALLOYS; SOLIDIFICATION

Subject Classification: 7512 .Astronautics--General (1975-)
COSATI Code: 2OC .Electricity & Magnetism

Processing eutectics in space

Summary Report
DOUGLAS, F. C.; GALASSO, S. F.
United Technologies Research Center, East Hartford, Conn.
Corporal Source Code: UFW34219
Publication Date: Nov. 1975
Report No.: NASA-CR-114196; R75-911721-10
Contract No.: NAS8-30669
Language: English

The investigations of directional solidification have indicated the necessity of establishing a secure foundation in earth-based laboratory processing in order to provide a controlling parameter. Zone melting of the eutectic films showed that for films of the order of 10 to 20 micrometers thick, the extra surface energy appears to act to stabilize a regular microstructure. The results suggest that the role of low-gravity as provided in space-laboratory processing is to be sought in the possibility of generating a higher thermal gradient in the solidifying ingot for a given power input-output arrangement than can be obtained under normal one-g processes. (Author)

Descriptors: *EUTECTICS; *SOLIDIFICATION; *SPACE MANUFACTURING; ALUMINUM ALLOYS; MICROSTRUCTURE; NICKEL ALLOYS; SURFACE ENERGY; THIN FILMS

Subject Classification: 7512 .Astronautics--General (1975-)
COSATI Code: 13H .Industrial Processes
The economic and technological feasibility of processing special-purpose materials under zero-gravity outer space conditions in the Space Shuttle program is examined and reviewed. Materials research can be advanced profoundly when gravity effects are eliminated as contributing factors. Gravity convection in melting and solidification interferes with complete homogenization. Drugs and vaccines can be produced via zero-g electrophoresis; glass fiber and crystal growth potentialities are impressive. Levitation (containerless) melting of tungsten, solar furnaces and multiple furnaces holds forth promise. Planning, costs, participation of private firms, ground support, intensification of normal earth-based research on materials considered for space processing, and logistics problems are also discussed. (R.D.V.)
Problems concerning the purity of electronic materials including contaminationless ultra-purification and crystal-growth processes are described.  Usual terrestrial purification methods are outlined and the influence of gravity on the results obtained is analyzed.  Space conditions, space vacuum and zero gravity, relevant to purification techniques are analyzed.  The possibilities for applying these conditions to improved known methods, floating zone technique, or to achieve new space processes are evaluated.  (Author (ESRO))

Source of Abstract/Subfile: ESA
Descriptors: *AEROSPACE ENVIRONMENTS; *CRYSTAL GROWTH; *PURIFICATION; *REDUCED GRAVITY; *SEMICONDUCTORS (MATERIALS); SPACE MANUFACTURING
Subject Classification: 7576 .Solid-State Physics (1975-)

A review was made of the processing of ceramic materials in space and of those space environment factors appearing to be useful in the processing of this class of materials. Applicability of these factors to various processing procedures appropriate to ceramics, such as containerless melting, is discussed.  Specific applications of these procedures in developing new and improved products and processes are reviewed.  (ESRO)

Source of Abstract/Subfile: ESA
Descriptors: *AEROSPACE ENVIRONMENTS; *CERAMICS; *REDUCED GRAVITY; *SPACE MANUFACTURING; CONTAINERLESS MELTS; PRODUCT DEVELOPMENT
Subject Classification: 7527 .Nonmetallic Materials (1975-)
ABI/INFORM DATABASE

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Pages 1 thru 3
Mining & Manufacturing Co. plans to market space-manufactured gallium arsenide crystals blended alloys. An $8-billion space station, which NASA hopes to place in orbit by 1994, would greatly aid these efforts. Already, McDonnell Douglas has found that space greatly facilitates the production of erythropoietin, a drug that could help anemics. Also, Microgravity Research Associates plans to market space-manufactured gallium arsenide crystals for use in semiconductor chips. A 10-year project by Minnesota Mining & Manufacturing Co., aims to produce and test crystals that could be used in a new kind of optical computer.

DESCRIPTORS: NASA (space); Drugs; Space; Manufacturing; Electronics; Semiconductors; Predictions; R&D.

CLASSIFICATION CODES: 8641 (CN=Pharmaceuticals Industry); 8650 (CN=Electrical & electronics industries); S400 (CN=Research & development)

Investing in the Final Frontier
Cohen, Jeffrey
Financial Planning v14n1 PP: 145-151 Nov 1985 ISSN: 0015-8259 JRNLCODE: FPN

Recent experiments in pharmaceutical manufacturing performed aboard the space shuttle by McDonnell Douglas Astronautics Co. may assist in providing investment methods for private commercial space projects, including satellite operations, which are being shifted to the private sector. Most of the investment opportunities in commercial space projects involve venture capital, joint ventures, or research and development (R&D) limited partnerships. The funding method most likely to be used by Space Industries Inc. David Thompson, president of Orbital Sciences Corp., notes that the investor enthusiasm in start-up companies has declined because returns on investments have not yet been generated. Venture capitalist William Claybaugh believes Investment funds can be increased through the materials processed in space Industry and government purchased private space products. The tax and regulatory environments are also likely to affect investments.

DESCRIPTORS: Space; Investments; Satellites; Limited partnerships; Many companies; Start up; Companies; R&D

CLASSIFICATION CODES: 3400 (CN=Investment analysis); 8680 (CN=Transportation equipment industry)
Solar Cell Refinements Are Making Possible More Efficient, Reliable Space Applications

Hirano, Iaizo

Dipl Office Equipment & Products (Japan) V14n80 PP: 68-69 Jun 1985 CODEN: DPEPAA ISSN: 0387-5245 JRNL CODE: DEP

DOC TYPE: Journal Paper LANGUAGE: English LENGTH: 2 Pages

AVAILABILITY: ABI/INFORM

In Japan, the National Space Development Agency (NASA) has designated the Sharp Corp. to develop a new, thin solar cell. The cell is made of single-crystal silicon wafers, 65 microns thick. This cell has become one of the 5 kinds of cells registered as devices approved by NASA; the other cells include a 100-micron and a 200-micron version. Manufacturing thinner cells has given rise to additional problems, including avoiding cracks and raising available effective surface percentage during the processing of the thin wafers. Since electrical output falls in thinner wafers, methods were developed to preserve the output in these wafers. Other improvements that were made include: 1. Improvement of power accumulation electrode efficiency, and 2. Improvement in incident efficiency through antireflection coating technology. Quality confirmation tests were conducted on the newly developed cells according to the test specifications of NASA.

DESCRIPTORS: Solar energy; Generators; Technological change; Innovations; Satellites; R&D; Sharp-Japan; Japan; Electronics industry; Case studies

CLASSIFICATION CODES: 9170 (CN=Non-US); 5400 (CN=Research & development); 8650 (CN=Electrical & electronics industries); 9110 (CN=Company specific)

Manufacturing in Space: Europe and Japan Prepare for Takeoff

Wood, Peter; Lenoir, William


DOC TYPE: Journal Paper LANGUAGE: English LENGTH: 2 Pages

AVAILABILITY: ABI/INFORM

The German Spacelab to be carried aboard the US space shuttle in October 1985 and a European-built space platform slated for launch in 1987 are examples of a growing interest in industrial space research on the part of European companies. The orbital environment allows for research and manufacturing efficiency that cannot be matched on Earth. Fields such as electronics, materials processing, and pharmaceuticals stand to benefit most from space research. For instance, joint venture between McDonnell Douglas and Johnson & Johnson produced a highly valued hormone on a 1984 shuttle flight. Prospective space manufacturers may become involved through their governments. Companies may also deal directly with the US National Aeronautics and Space Administration (NASA), but this means the loss of government supports. Some Japanese firms are forming groups to split the costs of a space program; others are proposing partnerships with US firms.

DESCRIPTORS: Space; Manufacturing; Research; European Space Agency; NASA (space); R&D; Costs; Japan; Europe; Many companies

CLASSIFICATION CODES: 5400 (CN=Research & development); 9180 (CN=International)

The Region's Business Boards the Shuttles to Profit in Space

Bailey, Douglas M.


DOC TYPE: Journal Paper LANGUAGE: English LENGTH: 3 Pages

AVAILABILITY: ABI/INFORM

In February 1985, Ludwig van den Berg of EG&G Inc. (Wellesley, Massachusetts) will fly into outer space aboard a National Aeronautics and Space Administration (NASA) space shuttle to perform a series of mercuric iodide crystal growing experiments. This could lead EG&G to develop and market sensitive radioactive isotopes for medical diagnostic kits. A number of New England companies are planning to compete for some of the space station research contracts that will soon be awarded by the government. Texas, Florida, California, and Michigan have already begun aggressive programs to compete in this area. The Center estimates that combined gross annual revenues from specific space commercialization efforts will total $65.3 billion by the year 2000, with the largest developments in pharmaceutical production.

DESCRIPTORS: R&D; NASA (space); Government contracts; Case studies

CLASSIFICATION CODES: 5400 (CN=Research & development); 9550 (CN=Public sector); 9110 (CN=Company specific)

Nuclear-Electric Power in Space

Truscello, Vincent C.; Davis, Herbert S.


DOC TYPE: Journal Paper LANGUAGE: English LENGTH: 8 Pages

AVAILABILITY: ABI/INFORM

Nuclear reactor power systems could produce many new applications in space, but design difficulties abound. Among potential space missions requiring large amounts of electricity are an advanced direct-broadcast satellite, an advanced power source for the future space station.
The $30 Billion Potential for Making Chemicals in Space

The chemical process industry continues to be very excited about the US space program. The chemical process industry has long recognized the potential of space. Other companies have planned additional experiments in the production of drugs, drugs, crystals, and glass. It has been estimated that, because of the potential of technology transfer and spinoff industries, every $1 spent on basic research in space will generate $40 worth of economic growth on earth. Manufacturing in space could generate over $42 billion in sales annually by the year 2000. NASA and the White House are putting the finishing touches on the national space commercialization policy. Chart.

DESCRIPTORS: Chemical industry; Space; R&D; Production; NASA (space); Many companies
CLASSIFICATION CODES: 8640 (CN=Chemical industry); 5400 (CN=Research & development)

Some analysts think the US could lose the head start in the commercial exploitation of space. Short-term financial pressures coupled with extended payoff periods could cause the US to abdicate its leading role to the Europeans and Japanese. While agreeing to participate in US efforts, both Europe and Japan have a goal of femating for their sometimes apathetic abilities. Even if optimistic projections are not fully met, space industries could be among the fastest-growing activities in the next century. Despite the lack of a firm, long-term US government financial commitment, some 350 US companies have invested in space research, and 20 are negotiating with the National Aeronautics & Space Administration on such ventures as: 1. metal formation, 2. electroplating, 3. catalysts, 4. glass alloys, and 5. long-term blood storage. The first space venture to reach commercial production, perhaps by 1987, may be a government-industry effort in electrophoresis. Besides economic issues, political, social, and legal questions could pose problems.

DESCRIPTORS: Earth stations (IT); Communications satellites International; Economic policy
CLASSIFICATION CODES: 1210 (CN=Economic policy & planning); 5250 (CN=Telecommunications systems); 9180 (CN=International)

Pharmacy Poised to Enter Age of Made-in-Space Drugs

Within the near future, new pharmacologic agents to aid in the treatment of such conditions as diabetes and hemophilia are expected to be produced by pharmaceutical manufacturers in the production of drugs, crystals, and glass. It has been estimated that, because of the potential of technology transfer and spinoff industries, every $1 spent on basic research in space will generate $40 worth of economic growth on earth. Manufacturing in space could generate over $42 billion in sales annually by the year 2000. NASA and the White House are putting the finishing touches on the national space commercialization policy. Chart.

DESCRIPTORS: Chemical industry; Space; R&D; Production; NASA (space); Many companies
CLASSIFICATION CODES: 8640 (CN=Chemical industry); 5400 (CN=Research & development)

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DESCRIPTORS: Earth stations (IT); Communications satellites International; Economic policy
CLASSIFICATION CODES: 1210 (CN=Economic policy & planning); 5250 (CN=Telecommunications systems); 9180 (CN=International)
Industry's First Astronaut

Kuzela, Lad

Industry Week v22n7 PP: 15-16 Jun 29, 1984 CODEN: IWEA4
ISSN: 0039-0895 JRNLE: IW

AVAILABILITY: ABI/INFORM

Charles Walker is scheduled to become industry's first astronaut in the first fully automated space factory. Walker is the chief test engineer for the electrophoresis project currently being developed by McDonnell Douglas Corp. The electrophoresis process involves subjecting human and animal substances to an electrical charge to produce increased quantities and purities of particular cells, enzymes, hormones, or proteins. Because of the lack of gravity, space factories can separate more than 700 times more material and attain purity levels 4 times greater than those possible on earth. If the electrophoresis experiments succeed, McDonnell Douglas expects to launch a fully automated pre-commercial factory in 1985. Applications of the electrophoresis materials include the production of certain medicines and the improved isolation and purification of beta cells to aid in diabetes research.

DESCRIPTORS: McDonnell Douglas-St Louis; Aerospace industry; Case studies; Innovations

CLASSIFICATION CODES: 8680 (CN=Transportation equipment industry); 5400 (CN=Research & development); 9110 (CN=Company specific)

The IEEE's Crystal Ball

Holmes, Edith

Data Communications v13n4 PP: 67-68 Apr 1984 CODEN: DACODM
ISSN: 0361-8684 JRNLE: DC

AVAILABILITY: ABI/INFORM

At a recent symposium, members of the Institute of Electrical and Electronics Engineers (IEEE) offered views on data communications future. To Howard Frank, president and chief executive officer of Contel Information Systems Inc., the communications industry is going through a chaotic period in which the breakup of AT&T, though much discussed and often blamed, is only one element of an approaching crisis. William L. Mayo, vice-president of satellite systems for Comsat General Corp., stated that Comsat, in a joint venture with NBC, is building the second-largest long-distance network in the US. Richard G. Gould, president of Telecommunications Systems, an engineering company, commented that the recent commercialization of the National Aeronautics and Space Administration's (NASA) 20/30 gigahertz satellite program takes away from the ability to demonstrate to the Third World that the US will sponsor the technology that will provide the orbital slots and the spacecraft capacity needed in the future.

DESCRIPTORS: Data communications; Communications industry; Trends; Communications networks; Television broadcasting; Satellite communications; Satellite systems; Telecommunications

CLASSIFICATION CODES: 8330 (CN=Broadcasting & telecommunications)

Flat-Panel Displays: Technology Choices Multiply

Sherr, Sol

Mini-Micro Systems v17n4 PP: 77 Apr 1984 ISSN: 0364-9342
JRNLE: MOD

AVAILABILITY: ABI/INFORM

Over the next few years, any business graphics application where space is a premium will be a major market for flat-panel displays. Popular applications include portable computers and multiterminal systems for banks and other financial institutions. Based on a forthcoming Frost & Sullivan Inc. study, sales for flat-panel displays will increase at a compounded annual rate of 34% between 1983 and 1987, and then slow to 10% per year through 1992 in constant-dollar terms. By 1992, flat-panel displays will account for about 60% of the display market. Major technology trends to watch involve: 1. light-emitting diodes (LED), 2. thin-film electroluminescence, 3. gas discharge (plasma), 4. liquid-crystal displays (LCD), 5. flat cathode ray tube (CRT) terminals, 6. incandescence, 7. electrochemical displays, and 8. electrochromics and electrophoretics. Table.

DESCRIPTORS: Flat; Panels; Displays; Markets; Technology; Electronics industry

CLASSIFICATION CODES: 5230 (CN=Computer hardware)

Solid State Integrated Circuits: The Case for Gallium Arsenide

Eden, Richard C.; Livingston, Anthony R.; Welch, Bryant M.

AVAILABILITY: ABI/INFORM

Because of its energy-band structure, gallium arsenide (GaAs) is an ideal medium for electronics circuitry. The GaAs semiconductor holds significant promise for high-speed computers, and manufacturing problems are now beginning to be overcome. Electrons in GaAs are very "light" and highly mobile, and the effective mass of its electrons is only 7% that of electrons in silicon. Electron mobility in the channels of GaAs field-effect transistors (FET) is about an order of magnitude higher than in silicon FETs. GaAs is suited for a wide range of applications, such as high-data-rate communications, wide-bandwidth instrumentation, and high-speed computers. For some military and space applications, they offer exceptional radiation hardness. Also discussed are: 1. the choice of device approaches, 2. manufacturing GaAs devices, 3. heterojunction devices, and 4. GaAs production...
Remote Sensing: The Best View In Town/Reliable Power:
Approaching Perfection

Kaplan, Gadi


DOC TYPE: Journal Paper LANGUAGE: English LENGTH: 4 Pages

AVAILABILITY: ABI/INFORM

Through the use of remote-sensing satellites, ocean and land masses can be viewed in the infrared, visible, and microwave portions of the spectrum. Three major developments led to remote sensing as it is known today: 1. the ability to stabilize satellites mechanically in 3 axes simultaneously, 2. the ability to optically scan a scene hundreds of kilometers away and to obtain through meaningful detail about it, and 3. the ability to derive useful information from large data amounts. These solar-cell arrays have high redundancy that stems from the series and parallel connections of individual cell arrays. Future modules will be light, highly modular, and easily retractable and deployable. Work has begun on the development of spaceborne gallium arsenide solar cells. These cells are more efficient than silicon cells and can maintain acceptable efficiencies at higher temperatures. Chart.

