NASA SP-7046(13)

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Technology for Large Space Systems

A Bibliography with Indexes

NASA SP-7046(13)
March 1986

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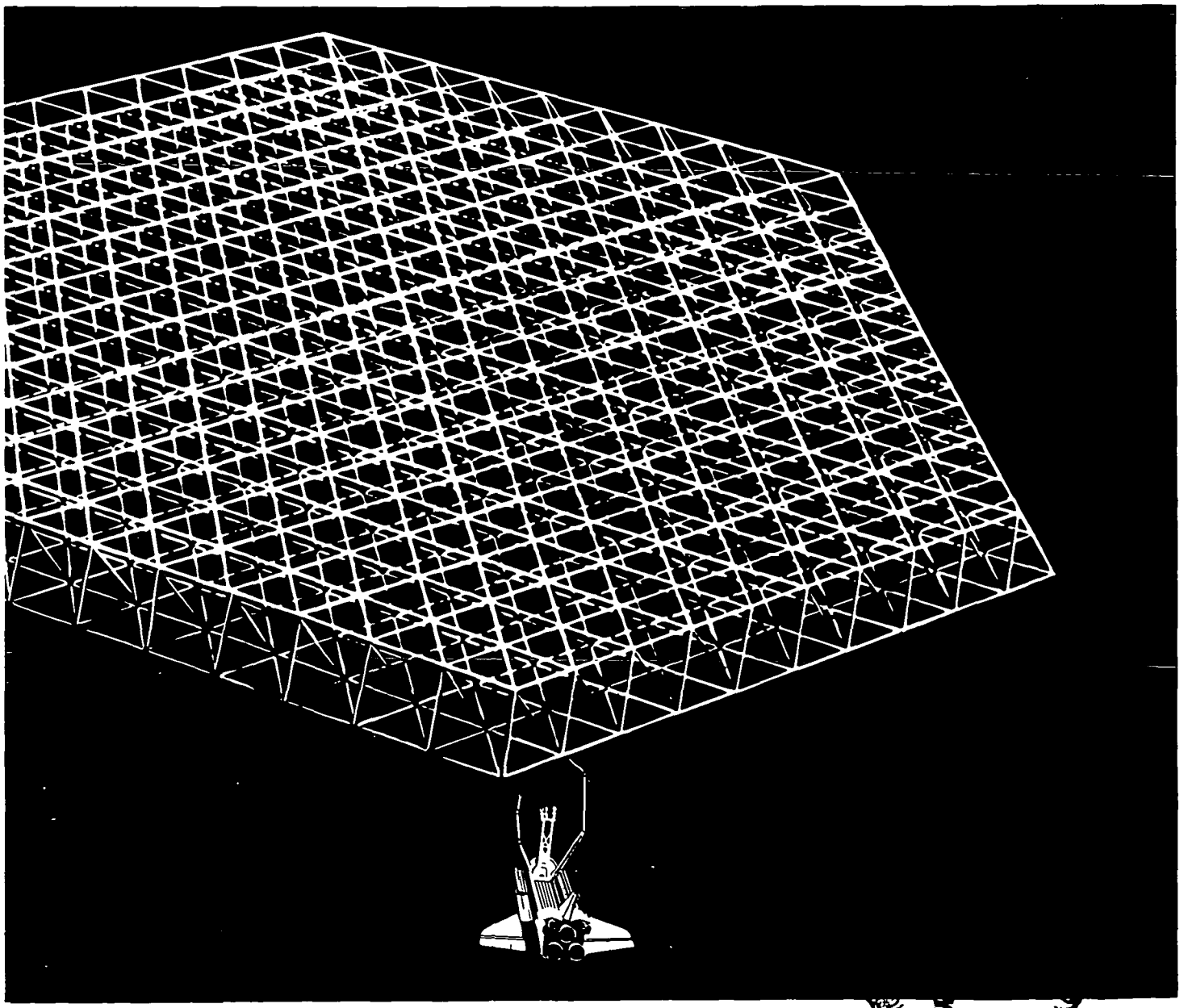

Technology for Large Space Systems

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TECHNOLOGY FOR LARGE SPACE SYSTEMS

A BIBLIOGRAPHY WITH INDEXES

Supplement 13

Compiled by
Technical Library Branch
and
Edited by
Space Systems Division
NASA Langley Research Center
Hampton, Virginia

A selection of annotated references to unclassified reports and journal articles that were introduced into the NASA scientific and technical information system between January 1 and June 30, 1985 in

- *Scientific and Technical Aerospace Reports (STAR)*
- *International Aerospace Abstracts (IAA)*

NASA Scientific and Technical Information Branch 1986
National Aeronautics and Space Administration
Washington, DC

NOTE TO AUTHORS OF PROSPECTIVE ENTRIES

The compilation of this bibliography results from a complete search of the *STAR* and *IAA* files Many times a report or article is not identified because either the title, abstract, or key words did not contain appropriate words for the search A number of words are used, but to best insure that your work is included in the bibliography, use the words *Large Space Structures* somewhere in your title or abstract, or include them as a key word

This supplement is available from the National Technical Information Service (NTIS), Springfield, Virginia 22161 at the price code A07 ($16 95 domestic; $33 90 foreign)

INTRODUCTION

This bibliography is designed to be helpful to the researcher and manager engaged in developing technology within the discipline areas of the Large Space Systems Technology (LSST). Also, the designers of large space systems for approved missions (in the future) will utilize the technology described in the documents referenced herein

This literature survey lists 399 reports, articles and other documents announced between January 1, 1985 and June 30, 1985 in *Scientific and Technical Aerospace Reports (STAR)*, and *International Aerospace Abstracts (IAA)*.

The coverage includes documents that define specific missions that will require large space structures to achieve their objectives. The methods of integrating advanced technology into system configurations and ascertaining the resulting capabilities is also addressed.

A wide range of structural concepts are identified. These include erectable structures which are earth fabricated and space assembled, deployable platforms and deployable antennas which are fabricated, assembled, and packaged on Earth with automatic deployment in space, and space fabricated structures which use pre-processed materials to build the structure in orbit.

The supportive technology that is necessary for full utilization of these concepts is also included These technologies are identified as analysis and design techniques, structural and thermal analysis, structural dynamics and control, electronics, advanced materials, assembly concepts, and propulsion

A separate companion document "Space Station Systems Bibliography" (NASA SP-7056) incorporates space station technology not applicable to large space systems Space station systems technology that is also applicable to large space systems may be documented in both bibliographies

Robert L Wright, *Space Systems Divison*
Sue K Seward, *Technical Library Branch*

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TECHNOLOGY FOR LARGE SPACE SYSTEMS

A Bibliography (Suppl. 13)

MARCH 1986

01

SYSTEMS

Includes mission and program concepts and requirements, focus missions, conceptual studies, technology planning, systems analysis and integration, and flight experiments

A85-12502#
SPACE EXPLOITATION - SPACELAB AN EASY APPROACH FOR DEVELOPING COUNTRIES: PROSPECTIVES AND SUGGESTIONS BY AERITALIA
E VALLERANI (Aeritalia S p A , Turin, Italy) IN International Scientific Conference on Space, 23rd, Rome, Italy, March 24, 25, 1983, Proceedings Rome, Rassegna Internazionale Elettronica Nucleare ed Aerospaziale, 1984, p 45-49

The problem of access by developing countries to space information and resources is discussed from the Italian point of view The international cooperation involved in the development of IRIS, Spacelab, and Eureca is considered, the ongoing commercialization of space in the STS, Ariane, and Space Station programs is examined, and the need for careful planning and preparation in the developing countries to take advantage of future space-exploitation opportunities is stressed It is proposed that Italian universities and industry provide assistance in training personnel and designing payloads to meet the needs of developing countries T K

A85-13009#
UTILIZATION OF A TELEOPERATED SERVICE VEHICLE FOR SPACECRAFT SERVICING
C COUGNET (Matra, S A , Toulouse, France) and C BERGER (Matra, S A , Velizy-Villacoublay, Yvelines, France) International Astronautical Federation, International Astronautical Congress, 35th, Lausanne, Switzerland, Oct 7-13, 1984 15 p Research supported by the European Space Agency
(IAF PAPER 84-48)

Potential, commercially oriented European space missions are discussed in terms of the required capabilities, equipment, and applications A trend toward heavier lift launch vehicles is foreseen, together with an interface with a long-life orbital base of operations and teleoperated service vehicles (TSV) On-orbit servicing of satellites is inevitable for improving the reliability, mission duration, and cost effectiveness of space utilization hardware. The TSV would operate out of a space station and be capable of orbital transfer, rendezvous, and servicing functions It would place, retrieve, and repair satellites and provide space station logistic support. The TSV could also be either ground-based or expendable, and in any case would be controlled via relay satellite, unless interfacing with the Shuttle or functioning in proximity to the Space Station Particularly frequent use would be made of the TSV in servicing space-based materials processing facilities M S K

A85-13016#
UTILIZATION AND ECONOMICS OF A EUROPEAN LOW EARTH ORBIT SPACE PLATFORM
R C PARKINSON and I V FRANKLIN (British Aerospace, PLC, Space and Communications Div , Stevenage, Herts , England) International Astronautical Federation, International Astronautical Congress, 35th, Lausanne, Switzerland, Oct 7-13, 1984 7 p
(IAF PAPER 84-57)

In addition to the manned, core station, the facilities of the Space Station are to include also a Teleoperated Service Vehicle, a cryogenic Orbit Transfer Vehicle, and unmanned Space Platforms Following President Reagan's invitation for international participation in the Space Station program, the Space Platform is of particular interest to Europe A Space Platform is defined as an unmanned orbiting facility in which essential services are supplied by a common Resources Module while payloads can be attached or recovered on a temporary basis The present investigation is concerned with the extent of potential interest in Europe in using such a Platform, the associated costs of development and operation, and the economic attractions to Europe of undertaking such a development It is concluded that the Space Platform (or Platforms) appears to represent a cost-effective area of participation in the U S Space Station program, at a cost Europe could afford, and with a function useful both to Europe and the U S G R

A85-13045#
SOME RESULTS OF THE MSAT PHASE B STUDIES AND THEIR IMPACT ON SYSTEM DESIGN
J L MCNALLY, H R RAINE, and J D B KENT (Canadian Department of Communications, Communications Research Centre, Nepean, Ontario, Canada) International Astronautical Federation, International Astronautical Congress, 35th, Lausanne, Switzerland, Oct 7-13, 1984 10 p. refs
(IAF PAPER 84-89)

In 1980, the Department of Communications (DOC) decided to commence Phase A feasibility studies for a mobile satellite system in the 800 MHz band The considered system would use a geostationary satellite to provide direct communication with vehicles in nonurban areas throughout Canada including offshore coverage of territorial waters. Promising results were obtained with respect to potential market, system feasibility, and commercial viability It was, therefore, decided to proceed with the second phase (Phase B Project Definition) in April 1982 Phase B involved an examination of system architecture, spacecraft, mobile radios, ground stations, Demand Assignment Multiple Access (DAMA) systems, and business requirements The present investigation attempts to provide an outline of some of the results and to project some plans for the future It is concluded that during the studies there has been an evolution toward a commercially-realizable first generation system G R