CLASSIFICATION CODES: Space; Satellites; NASA (space); Solar energy; Reliability

CLASSIFICATION CODES: 5400 (CN=Research & development); 1500 (CN=Energy/Environment)

Commercialization: High Time for Profits?

Perry, Tekla S.


DOC TYPE: Journal Paper LANGUAGE: English LENGTH: 7 Pages

AVAILABILITY: ABI/INFORM

Potential competitors are estimating commercial space-launching revenues could total $6 billion through 1991. Other companies hope to manufacture pharmaceuticals, alloyed metals, and gallium arsenide crystals in space. Still others plan to gather data by means of their own satellites and then sell the information for profit. Another area of potential profit is remote sensing. Comsat Corp. (Washington, DC) wants to purchase Landsats from the government providing the weather system is included and the government guarantees the purchase of weather information. The government has stated it will stop giving government weather information to Landsat users and wants to either transfer Landsat to the private sector or shut it down by 1988. If Landsat is withdrawn, Terre-Mar Inc. (Mountain View, California) plans to commercialize remote sensing with its own system. A table of companies and their potential projects is included. Table.

CLASSIFICATION CODES: Satellite communications; International; Commercialization; Communications satellites; Space

CLASSIFICATION CODES: 9160 (CN=International); 5250 (CN=Telecommunications systems)

The Evolution of Civilian Space Exploitation

Logsdon, John M.

Futures (UK) v14n5 PP: 393-404 Oct 1982 CODEN: FUTUBD ISSN: 0016-3287 JRNL CODE: FUR

DOC TYPE: Journal Paper LANGUAGE: English LENGTH: 12 Pages

AVAILABILITY: ABI/INFORM

The nature of the uses to which humans are putting space technology is in a rapid state of flux. It becomes increasingly possible to view space as a satisfactory workplace to conduct routine and productive activities that are related to human needs. Materials processing.

(cont. next page)
communications, and earth observation all constitute potential commercial areas for civil activities in space. However, major challenges as well as opportunities are now presented by the relationships between: 1. civilian and military uses of space, and 2. governmental and non-governmental bodies involved. Governments of Industrial countries are trying to identify the proper level of public investment in space technology and the best way to obtain associated benefits. Substantial rewards apparently await the opening up of space to industrial and private sector, and the private sector is destined to become much less of a junior partner in the future exploitation of space. Determinants of space policy and programs in the future will be even more diverse than in the past, with commercialization assuming a much larger role. Tables.

**CLASSIFICATION CODES:** Space; Exploration; NASA (space); Strategy; R&D; Innovation; Technology; Public sector

**AVAILABILITY:** ABI/INFORM

Galium Arsenide: Silicon's New Competition

*Post, Charles T.*

Iron Age v225n31 PP: 51-52 Nov 1, 1982 CODEN: IRAGAN ISSN: 0164-5137 JRLN CODE: IAR

**DOC TYPE:** Journal Paper LANGUAGE: English LENGTH: 2 Pages

**AVAILABILITY:** ABI/INFORM

A new technology, still in the early stages of development, may give a big boost to optical power transmission systems and may make power generation in space more practical. Gallium arsenide devices have the potential to make direct broadcast from satellites to rooftop antennas possible. Researchers in microelectronics are particularly interested in gallium arsenide, which promises to improve performance in handling many of the electronic chores now performed by silicon. Gallium arsenide semiconductors could provide more efficient microelectronic devices, faster digital data processing, and longer lived solar cells for space applications. Gallium arsenide could also be a serious candidate for solid state injection lasers. Gallium arsenide wafers are much easier to produce and are now much easier to produce.

**CLASSIFICATION CODES:** Semiconductors; Innovations; Applications; Communications; Materials

**AVAILABILITY:** ABI/INFORM

Out of This World-Business Probes the Promise of Space

*Hobbs, Shirley* (1986)

*Dialog File 15: ABI/Inform - 71-86/May, Week 2 (Copr. Data Courier Inc.1986)*

**OUT OF THIS WORLD**

Business Probes the Promise of Space

Schletri, Shirley Hobbs

Barron's v211n17 PP: 8-9 Apr 26, 1982 CODEN: BRNSAD ISSN: 0005-0017 JRLN CODE: BAR

**DOC TYPE:** Journal Paper LANGUAGE: English LENGTH: 2 Pages

**AVAILABILITY:** ABI/INFORM

Many companies are already booking space on the Space Shuttle in hopes of reaping commercial benefits. One such project is that of GTI Inc. (San Diego, California), a maker of electronic devices, which is building a furnace with room for many crucibles that will be used to test various metal alloying processes. McDonnell Douglas and Johnson & Johnson will conduct experiments on the feasibility of making drugs in space. Microgravity Research Associates (Coral Gables, Florida) is planning to "grow" semiconductor crystals in space. Space Transportation of Princeton, New Jersey wants to contract with the National Aeronautics and Space Administration (NASA) to build and operate a shuttle whose space they can rent out. The Shuttle is receiving stiff competition from Europe's Ariane and from Japan. Its fixed-price contracts have priced this service too low. Eventually, the shuttle may be used to build manned space stations or a huge solar energy collector.

**CLASSIFICATION CODES:** Commercial; Space; Shuttles; Communications satellites; NASA (space)

**AVAILABILITY:** ABI/INFORM

NASA Will Be Looking for a Payback from Its Payloads

*Barlow, George A.*

Iron Age v225n9 PP: 42-43 Mar 19, 1982 CODEN: IRAGAN ISSN: 0164-5137 JRLN CODE: IAR

**DOC TYPE:** Journal Paper LANGUAGE: English LENGTH: 2 Pages

**AVAILABILITY:** ABI/INFORM

The Space Shuttle was initiated to stimulate the profitable use of space. The biggest business customer on these flights will be the communications industry due to the rapid growth of satellite business. Metallurgical and chemical experiments will also be numerous on the shuttle due to the zero gravity environment which produces alloys with different characteristics from those produced on earth. GTI Corp. plans to conduct low-gravity metallurgical research for industry, using a 200-pound cylindrical furnace that will resolidify metal alloys. Cavities within the furnace will undergo different time-temperature profiles controlled by a computer. The Japanese and German governments plan to conduct materials processing experiments in an international space lab, which consists of a pressurized module providing laboratory facilities and an unpressurized instrument pallet, all carried in the shuttle's cargo bay. Each request for shuttle space is examined for propriety, scientific aim, and safety.

**CLASSIFICATION CODES:** NASA (space); Space; Shuttles; Commerce; Markets

**AVAILABILITY:** ABI/INFORM
Count-Up for Space Insurance

Bannham, Russ
Jrnl of Insurance v43 PP: 26-30 Jan/Feb 1982 ISSN: 0022-1929
JRNLS CODE: III
DOC TYPE: Journal Paper LANGUAGE: English LENGTH: 4 Pages
AVAILABILITY: ABI/INFORM

Recent successes by the space shuttle Columbia have hastened the day when space enterprises will be possible. Many industries will benefit from the use of space as the communications industry already has. Given the fact that some industries are actively planning to manufacture in space, the pharmaceutical industry in particular, the insurance industry will soon be challenged to provide the proper coverages in such new manufacturing facilities, liability, and bodily injury exposures. Exposures will be high as illustrated by the fact that the US government has already insured the space shuttle for about $100 million. The ultimate role of the shuttle is to act as a 'space truck' used for the assembly of space platforms and other jobs. Space travel, which is expected to be common at some future period, poses yet another challenge to the insurance industry. Both insurance and reinsurance will be needed in new areas, and it is probable that international consortiums will have to be formed. As rocket technology to space becomes commonplace, previous concepts of risks, hazards, and peril will have to be re-evaluated.

DESCRIPTORS: Space; Vehicles; Satellites; Insurance coverage; Property Insurance; Liability Insurance
CLASSIFICATION CODES: 8680 (CN=Transportation equipment industry); 8650 (CN=Electrical & electronics industries); 8220 (CN=Property & casualty insurance)

Implications of the Shuttle: Our Business in Space/Spacelab:
Whence, and Whither

Grey, Jerry; Owen, Kenneth
DOC TYPE: Journal Paper LANGUAGE: English LENGTH: 11 Pages
AVAILABILITY: ABI/INFORM

The technology to build reusable, reliable, and economical vehicles to launch payloads into space is now available. The US National Aeronautics and Space Administration (NASA) has developed a reusable shuttle with many new capabilities. Europe's contribution to space-shuttle development is Spacelab, a manned laboratory that will fit into the orbiter's cargo bay and make extended observations on selected scientific flights. The most exciting aspect of space industrialization involves the application of space technology to industrial processes. The precursors to these enterprises are already growing rapidly. A broad segment of private industry has become familiar with the prospects for industry in space. Some of the industries include:
1. pharmaceuticals, 2. electronic devices, 3. glass products, and 4. advanced alloys. Commercial success is promising, but can only be accomplished through imaginative partnerships between public and private enterprise.

DESCRIPTORS: Space; Vehicles; Shuttles; ESRO; NASA (space); Joint ventures; Aerospace industry; Projects
CLASSIFICATION CODES: 8680 (CN=Transportation equipment industry)

Europe's Launch Into Space Business
Cowen, Robert
DOC TYPE: Journal Paper LANGUAGE: English LENGTH: 2 Pages
AVAILABILITY: ABI/INFORM

As commercial opportunities in space improve, the competition will not be left to the superpowers. Europe has announced the development of Ariane, the first commercial operational space carrier. Initial problems were corrected in earlier tests. If the fourth and final test flight is successful, Ariane will be the first of what will be a family of increasingly powerful launchers to challenge the US and the USSR for the expanding business of lofting other countries' satellites into space. An enormous demand is expected for launch vehicles for communications satellites, as well as microgravity, earth-observing, and scientific satellites. The relatively low cost of launching such satellites with the space shuttle has created a demand beyond the shuttle's capacity. Ariane offers an alternative until the shuttle, which is not operational, completes its flight tests. Ariane space, a private company with shareholders that include 36 companies and 11 banks in various European Space Agency (ESA) member countries, is likely to pick up some of the expendable launcher business.

DESCRIPTORS: Europe; ESRO; Projects; Space; Vehicles; Shuttles
CLASSIFICATION CODES: 8680 (CN=Transportation equipment industry)

Space Shuttle Lab Could Help Launch New Drugs
Anonymous
Chemical Week v126n7 PP: 40-41 Feb 13, 1980 CODEN: CHWKA9 ISSN: 0009-272X JRNLS CODE: CEM
DOC TYPE: Journal Paper LANGUAGE: English
AVAILABILITY: ABI/INFORM

Some of science's most promising new drugs have lacked low-cost ways to produce them. However, in 1982, the National Aeronautics and Space Administration (NASA) and McDonnell Douglas Corp. will begin joint testing of a drug purification system onboard the space shuttle. The technique is known as electrophoresis, and in the weightless environment of space it could increase yields of certain drugs by 400 times the yields possible on earth. Drugs being considered for such production are antihemophilic B, beta pancreatic cells, and urokinase.
constraints presented in a gravity environment are absent in electrophoresis, and industrial chemicals appear to be other potential products of the space-shuttle project. If the tests in space prove to be successful, it is likely that partnership arrangements will be made with a number of pharmaceutical companies. McDonnell Douglas scientists have come up with a continuous flow system that maintains a steady stream of materials in the electrophoresis unit, and the process employed to purify drugs depends on the electrical field in a solution.

DESCRIPTORS: New; Drugs; Space; Vehicles; NASA (space); McDonnell Douglas-St Louis; Research
CLASSIFICATION CODES: 8641 (CN=Pharmaceuticals Industry); 8680 (CN=Transportation equipment Industry)

79001592
Space Law for Business Planners
Dula, Arthur M.
Journal of Contemporary Business v7n3 PP: 113-126 1978 CODEN: JCBUDU
JCBU ISSN: 0042-0298 JRNLE CODE: JCB
DOC TYPE: Journal Paper LANGUAGE: English
AVAILABILITY: ABI/INFORM

Space law is a combination of International and national law that provides a guide for control of business activity in space. Since 1968 the space powers have changed international legal concepts to create customary aerospace law. Multinational treaties originating in the United Nations crystallize this international law which affects the manner in which the U.S. conducts business in space. From the beginning of space exploration, the Soviet Union has expressed the view that profit-making private companies should not be allowed to operate in space. The U.S. reacted by creating the Communications Satellite Corporation which was an economic and technical success. The National Aeronautics and Space Administration (NASA) was drafted not for American profit but as a vehicle for international prestige. Nevertheless, a small portion of NASA's rules and regulations relate to business. Other federal statutes, rules, and regulations relating to Federal Communications will directly affect business done with NASA and must therefore, be considered as part of U.S. space law. NASA regulations disclaim liability for any damage to private business payloads, even if caused by them. Users of the shuttle are subject to the court system and the common tort law of the U.S. References.

DESCRIPTORS: Space; Law; International; Private enterprise; NASA (space); Liability; Users; UN; Treaties; Business; Planning
CLASSIFICATION CODES: 4300 (CN=Law); 1100 (CN=Economics)

78018877
Heat Treating in a Flash
Williams, Earl A.
Production v32n5 PP: 56-62 Nov. 1978 CODEN: PDTDAG ISSN: 0032-9519 JRNLE CODE: PRD
DOC TYPE: Journal Paper LANGUAGE: English

AVAILABLE: ABI/INFORM
Laser beam heat treatment, using a concentrated beam of energy, selectively hardens parts nearly instantly and guarantees improved scuff resistance and longer service life. The electron beam (EB) system allows hardening of large thin parts, parts with thin cross-sections and in most cases, conventional post-straightening and grinding operations are no longer required. The heat treating is accomplished by focusing an energy beam on a metal surface. In seconds, the beam heats the localized area to its transformation temperature. Advantages include: 1. economic selective hardening, 2. minimal or no distortion, 3. noncontamination, 4. in-line process capability, 5. self-quenching, 6. energy conservation, 7. minimization or elimination of post-hardening clean-up, 8. simple parts handling and tooling, 9. use of lower cost materials, and 10. a minimum amount of floor space is required. EB heating is an accurate, predictable process but the material's physical properties affect its heat treat characteristics. Maintenance relating to conventional heat treating is virtually eliminated. Illustrations.

DESCRIPTORS: Industrial; Technology; Lasers; Manufacturing; Heat treating (PROD); Metalworking Industry; Many companies
CLASSIFICATION CODES: 8650 (CN=Electrical & electronics Industries); 5300 (CN=Production management); 8660 (CN=Metalworking Industry)

78016858
Making Space: Launching Industry Into Orbit
Clutterbuck, David
International Mgmt (UK) v33n9 PP: 18-21 Sept. 1978 CODEN: ITMGAT ISSN: 0020-7888 JRNLE CODE: IMG
DOC TYPE: Journal Paper LANGUAGE: English
AVAILABILITY: ABI/INFORM
Companies will have to act now if they expect to exploit the reality of the rapid progress towards space manufacturing. The range of products that space manufacturing would make possible or improve is practically unlimited. One major advance that makes space manufacturing possible is the reusable space shuttle, which NASA will test launch in 1979. A variety of space experiments are set to begin in 1980, many of which could lead to the establishment of factories in space. Experiment designers include universities, research organizations, and companies from both the U.S., Western Europe, and Japan. Of the processes expected to be vastly improved with experimentation are methods of making new alloys, ultra-pure materials, supermagnets, and better crystals. Expectations are high already; for instance, it is known that the drug eurokinase cannot be made on earth because of gravity interference. Space production of eurokinase could save an estimated 50,000 deaths from heart attacks every year in the U.S. alone.

DESCRIPTORS: Technology; Space; Vehicles; NASA (space); Shuttles; Experiments; Technological change; Manufacturing; (cont. next page)
THE PROMISE OF THE SPACE FACTORY
WALTZ, DONALD M.
ISSN: 0040-1692 JRNLCODE: TCR
DOC TYPE: Journal Paper LANGUAGE: English
AVAILABILITY: ABI/INFORM

THE NEW AND CHEAPER PRODUCTS TO BE MANUFACTURED IN SPACE WILL BE PRIMARILY THOSE THAT CAN BENEFIT FROM THE LACK OF GRAVITY. THE SINGLE CRYSTAL SILICON USED FOR INTEGRATED CIRCUITS COULD BE PRODUCED IN MUCH GREATER YIELD BECAUSE OF THE ABSENCE OF CONVECTION. LASING GLASSES COULD THEORETICALLY BE PREPARED IN SPACE BY INCREASING THE CALCIUM OXIDE CONTENT OF COMMERCIAL GLASSES CURRENTLY MARKETED. CONTAINERLESS SPACE PRODUCTION OF GLASS FIBERS COULD GREATLY INCREASE THE QUALITY OF FIBERS. SOME BIOLOGICAL ENTITIES CANNOT BE ISOLATED WITH CURRENT TECHNIQUES, BUT ACCURATE SEPARATION COULD BE ACHIEVED IN ZERO GRAVITY BECAUSE THE CELLS DIFFER IN MASS/CHARGE RATIOS. THE PROCESS DEVELOPMENT PHASE OF SPACE MANUFACTURING IN THE 1980'S WILL INVOLVE STUDIES OF MATERIALS BEHAVIOR AND MANUFACTURING EQUIPMENT AND THE DESIGN OF PILOT PLANT OPERATIONS. THE INDUSTRIAL UTILIZATION PHASE SHOULD BE IN THE 1990'S. CHARTS, REFERENCES.