A85-13144#
ECONOMICS OF PERMANENT POLAR PLATFORMS (PPP) FOR GLOBAL MONITORING
D E KOELLE (ERNO Raumfahrttechnik GmbH, Ottobrunn, West Germany) International Astronautical Federation, International Astronautical Congress, 35th, Lausanne, Switzerland, Oct 7-13, 1984 8 p
(IAF PAPER 84-226)

Economic considerations in the development of a design for a Permanent Polar Platform (PPP) for global monitoring are discussed Attention is given to the need for interchaneability in the design of various payload modules including propulsion system, an auxiliary tank system, an equipment and avionics system and an orbital crew cabin The costs of several different design configurations are compared with total LANDSAT system costs are found to be competitive It is shown that the overall costs of the system can be cut in half once the permanent platforms are in place I H

A85-13233#
ORIENTATION AND TRENDS IN EUROPEAN TECHNOLOGY
H STOEWER (ESA, Systems Engineering Dept, Noordwijk, Netherlands) International Astronautical Federation, International Astronautical Congress, 35th, Lausanne, Switzerland, Oct 7-13, 1984 13 p
(IAF PAPER 84-377)

The current status and future directions of technology development programs under the direction of the ESA Space Research and Technology Center and on a national level in the ESA member states are surveyed in a number of charts and tables and briefly characterized Areas examined include data handling, power generation, structures, controls, software, and robotics, to serve missions including earth-space telematics, the Telecom system, terrestrial remote sensing, deep-space exploration and observation, microgravity utilization, space platforms, and in-orbit operations T K

A85-13244#
CONSTRUCTION OF LARGE PRECISION REFLECTORS USING THE AFT CARGO CARRIER
J M HEDGEPETH (Astro Research Corp, Carpinteria, CA), T B MOBLEY (Martin Marietta Aerospace, New Orleans, LA), and T C TAYLOR (Taylor and Associates, Inc, Wrightwood, CA) International Astronautical Federation, International Astronautical Congress, 35th, Lausanne, Switzerland, Oct 7-13, 1984 8 p
(IAF PAPER 84-389)

The Aft Cargo Carrier (ACC) will provide a large-sized volume for launching into orbit This paper reports a conceptual study aimed at examining approaches for using this capability in aiding the establishment of large precision reflectors in space Attention is paid, in particular, to infrared telescopes with decameter apertures The ACC is described, and various stowage schemes are discussed A novel technique of compacting the backup structure during launch is explained Author

A85-16109*# National Aeronautics and Space Administration, Washington, D C
THE FUTURE OF SPACE FLIGHT
J W MOORE (NASA, Washington, DC) International Air Transport Association, Dr Albert Plesman Memorial Lecture, 9th, Technische Hogeschool Delft, Delft, Netherlands, Oct 26, 1984, Paper 61 p

The history of the NASA space program is traced, and future plans are outlined Projects discussed include Mercury, Gemini, Apollo, Skylab, Apollo-Soyuz, science-applications spacecraft (Ranger, Surveyor, Mariner, Pioneer, and Voyager), the Space Shuttle, the planned Space Station, orbital maneuvering vehicles, lunar bases, and planetary exploration Numerous photographs and drawings are provided T K

A85-20507
INTERNATIONAL SPACE PROGRAMMES AND POLICIES
N JASENTULIYANA, ED and R. CHIPMAN, ED Amsterdam, North-Holland, 1984, 571 p No individual items are abstracted in this volume

The Second United Nations Conference on the Exploration and Peaceful Uses of Outer Space (UNISPACE) took place in Vienna, Austria, from 9 to 20 August 1982 with 94 states participating Part I of this publication provides a report which was adopted at the Conference, taking into account the state of space science and technology, applications of space science and technology, and international cooperation and the role of the United Nations The subjects discussed include experiments in the space environment, telecommunications, meteorology, remote sensing, navigation, global positioning, geodesy, space transportation and space platform technologies, mobile communications, maritime and aeronautical communication, satellite broadcasting, choices and difficulties in the use of space technology, mechanisms for enabling all states to benefit from space technology, and the compatibility of satellite systems Part II of the publication is concerned with the papers presented by 61 countries, while Part III provides a summary of the proceedings of the Conference along with the text of selected statements made at the Conference G R

A85-20866*# National Aeronautics and Space Administration Ames Research Center, Moffett Field, Calif
DETERMINATION OF ATMOSPHERIC DENSITY USING A SPACE-LAUNCHED PROJECTILE
G P MENEES, C PARK (NASA, Ames Research Center, Moffett Field, CA), K G BROWN (NASA, Ames Research Center, Moffett Field, CA, USAF, Washington, DC), and J F WILSON (Informatics General Corp, Palo Alto, CA) American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 23rd, Reno, NV, Jan 14-17, 1985 13 p refs
(AIAA PAPER 85-0327)

A method is proposed that provides advance information about unpredictable atmospheric density dispersions that must be accommodated during random operations of aeroassisted-orbital-transfer vehicles (AOTVs) The principal feature is that a test or 'scout' projectile precedes the AOTV through the same region of the atmosphere as that of the predicted transatmospheric flight trajectory The atmospheric density structure is determined from the vehicle's aerodynamic deceleration characteristics by on-board or ground-based tracking equipment The time lag between passage of the projectile and the AOTV can be adjusted to only that time necessary to implement required guidance, navigation, and control (GN&C) corrections The various strategies available to control the projectile's flight characteristics are analyzed in detail The results are correlated with aerothermodynamic heating and materials requirements to ensure the survival of the projectile and, consequently, the capability of the AOTV to navigate a variable upper atmosphere within specified limits Author

A85-22577* Arizona Univ, Tucson
DEPLOYABLE REFLECTOR CONFIGURATIONS
A B MEINEL, M P. MEINEL (Arizona, University, Tucson, AZ), and N J WOOLF (Steward Observatory, Tucson, AZ) IN Deployable optical systems, Proceedings of the Meeting, Los Angeles, CA, January 18, 19, 1983 Bellingham, WA, SPIE - The International Society for Optical Engineering, 1983, p 2-10
(Contract JPL-955687, NAGW-121)

Both the theoretical reasons for considering a non-circular format for the Large Deployable Reflector, and a potentially realizable concept for such a device, are discussed The optimum systems for diffraction limited telescopes with incoherent detection have either a single filled aperture, or two such apertures as an interferometer to synthesize a larger aperture For a single aperture of limited area, a reflector in the form of a slot can be used to give increased angular resolution It is shown how a 20 x 8 meter telescope can be configured to fit the Space Shuttle bay, and deployed with relatively simple operations The relationship between the sunshield design and the inclination of the orbit is discussed

The possible use of the LDR as a basic module to permit the construction of supergiant space telescopes and interferometers both for IR/submm studies and for the entire ultraviolet through mm wave spectral region is discussed. Author

A85-25117
A METHODOLOGY FOR ORGANIZING PERFORMANCE REQUIREMENTS FOR COMPLEX DYNAMICAL SYSTEMS
H. L. MALCHOW and S. R CROOPNICK (Charles Stark Draper Laboratory, Inc, Cambridge, MA) IEEE Transactions on Engineering Management (ISSN 0018-9391), vol EM-32, Feb 1985, p. 10-15 refs

Management of the development of complex dynamical systems includes the tasks of establishing system performance requirements These requirements are typically obtained from a nonsystematic process, which often results in premature constraining of system design This paper describes an orderly methodology for establishing performance requirements for complex systems The methodology uses a 'top-down' approach Connections between the system high level mission requirements and the lower level functional performance requirements are made in a series of steps The steps include identification of system activities, identification of activity-derived state vector elements, definition of state maintenance functions, and identification of functional components Author

A85-25697
SPACE - THE FUTURE OF MANKIND
G MUELLER Spaceflight (ISSN 0038-6340), vol 27, March 1985, p 104-107

Major advances in the fields of communication and air and space travel over the course of this century are reviewed, and the future plans concerning space travel are looked into for two decades ahead Among the future programs mentioned are: a continuously manned modular space station, with each module being capable of accommodating 12 people, which would be the prototype of the lunar and planetary expedition modules; a nuclear-powered interorbital shuttle, and the possibility of creating a lunar colony L T

A85-25700
SALYUT MISSION REPORT
N KIDGER Spaceflight (ISSN 0038-6340), vol. 27, March 1985, p 132-134

The 237-day flight of three Soviet cosmonauts, completed on October 2, 1984, is detailed, describing the mission objectives and the effects of such a long-term mission on the cosmonauts Salyut-7 docking with the Progress 23 cargo craft is also briefly described Some of the objectives of the mission included an attempt to determine the temperature profile of the Cygnus X-1 black-hole accretion disk and to observe X-ray pulsars and the Crab nebula. Over 500 experiments were conducted and 5500 earth photographs were taken; six EVAs were also performed, totalling 22 hours and 50 min The cosmonauts' condition upon return was described as a state of medium severity, such abnormalities as spine elongation (up to 5-6 cm total increase in height) and calcium losses in bones are noted to have been foreseen L T

A85-26011
EUROPE IN SPACE 1985-2000 [EUROPE SPATIALE 1985-2000]
P LANGEREUX Air et Cosmos (ISSN 0044-6971), vol 22, Feb 9, 1985, p 45-47, 50, 53 (3 ff) In French

Projects planned by the 13-member ESA in the last part of the century are surveyed, with particular note taken of the West German and French views The activities will proceed in the areas of science, remote sensing, telecommunications, microgravity materials processing, participation in the U S Space Station effort, and the development of new launch and space vehicles A desire has been expressed to build the unmanned polar orbiting segment of the Space Station, the Columbus The member nations will all contribute to design studies for the mini-Shuttle, Hermes, a project up to now carried solely by France Work will continue on the matching launch vehicle, the Ariane 5 and on free-flying platforms which will be visited only periodically and which will carry proof-of-technology experiments. The construction of modules for the U S Space Station is hoped to provide a technology and manufacturing base for building a European space station at some unspecified epoch in the future M S K

A85-26771#
THE COMMUNICATION-SATELLITE MARKET TO THE YEAR 2000 [DE COMMUNICATIESATELLIETMARKT TOT HET JAAR 2000]
R. J VAN DUINEN (Fokker, Schiphol, Netherlands) Ruimtevaart, vol 33, Aug -Oct 1984, p. 130-141 In Dutch.