CLASSIFICATION CODES: 860O (CN=Manufacturing Industries not elsewhere classified)

DESCRIPTORS: Space; Manufacturing; Predictions; Analysis
"Page missing from available version"

pages 1 thru 49
86007963
Still A-OK: The Promise of Factories in Space

Dumaine, Brian
Fortune v113n5 PP: 49-50 Mar 3, 1986 CODEN: FORTAP ISSN: 0015-8259 JRNL CODE: FOR

DCC TYPE: Journal Paper LANGUAGE: English LENGTH: 2 Pages
AVAILABILITY: ABI/INFORM

US companies with space manufacturing ambitions doubt that the recent shuttle disaster will alter long-term plans. In fact, $18 billion in sky-made product sales by US industry has been predicted for the year 2000. The zero-gravity of space allows manufacturers to: 1. easily rearrange molecules to make new drug compounds, 2. make materials with defect-free crystalline structures, and 3. mix metals to form perfectly blended alloys. An $8-billion space station, which NASA hopes to place in orbit by 1994, would greatly aid these efforts. Already, McDonnell Douglas has found that space greatly facilitates the production of erythropoietin, a drug that could help anemics. Also, Microgravity Research Associates plans to market space-manufactured gallium arsenide crystals for use in semiconductor chips. A 10-year project by Minnesota Mining & Manufacturing Co. aims to produce and test crystals that could be used in a new kind of optical computer.

DESCRIPTORS: NASA (space); Drugs; Space; Manufacturing; Experiments; Semiconductors; Predictions; R&D
CLASSIFICATION CODES: 8641 (CN=Pharmaceuticals industry); 8650 (CN=Electrical & electronics industries); 5400 (CN=Research & development)

85032447
Business Is Starting to Get Serious About Space

Payn<3, Seth; Hall, Alan; Helm, Leslie; Ellis, James E.

DCC TYPE: Journal Paper LANGUAGE: English LENGTH: 2 Pages
AVAILABILITY: ABI/INFORM

The successful record of the National Aeronautics and Space Administration's (NASA) space shuttle has finally attracting paid, on-board research and development experiments by private industry. McDonnell Douglas Astronautics Co. and Ortho Pharmaceutical Corp. have an aggressive program to develop new drugs in space. The shuttle has already performed 6 experiments for McDonnell Douglas, and the company has identified 6 biological products that would be profitable ventures. Other companies, including 3M Co., Rockwell, Boeing, and General Motors, are now negotiating with NASA for experiments in orbit, and industry flights on the shuttle will double or triple in 1986. This corporate commitment will help NASA justify building a manned space station by 1994. Support is also emerging from private industry to fund new universities Centers for Commercial Development of Space. NASA hopes these university/business labs will prepare experiments for the shuttle that will be ready for scaling up to production when a permanent space station is built in the 1990s.

DESCRIPTORS: Space; Travel; Commercial; Applications; Drugs
R&D; NASA (space); Experiments; Many companies; Research centers
CLASSIFICATION CODES: 5400 (CN=Research & development); 9550 (CN=Public sector)

84028775
Competition: Who'll Win the Race for Profits in Space?

Kuzela, Lad
Industry Week v222n3 PP: 28-31 Aug 6, 1984 CODEN: IWEA4 ISSN: 0039-0895 JRNL CODE: IW

DCC TYPE: Journal Paper LANGUAGE: English LENGTH: 4 Pages
AVAILABILITY: ABI/INFORM

Some analysts think the US could lose the head start in the commercial exploitation of space it gained with the Space Shuttle. Short-term financial pressures coupled with extended payoff periods could cause the US to abdicate its leading role to the Europeans and Japanese. While agreeing to participate in US efforts, both Europe and Japan have a goal of independent space-related activities. Even if optimistic projections are not fully met, space industries could be among the fastest-growing activities in the next century. Despite the lack of a firm, long-term US government financial commitment, some 350 US companies have invested in space research and 20 are negotiating with the National Aeronautics & Space Administration on such ventures as: 1. metal formation, 2. electroplating, 3. catalysts, 4. glass alloys, and 5. long-term blood storage. The first space venture to reach commercial production, perhaps by 1987, may be a government-industry effort in electrophoresis. Besides economic issues, political, social, and legal questions could pose problems.

DESCRIPTORS: Earth stations (TC); Communications satellites International; Economic policy
CLASSIFICATION CODES: 1120 (CN=Economic policy & planning); 5250 (CN=Telecommunications systems); 9180 (CN=International)

84027623
Pharmacy Poised to Enter Age of Made-In-Space Drugs

White, John P.
Drug Topics v128n15 PP: 94,96 Aug 6, 1984 CODEN: DGTNA7 ISSN: 0012-6616 JRNL CODE: RXT

DCC TYPE: Journal Paper LANGUAGE: English LENGTH: 2 Pages
AVAILABILITY: ABI/INFORM

Within the near future, new pharmacologic agents to aid in the treatment of such conditions as diabetes and hemophilia are expected to be produced by pharmaceutical manufacturing operations located in outer space. The shuttle launch, scheduled for August 24 will carry McDonnell Douglas Corp. engineer Charles D. Walker, who will begin the Electrophoresis Operations in Space (EOS) project. Using continuous flow electrophoresis, Walker will separate a hormone from a protein solution without the severely limiting effects of gravity on (cont. next page)
sample yield and purity, after the shuttle returns to earth, Ortho Pharmaceutical Corp., a partner of McDonnell Douglas in the venture, will conduct the animal and human testing of the material manufactured in space. Ortho hopes the product will be ready to distribute commercially by 1987. A much larger, fully automated electrophoresis unit with greatly increased production capacity is planned for a 1985 shuttle flight. By 1988, a full-scale manufacturing plant is expected to be placed in orbit. Diagram.

DESCRIPTORS: Pharmaceutical industry; Experiments; Joint ventures; Research
CLASSIFICATION CODES: 8641 (CN=Pharmaceuticals industry); 5400 (CN=Research & development)

84011364
Space Commercialization: How Soon the Payoffs?
Logsdon, John M.
Futures (UK) v16n1 PP: 71-78 Feb 1984 CODEN: FUTUBD ISSN: 0016-3287 JRNL CODE: FUR
DOC TYPE: Journal Paper LANGUAGE: English LENGTH: 8 Pages
AVAILABILITY: ABI/INFORM

Space advocates have increasingly promoted the commercial potential of space activities to justify public expenditures for space programs. Satellite communications will continue to be a viable space enterprise; however, transportation services for satellite launching have limited commercial prospects. The commercial viability of on-orbit services will be dependent upon the development of a large-scale space industry based on materials processing and space manufacturing. While space manufacturing may yield potentially high payoffs to the private sector, these will not be realized in the short term. A substantial amount of research into real space business opportunities must be conducted before sizable private investments are made in space manufacturing. In addition, space manufacturing will require the development of an extensive orbital infrastructure which will take years to complete. Space advocates should stress the scientific and exploration benefits of the space program rather than its remote economic payoffs. References.

DESCRIPTORS: Space; Commercialization; NASA (space); R&D; Telecommunications; Transportation; Predictions
CLASSIFICATION CODES: 5400 (CN=Research & development); 1110 (CN=Economic conditions & forecasts)

83029478
Commercialization: High Time for Profits?
Perry, Tekla S.
DOC TYPE: Journal Paper LANGUAGE: English LENGTH: 7 Pages
AVAILABILITY: ABI/INFORM

Potential competitors are estimating commercial space-launching revenues could total $6 billion through 1991. Other companies hope to manufacture pharmaceuticals, alloyed metals, and gallium arsenide crystals in space. Still others plan to gather data by means of their own satellites and then sell the information for profit. Another area of potential profit is remote sensing. Comsat Corp. (Washington, DC) wants to purchase Landsats from the government providing the weather system is included and the government guarantees the purchase of weather information. The government has stated it will stop giving away information and wants to either transfer Landsats to the private sector or shut it down by 1988. If Landsat is withdrawn, Terre-Mar Inc. (Mountain View, California) plans to commercialize remote sensing with its own system. A table of companies and their potential projects is included. Table.

DESCRIPTORS: Space communications; International; Commercialization; Communication satellites; Space
CLASSIFICATION CODES: 9180 (CN=International); 5250 (CN=Telecommunications systems)

78016858
Made In Space: Launching Industry Into Orbit
Clutterbuck, David
International Mgmt (UK) v33n9 PP: 18-21 Sept. 1978 CODEN: ITMGAT ISSN: 0020-7888 JRNL CODE: IMG
DOC TYPE: Journal Paper LANGUAGE: English
AVAILABILITY: ABI/INFORM

Companies will have to act now if they expect to exploit the reality of the rapid progress towards space manufacturing. The range of products that space manufacturing would make possible or improve is practically unlimited. One major advance that makes space manufacturing possible is the reusable space shuttle, which NASA will test launch in 1979. A variety of space experiments are set to begin in 1980, many of which could lead to the establishment of factories in space. Experiment designers include universities, research organizations, and companies from both the U.S., Western Europe, and Japan. Of the processes expected to be vastly improved with experimentation are methods of making new alloys, ultra-pure materials, superconductors, and better crystals. Expectations are high already; for instance, it is known that drugs like eurokinase cannot be made on earth because of gravity interference. Space production of eurokinase could save an estimated 50,000 deaths from heart attacks every year in the U.S. alone.

DESCRIPTORS: Technology; Space; Vehicles; NASA (space); Shuttles; Experiments; Technological change; Manufacturing; Audits
CLASSIFICATION CODES: 8680 (CN=Transportation equipment industry); 5400 (CN=Research & development); 4100 (CN=Accounting)
BIOSIS PREVIEWS DATABASE

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CODON (BRISBANE, CA) PRODUCT PURIFICATION ON SPACE SHUTTLE.

ANON

APPLIED GENETICS NEWS, VOL. 6, NO. 5, P. 6, 1 PAGE, 1985.

Language: ENGLISH

Codon has developed a method to produce large quantities of erythropoietin that uses genetic engineering techniques. McDonnell Douglas, who contracted the development, is using its Electrophoresis Operation in Space (EOS) device to purify the product aboard the space shuttle launched on November 25, 1985. The EOS device is capable of separating 700 times the material that a similar device on Earth could separate. It can also purify the materials four times greater. Codon anticipates manufacturing the erythropoietin for clinical markets.

Descriptors: GENETIC ENGINEERING; GENETICS; NEW TECHNIQUE; RESEARCH AND DEVELOPMENT; SCIENTIFIC RESEARCH

Subject Codes/Headings: 04600 - PROTEINS & RELATED COMPOUNDS; 72100 - METHODS, MATERIALS & APPARATUS

Company Name: CODON, BRISBANE, CA

PHARMACEUTICAL INDUSTRY EXPLORES COMMERCIAL POTENTIAL OF SPACE RESEARCH.

Orr T


Language: ENGLISH

Pharmaceutical industry explores commercial potential of space research.

Descriptors: DRUG MANUFACTURING; PURIFICATION

Subject Codes/Headings: 21100 - PHARMACOLOGY & CHEMOTHERAPY

Company Name: HAYASHIBARA, BRISBANE, CA

HAYASHIBARA TO ENGAGE IN SHUTTLE LAB EXPERIMENT.

ANON


Language: ENGLISH

Hayashibara Biochemical Laboratories Inc. (HBL) will engage in experiments for mass separation and purification of physiological activating substances such as interferon. The electrophoresis operation in space (EOS) module on board an American space shuttle will be used for the experiments. Hayashibara will be the first Japanese user of the EOS system, which was developed by McDonnell Douglas Corp.

Descriptors: BIOTECHNOLOGY; CHEMICAL INDUSTRY; CHEMICALS; JAPAN; RESEARCH; RESEARCH AND DEVELOPMENT; SCIENTIFIC RESEARCH; SPACE EXPLORATION; TECHNIQUE; TECHNOLOGY

Subject Codes/Headings: 15800 - ENDOCRINE SYSTEM; 21100 - PHARMACOLOGY & CHEMOTHERAPY; 72100 - METHODS, MATERIALS & APPARATUS; 80200 - AEROSPACE & UNDERWATER BIOLOGY

Company Name: HAYASHIBARA BIOCHEMICAL LABORATORIES INC., JAPAN

MCDONELL-DOUGLAS SEeks NEW PARTNER FOR SPACE SHUTTLE PRODUCT.

HESTER A S


Language: ENGLISH

Descriptors: ZERO GRAVITY ELECTROPHORESIS; PROTEIN PURIFICATION

Subject Codes/Headings: 04600 - PROTEINS & RELATED COMPOUNDS; 72100 - METHODS, MATERIALS & APPARATUS

PHARMACEUTICAL INDUSTRY EXPLORES COMMERCIAL POTENTIAL OF SPACE RESEARCH.

Orr T


Language: ENGLISH

Descriptors: ELECTROPHORESIS-OPERATIONS-IN-SPACE; ENDOCRINOCUMS INC; AUTOMATED CULTURE SYSTEM; PRODUCT DEVELOPMENT; BIOTECHNOLOGY INDUSTRY; PHARMACEUTICAL INDUSTRY

Subject Codes/Headings: 04600 - PROTEINS & RELATED COMPOUNDS; 72100 - METHODS, MATERIALS & APPARATUS

Company Name: HAYASHIBARA, BRISBANE, CA

PURIFIED CELL PRODUCTS PRODUCED IN SPACE.

ANON


Language: ENGLISH

Descriptors: PROTEIN; ENZYME; HORMONE; BILOGICS; ELECTROPHORESIS-OPERATIONS-IN-SPACE; ENDOCRINOCUMS INC; AUTOMATED CULTURE SYSTEM; PRODUCT DEVELOPMENT; BIOTECHNOLOGY INDUSTRY; PHARMACEUTICAL INDUSTRY

Subject Codes/Headings: 04600 - PROTEINS & RELATED COMPOUNDS; 72100 - METHODS, MATERIALS & APPARATUS; 80200 - AEROSPACE & UNDERWATER BIOLOGY

Company Name: HAYASHIBARA, BRISBANE, CA

SPACE SHUTTLE DRUG TESTED.

AM PHARM ASSOC


Language: ENGLISH

Descriptors: PRODUCT DEVELOPMENT

Subject Codes/Headings: 21100 - PHARMACOLOGY & CHEMOTHERAPY; 72100 - METHODS, MATERIALS & APPARATUS; 80200 - AEROSPACE & UNDERWATER BIOLOGY

Company Name: ORTHO PHARMACEUTICAL CORPORATION

SPACE BIOPROCESSING.

TODD P


Language: ENGLISH

Descriptors: ELECTROPHORESIS; ISOELECTRIC FOCUSING; BIOTECHNOLOGY

Subject Codes/Headings: 80300 - BIOENGINEERING
Sp.ico Industries of Houston, Texas, and the National Aeronautics and Space Administration (NASA) have signed an agreement to launch into orbit via space shuttle a drug and chemical factory in 1989. The agreement also calls for the cooperation of Sp.ico and NASA during the definition and initial design phase of the new space station which is estimated to cost between 250 and 500 million dollars. The factory will represent the first effort by a private company and NASA to share information for a commercial space bound operation. Once launched, the facility would maintain an orbital altitude of 256 miles, where pharmaceuticals, chemicals and exotic metals and alloys will be produced to take advantage of zero gravity conditions. A photograph shows a model of the Sp.ico Industries orbital factory.

Descriptors: AGREEMENTS; CHEMICALS; CONTRACTS; CORPORATIONS; FACILITY PLANNING; FACTORIES; FEDERAL GOVERNMENT; GOVERNMENT; GOVERNMENT AGENCY; INDUSTRIAL ENGINEERING; INDUSTRIAL PLANS; METALS; NASA; OUTER SPACE; PHARMACEUTICALS; PRIVATE COMPANIES; PRIVATE SECTOR; SPACE PLANNING; SPACE SHUTTLE.

Subject Codes/Headings: 21100 - PHARMACOLOGY & CHEMOTHERAPY; 72100 - METHODS, MATERIALS & APPARATUS; 029341 - PROTEIN CRYSTAL GROWTH IN SPACE.

Charles Walker is discussed as the first Industry representative astronaut. Walker is employed by the McDonnell Douglas Corporation and was sent up in the space shuttle to test his patented electrophoresis process for the purification of biological substances. McDonnell Douglas plans to build large-scale electrophoresis factories in space. Space production increases yields by more than 700 times earth production because gravity does not interfere with separations.

Descriptors: BIOLOGICALS; MANUFACTURING; OUTER SPACE; RESEARCH; SCIENTIFIC RESEARCH; SPACE SHUTTLE; TECHNOLOGY; TESTING.

Subject Codes/Headings: 72100 - METHODS, MATERIALS & APPARATUS; 029338 - RESEARCH IN PHARMACEUTICAL TECHNOLOGY AS A COMPONENT OF THE USA MICROGRAVITY SCIENCES AND APPLICATIONS PROGRAM.

The potential for chemical manufacturing in space and the plans of a number of companies to perform experiments and limited manufacturing aboard the space shuttle are discussed. The effects and advantages of zero gravity conditions on some chemical reactions and physical transformations are explained. It is estimated that manufacturing in space could generate sales of $42 billion by the year 2000. Plans of specific companies are described, and a table lists the fields of (cont. next page).
Interest of companies which have approached NASA about conducting research aboard the space shuttle. Genetic engineering, monoclonal antibodies, semiconductor materials, and collagen fibers are noted as areas of particular interest for space development. Photographs of industry personnel and space equipment are included.