The developmental history of communication satellites (CSs) is traced, the demands placed on industry by the increasing sophistication of CS payloads, the need to adapt the CS to different launchers (STS or Ariane), and the requirement of longer service life are reviewed, and the evolution of the markets for fixed (telephone, telex, and facsimile), video, business, and broadcasting service is projected over the period 1980-2000 and illustrated with tables and graphs It is predicted that the worldwide market, expressed in terms of the demand for 36-Mhz transponders, will increase from 426 in 1980 to 1410 in 1985, 3100 in 1990, 5580 in 1995, and 9870 in 2000, with the main increase in transponders for voice communications The potential for Netherlands participation in the growth of the CS market is evaluated, and the need for government leadership and for active promotion efforts is stressed T K

A85-27375
COMMERCIALIZATION OF SPACE - INCENTIVES, IMPEDIMENTS AND ALTERNATIVES
H R MARSHALL, JR (U S Department of State, Bureau of Oceans and International Environmental and Scientific Affairs, Washington, DC) Journal of Space Law, vol 12, Fall 1984, p 163-173 refs

The major issues concerned with the development of commercial enterprises in space are considered Attention is given to the need to streamline redundant national and international regulations to permit greater cooperation between firms in the development of such projects as the NASA Space Station, the ELV, SPOT, and the Ariane ELV project The possibility of impeding the growth of space enterprises through excessive concern for the political implications of technology transfer is discussed I H

A85-27695#
DEVELOPMENT AND APPLICATION OF NEW TECHNOLOGIES IN ESA'S OLYMPUS PROGRAMME
R BONHOMME and R STEELS (ESA, Olympus Programme Office, Noordwijk, Netherlands) ESA Journal (ISSN 0379-2285), vol 8, no 4, 1984, p 357-379

A number of examples of how new designs and technologies are being applied in the ESA Olympus program in both the spacecraft platform and the payloads are given, and results on the latest development and test activities are reported. The subsystems considered include the solar array subsystem, combined propulsion subsystem, altitude and orbit control subsystem, structure subsystem, and thermal subsystem on the platform, and the Specialized Services element, the television broadcast element, the Propagation Package element, the TV broadcast antenna, low-noise receivers, and traveling wave-tube amplifiers on the payload A brief review is given of prospects for large spacecraft derived from the Olympus design, emphasizing multimission applications C D

A85-28275
CRC HANDBOOK OF SPACE TECHNOLOGY: STATUS AND PROJECTIONS
R M HORD (General Research Corp , McLean, VA) Boca Raton, FL, CRC Press, Inc, 1985, 296 p refs

This volume presents trends and forecasts for figures of merit which may be used to characterize technological capabilities in the major discipline areas of space technology. The trends are

based on historical data, and the forecasts represent the consensus opinions of experts who are active contributors in their respective fields The major discipline areas included in this volume are transportation systems, spacecraft systems, information systems, chemical propulsion, electric propulsion, aerothermodynamics, power, materials and structures, automation, guidance, control, sensors, communications, data processing, and human factors The trends and forecasts presented generally consist of a graphical display for each relevant figure of merit, accompanied by a descriptive narrative The projections show the expected improvement in each of the discipline areas over the next twenty years C D

N85-10871# Committee on Appropriations (U S Senate)
NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
In its Department of Housing and Urban Development and Certain Independent Agencies for Fiscal Year 1985, Pt 2 p 1075-1241 Washington GPO 1984
Avail Committee on Appropriations

Appropriations for the space station, space transportation capability development, space science and applications, technology utilization, aeronautical research and technology, space research and technology, tracking and data advanced system, shuttle production and operational capability, space and ground networks, communication and data systems, and construction of facilities are detailed B G

N85-10872# Committee on Appropriations (U S Senate)
OFFICE OF TECHNOLOGY ASSESSMENT
In its Department of Housing and Urban Development and Certain Independent Agencies Appropriations for Fiscal Year 1985, Pt 2 p 1233-1241 Washington GPO 1984
Avail Committee on Appropriations

Three major issues were addressed how best to push toward more capable automated space systems and the wider use thereof, how to determine the optimum division of responsibility between people and machines, and how to estimate the importance of space automation to Earth applications B G

N85-11011*# National Aeronautics and Space Administration Marshall Space Flight Center, Huntsville, Ala
SECOND SYMPOSIUM ON SPACE INDUSTRIALIZATION
C M JERNIGAN, ed Oct 1984 427 p refs Symp held in Huntsville, Ala , 13-15 Feb 1984 Sponsored in cooperation with AIAA and Alabama Univ
(NASA-CP-2313, M-464, NAS 1 55 2313) Avail NTIS HC A19/MF A01 CSCL 22A

The policy, legal, and economic aspects of space industrialization are considered along with satellite communications, material processing, remote sensing, and the role of space carriers and a space station in space industrialization

N85-11035*# Booz-Allen and Hamilton, Inc , Arlington, Va
CONCEPT FOR A COMMERCIAL SPACE STATION LABORATORY
P W WOOD and P M STARK *In* NASA Marshall Space Flight Center 2nd Symp on Space Industrialization p 204-215 Oct 1984
Avail NTIS HC A19/MF A01 CSCL 22B

The concept of a privately owned and operated fee-for-service laboratory as an element of a civil manned space station, envisioned as the venture of a group of private investors and an experienced laboratory operator to be undertaken with the cooperation of NASA is discussed This group would acquire, outfit, activate, and operate the labortory on a fee-for-service basis, providing laboratory services to commercial firms, universities, and government agencies, including NASA This concept was developed to identify, stimulate, and assist potential commercial users of a manned space station A number of the issues which would be related to the concept, including the terms under which NASA might consider permitting private ownership and operation of a major space station component, the policies with respect to international participation in the construction and use of the space station, the basis for charging users for services received from the space station, and the types of support that NASA might be willing to provide to assist private industry in carrying out such a venture are discussed R J F

N85-11911# Committee on Science and Technology (U S House)
INTERNATIONAL COOPERATION AND COMPETITION IN SPACE
Washington GPO 1984 230 p refs Hearing before the Comm on Sci and Technol , 98th Congr , 2d Sess , No 104, 25 Jul 1984
(GPO-38-001) Avail Subcommittee on Space Science and Applications

Testimony and dialogue from a meeting of the House Subcommittee on Space Science and Applications are presented The Subcommittee met to survey the status of and prospects for international cooperation and competition in space

N85-12084*# Boeing Aerospace Co , Seattle, Wash
DEFINITION OF TECHNOLOGY DEVELOPMENT MISSIONS FOR EARLY SPACE STATIONS: LARGE SPACE STRUCTURES Final Report
31 May 1983 108 p refs
(Contract NAS8-35043)
(NASA-CR-171209, NAS 1 26 171209, D180-27677-1) Avail NTIS HC A06/MF A01 CSCL 22B

The testbed role of an early (1990-95) manned space station in large space structures technology development is defined and conceptual designs for large space structures development missions to be conducted at the space station are developed Emphasis is placed on defining requirements and benefits of development testing on a space station in concert with ground and shuttle tests M G

N85-12932*# National Aeronautics and Space Administration Langley Research Center, Hampton, Va
CONCEPTUAL DESIGN FOR SCALED TRUSS ANTENNA FLIGHT EXPERIMENT
W H LEE Nov 1984 40 p refs
(NASA-TM-85804, L-15838, NAS 1 15 85804) Avail NTIS HC A03/MF A01 CSCL 22B

The conceptual design for a scaled truss antenna structures experiment program (STASEP) is presented The hardware analysis of the scaled truss antenna structure (STAS) was performed by interactive design and evaluation of advanced spacecraft (IDEAS) computer aided, interactive, design and analysis program Four STAS's were designed to be launched by the Shuttle, tested by using the space technology experiments platform (STEP) and space transportation system (STS), and then free flown in short lifetime orbits Data were gathered on deployment, structural characteristics, geometric accuracies, thermal performance, and drag and lifetime as an orbiting spacecraft Structural and thermal properties were determined for the STAS, including mass properties, thermal loading, structural natural frequencies, and mode shapes The necessary analysis, scaling, and ground testing are discussed E A K

N85-13886*# National Aeronautics and Space Administration Lewis Research Center, Cleveland, Ohio
MISSIONS/PLANNING PANEL
J S FORDYCE *In its* Space Power p 57 Apr 1984
Avail NTIS HC A14/MF A01 CSCL 22A

A panel discussion was held to develop a viewpoint of space power technology needs and state of readiness for future mission scenarios Among the points made in the discussion, it was agreed that missions, particularly the far term ones, do serve to drive technology, however, as the missions become nearer term, issues of schedule and cost severely limit the willingness to accept risk There are, in fact, no rewards to a mission manager for introducing new technology Mission downscaling is the usual response to technology limitations All panelists agreed that there exists a serious gap between when technologists feel their job is done

and what mission managers need for decision Typically a two to three year engineering development gap exists It is essential to take technologies to the engineering model level and conduct a flight demonstration to close this gap All agreed that increased effort should be made to achieve stronger interactions between planners and technologists and that workshops like the present one are a step in the right direction Technologists need mission credibility and vice versa R J F

N85-13908*# *Hughes Aircraft Co , Canoga Park, Calif*
ENVIRONMENTAL INTERACTIONS WORKING GROUP REPORT
N J STEVENS and M WISKERCHEN (NASA, Washington, D C) *In* NASA Lewis Research Center Space Power p 323-326 Apr 1984
Avail NTIS HC A14/MF A01 CSCL 10B

Interactions between spacecraft systems and the space charged particle environment are reviewed and recommendations are presented for both near-term and far-term research considerations. Transient environment models, large space structures, solar and nuclear power systems/environment interactions, single event upsets, material degradation, and planetary missions are addressed M G

N85-14002# Messerschmitt-Boelkow-Blohm G m b H , Ottobrunn (West Germany) Space Div
OFFSET UNFURLABLE ANTENNA CONCEPTS
H KELLERMEIER, W SCHAEFER, and H VORBRUGG *In* ESA Workshop on Mech Technol for Antennas p 19-25 Sep 1984 refs
Avail NTIS HC A09/MF A01

A design definition study for an unfurlable offset antenna applicable to a wide mission spectrum of communication satellites was carried out A radial rib reflector concept with auxiliary adjustment ribs, and a three dimensional scissors truss concept were considered The radial rib reflector is seen to provide the greatest versatility The foldable ribs can be deployed and latched up by redundant cables driven by a central electric drive unit The design has a built-in retraction capability Author (ESA)

N85-16990*# National Aeronautics and Space Administration, Washington, D.C
NASA OAST PERSPECTIVE
F STEPHENSON *In* NASA. Lewis Research Center OTV Propulsion Issues p 1-14 Apr 1984 refs
Avail NTIS HC A13/MF A01 CSCL 22B

An advanced OTV is one of a number of advanced STS vehicles that the NASA OAST Space Systems Division Transportation Systems Office identified as candidates for future vehicle development. Vehicle requirements as well as technology needs and need dates were established and technology programs initiated to support those potential developments in a timely manner It is assumed that advanced OTV will be space based and fully reusable for low cost operations, use aeroassist for return to low-Earth-orbit, and evolve to a man-rated system The propulsion system will need to maintain high performance over a wide thrust range for mission flexibility, ranging from the transfer of large, acceleration limited structures from LEO to GEO, to demanding high reliability round-trip manned missions Technology advances are needed in propulsion, aerobraking, low-gravity cryogenic fluid management, and in environmentally compatible, low-loss cryogenic tankage In addition, diagnostic instrumentation for monitoring the health of on-board components and systems, and automated check-out capability will enhance low-cost space based OTV operations. Author

N85-19205# Joint Publications Research Service, Arlington, Va
COMMERCIAL SPACE: EUROPE SHOULD HAVE INDEPENDENT STRATEGY
In its West Europe Rept. Sci and Technol (JPRS-WST-85-004) p 1-5 30 Jan. 1985 Transl into ENGLISH from Aarde and Kosmos (Netherlands), Nov. - Dec 1984 p 518-522
Avail NTIS HC A04/MF A01

The impact of space commercialization on Europe is discussed Advantages and disadvantages are discussed with emphasis on the following areas competition, legal liabilities, economics, and development of European spacecraft B G

N85-20341*# National Aeronautics and Space Administration Marshall Space Flight Center, Huntsville, Ala.
TETHERED SATELLITE SYSTEM PROJECT OVERVIEW
J H LAUE *In its* Appl of Tethers in Space, Vol 1 16 p Mar 1985
Avail NTIS HC A13/MF A01 CSCL 13I

The Skyhook concept is reviewed and the use of a tethered satellite system (TSS) to enable scientific investigations from the shuttle using a closed loop control system is examined The tethered satellite system has capabilities for deployment toward or away from Earth, for multiple round trip missions, and for deployment at distances up to 100 KN from the orbiter The deployer, which consists of an entendable boom, a reel for the tether, and the tether itself, permits deployment and retrieval at a safe distance, allows alignment of the force vector of the tether through the center of gravity of the shuttle, and gives some initial gravity gradient separation to aid in deployment and ultimate retrieval of the tethered satellite Charts show TSS activities in terms of systems studies, key guidelines, Italian and U S responsibilities, user activities, and major science and applications accommodation features Scientific objectives for TSS-1 and TSS-2 verification missions and the current status of the project are also given A R H

N85-20343*# Consiglio Nazionale delle Ricerche, Rome (Italy)
TSS SATELLITE OVERVIEW
G MANARINI *In* NASA Marshall Space Flight Center Appl of Tethers in Space, Vol 1 21 p Mar 1985
Avail NTIS HC A02/MF A01 CSCL 13I

The responsibilities of NASA and PSN/CNR in the tethered satellite system cooperative program are listed and PSN/CNR-AIT system support and technologies studies are summarized Results are given for investigations of active vs passive satellite trade offs, analysis of alternative maneuvers, satellite attitude and position determination analysis failure modes analysis, moveable boom dynamic analysis, double tethered satellite system, and thermo/dynamic analysis for 100 km to 120 km altitude range Objectives for the space plasma science mission and its applications are outlined and the TSS satellite configuration is highlighted Programmatic aspects are included A R H

N85-20346*# Rome Univ (Italy)
SCIENCE APPLICATIONS, PART 1
F MARIANI *In* NASA Marshall Space Flight Center Appl of Tethers in Space, Vol 1 11 p Mar 1985 refs
Avail NTIS HC A13/MF A01 CSCL 22A

The tethered satellite system mission can allow direct observation of the structure and the dynamics of the lower atmosphere, as well as answer some basic questions on the chemical composition of the atmosphere, the coupling mechanisms between small and large scale motions, the global wind field of the lower atmosphere, and how it is influenced by waves and tides, the mass, momentum, and energy fluxes in the lower thermosphere, how the above are affected by externally perturbed conditions (for example by magnetic storms, solar wind and its variability, etc), and the pattern of electric current circulation and its relationship with the magnetospheric environment. Fundamental plasma processes can also be studied Similarity of conditions in other plasmas in space makes it possible to get information on the magnetospheres of the giant planets or more generally on the solar system The electrodynamic phenomena associated with

the Jovian satellite Io (radioemission, UV emission, energetic electron precipitation) can be examined by simple scaling to the terrestrial case A R H

N85-20347*# National Aeronautics and Space Administration, Washington, D C
SCIENCE APPLICATIONS, PART 2
J P MURPHY *In* NASA Marshall Space Flight Center Appl of Tethers in Space, Vol 1 18 p Mar 1985
Avail NTIS HC A13/MF A01 CSCL 22A

The goals of the Geopotential Research Program are to contribute to the understanding of the solid earth, the origin and evolution of the earth, its internal structure and the dynamics of the core and the mantle, the movements and deformations of the tectonic plates that make up the surface of the earth, its rotational dynamics, the changes in the rotation rate of the earth, the orientation of the pole in space, variations of the gravity and magnetic field of the earth, the origin of the earth and the way in which the solid earth interacts with the oceans and the atmosphere Author

N85-21225# Committee on Commerce, Science, and Transportation (U S Senate)
COMMERCIAL SPACE LAUNCHES
Washington GPO 1984 19 p Rept to accompany H R 3942 presented by the Comm on Com , Sci , and Transportation, 98th Congr , 2nd Sess , 3 Oct 1984
(S-REPT-98-656, GPO-51-010) Avail US Capitol, Senate Document Room

This bill is to establish a framework within which expendable launch vehicles (ELVs) and their associated facilities and launch services may be licensed for commercial launches This legislation also designates the Department of Transportation (DOT) as the lead Federal agency to facilitate and expedite the issuance and transfer of commercial space launch licenses Author

02

ANALYSIS AND DESIGN TECHNIQUES

Includes interactive techniques, computerized technology design and development programs, dynamic analysis techniques, environmental modeling, thermal modeling, and math modeling

A85-12992#
DESIGN CONSIDERATION OF SPACE CONSTRUCTION FACILITY
M NAGATOMO (Tokyo, University, Tokyo, Japan), T YAMANAKA (National Aerospace Laboratory, Chofu, Tokyo, Japan), and S SONOYAMA (National Space Development Agency of Japan, Tokyo, Japan) International Astronautical Federation, International Astronautical Congress, 35th, Lausanne, Switzerland, Oct 7-13, 1984 9 p refs
(IAF PAPER 84-26)

Space operation and space construction are unique capabilities of the Space Station These activities involve the utilization of the vicinity space of the space station A preliminary study on the requirements of space construction and their interfaces with space operation indicated that the work of space construction includes fabrication, assembly, testing, and operation Choices of installation, commonality, dynamics of Space Station, and interface with transportation have been considered as design factors of a space-construction facility A configuration study has been made to see how the facility is related to the total Space-Station system concerning these design factors For future evolution, space construction will be a central function of the Space Station, which should be so designed Author

A85-12995#
ARCHITECTURE AND IMPLEMENTATION OF AN IN-ORBIT INFRASTRUCTURE
P MOLETTE and C COUGNET (Matra, S A , Toulouse, France) International Astronautical Federation, International Astronautical Congress, 35th, Lausanne, Switzerland, Oct 7-13, 1984 14 p Research supported by the European Space Agency
(IAF PAPER 84-29)

The analysis of future commercial space-processing and earth-observation missions indicates that their implementation in space, their operational utilization as well as their maintenance will advantageously be supported by a common in-orbit infrastructure (IOI) Thus, a space-processing mission will be accommodated on a platform in LEO and will require dedicated vehicle and servicing equipment to ensure its logistic resupply, the maintenance and exchange of payload facilities, and the maintenance and refueling of the platform This space-processing mission is the most demanding one, and the definition of the architecture of the IOI is based on its requirements The IOI has to fulfill several functions, and the repartition of the tasks among some of or all its elements will depend on the scenario of utilization of the platform and on the time frame Three candidate IOI architectures are proposed which differ in their level of utilization of U S facilities, and a scenario of implementation of a European IOI is proposed It is split into three successive steps which allow Europe to benefit from participation in the U S Space Station on the way to complete independence in supporting commercial missions and manned flights Author

A85-13100#
IMPACTS OF LIFE SUPPORT SYSTEM ON SPACE STATION DESIGN
W G NELSON, L R PRICE, and M M YAKUT (McDonnell Douglas Astronautics Co , Huntington Beach, CA) International Astronautical Federation, International Astronautical Congress, 35th, Lausanne, Switzerland, Oct 7-13, 1984 8 p
(IAF PAPER 84-166)

It is pointed out that recent NASA and U S industry activity has been directed toward a manned Space Station as the next major U S space venture Identified needs and attributes regarding a space station include low cost, long life, and ample resources for mission support Environmental Control/Life Support Systems (ECLSS) requirements for the Space Station Architecture are considered along with a parametric data base The data base developed includes a hierarchy of information necessary to resolve the key issues associated with Space Station ECLSS Loop closure represents a key variation in the ECLSS design options The four options compared are related to no water or O2 recovery, wash and condensate water recovery, all water recovery, and all water plus partial O2 recovery Attention is also given to the effect of incremental increases in capability, centralized versus decentralized ECLSS equipment arrangements, optimum ECLSS concepts, and concepts for ECLSS evolution Author

A85-13247#
DEPLOYABLE REFLECTOR ANTENNAS - MECHANICAL DESIGN OF THE REFLECTIVE SURFACE
C SIRMAIN, J -N GIRAUDBIT, and A LIEUTIER (Centre National d'Etudes Spatiales, Toulouse, France) International Astronautical Federation, International Astronautical Congress, 35th, Lausanne, Switzerland, Oct 7-13, 1984 9 p
(IAF PAPER 84-393)

A review is given of CNES R&D on 1-10 GHz mesh deployable reflector antennas, 5-30 meters in diameter The analysis philosophy and the LIMA surface computation program are described The features of this program include modularity, computation of the gridded surface, the pillow effect, BFP/RMS, and reflector cut, model adjustment and interpolations, and application to all faceted surfaces, even nonparaboloid ones Consideration is also given to surface contour faults, geometrical imperfection sensitivity, contour optimization, and coupling between the backing structure and the mesh contouring system L M

A85-14429
SPACE STATION/SPACE PLATFORM SYSTEM DESIGN CONSIDERATIONS
A. E SABROFF and R. E. SHARPLES (TRW Electronics and Defense Sector, Redondo Beach, CA) IN EASCON '83; Proceedings of the Sixteenth Annual Electronics and Aerospace Conference and Exposition, Washington, DC, September 19-21, 1983 New York, Institute of Electrical and Electronics Engineers, 1983, p 17-26

The Space Applications Board of the National Research Council conducted a summer study in mid-August 1982 at Crestwood, Colorado This paper summarizes the findings of the System Design Panel, one of six panels formed to do the study, and augments these findings with results from recent NASA space station mission analysis studies The paper is organized into discussions of four major categories cost/benefit system design issues, user design requirements, manned system design issues, and technology design issues For each category, the recommendations of the Panel are summarized and illustrated Key results include the ideas that man-in-space is an application in its own right with significant future potential, and that an appropriate first step in the evolution of man working in space should be the development of a 'space service station' capability Author

A85-15496#
SOME DESIGN CONCEPTS FOR INTELSAT VII
G R WELTI (COMSAT Laboratories, Clarksburg, MD) IN International Conference on Digital Satellite Communications, 6th, Phoenix, AZ, September 19-23, 1983, Proceedings New York, Institute of Electrical and Electronics Engineers, 1983, p. XI-1 to XI-8 Research sponsored by the Communications Satellite Corp refs