Descriptors: BIOTECHNOLOGY; CHEMICAL INDUSTRY; ELECTRONIC INDUSTRY; GENETICS; MANUFACTURING; NASA; PHARMACEUTICAL INDUSTRY; RESEARCH AND DEVELOPMENT; SPACE SHUTTLE; TECHNOLOGICAL CHANGE; TECHNOLOGY

Subject Codes/Headings: 51100 - GENETICS-GENERAL
CODON (BRISBANE, CA) PRODUCT PURIFICATION ON SPACE SHUTTLE.

**ANON**


**Language:** ENGLISH

Codon has developed a method to produce large quantities of erythropoietin that uses genetic engineering techniques. McDonnell Douglas contracted the development, is using its Electrophoresis Operation in Space (EOS) device to purify the product aboard the space shuttle launched on November 25, 1985. The EOS device is capable of separating 700 times the material that a similar device on Earth could separate. It can also purify the materials four times greater. Codon anticipates manufacturing the erythropoietin for clinical markets.

**Descriptors:** GENETIC ENGINEERING; GENETICS; NEW TECHNIQUE; RESEARCH AND DEVELOPMENT; SCIENTIFIC RESEARCH

**Subject Codes/Headings:** 04600 - PROTEINS & RELATED COMPOUNDS; 51100 - GENETICS-GENERAL; 72100 - METHODS; MATERIALS & APPARATUS

Company Name: CODON, BRISBANE, CA

PHARMACEUTICAL INDUSTRY EXPLORES COMMERCIAL POTENTIAL OF SPACE RESEARCH.

**ORR T**


**Language:** ENGLISH

**Descriptors:** DRUG MANUFACTURING; PURIFICATION

**Subject Codes/Headings:** 21100 - PHARMACOLOGY & CHEMOTHERAPY

BIOPROCESSING IN SPACE: HUMAN CELLS ATTACH TO BEADS IN MICROGRAVITY.

**TSCHOPP A; COGOLI A; LEWIS M L; MORRISON D R**

LABORATORIUM FOR BIOCHEMIE, E.T.H.-ZENTRUM, CH-8092 ZURICH, SWITZERLAND.


**Language:** ENGLISH

Attachment to a substrate and survival of human embryonic kidney (HEK) cells was tested in an incubator installed in the flight-deck of the Space Shuttle Challenger during its eighth mission. HEK cells are producing the enzyme urokinase and are presently investigated as candidates after electrophoretic separation in an apparatus developed and manufactured by McDonnell Douglas. Attachment of HEK cells to a substrate is mandatory for survival and production of urokinase after electrophoretic separation. Analysis of the samples shows that cells adhere, spread and survive in microgravity (< 10-3 times g) conditions and the ground controls at 1 times g. This result represents an important step towards further bioprocessing in space.

**Descriptors:** SPACE SHUTTLE CHALLENGER; UROKINASE PRODUCTION; BIOTECHNOLOGY

**Subject Codes/Headings:** 04625 - ENZYMES; 21100 - PHARMACOL-
GPO DATABASE

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Publication Date(s): 1984

LCCN: gp 85018222

Place of Publication: Washington, D.C. ; National Aeronautics and Space Administration.

Languages: English

Document Type: Monograph


Descriptors: Gallium compounds; Solar batteries

Investigation of test methods, material properties, and processes for solar cell encapsulants twenty-sixth quarterly progress report / for Jet Propulsion Laboratory ; by P.B. Willis, B. Baum ; by Springborn Laboratories, Inc

Willis, P. B.

Baum, B.

Corporate Source: Jet Propulsion Laboratory (U.S.) Springborn Laboratories.

Series: NASA-CR ; 173940 ; NASA contractor report ; 173940. Pasadena, Calif. ; The Laboratory, 1983 1 v. ; ill. ; 28 cm.

Publication Date(s): 1983

LCCN: gp 85018215

Place of Publication: California GPO Item No.: 830-H-14 (microfiche)

Technical Report No.: N 84-34029; DOE/JPL-954527-26

Languages: English

Document Type: Monograph


Descriptors: Solar cells; Testing

Crystal growth of device quality GaAs in space annual report / to National Aeronautics and Space Administration ; submitted by Harry C. Gatos and Jacek Lagowski

Gatos, Harry C.

Lagowski, J.


Publication Date(s): 1984

LCCN: gp 85018215

Place of Publication: Washington, D.C. ; National Aeronautics and Space Administration.

Languages: English

Document Type: Monograph


Descriptors: Gallium compounds; Cosmochemistry

Materials Processing In Space Workshop minutes, October 27-28, 1982

Corporate Source: Materials Processing in Space Workshop (1982 ; Redondo Beach, Calif.)

Corporate Source: TRW Defense and Space Systems Group.

United States. National Aeronautics and Space Administration.

Series: NASA-CR ; 173517 ; NASA contractor report ; 173517. Redondo Beach, Calif. ; TRW, 1982 1 v. ; ill. ; 28 cm.

Publication Date(s): 1982

LCCN: gp 85013337

Place of Publication: California GPO Item No.: 830-H-14 (microfiche)

Technical Report No.: N 84-24601

Languages: English

Document Type: Monograph

"Part of the Space Station Needs, Attributes and Architectural Options study that TRW is performing for NASA." "N84-24601"--Microfiche header. Microfiche.-- [Washington, D.C.? ; National Aeronautics and Space Administration, 1984]. 1 microfiche ; 11 x 15 cm.
Crystal growth of device quality GaAs in space submitted by Harry C. Gatos and Jacek Lagowski

Analysis of electrophoresis performance final report / prepared for George C. Marshall Space Flight Center; prepared by Glyn O. Roberts

Analysis of costs of gallium arsenide and silicon solar arrays for space power applications / Kent S. Jeffries


Chemical products and biological preparations: low gravity research in fluid processes

Analysis of costs of gallium arsenide and silicon solar arrays for space power applications / Kent S. Jeffries


Publication Date(s): 1985

LCCN: gp 85013208

Place of Publication: District of Columbia GPO Item No.: 830-H-14 (microfiche)

Technical Report No.: 1983-03-4051

Languages: English

Document Type: Monograph

Descriptors: Materials Processing in Space Workshop; Redondo Beach, Calif.; Space stations - Industrial applications


Descriptors: Gallium compounds; Integrated circuits


Descriptors: Crystals-Growth; Fluid dynamics (Space environment); Skylab Program; Gravitation; Crystals-Growth; Fluid dynamics (Space environment); Skylab Program; Gravitation

Analysis of costs of gallium arsenide and silicon solar arrays for space power applications / Kent S. Jeffries

Analysis of costs of gallium arsenide and silicon solar arrays for space power applications / Kent S. Jeffries

Analysis of costs of gallium arsenide and silicon solar arrays for space power applications / Kent S. Jeffries

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Analysis of costs of gallium arsenide and silicon solar arrays for space power applications / Kent S. Jeffries

Analysis of costs of gallium arsenide and silicon solar arrays for space power applications / Kent S. Jeffries

Descriptors: Rockets (Aeronautics)-Launching

0123112 NAS 1.26-3370
A study of crystal growth by solution technique / R. B. Lal

Lal, R. B., 1935-


Series: NASA contractor report ; 3370


Publication Date(s): 1981

LCCN: gp 81005854

Place of Publication: District of Columbia GPO Item No.: 820-H-14 (microfiche)

Languages: English

Document Type: Monograph


Descriptors: Crystals-Growth

0122231 NAS 1.53-OSTA 80-1
Fluids investigations in space related to materials processing

Corporate Source: United States. National Aeronautics and Space Administration.

Series: Announcement of opportunity ; A.D. no. OSTA 80-1


Publication Date(s): 1980

LCCN: gp 81003795

Place of Publication: District of Columbia GPO Item No.: 830-H-5

Languages: English

Document Type: Monograph


Descriptors: Fluid dynamics (Space environment)-Materials research

0179476 NAS 1.60-2016

Approximate analysis of thermal convention in a crystal-growth cell for Spacelab 3 / Robert F. Dressler

Dressler, Robert F.


Series: NASA technical paper ; 2016


Publication Date(s): 1982

LCCN: gp 8301937

Place of Publication: District of Columbia GPO Item No.: 820-H-15 (microfiche)

Languages: English

Document Type: Monograph


Descriptors: Convection (Astrophysics); Crystals-Growth
Materials processing in space: early experiments / Robert J. Naumann and Harvey W. Herring

Corporate Source: United States. National Aeronautics and Space Administration.
Series: NASA SP ; 443
Publication Date(s): 1980
LCCN: 80037370
Price: $10.00

Float-zone processing in a weightless environment / A. A. Fowle...

Series: NASA contractor report ; NASA CR-2768; United States.; National Aeronautics and Space Administration. NASA contractor report
Publication Date(s): 1976
LCCN: 76009418
Place of Publication: District of Columbia
Languages: English
Document Type: Monograph
Descriptors: Silicon crystals
DIALOG File 66: GPO MONTHLY CATALOG - JUL 1978 TO MAY 1986

0650113 Y 4.J 89/1-99/16

Patents in space : hearing before the Subcommittee on Courts, Civil Liberties, and the Administration of Justice of the Committee on the Judiciary, House of Representatives, Ninety-ninth Congress, first session ... June 13, 1985


Publication Date(s): 1985

LCNN: gc 86005715

Place of Publication: District of Columbia GPO Item No.: 1020-A, 1020-B (microfiche)


Languages: English

Document Type: Monograph

Geographic Location: United States

Distributed to some depository libraries in microfiche.

Shipping list no.: 85-10B9-P. Includes bibliographies.

Descriptors: Patents - United States; Inventors - United States; Space industrialization - United States

0640117 Y 3.T 22/2-2 In 8/2

International cooperation and competition in civilian space activities


Publication Date(s): 1985

LCNN: gc 85023884

Price: $17.00

Place of Publication: District of Columbia GPO Item No.: 1070-M

Stock No.: 052-003-00958-7; GPO

Technical Report No.: OTA-ISC-239

Local Call No.: TL789.8.U51569

Languages: English

Document Type: Monograph

Geographic Location: United States


Descriptors: Space sciences - International cooperation; Space industrialization - International cooperation; Reusable space vehicles - Government policy - United States; Artificial satellites in telecommunication

0638029 NAS 1.55-2313

Second Symposium on Space Industrialization proceedings of a symposium sponsored by NASA Marshall Space Flight Center, the American Institute of Aeronautics and Astronautics, University of Alabama, and held at Huntsville Hilton Inn, Huntsville, Alabama, February 12-15, 1984


Series: NASA conference publication ; 2313


Publication Date(s): 1984

LCNN: gc 85021795

Place of Publication: District of Columbia GPO Item No.: 830-H-1 (microfiche)


Languages: English

Document Type: Monograph


Descriptors: Space stations - Industrial applications; Artificial satellites in telecommunication - Congresses

0496955 Y 4.Sci 2-99/30


Publication Date(s): 1985

LCNN: gc 86007720

Place of Publication: District of Columbia GPO Item No.: 1025-A-1, 1025-A-2 (microfiche)

Technical Report No.: No. 30 (United States. Congress. House. Committee on Science and Technology)

Languages: English

Document Type: Monograph

Geographic Location: United States

Distributed to some depository libraries in microfiche.

Shipping list no.: 85-1069-P. "No. 30."

Descriptors: Eosat; Landsat satellites
Establishment of centers for the commercial development of space

Corporate Source: United States. National Aeronautics and Space Administration.


Publication Date(s): 1985

LC: GP 85019492

Place of Publication: District of Columbia GPO Item No.:

830-C

Languages: English

Document Type: Monograph

Descriptors: Astronautics

Insurance and the commercialization of space /

Printed at the direction of Hon. John C. Danforth for the use of the Committee on Commerce, Science, and Transportation, United States Senate


Series: S. pt : 99-16; United States ; Congress 1985).; Senate. S. pt. :


Publication Date(s): 1985

LC: GP 85016191

Place of Publication: District of Columbia GPO Item No.:

1041-A, 1041-B (microfiche)

Technical Report No. : N 84-27788

Languages: English

Document Type: Monograph

Descriptors: Insurance-United States; Insurance, Government risks - United States; Space industrialization

Manufacturing in space : fluid dynamics numerical analysis /

Prepared for NASA Headquarters by S.J. Robertson

Robertson, S. James.


Publication Series: LMSC-HREC TR ; D 951333; NASA-CR ; 175401; NASA contractor report ; 175401.


Publication Date(s): 1984

LC: GP 85013435

Place of Publication: District of Columbia GPO Item No.:

830-H-14 (microfiche)

Technical Report No. : N 84-19748

Languages: English

Document Type: Monograph

Descriptors: Space stations; Industrial applications; Fluid dynamics (Space environment)

Presentation of opportunities for the chemical industry to become involved in space experimentation final report /

Prepared for National Aeronautics and Space Administration, NASA Headquarters by Edmund Young and Associates


Publication Series: NASA-CR ; 173594; NASA contractor report ; 173594.


Publication Date(s): 1984-9999

LC: GP 85013270

Place of Publication: District of Columbia GPO Item No.:

830-H-14 (microfiche)

Technical Report No. : N 84-25777

Languages: English

Document Type: Monograph

Descriptors: Space station needs; Attributes; Architectural options; Commercial opportunities in space / prepared by H.L. Wolbers, Jr.

Wolbers, H. L.


Publication Series: NASA-CR ; 173698; NASA contractor report ; 173698.


Publication Date(s): 1984

LC: GP 85013293

Place of Publication: District of Columbia GPO Item No.:

1041-A, 1041-B (microfiche)

Technical Report No. : N 84-27788

Languages: English

Document Type: Monograph

Descriptors: Insurance-United States; Insurance, Government risks - United States; Space industrialization


Manufacturing in space : fluid dynamics numerical analysis /

Prepared for NASA Headquarters by S.J. Robertson

Robertson, S. James.


Publication Series: LMSC-HREC TR ; D 951333; NASA-CR ; 175401; NASA contractor report ; 175401.


Publication Date(s): 1984

LC: GP 85013435

Place of Publication: District of Columbia GPO Item No.:
DIALOG File 68: GPO MONTHLY CATALOG - JUL 1976 TO MAY 1988

Aeronautics and Space Administration. - 1984. - microfiches : 11 x 15 cm.

Contents: Note: pt. 1. A portion of the study to encourage and facilitate industrial investment and involvement in space. Descriptors: Chemical Industry-United States; Catalysts; Cosmochemistry

0228272 NAS 1.26-173517
Materials Processing in Space Workshop minutes, October 27-28, 1982
Corporate Source: Materials Processing in Space Workshop (1982 : Redondo Beach, Calif.)
Redondo Beach, Calif. : TRW, [1982] 1 v. : Ill. ; 28 cm.
Publication Date(s): 1982
LCCN: gp 85013246
Place of Publication: California GPO Item No.: 830-H-14 (microfiche)
Languages: English
Document Type: Monograph
Descriptors: Materials Processing in Space Workshop; (1982 : Redondo Beach, Calif.); Space stations-Industrial applications

0227637 GS 4.110-98-575
An Act to Facilitate Commercial Space Launches, and for Other Purposes
Uniform Title: Commercial Space Launch Act
Corporate Source: United States.
Publication Date(s): 1985
LCCN: gp 85012611
Price: $1.00
Place of Publication: District of Columbia GPO Item No.: 575
Stock No.: 022-003-96330-8; GPO
Technical Report No.: Public Law 98-575
Languages: English
Document Type: Monograph
Geographic Location: United States
Descriptors: Astronautics and state-United States; Launch vehicles (Astronautics)

0226334 S 1.71/4-622
Commercialization of outer space : October 9, 1984
Marshall, Harry R.
Publication Date(s): 1984
LCCN: gp 85011307
Place of Publication: District of Columbia GPO Item No.: 877-C
Languages: English
Document Type: Monograph
Descriptors: Astronautics and state-United States; Launch vehicles (Astronautics)

0226231 NAS 1.26-173688
Space station commercial user development
Publication Date(s): 1984
LCCN: gp 85011204
Place of Publication: District of Columbia GPO Item No.: 575
Technical Report No.: N 84-27756
Languages: English
Document Type: Monograph
Descriptors: Astronautics and state-United States; Launch vehicles (Astronautics)

0224553 Y 4.Sci 2-98/108
Initiatives to promote space commercialization : hearing before the Subcommittee on Space Science and Applications of the Committee on Science and Technology, U.S. House of Representatives, Ninety-eighth Congress, second session, June 19, 1984
Publication Date(s): 1984
Price: $1.00
DIALOG File 68: GPO MONTHLY CATALOG - JUL 1976 TO MAY 1986

LCCN: gp 85009526
Place of Publication: District of Columbia GPO Item No.: 1025-A-1, 1025-A-2 (microfiche)
Languages: English
Document Type: Monograph
Geographic Location: United States
Distributed to some depository libraries in microfiche.

No. 108.

Descriptors: Space Industrialization

0224472 Y 4.C 73/7-5568.98-1105
Commercial Space Launch Act : hearing before the Subcommittee on Science, Technology, and Space of the Committee on Commerce, Science, and Transportation, United States Senate, Ninety-eighth Congress, first session, on S. 2931 ... September 6, 1984
Series: S. hrg. ; 98-1105; United States.; Congress 1984).; Senate. S. hrg
Publication Date(s): 1984
LCCN: gp 85009446
Place of Publication: District of Columbia GPO Item No.: 1041-A, 1041-B (microfiche)
Languages: English
Document Type: Monograph
Geographic Location: United States
Distributed to some depository libraries in microfiche.

Serial no. 98-105.