Cost-effective architectures for Intelsat VII spacecraft are described These spacecraft yield a capacity of 228,000 channels in the Atlantic Operating Region primary mission by reusing the expanded Ku-band spectrum four times, using wideband beam-hopping transponders with twenty-six 0 7-deg spot beams The spacecraft mass is 23 percent greater than that of Intelsat VI Author

A85-16648
PRINCIPAL COMPONENT ANALYSIS OF FLEXIBLE SYSTEMS - OPEN-LOOP CASE
E A JONCKHEERE (Southern California, University, Los Angeles, CA) IEEE Transactions on Automatic Control (ISSN 0018-9286), vol AC-29, Dec 1984, p 1095-1097 refs
(Contract AF-AFOSR-80-0013)

A generic class of flexible systems, characterized by finitely many lightly damped harmonic oscillators, is analyzed by means of the 'open-loop principal component analysis', that is, singular value analysis and Gramian balancing As the main result, it is shown that, as the damping ratio goes to zero, the balanced state coordinates are decoupled and coincide with the modal coordinates Further, simple formulas expressing the 'asymptotic singular values' as functions of the modal parameters are derived Author

A85-18338#
OPTIMAL SIMULTANEOUS STRUCTURAL AND CONTROL DESIGN OF MANEUVERING FLEXIBLE SPACECRAFT
A. L HALE, W E DAHL (Illinois, University, Urbana, IL), and R J LISOWSKI (U S Air Force Academy, Colorado Springs, CO, Illinois, University, Urbana, IL) Journal of Guidance, Control, and Dynamics (ISSN 0731-5090), vol 8, Jan -Feb 1984, p 86-93 refs

An optimization problem for maneuvering flexible spacecraft is discussed wherein both structural parameters and active control forces are to be determined so that a specific cost functional is minimized The problem is an application of the general theory of optimal control of parametric systems For simplicity, only maneuvers from a specified initial state to a specified final state in a specified time interval are considered Numerical examples are presented for single-axis slew maneuvers of a symmetric four-boom flexible structure The mass and stiffness distributions of the booms are determined as part of the optimization problem Author

A85-19600#
COMPUTER AIDED DESIGN OF MULTIPLE INPUT/OUTPUT CONTROL SYSTEMS FOR MULTIBODY FLEXIBLE SPACE STATION
H C GELDERLOOS and B S HECK (Honeywell, Inc , Clearwater, FL) American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 23rd, Reno, NV, Jan 14-17, 1985 10 p. refs (AIAA PAPER 85-0223)

With the advent of Space Station on the horizon, several technical requirements have surfaced that are unique to the problem of controlling large space structures As the space station grows from a single module with solar panels to multiple modules with attached bodies and experiments, a control analysis tool with emphasis on high-fidelity modeling of multi-body flexible structures is required The computer aided design tool described in this paper easily generates nonlinear structural models for different configurations and orientations The control system design and analysis tool includes structural dynamics, coupling of attached bodies, mass property changes, articulation of payloads and docking transients Multiple input/output optimal control systems for the linear models are developed with modern and classical control techniques using the computer aided design tools Preliminary results of a Space Station attitude controller are presented Author

A85-22579
DESIGN CONCEPTS FOR REFLECTOR ANTENNA STRUCTURES
J M HEDGEPETH (Astro Research Corp , Carpinteria, CA) IN Deployable optical systems, Proceedings of the Meeting, Los Angeles, CA, January 18, 19, 1983 Bellingham, WA, SPIE - The International Society for Optical Engineering, 1983, p 21-31 refs

Attention is given to the structural configurations of future large space antennas whose diameter/wavelength ratios are typically of the order of less than 10,000, as required by submillimeter wave and IR astronomy An example of such a reflector is the Large Deployable Reflector IR telescope's 20-m primary mirror, which is off-axis Cassegrainian design with focal length equal to aperture diameter In order to reduce system noise, the reflecting surfaces are maintained at very low temperatures by means of multilayer insulation-based thermal shielding Emphasis is presently given to telescope deployment concepts, active control of the hexagonal reflector panels, and the intrinsic accuracy of truss-structure reflectors O C

A85-22685* National Aeronautics and Space Administration Ames Research Center, Moffett Field, Calif
A MODULAR APPROACH TO DEVELOPING A LARGE DEPLOYABLE REFLECTOR
R PITTMAN, C LEIDICH, F MASCY, and B SWENSON (NASA, Ames Research Center, Advanced Studies Office, Moffett Field, CA) IN Infrared technology IX, Proceedings of the Ninth Annual Meeting, San Diego, CA, August 23-25, 1983 Bellingham, WA, SPIE - The International Society for Optical Engineering, 1983, p 115-128 refs

NASA is currently exploring the feasibility of developing a large deployable reflector (LDR) astronomical facility to perform astrophysical studies in the mid 1990's in the IR and submillimeter portion of the spectrum This paper examines a combination of automatic deployment and on-orbit assembly that may reduce the technological complexity and cost of the LDR system Two Shuttle volume budget scenarios are examined to assess the potential of various technological tools to reduce the LDR system complexity. It is noted that the LDR design must be flexible and allow one subsystem to be modified without adversely affecting the entire system. One way to achieve this flexibility is a modular design approach (MDA) in which the major subsystems are physically separated during launch and assembled on orbit NASA is defining

a technology development plan for LDR that will identify the technology advances that are required It is concluded that the MDA offers the flexibility to easily incorporate these advances into the design B J

A85-24908
SPACE FRAME DESIGN, DEVELOPMENT AND OPTIMIZATION OF ANTENNA PLATFORM STRUCTURE FOR A MOBILE 3D RADAR
K VAJRAVELU (Bharat Electronics, Ltd , Bangalore, India) IN International Radar Symposium, Bangalore, India, October 9-12, 1983, Proceedings Bangalore, India, Institution of Electronics and Telecommunication Engineers, 1983, p 544-549 refs

A85-26675
INTERNATIONAL FEM-CONGRESS, BADEN-BADEN, WEST GERMANY, NOVEMBER 14, 15, 1983, PROCEEDINGS
Stuttgart, West Germany, IKO Software Service GmbH, 1983, 412 p In English and German No individual items are abstracted in this volume

Various papers on the Finite Element Method (FEM) are presented The topics addressed include experimental and theoretical evaluation of pipe systems in nuclear reactors under blowdown conditions, reduction of a special thermoviscoelastoplastic problem from 3-D to 2-D, a general, nonlinear FE program system, nonlinear analysis and the optimization of a microswitch wire snap, satellite structural analysis with ASKA calculative method, and application of calculation and test methods to fortuitously excited vibrations in space flight Also considered are interactive coupling of CAD system and structural mechanics, CAD/FEM coupling, equilibrium modelling in the closed mesh of a finite element analysis, effective evaluation of a stress concentration problem, modal coordinates in FE dynamic calculations, application of the PISCES code for nuclear safety problems, general and simplified FE models for crankshaft calculations, use of finite elements to optimize machine parts, and use of FEM with CAD/CAM system C D

A85-27696#
SPACECRAFT SYSTEMS ENGINEERING AND GEOMETRY MODELLING - THE ESABASE-MATVIEW APPROACH
J G FERRANTE, P COFFINIER, B AUBE (Matra, S A , Toulouse, France), and J DE KRUYF (ESA, Mathematical Support Div , Noordwijk, Netherlands) ESA Journal (ISSN 0379-2285), vol 8, no 4, 1984, p 381-394 refs

The use of two software packages, ESABASE and MATVIEW, in the design of spacecraft is discussed The former provides a multidisciplinary framework for integrated systems engineering, while the latter supports ESABASE geometry modeling and interacts with a wide range of systems-analysis applications The ESABASE approach to spacecraft design is reviewed, introducing integrated computer-aided engineering concepts into the design of complex earth-orbiting spacecraft Background information and the rationale for MATVIEW's decomposition of geometrical shapes into discrete planar finite elements are given Some current and future system-level applications analyses that are being integrated into ESABASE are described The VWHEAT and SINDA thermal application module coupled to ESABASE at the subsystem level is discussed in detail C D

N85-10391*# Grand Valley State Coll , Allendale, Mich
SHEAR DEFORMATION PLATE CONTINUA OF LARGE DOUBLE-LAYERED SPACE STRUCTURES
M S HEFZY and A H NAYFEH (Cincinnati Univ) *In* NASA Langley Research Center Res in Struct and Dyn , 1984 p 197-217 Oct 1984 refs
(Contract NSG-1185)
Avail NTIS HC A18/MF A01 CSCL 20K

The energy equivalence to construct equivalent continua for the actual lattice structure is described An energy equivalent continuum is defined as that which has the same amount of strain and kinetic energies stored in it as the original lattice structure when both are subjected to the same loading conditions The equivalent continuum is characterized by its strain and kinetic energies from which the constitutive relations and the equations of motion can be derived A simple method to model large rigid jointed lattices as continuous media with couple stresses is presented The transition from the discrete system to the continuous medium is achieved by expanding the displacements and the rotations of the nodal points in a Taylor series about a suitable chosen origin Basic kinematic assumptions are introduced to insure that the assumptions used in deriving the governing equations of the modeled continuum are satisfied The number of terms retained in the Taylor series expansion will depend upon the properties to be evaluated This implies that the kind of continuum needed to model from the discrete lattice, before the actual properties are derived was to predetermined E A K

N85-10677*# Boeing Aerospace Co , Kent, Wash
IAC USER MANUAL
R G VOS, D L BESTE, and J GREGG Jul 1984 391 p refs
(Contract NAS5-25767)
(NASA-CR-175300, NAS 1 26 175300) Avail NTIS HC A17/MF A01 CSCL 09B

The User Manual for the Integrated Analysis Capability (IAC) Level 1 system is presented The IAC system currently supports the thermal, structures, controls and system dynamics technologies, and its development is influenced by the requirements for design/analysis of large space systems. The system has many features which make it applicable to general problems in engineering, and to management of data and software Information includes basic IAC operation, executive commands, modules, solution paths, data organization and storage, IAC utilities, and module implementation M A C

N85-11050*# Martin Marietta Aerospace, New Orleans, La
EXTERNAL TANK AFT CARGO CARRIER Abstract Only
T B MOBLEY *In* NASA Marshall Space Flight Center 2nd Symp on Space Industrialization p 348 Oct 1984
Avail NTIS HC A19/MF A01 CSCL 22B

The External Tank (ET) Aft Cargo Carrier (ACC) is a low cost, low risk augmentation of the Space Transportation System (STS) It almost doubles the cargo volume of the STS while minimally impacting other STS elements (orbiter, ET and solid rocket boosters SRBs, launch facilities and STS operations In addition to increasing the potential volume of cargo carried on a Shuttle launch, the ACC provides the following additional benefits (1) Increased STS competitiveness for payloads, (2) Increased cargo manifest flexibility, (3) Increased spacecraft design options, (4) Alternate manifesting for special payloads, and (5) Future space platform/station design options Author

N85-11570*# Computer Sciences Corp , Hampton, Va
SMP: A SOLID MODELING PROGRAM
D P RANDALL, K H JONES, W H VONOFENHEIM, and R L GATES Hampton, Va NASA Langley Research Center Nov 1984 138 p refs
(Contract NAS1-16078)
(NASA-CR-172473, NAS 1 26 172473, TAO-34100) Avail NTIS HC A07/MF A01 CSCL 09B

A prototype solid modeling program, SMP, developed by CSC for Langley Research Center (LaRC) is documented in this paper The SMP software is employed by the System and Experiments Branch (SEB) of the Space Systems Division (SSD) for preliminary space station design, but is intended as a general purpose tool The SMP document provides details concerning the basic geometric modeling primitives and associated operators, the data representation scheme utilized to structure the geometric model, the available commands for both editing and displaying the solid model, the interactive user interface and the input/output interfaces to external software, and the utility of the package in the LaRC computing environment The document is sufficiently detailed to serve both as a user's guide and reference manual B W

N85-13838*# Control Dynamics Co , Huntsville, Ala
DEFINITION OF GROUND TEST FOR VERIFICATION OF LARGE SPACE STRUCTURE CONTROL Final Report, 30 Sep. 1980 - 31 Jul. 1984
G B. DOANE, III, J R. GLAESE, D K TOLLISON, T. G HOWSMAN, S. CURTIS, ed , and B BANKS Nov 1984 157 p refs
(Contract NAS8-34700)
(NASA-CR-171208, NAS 1 26 171208) Avail NTIS HC A08/MF A01 CSCL 22B

Control theory and design, dynamic system modelling, and simulation of test scenarios are the main ideas discussed The overall effort is the achievement at Marshall Space Flight Center of a successful ground test experiment of a large space structure A simplified planar model of ground test experiment of a large space structure A simplified planar model of ground test verification was developed The elimination from that model of the uncontrollable rigid body modes was also examined. Also studied was the hardware/software of computation speed

N85-14011# British Aerospace Dynamics Group, Stevenage (England) Space and Communications Div
BAE ANTENNA HARDWARE TECHNOLOGY FOR CURRENT SATELLITE PROJECTS
R K EMERY *In* ESA Workshop on Mech Technol for Antennas p 77-82 Sep 1984
Avail NTIS HC A09/MF A01

The mechanical design, development and manufacture of antenna hardware for satellite solid reflectors up to 3 2m diameter, feed chains, antenna pointing mechanisms, antenna deployment subsystems, and antenna support structures are discussed The technology involved and problems encountered are summarized
Author (ESA)

N85-19011*# Rockwell International Corp , Pittsburgh, Pa Space Station Systems Div.
GROUND TEST ARTICLE FOR DEPLOYABLE SPACE STRUCTURE SYSTEMS Bimonthly Report
G D MALLOY Jan. 1985 7 p
(Contract NAS8-34657)
(NASA-CR-171301, NAS 1 26 171301, BMR-5) Avail NTIS HC A02/MF A01 CSCL 22B

Santek's ability to recover from a schedule slip was reviewed and found satisfactory Diagonal member bond joints were subjected to static load to failure tests Results are considered adequate
B G

N85-19013*# National Aeronautics and Space Administration Marshall Space Flight Center, Huntsville, Ala.
GROUND TEST EXPERIMENT FOR LARGE SPACE STRUCTURES
D K TOLLISON (Control Dynamics Co) and H B WAITES Feb 1985 11 p
(NASA-TM-86489, NAS 1 15 86489) Avail NTIS HC A02/MF A01 CSCL 22B

In recent years a new body of control theory has been developed for the design of control systems for Large Space Structures (LSS) The problems of testing this theory on LSS hardware are aggravated by the expense and risk of actual in orbit tests Ground tests on large space structures can provide a proving ground for candidate control systems, but such tests require a unique facility for their execution The current development of such a facility at the NASA Marshall Space Flight Center (MSFC) is the subject of this report
Author

N85-20344*# Aeritalia S p A , Naples (Italy)
SATELLITE MODULE DESIGN
M VIGNOLI *In* NASA Marshall Space Flight Center Appl of Tethers in Space, Vol 1 19 p Mar 1985
Avail NTIS HC A02/MF A01 CSCL 22B

The tethered satellite system (TSS) satellite is a multimission vehicle able to carry scientific payloads aways from the shuttle orbiter in the range of 130 to 330 km in altitude The multimission capability is obtained adopting a modular concept of the satellite such to allow for easy reconfiguration, easy refurbishment, and cost and schedule minimization The modular concept is realized with a payload module (PM), a service module (SM), and an auxiliary propulsion module (APM) The satellite configuration for the electrodynamic and atmospheric missions is described as well as its mechanized capabilities Payload dedicated electrical facilities, satellite position determination accuracy, attitude control and measurement accuracy and attitude oscillation characteristics are summarized
A R H

N85-21232*# National Aeronautics and Space Administration Marshall Space Flight Center, Huntsville, Ala
NATURAL ENVIRONMENT DESIGN CRITERIA FOR THE SPACE STATION DEFINITION AND PRELIMINARY DESIGN
W W VAUGHAN and C E GREEN Mar 1985 16 p Revised
(NASA-TM-86498, NAS 1 15 86498) Avail NTIS HC A02/MF A01 CSCL 22B

The natural environment design criteria for the Space Station Program (SSP) definition and preliminary design are presented Information on the atmospheric, dynamic and thermodynamic environments, meteoroids, radiation, magnetic fields, physical constants, etc is provided with the intension of enabling all groups involved in the definition and preliminary design studies to proceed with a common and consistent set of natural environment criteria requirements The space station program elements (SSPE) shall be designed with no operational sensitivity to natural environment conditions during assembly, checkout, stowage, launch, and orbital operations to the maximum degree practical
M G

N85-21262*# National Aeronautics and Space Administration Johnson (Lyndon B) Space Center,
DESIGN STUDY OF AN INTEGRATED AEROBRAKING ORBITAL TRANSFER VEHICLE
C D SCOTT, B B ROBERTS, K NAGY, P TAYLOR, J D GAMBLE, C J CEREMELI, K R KNOLL, C P LI, and R C REID Mar 1985 40 p refs
(NASA-TM-58264, S-542, NAS 1 15 58264) Avail NTIS HC A03/MF A01 CSCL 22B

An aerobraking orbital transfer vehicle (AOTV) concept, which has an aerobrake structure that is integrated with the propulsion stage, is discussed The concept vehicle is to be assembled in space and is space-based The advantages of aeroassist over an all propulsive vehicle are discussed and it is shown that the vehicle considered is very competitive with inflatable and deployable concepts from mass and performance aspects The aerobrake geometry is an ellipsoidally blunted, raked-off, elliptical wide-angle cone with a toroidal skirt Propellant tanks, engines, and subsystems are integrated into a closed, isogrid aerobrake structure which provides rigidity The vehicle has two side-firing, gimbaled RL-10 type engines and carries 38,000 kg of useable propellant. The trajectory during aerobraking is determined from an adaptive guidance logic, and the heating is determined from engineering correlations as well as 3-D Navier-Stokes solutions The AOTV is capable of placing 13,500 kg payload into geosynchronous Earth orbit (GEO) or carrying a LEO-GEO-LEO round-trip payload of 7100 kg A two-stage version considered for lunar missions results in a lunar surface delivery capability of 18,000 kg or a round-trip capability of 6800 kg with 3860 kg delivery-only capability.
M G

03

STRUCTURAL CONCEPTS

Includes erectable structures (joints, struts, and columns), deployable platforms and booms, solar sail, deployable reflectors, space fabrication techniques, and protrusion processing

A85-12933
THE STRONGEST STRUCTURES WITH MACROSTIFFNESS CONSTRAINTS
J HOLNICKI-SZULC (Polska Akademia Nauk, Instytut Podstawowych Problemow Techniki, Warsaw, Poland) Journal of Structural Mechanics (ISSN 0360-1218), vol 12, no 2, 1984, p 181-197 refs

An example of a truss structure with limited global stiffness, measured by some parameter k, is discussed The optimal structural design problem of maximizing the external load intensity, with axial stresses in the rods of the truss remaining within an allowable range, is well known and leads to a statically determinate solution with uniformly loaded elements However, if one takes into account the additional constraint on stiffness k, the problem is open and the solution leads, in general, to a redundant truss The paper presents this problem and proposes its application to optimal design of supporting structures Author

A85-13240#
INFLATABLE SPACE-RIGIDIZED STRUCTURES - RECENT DEVELOPMENTS OF THE MATERIAL TECHNOLOGY
M C BERNASCONI (Contraves AG, Zurich, Switzerland), W SEIZ (Ciba-Geigy AG, Marly, Switzerland), and G G REIBALDI (ESA, Mechanical Systems Div, Noordwijk, Netherlands) International Astronautical Federation, International Astronautical Congress, 35th, Lausanne, Switzerland, Oct 7-13, 1984 13 p Sponsorship European Space Agency refs
(Contract ESA-4023/79-NL-AK)
(IAF PAPER 84-384)

Trends related to the growing industrial significance of space systems point to the need for structures whose size substantially exceeds the linear dimensions of the transportation vehicle The large elements required may be obtained on the basis of a use of expandable or erectable structures Inflatable, space-rigidized structures represent a class of expandable structures with a number of significant advantages The wall of an inflatable, chemically-rigidized object consists of a thin, fiber-reinforced composite lamina This 'balloon' is assembled and launched with the wall in its flexible, prepegged state, to enable its folding for stowage in the transportation vehicle Attention is given to details regarding inflatable structures in space, aspects of material selection, and materials development tests G R

A85-13248#
VARIABLE GEOMETRY TRUSS AND ITS APPLICATION TO DEPLOYABLE TRUSS AND SPACE CRANE ARM
K MIURA (Tokyo, University, Tokyo, Japan), K SUZUKI (Godo Works Co, Ltd, Tokyo, Japan), and H FURUYA International Astronautical Federation, International Astronautical Congress, 35th, Lausanne, Switzerland, Oct 7-13, 1984 10 p
(IAF PAPER 84-394)

The purpose of this paper is to explain the variable-geometry-truss (VGT) concept and to discuss its applications to deployable linear and curvilinear trusses and a manipulator arm The VGT consists of the repetition of an octahedral truss module longitudinally The geometrical transformation of an octahedron is the basis of the present concept The principal mechanical feature of the truss is that the lateral members of the truss are variable-length beams, while the diagonal members are fixed-length beams Through such mechanisms, the truss can be transformed to varieties of configurations Both simultaneous and sequential modes of transformation (that is, deployment) are shown An application of the concept to a manipulator arm having multiple degrees of freedom is discussed The resulting VGT manipulator can be programmed to retreat and deploy and take a position in any desired configuration The basic kinetic geometry of the VGT manipulator is established Author