Descriptors: Astronautics and state-United States; Launch vehicles (Astronautics); Astronautics

0217174 Y 4.Sci 2-98/85
The Expendable Launch Vehicle Commercialization Act : hearings before the Subcommittee on Science and Applications of the Committee on Science and Technology, U.S. House of Representatives, Ninety-eighth Congress, first and second sessions, November 18, 1983; March 29, 1984
Publication Date(s): 1984
LCCN: gp 84024774
Place of Publication: District of Columbia GPO Item No.: 1008-C, 1008-D (microfiche)
Technical Report No.: No. 85 (United States. Congress. House. Committee on Science and Technology)
Languages: English
Document Type: Monograph
Geographic Location: United States
Distributed to some depository libraries in microfiche.

No. 85.

Descriptors: United States; Dept. of Transportation; Reusable space vehicles-Government policy-United States; Business enterprises-United States

Geographic Location: United States


Descriptors: Space stations-Government policy-United States; Space sciences-Government policy-United States; Aeronautics and state-United States; Space industrialization

0219330 Y 1.1/5-98-656
Commercial space launches : report (to accompany H.R. 3942)
Publication Date(s): 1984
LCCN: gp 85003749
Place of Publication: District of Columbia GPO Item No.: 1008-C, 1008-D (microfiche)
Languages: English
Document Type: Monograph
Geographic Location: United States
Caption title. Distributed to some depository libraries in microfiche.

"October 3 ... 1984."

Descriptors: Launch vehicles (Astronautics); Astronautics and state-United States

0224428 Y 3.T 22/2-C 49/2
Civilian space stations and the U.S. future in space
Publication Date(s): 1984
LCCN: gp 85009401
Price: $7.50
Place of Publication: District of Columbia GPO Item No.: 1070-M
Stock No.: 052-003-00969-2; GPO
Technical Report No.: OTA-STI-241
Languages: English
Document Type: Monograph

Geographic Location: United States


Descriptors: Space stations-Government policy-United States; Space sciences-Government policy-United States; Aeronautics and state-United States; Space industrialization

011108
021409 Y 4.Sci 2-L 22


Publication Date(s): 1984
LCCN: gp 84021709
Place of Publication: District of Columbia GPO Item No.: 1025-A-1, 1025-A-2 (microfiche)
Languages: English
Document Type: Monograph
Distributed to some depository libraries in microfiche.

Descriptors: Landsat satellites-Economic aspects-United States; Industry and state-United States; Business enterprises-Government policy-United States

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0213200 Y 1.1/8-98-816
Commercial Space Launch Act : report (to accompany H.R. 3942): Cost estimate of the Congressional Budget Office


Publication Date(s): 1984
LCCN: gp 84017098
Place of Publication: District of Columbia GPO Item No.: 1025-A-3, 1025-A-4 (microfiche)
Languages: English
Document Type: Monograph
Distributed to some depository libraries in microfiche.

Descriptors: Landsat satellites-Economic aspects-United States; Industry and state-United States; Business enterprises-Government policy-United States

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0212495 Y 4.C 73/7-S.hrg.98-747
Landsat commercialization : hearing before the Subcommittee on Science, Technology, and Space of the Committee on Commerce, Science, and Transportation, United States Senate, Ninety-eighth Congress, second session, on S. 1855 ... S. 2292 ... March 22, 1984


Senate. S. hrg. :
Publication Date(s): 1984
LCCN: gp 84018612
Price: $1.00
Place of Publication: District of Columbia GPO Item No.: 1025-A-1, 1025-A-2 (microfiche)

Languages: English
Document Type: Monograph
Distributed to some depository libraries in microfiche.

Descriptors: Landsat satellites-Business enterprises-United States

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Role of technology in promoting industrial competitiveness : hearings before the Subcommittee on Science, Technology, and Space of the Committee on Commerce, Science, and Transportation, United States Senate, Ninety-eighth Congress, first session ...

Science, Technology, and Space.


Conference Title: United Nations Conference on the Exploration and Peaceful Uses of Outer Space (2nd : Vienna, Austria) , 1982 :
Publication Date(s): 1983
LCCN: gp 84005993
Place of Publication: District of Columbia GPO Item No.: 1017-A. 1017-B (microfiche)
Languages: English
Document Type: Monograph
Geographic Location: United States
At head of title: 97th Congress. 2d session. Committee-print. Distributed to depository libraries in microfiche.
Descriptors: Space law; Artificial satellites in telecommunication; Remote sensing; Space stations-Industrial applications; Space law; Artificial satellites in telecommunication; Remote sensing; Space stations-Industrial applications

Role of technology in promoting industrial competitiveness : hearings before the Subcommittee on Science, Technology, and Space of the Committee on Commerce, Science, and Transportation, United States Senate, Ninety-eighth Congress, first session, on S. 428 ... S. 632 ... S. 1289 ... June 21 and 23, 1983
Publication Date(s): 1983
LCCN: gp 84005993
Place of Publication: District of Columbia GPO Item No.: 1041-A. 1041-B (microfiche)
Publication Date(s): 1983
LCCN: gp 84005993
Place of Publication: District of Columbia GPO Item No.: 1041-A. 1041-B (microfiche)
Publication Date(s): 1983
LCCN: gp 84005993
Place of Publication: District of Columbia GPO Item No.: 1041-A. 1041-B (microfiche)
Publication Date(s): 1983
LCCN: gp 84005993
Place of Publication: District of Columbia GPO Item No.: 1041-A. 1041-B (microfiche)
Publication Date(s): 1983
LCCN: gp 84005993
Place of Publication: District of Columbia GPO Item No.: 1041-A. 1041-B (microfiche)
Publication Date(s): 1983
LCCN: gp 84005993
Place of Publication: District of Columbia GPO Item No.: 1041-A. 1041-B (microfiche)
session, June 11-12, 1980

Variant Title: Space Industrialization Act of 1980


Publication Date(s): 1980

LCCN: gp 81004165

Place of Publication: District of Columbia GPO Item No.: 1025-A

Technical Report No.: No. 132 (United States. Congress. House. Committee on Science and Technology)

Languages: English

Document Type: Monograph

Geographic Location: United States

"No. 132."

Descriptors: Space Industrialization Corporation; Space stations—Industrial applications—Finance; Astronautics and state—United States

0116591 Y 4.C 73/7-96-105

Industrial applications of recombinant DNA techniques: hearing before the Subcommittee on Science, Technology, and Space. Joint hearing on Commerce, Science, and Transportation, United States Senate, Ninety-sixth Congress, second session ... May 20, 1980


Series: Serial - Senate, Committee on Commerce, Science, and Transportation ; no. 96-105; United States.; Congress.; Senate.; Committee on Commerce, Science, and Transportation.


Publication Date(s): 1980

LCCN: gp 80009358

Place of Publication: District of Columbia GPO Item No.: 1025-A

Languages: English

Document Type: Monograph

Geographic Location: United States

"Hearings held May 22-June 27, 1979. Includes bibliographical references.

Descriptors: Space Industrialization Corporation; Space stations—Industrial applications

0101018 Y 4.Sci 2-96/47

The Space Industrialization act of 1979 : hearings before the Subcommittee on Space Science and Applications of the Committee on Science and Technology, U.S. House of Representatives, Ninety-sixth Congress, first session, on H.R. 2337 ...


Series: Serial - House, Committee on Science and Technology ; no. 96-47; United States.; Congress.; House.; Committee on Science and Technology. Serial, 96th Congress ;


Publication Date(s): 1979

LCCN: gp 800009358

Place of Publication: District of Columbia GPO Item No.: 1025-A

Languages: English

Document Type: Monograph

Geographic Location: United States

Hearings held May 22-June 27, 1979. Includes bibliographical references.

Descriptors: Space Industrialization Corporation; Space stations—Industrial applications

0090202 C 3.24/8-MC 77-1-37 B-6 (P)

1977 census of manufactures : Industry series, space vehicle equipment, N.E.C., SIC 3769

Variant Title: Industry series, space vehicle equipment, N.E.C., SIC 3769; Space vehicle equipment, N.E.C., SIC 3769


Series: MC 77-1 ; 37 B-6 (P)


Publication Date(s): 1979

LCCN: 79022094

Place of Publication: District of Columbia GPO Item No.: 135

Languages: English

Document Type: Monograph

Geographic Location: United States


Descriptors: Space vehicles-Equipment and supplies; Statistics; United States—Manufactures—Statistics
Government space leased to commercial activities by agencies other than the General Services Administration : report / by the Comptroller General of the United States
Corporate Source: United States. General Accounting Office.
Publication Date(s): 1978
Publication Date(s): 1978
LCCN: gp 78005974
Place of Publication: District of Columbia GPO Item No.: 1025-A
Languages: English
Document Type: Monograph
Geographic Location: United States
Includes bibliographical references.
Space processing : hearing before the Subcommittee on Aerospace Technology and National Needs of the Committee on Aeronautical and Space Sciences, United States Senate, Ninety-fourth Congress, second session, June 17, 1976


Publication Date(s): 1976
LCCN: gp 76009754
Price: $1.10
Place of Publication: District of Columbia
Languages: English
Document Type: Monograph
Item 1032-A Includes bibliographical references.
Descriptors: Space stations-Industrial applications
The NTIS (National Technical Information Service) database consists of government-sponsored research, development, and engineering plus analyses prepared by federal agencies, their contractors or grantees. It is the means by which unclassified, publicly available, unlimited distribution reports are made available for sale by such agencies as NASA, DDC, DOE, HUD, DOT, Department of Commerce and other government agencies.
Marketing the Use of the Space Environment for the Processing of Biological and Pharmaceutical Materials

The perceptions of U.S. biotechnology and pharmaceutical companies concerning the potential use of the space environment for the processing of biological substances was examined. Physical phenomena that may be important in space-based processing of biological materials are identified and discussed in the context of past and current experiment programs. The capabilities of NASA to support future research and development, and to engage in cooperative risk-sharing programs with industry are discussed. Meetings were held with several biotechnology and pharmaceutical companies to provide data for a statistical analysis of the attitudes and perceptions of these industries toward the use of the space environment. Recommendations are made for actions that might be taken by NASA to facilitate the marketing of the use of the space environment, and in particular the Space Shuttle, to the biotechnology and pharmaceutical industries.

Identifiers: Industries; Cooperative programs; NTIS/NASA

Section Headings: 60 (Biological and Medical Sciences-Pharmacology); 6B (Biological and Medical Sciences-Bioengineering); 570 (Medicine and Biology-Pharmacology and Pharmacological Chemistry); 84GE (Space Technology-General); 7OE (Administration and Management-Research Program Administration and Technology Transfer); 95C (Biomedical Technology and Human Factors Engineering-Biomedical Instrumentation and Bioengineering); 96A (Business and Economics-Domestic Commerce, Marketing, and Economics).
European Utilization Aspects of a US Manned Space Station.

Volume 2

(Final rept)
Deutsche Forschungs- und Versuchsanstalt fuer Luft- und Raumfahrt e.V., Cologne (Germany, F.R.).
Corporation Source Codes: 062739000; D0696939
Sponsor: National Aeronautics and Space Administration, Washington, DC.
Report No.: ESA-CR(P)-1987-V-2
Apr 83 393p
Prepared in cooperation with MBB GMBH, Bremen, West Germany, Aeritalia Spa, Turin, British Aerospace Aircraft Group, Bristol, Dornier-Werke GmbH, Friedrichshafen, West Germany, and Matra, Toulouse.
Languages: English
NTIS Prices: PC A17/MF A01 Journal Announcement: GRAI8520; STAR2317

Country of Publication: Germany, Federal Republic of
Contract No.: ESA-5243/82/F-F(C)(SC)
European payload candidates which can be beneficially supported by a manned space station (MSS) are identified. The required operational space station support is assessed. Alternative approaches if no manned space station is available are discussed and the impact identified. The MSS is needed in life sciences, space technology, and materials science. The MSS need to be completed by free flying platforms for automatic material processes, space sciences, and Earth observations. The majority of identified payload candidates are for basic research. Commercial payloads are only identified in telecommunications. Identification of commercial materials processing payloads depends on the results from Spacelab.

Descriptors: *European space programs; *International cooperation; *Manned orbital laboratories; *NASA programs; *Orbital space stations; Space commercialization; Space processing; Spaceborne astronomy; Spaceborne experiments; Spacecraft design

Identifiers: *Foreign technology; NTISNASAE

Section Headings: 22A (Space Technology--Astronautics); 84GE (Space Technology--General)

European Utilization Aspects of a US Manned Space Station.

Volume 1

(Final rept)
Deutsche Forschungs- und Versuchsanstalt fuer Luft- und Raumfahrt e.V., Cologne (Germany, F.R.).
Corporation Source Codes: 062739000; D0696939
Sponsor: National Aeronautics and Space Administration, Washington, DC.
Report No.: ESA-(P)-1987-V-1
Apr 83 65p
Prepared in cooperation with MBB GMBH, Bremen, West Germany, (cont. next page)
Aeritalia Spa, Turin, British Aerospace Aircraft Group, Bristol, Dornier-Werke GmbH, Friedrichshafen, West Germany, and Matra, Toulouse.

Languages: English

NTIS Prices: PC A04/MF A01 Journal Announcement: GRA18520;
STAR2317

Country of Publication: Germany, Federal Republic of

Contract No.: ESA-5243/82/F-PC(SC)

European payload candidates which can be beneficially supported by a manned space station (MSS) are identified. The required operational station support is assessed. Alternative approaches to no manned space station are available and the impact identified. The MSS is needed in life sciences, space technology, and materials science. The MSS needs to be completed by free flying platforms for automatic material processes, space sciences, and Earth observations. The majority of identified payload candidates are for basic research. Commercial payloads are only identified in telecommunications. Identification of commercial materials processing payloads depends on the results from Spacelab.

Descriptors: *European space programs; *International cooperation; Manned orbital laboratories; Nasa programs; Orbital space stations; Space commercialization; Space processing; Spaceborne astronomy; Spaceborne experiments; Spacecraft design

Identifiers: Foreign technology; NTISNASA

Section Headings: 22A (Space Technology--Astronautics); 84GE (Space Technology--General)

1122865 N85-18993/4/XAB

Commerce Lab: Mission Analysis and Payload Integration Study (Interim progress rept)

Wyle Labs., Inc., Huntsville, AL.

Corp. Source Codes: 018042000; W9307657

Sponsor: National Aeronautics and Space Administration, Washington, DC.

Report No.: NAS 1.26:174381; NASA-CR-174381

6 Dec 84

Languages: English

NTIS Prices: PC A05/MF A01 Journal Announcement: GRA18513;
STAR2310

Country of Publication: United States

Contract No.: NAS8-36109

Conceived as one or more arrays of carriers which would fly aboard space shuttle, Commerce Lab can provide a point of focus for implementing a series of shuttle flights, co-sponsored by NASA and U.S. domestic concerns, for performing materials processing in research and pre-commercial investigations. As an orbiting facility for testing, developing, and implementing hardware and procedures, Commerce Lab can enhance space station development and hasten space platform production capability. Tasks considered include: (1) synthesis of user requirements and identification of common element and voids; (2) definition of performance and infrastructure requirement and alternative approaches; and (3) carrier, mission model, and infrastructure development.

Descriptors: Reduced gravity; Space commercialization; Space laboratories; Space processing; Space shuttle payloads; User requirements; Government/Industry relations; Interfaces; Mission planning; Payload integration plan; Spaceborne experiments; Tradeoffs

Identifiers: NTISNASA

Section Headings: 22A (Space Technology--Astronautics); 84A (Space Technology--Astronautics)

A monodisperse latex reactor experiment has flown five times on the space shuttle, with three more flights currently planned. The objectives of this project is to manufacture, in the microgravity environment of space, large particle-size monodisperse polystyrene latexes in particle sizes larger and more uniform than can be manufactured on Earth. Historically it has been extremely difficult, if not impossible, to manufacture in quantity very high quality monodisperse latexes on Earth in particle sizes much above several micrometers in diameter due to buoyancy and sedimentation problems during the polymerization reaction. However the MLR project has succeeded in manufacturing in microgravity monodisperse latex particles as large as 30 micrometers in diameter with a standard deviation of 1.4 percent. It is expected that 100 micrometer particles will have been produced by the completion of the three remaining flights. These tiny, highly uniform latex microspheres have become the first material to be commercially市场化 that was manufactured in space.

Descriptors: Chemical reactors; Latex; Microgravity applications; Microparticles; Polystyrene; Space processing; Space shuttle payloads; Particle size distribution; Polymerization; Space commercialization; Spheres

Identifiers: Chemical reactors; Latex; Microgravity applications; Microparticles; Polystyrene; Space processing; Space shuttle payloads; Particle size distribution; Polymerization; Space commercialization; Spheres

Section Headings: 111 (Materials--Plastics); 22B (Space Technology--Spacecraft); 7A (Chemistry--Chemical Engineering) 710 (Materials Sciences--Plastics); 84GE (Space Technology--General); 99B (Chemistry--Industrial Chemistry and Chemical Process Engineering)
The chemical/petrochemical industry devotes a large percentage of its gross income to research and development, with much of its R and D of a long-term nature. As the chemical industry is examined as a candidate for space investigations, it is readily apparent that research and development in the space environment may lead to attractive commercial opportunities. The advantages of low gravity manufacturing, with a particular emphasis on chemical catalysts, are presented herein specifically for the chemical industry. Research from the Skylab program and Apollo Soyuz test project is reviewed, including acoustic levitation, crystal growth, and container less melts. Space processing of composite materials, alloys, and coatings is also discussed.

Descriptors: Catalysts; Industries; Low gravity manufacturing; Metallurgy; Space commercialization; Space processing; Acoustic levitation; Alloys; Apollo Soyuz test project; Coatings; Composite materials; Containerless melts; Crystal growth; Promotion; Public relations; Skylab program; Spacelab

Identifiers: NTISNASA

Section Headings: 22A (Space Technology--Astronautics); 84GE (Space Technology--General)

Alternative Strategies for Space Station Financing
Walklet, D. C.; Heenan, A. T.
Terra-Mar, Mountain View, CA.
Corp. Source Codes: 080736000; 10425679
Sponsor: National Aeronautics and Space Administration
Washington, DC.
Report No.: NAS 1.26:175412; NASA-CR-175412
1 Sep 83 35p
Languages: English
NTIS Prices: PC A03/MF A01 Journal Announcement: GRAI8441;STAR2211
Country of Publication: United States
Contract No.: NASW-3750
The attributes of the proposed space station program are oriented toward research activities and technologies which generate long term benefits for mankind. Unless such technologies are deemed of national interest and thus are government funded, they must stand on their own in the market place. Therefore, the objectives of a United States space station should be based on commercial criteria; otherwise, such a project attracts no long term funding. There is encouraging evidence that some potential space station activities should generate revenues from shuttle related projects within the decade. Materials processing concepts as well as remote sensing 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.

Identifiers: NTISNASA
Section Headings: 22B (Space Technology--Spacecraft); 22A (Space Technology--Astronautics); 5C (Behavioral and Social Sciences--Economics); 84C (Space Technology--Manned Spacecraft); 84A (Space Technology--Astronautics); 7OE (Administration and Management--Research Program Administration and Technology Transfer)
Section Headings: 22A (Space Technology--Astronautics); 13H (Mechanical, Industrial, Civil, and Marine Engineering--Industrial Processes); 84GE (Space Technology--General); 94G (Industrial and Mechanical Engineering--Manufacturing Processes and Materials Handling)

097230 N82-19226/0

Manufacturing in Space: Fluid Dynamics Numerical Analysis


Robertson, S. J. ; Nicholson, L. A. ; Spradley, L. W.

Lockheed Missiles and Space Co., Inc., Huntsville, AL.

Contract No.: NASW-3281

Country of Publication: United States

Report No.: NASA-CR-168610; LMSC-HREC-TR-D784480

Aug 81 51p

Languages: English

NTIS Prices: PC A04/MF A01 Journal Announcement: GRAI8215:

STAR2010

Natural convection in a spherical container with cooling at the center was numerically simulated using the Lockheed-developed General Interpolants Method (GIM) numerical fluid dynamic computer program. The numerical analysis was simplified by assuming axisymmetric flow in the spherical container, with the symmetry axis being a sphere diagonal parallel to the gravity vector. This axisymmetric-spherical geometry was intended as an idealization of the proposed L1/Kr/00s growing experiments to be performed on board Spacelab. Results were obtained for a range of Rayleigh numbers from 25 to 10,000. For a temperature difference of 10°C from the cooling sting at the center to the container surface, and a gravitational loading of 0.000001 g a computed maximum fluid velocity of about 2.4 x 10^-5 cm/sec was reached after about 250 sec. The computed velocities were found to be approximately proportional to the Rayleigh number over the range of Rayleigh numbers investigated.

Descriptors: *Computational fluid dynamics; *Computer programs; *Computerized simulation; *Crystal growth; *Space manufacturing; *Axlsymmetric flow; *Circular cylinders; *Convension; *Cooling; *Flow velocity; *Gravitation; *Rayleigh number; *Spacelab

Identifiers: NTISNASA

Section Headings: 22A (Space Technology--Astronautics); 13H (Mechanical, Industrial, Civil, and Marine Engineering--Industrial Processes); 84GE (Space Technology--General); 94G (Industrial and Mechanical Engineering--Manufacturing Processes and Materials Handling)

983984 N82-15009/0

Investigations on the Influence of Gravity on Joining Processes with Liquid Melts, and of Brazing and Welding Experiments under Weightlessness

(cont. next page)
Physical mechanisms in welding and brazing likely to be affected by space conditions are considered and the literature on actual space experiments is reviewed. Proposed Spacelab test experiments and complementary testing on Earth are described. Further development needs are identified in arc welding. It is proposed to analyze the influence of gravity on material transfer, on the shape and structure of seam, and on the segregation of the phases by: (1) taking advantage of rotary motions on Earth in order to raise the g level or to create short-time microgravity; (2) working in an aircraft or rocket under longer microgravity conditions; and (3) performing arc-spot welding in a vacuum so as to develop this process for use in space.

Descriptors: *Brazing; *Fusion welding; *Space manufacturing; *Space processing applications; low gravity manufacturing; Melting; Production management; Solubility manufacturing

Identifiers: *Foreign technology; NTISNASA

Section Headings: 22A (Space Technology--Astronautics); 13H (Mechanical, Industrial, Civil, and Marine Engineering--Industrial Processes); 84GE (Space Technology--General); 94G (Industrial and Mechanical Engineering--Manufacturing Processes and Materials Handling)
The feasibility of commercial manufacturing of pharmaceuticals in space is analyzed and the study results are presented. The feasibility of producing pharmaceuticals in space is discussed. The selection and study of candidate products, their production requirements, and the separation of serum proteins by the continuous flow electrophoresis process are investigated. The production requirements of twelve candidate products including antihemophilic factor, beta cells, erythropoietin, epidermal growth factor, alpha-1-antitrypsin, and interferon are evaluated.

Descriptors: *Electrophoresis; *Pharmacology; *Space manufacturing; *Space processing; Cells (Biology); Epidermis; Industries: Interferon; Research and development
Identifiers: *Drugs; NTISNASA
Section Headings: 60 (Biological and Medical Sciences--Pharmacology); 22A (Space Technology--Astronautics)
570 (Medicine and Biology--Pharmacology and Pharmacological Chemistry); 84GE (Space Technology--General)

A technical analysis on the feasibility of commercial manufacturing of pharmaceuticals in space is presented. The method of obtaining pharmaceutical company involvement, laboratory results of the separation of serum proteins by the continuous flow electrophoresis process, the selection and study of candidate products, and their production requirements is presented. Antihemophilic factor, beta cells, erythropoietin, epidermal growth factor, alpha-1-antitrypsin, and interferon were studied. Production mass balances for antihemophilic factor, beta cells, and erythropoietin were compared for space versus ground operation.

Descriptors: *Electrophoresis; *Pharmacology; *Space manufacturing; *Space processing; Cells (Biology); Epidermis; Industries: Interferon; Research and development
Identifiers: *Drugs; NTISNASA
Section Headings: 60 (Biological and Medical Sciences--Pharmacology); 22A (Space Technology--Astronautics)
570 (Medicine and Biology--Pharmacology and Pharmacological Chemistry); 84GE (Space Technology--General)
The cited articles from worldwide literature concern manufacturing in space. Stressed are the effects of weightlessness on a variety of manufacturing processes such as crystal growth, welding, zone melting, casting, and the construction of structures. Articles concerning materials science research in the European Spacelab program are included. (Contains 331 citations).

Descriptors: +Manufacturing; +Bibliographies; Aerospace environments; Construction; Weightlessness; Processing; Abstracts

Identifiers: +Space manufacturing; NTISNTIST

Section Headings: 13H (Mechanical, Industrial, Civil, and Marine Engineering--Industrial Processes); 22A (Space Technology--Astronautics); 84GE (Space Technology--General)

This special bibliography lists 724 articles, papers, and reports which discuss various aspects of the use of the space environment for materials science research or for commercial enterprise. The potentialities of space processing and the improved materials processes that are made possible by the unique aspects of the space environment are emphasized. References identified in April, 1978 are cited.

Descriptors: +Bibliographies; +Low gravity manufacturing; +Space processing; Ceramics; Containerless melts; Electrophoresis; Solidification; Space industrialization; Space manufacturing

Identifiers: NTISNASA

Section Headings: 20L (Physics--Solid-state Physics); 22B (Space Technology--Spacecraft); 46D (Physics--Solid State Physics); 84GE (Space Technology--General); 71GE (Materials Sciences--General)

The advantages of space for manufacturing more perfect microcrystalline morphologies and structures will be
Identifiers: *Space processing; Space manufacturing; Bridgman growth technique; Mercury chlorides; NTISCOMNBS; NTISNASA

Section Headings: 20B (Physics--Crystallography); 11A (Materials--Ceramics, Refractories, and Glasses); 11F (Materials--Metallurgy and Metallography); 22A (Space Technology--Aeronautics); 46D (Physics--Solid State Physics); 71GE (Materials Sciences--General); 84GE (Space Technology--General)

562103 N77-13094/6

Possibilities for Industrial Material Production and Processing Techniques in Space from the Mechanical Engineering Point of View

Hau, E.; Leven, P.

Maschinenfabrik Augsburg-Nuernberg A.G., Munich (West Germany). Neue Technologie.

Report No.: BMFT-FB-W-76-03

Apr 76 43p

In German; English Summary.

NTIS Prices: PC AO3/MF AO1 Journal Announcement: GRAI7709:

STAR1504

Contract No.: BMFT-WRT-1074; GFW-RV-21-V-47/74

An investigation carried out within the GHG Engineering Group into possible industrial applications for Spacelab resulted in 22 proposals. Following more detailed discussion, 8 of these proposals were selected, and certain basic requirements for their industrial application in the near future are given. These proposals can be separated into two groups: industrial heat-treatment and casting techniques for highly stressed precision machine components (e.g. turbine blades and production of nonmetallic composite materials). Before any definitive conclusions regarding the suitability of these proposals can be reached, more detailed technological feasibility studies are necessary.

Identifiers: Mechanical engineering; *Space manufacturing; *Spacelab; Carbon fibers; Casting; Composite materials; Heat treatment; Hot working; Industries; Production engineering; Reinforcing fibers; Turbine blades

Identifiers: West Germany; NTISNASAE

Section Headings: 22A (Space Technology--Aeronautics); 22B (Space Technology--Spacecraft); 84C (Space Technology--Manned Spacecraft); 94G (Industrial and Mechanical Engineering--Manufacturing Processes and Materials Handling)

558502 N77-12083/0

Manufacturing Unique Glasses in Space

(Herrenbanner Report, 1 Nov 1974 - 31 Mar 1976)

Happe, R. P.


Report No.: NASA-RC-150067; SD-76-SA-0029

31 Mar 76 42p

NTIS Prices: PC AO3/MF AO1 Journal Announcement: GRAI7708;
An air suspension melting technique is described for making glasses from substances which to date have been observed only in the crystalline condition. A laminar flow vertical wind tunnel was constructed for suspending oxide melts that were melted using the energy from a carbon dioxide laser beam. By this method it is possible to melt many high-melting-point materials without interaction between the melt and crucible material. In addition, space melting permits cooling to suppress crystal growth. If a sufficient amount of undercooling is accompanied by a sufficient increase in viscosity, crystallization will be avoided entirely and glass will result. (Author)

Descriptors: Containerless melts; *Glass; *Oxides; *Space manufacturing; Amorphous materials; Crystallization; Melting points; Supercooling

Identifiers: NTIS/NASA

Section Headings: 11B (Materials--Ceramics, Refractories, and Glasses); 22B (Space Technology--Spacecraft); 71D (Materials Sciences--Ceramics, Refractories, and Glass); 84GE (Space Technology--General)
Possibilities of Manufacturing, and of Scientific Research in the Space Environment, and Effective Realization Thereof (Literature Study) Studie ueber die Moglichkeiten der Fertigung Bzw. Der Durchfuehrung von Wissenschaftlichen Untersuchungen Unten Weltraumbedingungen und ueber Deren Zweckmassige Gestaltung (Literaturstudie)

Battello Inst., Frankfurt am Main (West Germany).
Report No.: BMFT-FB-W-75-24
Dec 75 308p
In German; English Summary.

NTIS Prices: PC A10/MF A01 Journal Announcement: GRA17622;
STAR1417
Contract No.: BMFT-WRT-1073; GFW-RW-21-V-10/73

Ideen fur carrying out space experiments in the fields of materials science and biology as well as the results of experiments conducted during the Apollo 14 and the Skylab missions are summarized. Available literature published up to February 1974 was studied. Important aspects are emphasized for planning future experiments in the fields of ceramics, metals and alloys; composites; single crystals; and biological processes for which space manufacturing appears to be particularly interesting. (Author)

Descriptors: *Aerospace environments; Research and development; *Space laboratories; *Space manufacturing; Summaries; Apollo 14 flight; Ceramics; Composite materials; Electrophoresis; Glass; Literature; Metals; Single crystals; Skylab program

Identifiers: West Germany; NTISNASAE
Section Headings: 22A (Space Technology-Astronautics)

501600 N76-18199/9
Space Transportation
(Practical Applications of Space Systems)
National Academy of Sciences - National Research Council, Washington, D.C.
Report No.: NASA-CR-146277; PAPER-12
1975 40p

NTIS Prices: PC A03/MF A01 Journal Announcement: GRA17613;
STAR1409
Contract No.: NSR-09-012-06

User-oriented panels were formed to examine practical applications of information or services derived from earth orbiting satellites. Topics discussed include: weather and climate; uses of communication; land use planning; agriculture; forest; and range; inland water resources; retransrating resources; environmental quality; marine and maritime uses; and materials processing in space. Emphasis was placed on the Interface of the space transportation system (STS) with the applications envisioned by the user panels. User requirements were compared with expected STS capabilities in terms of availability, carrying payload to orbit, and estimated costs per launch. Conclusions and recommendations were reported.

Descriptors: *Earth resources program; *Space transportation; *Technology utilization; *User requirements; Decision making; Economic factors; Land use; Management planning; Oceanography; Resources management; Space manufacturing; Weather forecasting

Identifiers: NTISNASA
Section Headings: 22A (Space Technology-Astronautics); 84A (Space Technology--Astronautics); 84G (Space Technology-Unmanned Spacecraft); 70E (Administration and Management--Research Program Administration and Technology Transfer)

501586 N76-18183/3
Processing Eutectics in Space
(Summary Report)
Douglas, F. C.; Galasso, S. F.
United Technologies Research Center, East Hartford, Conn.
Report No.: NASA-CR-144196; R75-91721-10
Nov 75 72p

NTIS Prices: PC A04/MF A01 Journal Announcement: GRA17613;
STAR1409
Contract No.: NASA-29669

The investigations of directional solidification have indicated the necessity of establishing a secure foundation In earth-based laboratory processing in order to properly assess low-gravity processing. Emphasis was placed on evaluating the regularity of microstructure of the rod-like eutectic Al-A13N1 obtained under different conditions of growth involving the parameters of thermal gradient, solidification rate, and interfacial curvature. In the case of Al-A13N1, where the A13N1 phase appears as facets rods, solidification rate was determined to be a controlling parameter. Zone melting of thin eutectic films showed that for films of the order of 10 to 20 micrometers thick, the extra surface energy appears to act to stabilize a regular microstructure. The results suggest that the role of low-gravity as provided in space-laboratory processing of materials is to be sought in the possibility of generating a higher thermal gradient in the solidifying Ingot for a given power input-output arrangement than can be obtained under normal one-g processes. (Author)

Descriptors: *Eutectics; *Solidification; *Space manufacturing; Aluminum alloys; Microstructure; Nickel alloys; Surface energy; Thin films

Identifiers: Space processing; NTISNASA
Section Headings: 22A (Space Technology-Astronautics); 13H (Mechanical, Industrial, Civil, and Marine Engineering-Industrial Processes); 84C (Space Technology--Manned Spacecraft); 94G (Industrial and Mechanical Engineering--Manufacturing Processes and Materials Handling)

501583 N76-18162/7
Materials Processing in Space
(Practical Applications of Space Systems)
National Academy of Sciences - National Research Council,
National Academy of Sciences - National Research Council, (cont. next page)
The feasibility and possible advantages of processing materials in a nongravitational field are considered. Areas of investigation include biomedical applications, the processing of inorganic materials, and flight programs and funding. Descriptors: *Low gravity manufacturing; *Space manufacturing; Biomedical data; Calorimetry; Gravitational effects; Inorganic materials; Mission planning; Payloads

Identifiers: Space processing; NTIS NASA

Section Headings: 22A (Space Technology--Astronautics); 13H (Mechanical, Industrial, Civil, and Marine Engineering--Industrial Processes); 84C (Space Technology--Manned Spacecraft); 94G (Industrial and Mechanical Engineering--Manufacturing Processes and Materials Handling)

501581 N76-18160/1
Castle, J. G.
Alabama Univ., Huntsville, Dept. of Physics.
Report No.: NASA-CR-144187
Jan 76 30p
Document Type: Bibliography NTIS Prices: PC A03 Journal Announcement: GRA17613; STAR1409
Contract No.: NSR-30774

A selective bibliography is given on electrical characterization techniques for semiconductors. Emphasis is placed on noncontacting techniques for the standard electrical parameters for monitoring crystal growth in space, preferably in real time with high resolution. (Author)

Descriptors: *Bibliographies; *Semiconductors (Materials); *Space manufacturing; Crystal growth: Gallium arsenides; High resolution: Silicon

Identifiers: Space processing; NTIS NASA

Section Headings: 20L (Physics--Solid-state Physics); 22A (Space Technology--Astronautics); 46D (Space Technology--Astronautics); 84C (Space Technology--Manned Spacecraft); 94G (Industrial and Mechanical Engineering--Manufacturing Processes and Materials Handling)

496979 N76-16956/4
Space Processing of Crystalline Materials: A Study of Known Methods of Electrical Characterization of Semiconductors (Final Report)
Castle, J. G.
Alabama Univ., Huntsville, Dept. of Physics.
Report No.: NASA-CR-144158
Jan 76 24p
NTIS Prices: PC A02/MF A01 Journal Announcement: GRA17612; STAR1408
Contract No.: NAS8-24000

The development of the Skylab M512 Materials Processing Facility is traced from the design of a portable, self-contained electron beam welding system for terrestrial applications to the highly complex experiment system ultimately developed for three Skylab missions. The M512 experiment facility was designed to support six in-space experiments intended to explore the advantages of manufacturing materials in the near-zero-gravity environment of Earth orbit. Detailed descriptions of the M512 facility and related experiment hardware are provided, with discussions of hardware verification and man-machine interfaces included. An analysis of the operation of the facility and experiments during the three Skylab missions is presented, including discussions of the hardware performance, anomalies, and data returned to earth. (Author)

Descriptors: *Skylab program; *Space manufacturing; *Test facilities: Design analysis; Weightlessness

Identifiers: NTIS NASA

Section Headings: 22A (Space Technology--Astronautics); 84A (Space Technology--Astronautics); 84C (Space Technology--Manned Spacecraft); 94G (Industrial and Mechanical Engineering--Manufacturing Processes and Materials Handling)
A method and apparatus for continuously processing a single crystalline ribbon in a reduced gravity environment

A method and apparatus is described for continuously producing an uncontaminated single crystalline sheet of material of a controlled thickness having substantially optically flat surfaces. The method is performed in a reduced gravitational environment, such as outer space. A polycrystalline sheet of material is fed through a chamber with a heating element which progressively melts a transverse strip of the material as it is moved through the chamber. A single crystalline seed is positioned closely adjacent the molten zone for transforming the polycrystalline material into a single crystalline foil. The heating element has curved ends and terminates short of the opposed edges of the polycrystalline sheet.