A85-18435#
MODULAR COMPUTER SYSTEM CUTS SPACECRAFT SIMULATION COSTS
S E TICE, J L. ZELON, and R A REPIC (Rockwell International Corp, Space Station Systems Div, Pittsburgh, PA) Aerospace America (ISSN 0740-722X), vol 23, Jan 1985, p 82-86

The capabilities and applications of the space-vehicle computer-based design system (SVCDS) are described The growing complexity of space operations has driven the need for incorporating higher-order primitives for displaying and manipulating realistic hardware and anthropomorphic shapes The SVCDS provides for rapid geometric analysis, kinematics calculations, geometric reform, database interfacing and English language commands Cross-sectional points are entered and structures are built in stacks using either surface points or quartics, the latter permitting a parametric design approach Factors such as the aerodynamic center of gravity, lift and moment can also be estimated for lifting bodies with a high degree of accuracy at the first cut The system interfaces with a variety of aerodynamic, fluid dynamic and finite element structural codes A kinematics program module serves in generating models for added features, e g, a manipulator arm SVCDS has been used to study configurations for the Shuttle, OTV, the Space Station, and serviceability for the Navstar and P-80-1 satellites M S K

A85-18694#
MINIMUM WEIGHT DESIGN OF TRUSS STRUCTURES WITH GEOMETRIC NONLINEAR BEHAVIOR
N S KHOT (USAF, Flight Dynamics Laboratory, Wright-Patterson AFB, OH) and M P KAMAT (Virginia Polytechnic Institute and State University, Blacksburg, VA) (Structures, Structural Dynamics and Materials Conference, 24th, Lake Tahoe, NV, May 2-4, 1983, Collection of Technical Papers Part 1, p 383-391) AIAA Journal (ISSN 0001-1452), vol 23, Jan 1985, p 139-144 Previously cited in issue 12, p 1739, Accession no A83-29767 refs

A85-23663* Jet Propulsion Lab, California Inst of Tech, Pasadena
SURVEY OF DEPLOYABLE ANTENNA CONCEPTS
R E FREELAND (California Institute of Technology, Jet Propulsion Laboratory, Pasadena, CA) IN Satellite communication antenna technology Amsterdam, North-Holland, 1983, p 613-652 Previously announced in STAR as N83-26872 refs

Deployable space antenna concepts are surveyed Precision reflector antennas, stiffened membrane antennas, truss antennas, infrared antennas, and electrostatically figured membrane reflectors are described R.J F

A85-24817
DEVELOPMENT OF ADVANCED COMPOSITE TUBULAR STRUCTURES FOR ANTENNA REFLECTOR
G ALBERINI, G GERMANI, and A NOVELLINO (Selenia S p A, Rome, Italy) IN High performance composite materials. New applications and industrial production, Proceedings of the Fourth International Conference and Exhibition, Bordeaux, France, October 17-20, 1983 Chatou, Yvelines, France, Society for the Advancement of Materials and Process Engineering, 1983, p 199-208

An advanced composite tubular structure was developed for a antenna reflector used on a spacecraft Materials and processing development is described as well as design aspects of the composite tubular element High modulus unidirectional graphite fiber, Fiberite HYE-1534, with low thermal expansion coefficient was selected Among some lay-up orientations a lay-up (0,45,0,-45)s was chosen Cured laminate properties of used materials and results of mechanical tests of tubular structure are reported Author

A85-28489
MULTICRITICAL OPTIMIZATION OF A LARGE SPACE STRUCTURE [MNOGOKRITERIAL'NAIA OPTIMIZATSIIA KRUPROGABARITNOI KOSMICHESKOI KONSTRUKTSII]
B. V SAZYKIN Kosmicheskie Issledovaniia (ISSN 0023-4206), vol 23, Jan.-Feb 1985, p 84-91 In Russian refs

Interactive programming is used for the multicritical optimization of a large space structure with a tetrahedral base element. A mathematical model of a structure in circular orbit is constructed, taking into account the effect of gravitational forces, optical radiation pressure, and concentrated dynamic loads. The bending dynamics is described by a differential equation for the vibrations of a circular plate with free-contour boundary conditions The optimality conditions are obtained, and optimization results are presented for the load-bearing shell of the large space structure
B J

N85-10099# Spectra Research Systems, Inc., Huntsville, Ala
RESEARCH ON LARGE, HIGHLY ACCURATE, INFLATABLE REFLECTORS Final Report, 30 Sep. 1983 - 30 May 1984
R BRADFORD Jul. 1984 97 p
(Contract F04611-83-C-0053)
(AD-A145080, SRS-TR84-015-CU40; AFRPL-TR-84-040) Avail NTIS HC A05/MF A01 CSCL 13H

Very large and accurate reflective surfaces are required for future space applications such as solar rocket propulsion, radar, laser power transmission and relay, solar energy collection, telescopes, and others Present techniques used to construct highly accurate reflectors are limited in application to diameters of a few meters Metallized thin film membranes have the potential to satisfy the requirements of most future applications with minimum weight systems The objective of this research was to identify materials, construction and control techniques to improve the surface accuracy of inflatable reflectors Film joining and forming, support structure design options, surface accuracy measurement system options and electrostatic surface configuration control techniques were investigated Prototype models were designed, built, and tested to demonstrate film forming techniques, support structure deployment, and electrostatic membrane configuration control utilizing segmented charge plates and an electron gun A laser ray-tracing technique was employed to measure surface accuracies These demonstrations verified the feasibility of the concepts
Author (GRA)

N85-11031*# Boeing Aerospace Co., Seattle, Wash
MODULAR EXPERIMENTAL PLATFORM FOR SCIENCE AND APPLICATIONS
A. S HILL *In* NASA. Marshall Space Flight Center 2nd Symp on Space Industrialization p 136-148 Oct 1984 refs
Avail NTIS HC A19/MF A01 CSCL 22B

A modularized, standardized spacecraft bus, known as MESA, suitable for a variety of science and applications missions is discussed The basic bus consists of a simple structural arrangement housing attitude control, telemetry/command, electrical power, propulsion and thermal control subsystems The general arrangement allows extensive subsystem adaptation to mission needs Kits provide for the addition of tape recorders, increased power levels and propulsion growth Both 3-axis and spin stabilized flight proven attitude control subsystems are available The MESA bus can be launched on Ariane, as a secondary payload for low cost, or on the STS with a PAM-D or other suitable upper stage Multi-spacecraft launches are possible with either booster Launch vehicle integration is simple and cost-effective. The low cost of the MESA bus is achieved by the extensive utilization of existing subsystem design concepts and equipment, and efficient program management and test integration techniques
M G

N85-11363 *Connecticut Univ., Storrs.*
EFFECTS OF MEMBER IMPERFECTIONS ON THE BEHAVIOR OF SPACE TRUSSES Ph.D. Thesis
G D SMITH 1984 254 p
Avail Univ. Microfilms Order No. DA8416109

The effects of imperfections on the behavior of a compression member were determined as well as the effects of the member imperfections on the behavior of pin-ended space trusses Based on the results, quantitative conclusions were made as to the effects of the member imperfections, as well as qualitative conclusions An analytical model is developed to predict the behavior of an axially loaded compression member that is restrained by a structure surrounding it, has initial out-of-straightness, is eccentrically loaded at its ends, and/or has residual stresses present. The member cross-sections modelled are tubular and built-up cruciforms The behavior includes both elastic and inelastic pre-buckling behavior, the formation of a plastic hinge, and the post-buckling behavior of the member A computer model approximating the analytical member model developed, is presented The Multiple-Step-Up Linearization method, developed during this research to approximate the member's inelastic behavior, is described The member computer model developed is used to predict the behavior and ultimate load capacity of eight truss configurations
Dissert Abstr

N85-12200*# Astro Research Corp., Carpinteria, Calif
LARGE-DIAMETER ASTROMAST DEVELOPMENT Final Report
L A FINLEY 19 Jul 1984 43 p
(Contract NAS8-34547)
(NASA-CR-171201, NAS 1.26 171201, ARC-TN-1132) Avail NTIS HC A03/MF A01 CSCL 13B

The 15-m-long by 0.75-diameter deployable supermast was delivered The performance characteristics, design parameters, and developmental work associated with this mast are described The main differences, besides the length of these two mast sections, are a change in the longeron material (the principal structural member) to a circular cross section and the incorporation of a lanyard-bridle system which makes unaided deployment and retraction possible in zero gravity
B G

N85-13999# European Space Conference, Paris (France)
WORKSHOP ON MECHANICAL TECHNOLOGY FOR ANTENNAS
T D GUYENNE, ed and J J HUNT, ed Sep 1984 180 p refs Worshop held at Noordwijk, Netherlands, 26-28 Jun 1984
(ESA-SP-225, ISSN-0379-6566) Avail NTIS HC A09/MF A01

Deployable/furlable antennas, inflatable antennas, antenna design; antenna testing, and spacecraft structures/antenna control system interactions were discussed

N85-14000# *European Space Agency European Space Research and Technology Center, ESTEC, Noordwijk (Netherlands) Structures and Configuration Section*
ANTENNA MECHANICAL TECHNOLOGIES WITHIN ESA
G G REIBALDI *In* ESA Workshop on Mech Technol for Antennas p 3-10 Sep 1984 refs
Avail NTIS HC A09/MF A01

Spaceborne antenna technologies for telecommunication, remote sensing and scientific missions are reviewed Solid, deployable, furlable and inflatable reflectors are described Antenna technology support concepts in materials, analysis, testing, manufacturing, mechanisms and attitude control system/structures coupling are presented The need for technology commonality between different requirements is stressed An ESA technology flight demonstration program is summarized
Author (ESA)

N85-14001# Astro Research Corp., Carpinteria, Calif
HIGH PERFORMANCE DEPLOYABLE ANTENNA STRUCTURES
J M HEDGEPETH *In* ESA Workshop on Mech Technol for Antennas p 13-18 Sep 1984 refs
Avail NTIS HC A09/MF A01

Design requirements of large, deployable, spaceborne antennas are discussed The deployable structures used for the Solar

Maximum Mission Satellite high gain antenna, and the SEASAT SAR array are described A tetrahedral truss structure for antennas requiring high dimensional precision at low cost is proposed
Author (ESA)

N85-14004# Contraves Corp , Zurich (Switzerland)
LARGE SPACEBORNE ANTENNA REFLECTORS USING INFLATABLE SPACE RIGIDIZED STRUCTURES
M C BERNASCONI *In* ESA Workshop on Mech Technol for Antennas p 31-36 Sep 1984 refs Sponsored by ESA
Avail NTIS HC A09/MF A01

Center and offset fed reflectors for space applications were studied Stiffness and temperature distribution of scale models of a 10 m inflatable reflector were examined A feasibility study of a 20 m reflector for the QUASAT very long baseline interferometry mission was performed A manufacturing concept for a large offset antenna was developed The studies indicate that large inflatable antennas with good performance, high stiffness (3 17 Hz lowest frequency at 20 m aperture) and thermal stability (0 4 mm rms worst case at 20 m aperture) are feasible Manufacturing accuracy and packaging efficiency can be achieved at low cost
Author (ESA)