487462 N76-11191/3

Furnace and Support Equipment for Space Processing

A core facility capable of performing a majority of materials processing experiments is discussed. Experiment classes are described, the needs peculiar to each experiment type are outlined, and projected facility requirements to perform the experiments are treated. Control equipment (automatic control) and variations of the Czochralski method for use in space are discussed. (Author)

Identifiers: NTISNASA

Section Headings: 21A (Space Technology--Astronautics); 84A (Government Inventions For Licensing--General); 46D (Industrial and Mechanical Engineering--Manufacturing Processes and Materials Handling)

480116 N75-10165/8

Research on Metal Solidification in Zero-G State

A method and apparatus is described for continuously producing an uncontaminated single crystalline sheet of material of a controlled thickness having substantially optically flat surfaces. The method is performed in a reduced gravitational environment, such as outer space. A polycrystalline sheet of material is fed through a chamber with a heating element which progressively melts a transverse strip of the material as it is moved through the chamber. A single crystalline seed is positioned closely adjacent the molten zone for transforming the polycrystalline material into a single crystalline foil. The heating element has curved ends and terminates short of the opposed edges of the polycrystalline sheet.

489998 N76-13934/4

A Method and Apparatus for Continuously Processing a Single Crystalline Ribbon in a Reduced Gravity Environment

A method and apparatus is described for continuously producing an uncontaminated single crystalline sheet of material of a controlled thickness having substantially optically flat surfaces. The method is performed in a reduced gravitational environment, such as outer space. A polycrystalline sheet of material is fed through a chamber with a heating element which progressively melts a transverse strip of the material as it is moved through the chamber. A single crystalline seed is positioned closely adjacent the molten zone for transforming the polycrystalline material into a single crystalline foil. The heating element has curved ends and terminates short of the opposed edges of the polycrystalline sheet.
Segregation Effects During Solidification in Weightless Melts

477897 N75-33137/1

Segregation Effects During Solidification in Weightless Melts

(Final Report)
LI, C.
Grumman Aerospace Corp., Bethpage, N.Y. Research Dept.
Report No.: NASA-CR-143981; RE-507
Jul 75 164p
NTIS Prices: PC A08/MF A01 Journal Announcement: GRAI7602: STAR1324
Contract No.: NASA-29662
The computer programs are developed and used in the study of the combined effects of evaporation and solidification in space processing. The temperature and solute concentration profiles during directional solidification of binary alloys with surface evaporation were mathematically formulated. Computer programs are included along with an econotechnical model of crystal growth. This model allows: prediction of crystal size, quality, and cost; systematic selection of the best growth equipment or alloy system; optimization of growth or material parameters; and a maximization of zero-gravity effects. Segregation in GaAs crystals was examined along with vibration effects on GaAs crystal growth. It was found that a unique segregation pattern and strong convection currents exist in GaAs crystal growth. Some beneficial effects from vibration during GaAs growth were discovered. The implications of the results in space processing are indicated. (Author)

Descriptors: *Evaporation; *Solidification; *Space manufacturing; *Weightlessness; Computer programs; Crystal growth; Gallium arsenides; Prediction analysis techniques; Computer programs; Thermodynamics; Energy levels; Economic analysis

477899 N75-33085/2

Bibliography of the Space Processing Program. Volume 1: A Compilation Through June 1974, Parts 1 and 2

Shoulitz, M. B.; Mcclurken, Jr., E. W.
Universities Space Research Association, Charlottesville, Va.
Report No.: NASA-CR-143985
Oct 75 653p
Document Type: Bibliography
NTIS Prices: PC A99 Journal Announcement: GRAI7602: STAR1324
 Contract No.: NASA-31349; NGR-47-102-003
A compilation of NASA research efforts in the area of space environmental effects on materials and processes is presented. Topics considered are: (1) fluid mechanics and heat transfer; (cont. next page)
DIALOG File 6: NTIS - 64-88/ISS11 (Copr. NTIS)

(2) crystal growth and containerless melts; (3) acoustics; (4) glass and ceramics; (5) electrophoresis; (6) welding; and (7) electrophotography.

Descriptors: *Aerospace environments; *Bibliographies; *Space processing; *Space manufacturing; *Space programs; *Spacecraft construction materials; Abstracts: Acoustics; Ceramics: Containerless melts; Contracts: Crystal growth; Electrophoresis: Exobiology; Fluid mechanics; Research projects: Space shuttles; Weightlessness; Welding

Identifiers: NTISNASA

Section Headings: 22A (Space Technology--Astronautics); 84A (Space Technology--Astronautics); 84C (Space Technology--Manufactured spacecraft)

46337 N75-27081/9

Space Processing of Composite Materials

(Final Report)

Stauber, H. M.; Keye, S. T.

General Dynamics Corp., San Diego, Calif. Convair Div.

Report No.: NASA CR-143887; CASE-NAS-75-025

28 Feb 75 108p

NTIS Prices: PC A06/MF A01 Journal Announcement: GRAI7522; STAR1318

Contract No.: NAS8-29620

Materials and processes for the testing of aluminum-based fiber and particle composites, and of metal foams under extended-time low-g conditions were investigated. A wetting and dispersion technique was developed, based on the theory that under the absence of a gas phase all solids are wetted by liquids. The process is characterized by a high vacuum environment and a high temperature cycle. Successful wetting and dispersion experiments were carried out with sapphire fibers, whiskers, and particles, and with fibers of silicon carbide, pyrolytic graphite, and tungsten. The developed process and facilities permit the preparation of a precursur which serves as sample material for flight experiments. Low-g processing consists then merely in the uniform distribution of the reinforcements during a melting cycle. For the preparation of metal foams, gas generation by means of a thermally decomposing compound was found most adaptable to flight experiments. For flight experiments, the use of a premixed mixture of the component materials limits low-g processing to a simple melt cycle. (Author)

Descriptors: *Composite materials; *Low gravity manufacturing; *Space manufacturing; *Aluminum; Reinforcing fibers; Welding

Identifiers: NTISNASA

Section Headings: 11D (Materials--Composite Materials); 71F (Materials--Composite Materials)

463961 N75-25982/0

Technology in Space

Belyakov, I. T.; Borisov, Y. D.

Kanner (Leo) Associates, Redwood City, Calif.

Report No.: NASA TT F-16264

Jul 75 282p

NTIS Prices: PC A13/MF A01 Journal Announcement: GRAI7521; STAR1317

Contract No.: NASW-2481

The results of Soviet and foreign research in the field of production in space are discussed. Methods for manufacturing and processing various types of materials, such as ball bearings, lenses, and crystals, and the behavior of the materials in space are described. Information on assembly and installation work including joining, sealing, welding, and soldering is given. Cost advantages and disadvantages of production in space are covered. Background material to help the reader understand the characteristics of outer space and the behavior of the human body in a state of weightlessness is also included. (Author)

Descriptors: *Aerospace environments; *Space manufacturing; (cont. next page)
449121 N75-19285/6
Processing and Manufacturing in Space
Battrick, B. T.; Nguyen, T. D.
European Space Research Organization, Paris (France).
Report No.: ESRO-SP-101
Jul 74 358p
Document Type: Conference proceeding
NTIS Prices: PC A16/MF AO1 Journal Announcement: GRAI7514;
STAR131
The present state of knowledge of space environment influence on the handling and behavior of materials, and on the properties of materials processed in this environment, is reported. Reviews cover the fields of metallurgy, electronic materials, glass and ceramic technology, physical and chemical processes in fluids, electrophoretic separation, and techniques and equipment design. Some results from the Skylab program are included. Experimental designs for the Apollo Soyuz Test Project and Spacelab program are presented.

Descriptors: *Apollo soyuz test project; *Conferences; *Skylab program; *Space manufacturing; *Spacelab; Cells (Biology); Ceramics; Composite materials; Crystal growth; Electronics; Experimental design; Furnaces; Glass; Metalurgy; Onboard equipment; Semiconductors (Materials)
Identifiers: NTISNASA
Section Headings: 22A (Space Technology-Astronautics); 94G (Industrial and Mechanical Engineering-Manufacturing Processes and Materials Handling); 84A (Space Technology-Astronautics)

447197 N75-18272/5
Abstracts, Third Space Processing Symposium, Skylab Results
National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, Ala.
Report No.: NASA-TM-X-70406
1974 44p
Document Type: Conference proceeding
NTIS Prices: PC A03/MF AO1 Journal Announcement: GRAI7513;
STAR131
Skylab experiments results are reported in abstracts of papers presented at the Third Space Processing Symposium. Specific areas of interest include: exothermic brazing, metals melting, crystals, reinforced composites, glasses, eutectics; physics of the low-g processes; electrophoresis, heat flow, and convection demonstrations flown on Apollo missions; and apparatus for containerless processing, heating, cooling, and containing materials.
Descriptors: *Conferences; *Orbital workshops; *Skylab program; *Space manufacturing; *Apollo flights; *Composite materials; *Containerless melts; *Crystal growth; *Low gravity manufacturing
Identifiers: NTISNASA
Section Headings: 22A (Space Technology-Astronautics); 84A (Space Technology-Astronautics)

431348 N75-12017/0
Kattamis, T. Z.
Connecticut Univ., Waterbury.
Report No.: NASA-CR-129034
Dec 73 22p
NTIS Prices: PC AO2/MF AO1 Journal Announcement: GRAI7506;
STAR1303
The processing of nickel-silver alloy specimens in space is discussed. Four specimens were melted only partially, while a fifth was melted completely and assumed after solidification a perfectly spherical shape. Growth of the solid was epitaxial on the unmelted material or on the retaining sting and occurred without undercooling. Solidification was dendritic in all cases with nonequilibrium silver particles forming monotonically between dendrite arms. Substantial loss of silver by evaporation took place. Evaporation of the silver within internal gas cavities on the melt was followed by surface condensation after completion of solidification and cooling, leading to a silver-rich lining in these cavities. The material gave no microstructural evidence of any reduction in liquid convection. (Author)
Descriptors: *Fusion (Melting); *Nickel alloys; *Silver alloys; *Solidification; *Space manufacturing; *Weightlessness; Crystal growth; Metalurgy; Microstructure; Skylab program
Identifiers: NTISNASA
Section Headings: 13H (Mechanical, Industrial, Civil, and Marine Engineering-Industrial Processes); 94G (Industrial and Mechanical Engineering-Manufacturing Processes and Materials Handling)

420718 N74-33399/8
Serl-3
NTIS Prices: PC AO2/MF AO1 Journal Announcement: GRAI7426;
STAR1222
(cont. next page)
A variety of technologies were investigated to determine the benefits to be derived from space activities. The subjects accepted for product development are: (1) eutectics for cold cathodes, (2) higher purity fiber optics, (3) fluidic wafers, (4) large germanium wafers for gamma ray camera, (5) improved cathodes and capacitors, (6) optical filters, (7) corrosion resistant electrodes, (8) high strength carbon-based filaments for plastic reinforcement, and (9) new antibiotics. In addition, three ideas for services, involving disposal of radioactive wastes, blood analysis, and enhanced solar insulation were proposed. (Author)

Descriptors: Space manufacturing; Technology transfer; Technology utilization; Crystal growth; Equipment specifications; Metallurgy; Optical filters; Product development; Synthetic Fibers; Waste disposal

Identifiers: NTISNASA

Section Headings: 60 (Biological and Medical Sciences--Pharmacology); 570 (Medicine and Biology--Pharmacology and Pharmaceutical Chemistry)

420544 N74-32929/3
Feasibility Study for the Manufacture of Zero Gravity Pharmaceuticals, Immunological, and Viral Agents

Report No.: NASA-CR-120424
29 Aug 74; 67p
NTIS Prices: PC A04/MF A01 Journal Announcement: GRAI7426; STAR1222

Contract No.: NAS8-29874

The feasibility of extracting, isolating, purifying, separating, or preparing medical and biological products of high socio-economic value in space was studied. In particular, the study was designed to concentrate on the isolation or purification of virals, pharmaceutical and immunological agents by means of electrophoresis, as the Apollo 16 flight demonstrated that a mixed population of latex spheres (.2 and .8 microns) could be successfully separated by electrophoresis in space and without sedimentation with minimal convection. This prompted NASA scientists to look into the possibility of carrying out types of biochemical experiments that would utilize space for medical purposes. (Author)

Descriptors: Space manufacturing; Chemical reactions; Product development; Weightlessness

Identifiers: NTISNASA

Section Headings: 60 (Biological and Medical Sciences--Pharmacology); 570 (Medicine and Biology--Pharmacology and Pharmaceutical Chemistry)

420539 N74-32924/4
Research Study on Materials Processing in Space, Experiment M512

Rubenstein, M.; Hopkins, R. H.; Kim, H. B.
Westinghouse Research Labs., Pittsburgh, Pa.
Report No.: NASA-CR-120418
15 Jan 73; 105p
NTIS Prices: PC A06/MF A01 Journal Announcement: GRAI7426; STAR1222

Contract No.: NAS8-28727

Gallium arsenide, a commercially valuable semiconductor, has been prepared from the melt (M.P. 1237°C), by vapor growth, and by growth from metallic solutions. It has been established that growth from metallic solution can produce material with high, and perhaps with the highest possible, chemical homogeneity and crystalline perfection. Growth of GaAs from
metallic solution can be performed at relatively low temperatures (about 600°C) and is relatively insensitive to temperature fluctuations. However, this type of crystal growth is subject to the decided disadvantage that density induced convection currents may produce variations in rates of growth at a growing surface. This problem would be minimized under reduced gravity conditions. (Author)

Descriptors: *Gallium arsenides; *Semiconductors (Materials); *Space manufacturing; Chemical properties; Crystal growth; *Metallography; Product development

Identifiers: NTISNASA

Section Headings: 20L (Physics--Solid-state Physics); 46D (Physics--Solid State Physics)

414664 N74-29972/8
Materials Processing in Space MS12, Phase B Report
Pattee, H. E.; Monroe, R. E.
Battelle Columbus Labs., Ohio.
Report No.: NASA-CR-120266
15 Jul 73 74p

NTIS Prices: PC AO4/MF AO1 Journal Announcement: GRA17424;
STAR1219

Contract No.: NASA-28725

The metallographic characterization, analysis, and property measurement of ground samples for comparison with those processed on Skylab are described. Experiments on metals melting and exothermic brazing are summarized, and results are presented.

Descriptors: *Microstructure; *Space manufacturing; *Weightlessness; *Brazing; *Materials tests; *Metallography; *Microanalysis; Skylab program

Identifiers: NTISNASA

Section Headings: 11F (Materials--Metallurgy and Metallography); 71N (Materials Sciences--Nonferrous Metals and Alloys); 94G (Industrial and Mechanical Engineering--Manufacturing Processes and Materials Handling)

381656 N74-15526/8
The Space Shuttle Payload Planning Working Groups: Volume 9: Materials Processing and Space Manufacturing (Final Report)
National Aeronautics and Space Administration, Goddard Space Flight Center, Greenbelt, Md.
Report No.: NASA-TM-X-69459
May 73 73p

NTIS Prices: PC AO4/MF AO1 Journal Announcement: GRA17409;
STAR1206

The findings and recommendations of the Materials Processing and Space Manufacturing group of the space shuttle payload planning activity are presented. The effects of weightlessness on the fabrication processes, mixture stability, and control over heat and mass transport in fluids are considered for investigation. The research and development projects include: (1) metallurgical processes, (2) electronic materials, (3) biological applications, and (4) nonmetallic materials and processes. Additional recommendations are provided concerning the allocation of payload space, acceptance of experiments for flight, flight qualification, and private use of the space shuttle. (Author)

Descriptors: *Chemical reactions; *Space laboratories; *Space manufacturing; *Space missions; *Space shuttles; *Weightlessness; Equipment specifications; Payloads; Project management; Research projects; Test equipment

Identifiers: NTISNASA

Section Headings: 22A (Space Technology--Astronautics); 84A (Space Technology--Astronautics); 84C (Space Technology--Manned Spacecraft)

352677 N73-27677/6
Physical Phenomena Related to Crystal Growth in the Space Environment
Chu, T. L.
Southern Methodist Univ., Dallas, Tex. Electronic Sciences Center.
Report No.: NASA-CR-2281
Jul 73 38p

NTIS Prices: PC AO3/MF AO1 Journal Announcement: GRA17322;
STAR1118

Contract No.: NAS1-11869

The mechanism of crystal growth which may be affected by the space environment was studied. Conclusions as to the technical and scientific advantages of crystal growth in space over earth bound growth, without regard to economic advantage, were deduced. It was concluded that the crucibleless technique will most directly demonstrate the unique effects of the greatly reduced gravity in the space environment. Several experiments, including crucibleless crystal growth using solar energy and determination of diffusion coefficients of common dopants in liquid silicon were recommended. (Author)

Descriptors: *Crystal growth; *Space manufacturing; *Convection; *Diffusion coefficient; *Experimental design; *Silicon

Identifiers: NTISNASA

Section Headings: 20B (Physics--Crystallography); 80D (Physics--Crystallography)

319795 N73-15867
Proceedings of the Space Shuttle Sortie Workshop. Volume 2 Working Group Reports
National Aeronautics and Space Administration, Goddard Space Flight Center, Greenbelt, Md.
Report No.: NASA-TM-X-68842
4 Aug 72 56p

Document Type: Conference proceeding

NTIS Prices: PC E14/MF AO1 Journal Announcement: GRA17308;
STAR1106

Details are presented on the mission planning progress in (cont. next page)
each of the working paper reports. The general topics covered are the following: space technology; materials processing and space manufacturing; communications and navigation; earth and ocean physics; oceanography; earth resources and surface environmental quality; meteorology and atmospheric environmental quality; life sciences; atmospheric and space physics; solar physics; high energy cosmic rays; X-ray and gamma ray astronomy; ultraviolet-optical astronomy; planetary astronomy; infrared astronomy.

Descriptors: Aerospace engineering; Conferences; Experimental design; Mission planning; Shuttle; Space shuttles; Environmental quality; Instruments; Meteorology; Oceanography; Space manufacturing; Spaceborne astronomy

Identifiers: NTIS NASA

Section Headings: 22A (Space Technology--Astronautics); 84A (Space Technology-Astronautics); 84C (Space Technology--Manned Spacecraft)

212392 AD-720 136

Industrial Chemistry in Space
Libby, W. F.; Payton, P. H.
California Univ Los Angeles Dept of Chemistry

Corporation Source Codes: 072255
Report No.: AFOSR-TR-71-0595
20 Mar 70
5p

70-AV/SPt-2. 5p.

Document Type: Journal article

NTIS Prices: REPRINT Journal Announcement: GAI70108
Contract No.: AF-AFOSR-1255-67; NGL-05-007-003; AF-9538

Some aspects of chemical manufacture in an orbiting spacecraft are presented and discussed. The design and operation of a 100-meter-dia parabolic solar furnace is considered. Some further subjects of future chemical interest are also presented. (Author)

Descriptors: Chemical engineering; Space stations; Solar furnaces; Space stations; Crystal growth; Metallurgy; Astronautics

Identifiers: NTIS NASA

Section Headings: 22A (Space Technology--Astronautics); 7A (Chemistry--Chemical Engineering); 84A (Space Technology--Astronautics); 598 (Chemistry--Industrial Chemistry and Chemical Process Engineering)

166380 N70-14651

Space Processing and Manufacturing Meeting
National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, Ala.
Report No.: NASA-TM-X-66480; ME-69-1
21 Oct 69
546p


Document Type: Conference proceeding

NTIS Prices: Journal Announcement: USGRDR7010; STAR0804

No abstract available.

Descriptors: Apollo applications program; Applications technology--satellites; Conferences; Crystal growth; Exobiology; Glass; Manufacturing; Orbital workshops; Production engineering; Research and development; Weightlessness; Aerospace environments; Biosatellites; Chemical reactions; Gravitational effects; Manned orbital laboratories; Materials handling; Metal working; Reduced gravity; Solid state devices; Space laboratories; Space programs; Technology utilization; Vaccines

Section Headings: 22A (Space Technology--Astronautics)
PNI DATABASE

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86-09345
Riker-McDonnell Douglas looking at non-erythropoietin space projects
FDC Reports -- "The Pink Sheet" Vol. 48, No. 11, p. T&G-1,2, Coden: FPSDAN
Publ.Yr: Mar 17, 1986
Languages: ENGLISH
Descriptors: Riker, McDonnell Douglas; discussions; space-processed pharmaceuticals; erythropoietin; electrophoresis in space technology; Ortho agreement termination; 3M

86-04819
New erythropoietin space experiment
SCRIP World Pharmaceutical News No. 1060, p. 25, Coden: SCRIDK
Publ.Yr: Dec 16, 1985
Languages: ENGLISH
Descriptors: erythropoietin purification experiment; US space shuttle; McDonnell Douglas; Codon; Electrophoresis Operations in Space; EOS device; Riker, J. & J.; manufacturing process; agreement; 3M; Riker Laboratories

86-04287
McDonnell-3M space EPO
SCRIP World Pharmaceutical News No. 1055, p. 9, Coden: SCRIDK
Publ.Yr: Nov 27, 1985
Languages: ENGLISH
Descriptors: McDonnell Douglas; 3M; pharmaceutical products manufactured in space; erythropoietin; Ortho; R & D agreement; Riker Labs; EPO venture; experiments

86-03729
3M's Riker replaces J&J in space shuttle program
Medical Devices, Diagnostics and Instrumentation Reports -- "The Gray Sheet" Vol. 11, No. 47, pp. 11,12, Coden: MDDIDR
Publ.Yr: Nov 25, 1985
Languages: ENGLISH
Descriptors: McDonnell Douglas; Johnson & Johnson subsidiary; Ortho; R & D agreement; Riker Labs; EOS-1 device

86-03412
Drugs in space: McDonnell Douglas now processing erythropoietin
Publ.Yr: Dec 9, 1985
Languages: ENGLISH
Descriptors: Electrophoresis Operations in Space; EOS device; McDonnell Douglas; erythropoietin; Codon; Riker; Johnson & Johnson; agreement; Walker, C.

86-02423
Codon (Brisbane, CA) product undergoing purification on space shuttle
Applied Genetics News Vol. 6, No. 6, p. 6, Coden: AGNEEN
Publ.Yr: Dec 1985
Languages: ENGLISH
Descriptors: space shuttle contract; Codon; McDonnell Douglas; Astronautics; Electrophoresis Operation in Space; EOS device; erythropoietin; purification process; 3M; Riker Laboratories

86-00757
Riker will take J&J's place in space shuttle
FDC Reports -- "The Pink Sheet" Vol. 47, No. 47, pp. 11,12, Coden: FPSDAN
Publ.Yr: Nov 25, 1985
Languages: ENGLISH
Descriptors: McDonnell Douglas; Ortho; R & D agreement; Riker; J & J; Ortho; Amgen; Interleukin-2; hepatitis-B vaccine; Johnson & Johnson; EOS program; EOS-1 device

85-27775
Ortho Pharmaceutical Corp. pulls out of space contract with McDonnell Astronautics
Applied Genetics News Vol. 6, No. 3, p. 9, Coden: AGNEEN
Publ.Yr: Oct 1985
Languages: ENGLISH
Descriptors: cell separation; contract termination; McDonnell Astronautics; electrophoresis in space; Ortho Pharmaceutical

85-27689
Pharmaceuticals in space: Crystallography
SCRIP World Pharmaceutical News No. 1038, p. 14, Coden: SCRIDK
Publ.Yr: Sep 30, 1985
Languages: ENGLISH
Descriptors: pharmaceutical operations in space; McDonnell Douglas; Merck; Upjohn; SmithKline; US; bioprocessing in space; First. R.; business opportunities; market breakdown; forecasts: crystallography; Schering-Plough; Burroughs-Wellcome; Du Pont; agreements; Center for Macromolecular Crystallography; Pfizer; Genentech; Bugg, C.; alpha-2-interferon; CMC; R & D activity; Ortho
Identifiers: table

85-27536
UK space research offer
SCRIP World Pharmaceutical News No. 1037, p. 4, Coden: SCRIDK
Publ.Yr: Sep 25, 1985
Languages: ENGLISH
Descriptors: British Aerospace; UK; pharmaceutical companies
(cont. next page)
85-24131
Ortho dropping out of McDonnell Douglas space shuttle program

85-17039
Contracts and agreements; Endotronics, Inc. (Minneapolis, MN), and McDonnell Douglas Co. (St. Louis, MO) Sign contract for Endotronics to culture a cell line

85-05172
Blood storage experiment on space shuttle

85-01781
Spurs to space production

85-01414
Space hormone contaminated

Languages: ENGLISH
Descriptors: hormone manufactured in space; US; McDonnell Douglas; contamination; Walker, C.; Rose, J.; electrophoresis operations; Johnson & Johnson
84-06350

**J&J/McDonnell Douglas electrophoresis in space project**

- Medical Devices, Diagnostics and Instrumentation Reports - ('The Gray Sheet' Vol. 10, No. 12, pp. 12,13, Coden: MDDIDR
- Publ.Yr: Mar 19, 1984
- Languages: ENGLISH
- Descriptors: pharmaceutical specialist participation; Walker, C.; experiments; development schedule; Johnson & Johnson; McDonnell Douglas; J & J; electrophoresis in space; space shuttle flights; NASA cooperation; Fairchild; National Aeronautics & Space Administration; SII Corp.; production units

84-09921

**J&J/McDonnell Douglas electrophoresis in space project will put pharmaceutical specialist on June flight of space shuttle Discovery**

- FDC Reports - ('The Pink Sheet' Vol. 46, No. 11, pp. 3,
- Coden: FPSDAN
- Publ.Yr: Mar 12, 1984
- Languages: ENGLISH
- Descriptors: McDonnell Douglas; Walker, C.; pharmaceutical production specialist in space; electrophoresis; J & J; space bioprocessing project; Rose, J.; Johnson & Johnson; production schedule; NASA participation; commercial program; National Aeronautics and Space Administration; Fairchild; SII Corp.; biotechnology development; seminar/participants; Alpha Therapeutics; Cetus; Ciba-Geigy; DuPont; Lilly; Schering; Smith Labs; Scharp, D.

83-19062

**NASA to set up drug research centres**

- SCRIP World Pharmaceutical News No. 835, p. 6, Coden: SCRIP
- Publ.Yr: Oct 5, 1983
- Languages: ENGLISH
- Descriptors: NASA; US; university centres; pharmaceutical research; Halpern, R.; Johnson & Johnson; electrophoresis; National Aeronautics & Space Administration

83-19355

**Orbiting drug plant by 1987?**

- SCRIP World Pharmaceutical News No. 825 & 826, p. 13,
- Coden: SCRI0K
- Publ.Yr: Sep 5, 1983
- Languages: ENGLISH
- Descriptors: Johnson and Johnson; McDonnell Douglas; US; space shuttle flights; orbiting drug production plant; Rose, J.; electrophoresis

83-15740

**NASA bioprocessing/pharmaceutical research university centers**

- Medical Devices, Diagnostics and Instrumentation Reports - ('The Gray Sheet' Vol. 9, No. 38, p. 16,
- Coden: MDDIDR
- Publ.Yr: Sep 19, 1983
- Languages: ENGLISH
- Descriptors: Halpern, R.; university centers; biomedical research; NASA sponsorship; Stucki, J.; National Aeronautics & Space Administration; bioprocessing/pharmaceutical research field; McDonnell Douglas; J & J; electrophoresis purification space projects

83-16012

**NASA bioprocessing/pharmaceutical research university centers**

- Medical Devices, Diagnostics and Instrumentation Reports - ('The Gray Sheet' Vol. 9, No. 38, p. 16,
- Coden: MDDIDR
- Publ.Yr: Sep 19, 1983
- Languages: ENGLISH
- Descriptors: Halpern, R.; university centers; biomedical research; NASA sponsorship; Stucki, J.; National Aeronautics & Space Administration; bioprocessing/pharmaceutical research field; McDonnell Douglas; J & J; electrophoresis purification space projects

83-15740

**NASA bioprocessing/pharmaceutical research university centers**

- FDC Reports - ('The Blue Sheet' Vol. 26, No. 38, pp. 16,
- Coden: DRRSAL
- Publ.Yr: Sep 21, 1983
- Languages: ENGLISH
- Descriptors: Halpern, R.; university centers; Dear Colleague announcement; NASA sponsorship; National Aeronautics & Space Administration; bioprocessing/pharmaceutical research field; McDonnell Douglas; electrophoresis purification; J & J; space projects; NASA policy; commercialization
DIALOG File 42: Pharmaceutical News Index 74-86/Apr

86-04287
McDonnell-3M space EPO
SCRIP World Pharmaceutical News No. 1055, p. 9, Coden:SCRIDK
Publ.Yr: Nov 27, 1985
Languages: ENGLISH
Descriptors: McDonnell Douglas; 3M; pharmaceutical products manufactured in space; erythropoietin; Ortho; R & D agreement
Riker Labs; EPO venture; experiments

84-15389
Monodisperse latex microspheres to be first commercial space product
Medical Devices, Diagnostics and Instrumentation Reports - 'The Gray Sheet' Vol. 10, No. 31, pp. 16W-10, Coden: MDDIIJR
Publ.Yr: Jul 30, 1984
Languages: ENGLISH
Descriptors: National Aeronautics and Space Administration; National Bureau of Standards; NBS standard reference material medical applications; monodisperse latex spheres; NASA announcement; Vanderhoff, J.; production plans

84-15388
Administration's space commercialization policy
Medical Devices, Diagnostics and Instrumentation Reports - 'The Gray Sheet' Vol. 10, No. 31, pp. 16W-9, 10, Coden: MDDIIJR
Publ.Yr: Jul 30, 1984
Languages: ENGLISH
Descriptors: extraterrestrial business activities; commercial use of space; tax incentives; Administration policy; Reagan, R.; antitrust considerations; Johnson & Johnson; McDonnell Douglas; R & D focus
APPENDIX 6

EXPLANATORY CHARTS AND ADDITIONAL INFORMATION
TYPES OF INDUSTRY/NASA AGREEMENTS

- Industrial Guest Investigator (IGI)
- Technical Exchange Agreement (TEA)
- Joint Endeavor Agreement (JEA)
- Space Services Development Agreement (SSDA)
- Launch Services Agreement (LSA)
- Memorandum of Understanding (MOU)
- Agreement (negotiated for special circumstances such as a specific project)
AGREEMENTS

JE A APPROPRIATE WHERE:

1. R&D oriented
2. Commercial potential
3. U.S. corporation

JE A INAPPROPRIATE WHERE:

1. Revenue producing
2. Avoids procurement regulations
3. Able to compete on the merits
4. Not R&D
COMMON PRINCIPLES--NASA/INDUSTRY AGREEMENTS

- Technical idea
- Partnerships
- No exchange of funds
- Patent and data rights
- Mutual benefit
REQUIREMENTS FOR AN SSDA

1. Company Business Plan acceptable to NASA

2. First flight(s) of a new industry

3. Significant national economic or social benefit

4. Reasonable expectation of launch charge recovery in accordance with agreed terms
LAUNCH SERVICES AGREEMENT (SHUTTLE)

- Launch on Shuttle
- Standard package of services
- Risk allocation
- Financial arrangements
- Patent and data rights
- Boilerplate
- Special services
JOINT ENDEAVOR AGREEMENT

- No exchange of funds
- Quid pro quo
- Data rights protected
- Patent rights protected
- Company responsibilities
- NASA responsibilities
- Exclusivity
  -- Process
  -- Against another company
  -- Against the Government
- Boilerplate

OCP-0601
12/2/85
• No flight involved

• Exchange of technical information

• Ground based research analysis

• Minimum expense, paid by company

• NASA gets access to company research
### 1985 SELECTED CCDS

<table>
<thead>
<tr>
<th>Institution</th>
<th>Project Description</th>
<th>Amount</th>
</tr>
</thead>
<tbody>
<tr>
<td>Battelle Columbus Laboratories:</td>
<td>Multiphase materials processing</td>
<td>$850K</td>
</tr>
<tr>
<td>University of Alabama, Birmingham:</td>
<td>Macromolecular crystallography</td>
<td>$735K</td>
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<tr>
<td>University of Alabama, Huntsville:</td>
<td>Materials processing</td>
<td>$750K</td>
</tr>
<tr>
<td>Institute for Technology Development:</td>
<td>Remote sensing from space</td>
<td>$1,000K</td>
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<tr>
<td>Vanderbilt University:</td>
<td>Metallurgical processing</td>
<td>$1,140K</td>
</tr>
</tbody>
</table>

**Total:** $4,475

OCP-0113
1/28/86
AREAS OF POTENTIAL COMMERCIAL USE

- SPACE STATION/RESEARCH LAB
- REMOTE SENSING
- METEOROLOGICAL OBSERVATION
- SATELLITE SERVICING
- FREE FLYERS
  - REMOTE SENSING
  - METEOROLOGICAL OBSERVATION
  - SATELLITE SERVICING