N85-14007# National Space Development Agency, Ibaraki (Japan) Space Center
STRUCTURAL ASPECTS OF SAR ANTENNA FOR JAPANESE EARTH RESOURCES SATELLITE 1
H MITSUMA *In* ESA Workshop on Mech Technol for Antennas p 53-58 Sep 1984 refs
Avail NTIS HC A09/MF A01

Research and development to establish the basic technology of Synthetic Aperture Radar (SAR) for the Japanese Earth Resources Satellite-1 are described The solar array paddle technologies (honeycomb sandwich panel and deployment mechanism) were applied to the SAR antenna Structural and mechanical component tests, and thermal distortion tests are discussed
Author (ESA)

N85-17428# AEG-Telefunken, Wedel (West Germany) Anlagentechnik Aktiengesellschaft
DEVELOPMENT OF A FOLDLINE CONCEPT FOR AUTOMATIC REFOLDING OF A FLEXIBLE BLANKET (FOLDING ANALYSIS) Final Report
W SCHMITZ and T HEMPEL Paris ESA 1984 149 p refs
(Contract ESTEC-5198/82/NL-PB(SC))
(ESA-CR(P)-1933) Avail NTIS HC A07/MF A01

The technical viability of a solar array refolding system was established and a mathematical model to give input data and suggestions for the manufacture of test samples was developed Steps leading to the design parameters of the larger demonstration model are described together with the final outlook resulting from the functional investigation of this object The basic elements of the refolding system are blanket-integrated springs, which perform deflections normal to the blanket plane when the pre-tension is applied The stiffness of these springs must be lower than that of the blanket since a relatively great spring-way is required to support large deflections in the fold line area for defined refolding
Author (ESA)

N85-18352 Communications Research Centre, Ottawa (Ontario)
MODELLING AND IDENTIFICATION OF THE STRUCTURAL PROPERTIES OF AN ASTROMAST
Y SOUCY and F R VIGNERON Nov 1983 91 p refs
(CRC-1374) Avail Issuing Activity

Analytical modeling and identification of static and dynamic (modal) parameters for an Astromast are described The fundamental bending modes in the X and Y directions, three higher order transverse bending modes, and two modes in torsion, were identified in tests in the frequency range 1 8 to 46 Hz The associated damping factors range between 1 2 and 8 5 percent The factors associated with the fundamental bending and torsion modes were found to be the same in vacuum and in air No single configuration and technique was able to identify all of the modes, techniques involving base excitation with an electrodynamic exciter, base excitation with a hydraulic exciter, impact and step relaxation techniques were needed The MODAL-PLUS software was used for parameter identification It was observed to support impact and step relaxation testing fully, but to have limitations for the base excitation methods The experimentally-identified modal frequencies were compared with results produced by a finite element model and a continuum model
M G

N85-19004*# Astro Research Corp , Carpinteria, Calif
EFFICIENT STRUCTURES FOR GEOSYNCHRONOUS SPACECRAFT SOLAR ARRAYS Final Report
L R ADAMS 27 Sep 1983 29 p refs
(Contract NAS7-918, JPL-955847)
(NASA-CR-174448, JPL-9950-980, NAS 1 26 174448, ARC-TN-1125) Avail NTIS HC A03/MF A01 CSCL 22B

A prototype deployer for the STACBEAM (Stacking Triangular Articulated Compact Beam) is being developed The STACBEAM is an accordian-folded solar array blanket The prototype was constructed as a point design for support of a 23 9-kW blanket and is described
B G

N85-21495 Department of the Air Force, Washington, D C
DEPLOYABLE FOLDED ANTENNA APPARATUS Patent
F V BILEK and D N BUELL, inventors (to Air Force) 13 Nov 1984 10 p
(AD-D011503, US-PATENT-4,482,900, US-PATENT-APPL-SN-417726, US-PATENT-CLASS-417-726)
Avail US Patent and Trademark Office CSCL 09E

An antenna apparatus for use in space which is foldable into a small package for storage in a space vehicle is described The antenna apparatus utilizes a plurality of hinged members and diagonal tapes forming parallelogram frames, two opposite sides of which are hinged at the center to fold the frames in a given plane Similar frames are hinged on the first frames in a second plane whereby a plurality of cubes are formed when all are unfolded
Author (GRA)

N85-21697# Tokyo Univ. (Japan)
VARIABLE GEOMETRY TRUSS CONCEPT
K MIURA Sep 1984 20 p refs
(REPT-614, ISSN-0285-6808) Avail NTIS HC A02/MF A01

A concept for a one-dimensional deployable truss structure is presented The deployed configuration of the structure consists of the repetition of an octahedral truss module longitudinally, and thus it is exactly the so-called geodesic beam structure The principal mechanical feature of the truss is that the lateral members comprising the lateral triangular truss are telescoping beams Contracting of the lateral members results in the deployment of the truss structure The geometric transformation of this truss of variable geometry is presented It is shown that both simultaneous and sequential modes of transformation are possible The validity of the transformation applied to the deployment is verified through design of a conceptual model The applications of the concept to a curvilinear truss and a space manipulator arm are previewed
Author

04

STRUCTURAL AND THERMAL ANALYSIS

Includes structural analysis and design, thermal analysis and design, analysis and design techniques, and thermal control systems

A85-12884
EVALUATION OF EFFICIENTLY COMPUTED EXACT VIBRATION CHARACTERISTICS OF SPACE PLATFORMS ASSEMBLED FROM STAYED COLUMNS
J R. BANERJEE and F W WILLIAMS (University of Wales Institute of Science and Technology, Cardiff, Wales) Journal of Sound and Vibration (ISSN 0022-460X), vol 95, Aug 8, 1984, p 405-414 Research supported by the Science and Engineering Research Council refs

The exact stiffness matrix method computer program BUNVIS finds the natural frequencies and modes of vibration of rigidly jointed three dimensional frames which contain stayed columns very efficiently, by using substructuring and simple substitute columns to compute the stayed column stiffnesses BUNVIS is described and applied to a tetrahedral truss which was designed for use in space and which has stayed columns as its members and 21 966 degrees of freedom at its nodes Locating the first 4978 natural frequencies needed 2 h of VAX-11/780 CPU time and 5860 array locations These natural frequencies appeared in groups for which the associated modes are discussed Author

A85-13146#
MASS OPTIMISATION OF TELECOMMUNICATIONS SATELLITES
J A VANDENKERCKHOVE (ESA, Paris, France) International Astronautical Federation, International Astronautical Congress, 35th, Lausanne, Switzerland, Oct 7-13, 1984 8 p
(IAF PAPER 84-230)

The mass optimization of geostationary communications satellites is considered by analyzing a number of cases varying in the number and type of payloads, the platform scale factor, the lifetime, and the platform and payload reliabilities The results suggest that the optimal mass rarely exceeds 4000 kg BOL In most cases, the improvement in cost effectiveness that would result by exceeding 2500 kg is marginal and is probably not worth the complication of adding another payload to the platform B J

A85-13243*# National Aeronautics and Space Administration Langley Research Center, Hampton, Va
LARGE SPACE STRUCTURES GROUND AND FLIGHT PROGRESS
L D PINSON (NASA, Langley Research Center, Structural Dynamics Branch, Hampton, VA) International Astronautical Federation, International Astronautical Congress, 35th, Lausanne, Switzerland, Oct 7-13, 1984 9 p refs
(IAF PAPER 84-388)

Unprecedented challenges arise in connection with the design and certification of space systems which are too large to be transported into orbit fully assembled Special situations arising in the case of such systems make it necessary to rely much more on analysis than in past programs The present investigation is concerned with the status of some research activities oriented primarily to the improvement of analysis capabilities through coordinated ground and flight testing Aspects of system identification are explored, taking into account an eigensystem realization algorithm, and the Hoop-Column Antenna concept Attention is also given to a suitable method for analyzing the Hoop-Column antenna structure, a deployment analysis, certification issues for large space structures, a generic space station model, and the use of actuators G R

A85-13252#
THERMAL ANALYTICAL MODEL OF BIDIMENSIONAL AND UNIDIMENSIONAL STRUCTURAL ELEMENTS IN A SPACE ENVIRONMENT
C ARDUINI (Roma, Universita, Rome, Italy) International Astronautical Federation, International Astronautical Congress, 35th, Lausanne, Switzerland, Oct. 7-13, 1984 23 p refs
(IAF PAPER 84-399)

Global analytical thermal conductive-radiative modelling of one and two dimensional structural elements is proposed, based on approximations of the temperature field analogous to those made for displacements problems concerning elasticity The resulting models, their uses, and their limitations are discussed C D

A85-13253#
HEAT CONDUCTION PROBLEMS IN LARGE SPACE STRUCTURE
P SANTINI and A PAOLOZZI (Roma, Universita, Rome, Italy) International Astronautical Federation, International Astronautical Congress, 35th, Lausanne, Switzerland, Oct 7-13, 1984 27 p
(IAF PAPER 84-400)

The general equations of transient heat conduction in a large space structure consisting of barlike members are written For repetitive bays, and using Laplace-transform techniques, an exact solution is obtained, giving the temperature at any point and at any time An illustrative example based on a very simple geometry shows the influence of the various parameters involved in the analysis The solution for special cases (e g , unit step of heat source) is also written Numerical examples are provided Author

A85-18321#
SPACE STATION THERMAL CONTROL - AN INTERVIEW WITH ROBERT HASLETT
T BAER Mechanical Engineering (ISSN 0025-6501), vol 106, Dec 1984, p 22-33

The development of two-phase monogroove-heat-pipe thermal radiators for potential use in the NASA Space Station is described on the basis of an interview with the head of the Grumman Advanced Thermal Systems Group and illustrated with photographs, diagrams, and drawings The current design calls for 50-ft-long 2-kW modular elements (making up arrays to meet the eventual 300-kW Station heat-dissipation requirement) filled with NH3 for operation at 40-120 F, assembly in space using the Shuttle manipulator arm, automated performance monitoring and damage detection, and wall thickness sufficient to limit the threat to the system from micrometeoroids or space debris An advanced fin containing numerous small heat pipes and a rotating gimbal attachment to keep the radiator panels parallel to incoming sunlight are also being developed as NASA funding and commitment to the heat-pipe design approach are increased T K

A85-18812
MASS PROPERTIES ANALYSIS AND CONTROL OF ADVANCED SPACE STRUCTURES THROUGH COMPUTERIZED INTEGRATION WITH DESIGN AND STRUCTURAL ANALYSIS
J H NAKAI and W D HONEYCUTT (General Dynamics Corp , Convair Div , San Diego, CA) Society of Allied Weight Engineers, Annual Conference, 42nd, Anaheim, CA, May 23-25, 1983 23 p
(SAWE PAPER 1527)

The architecture of a computerized mass properties and control system program network for analyzing advanced space structures is described The network is a set of programs for every stage from preliminary design to finished product The applications include trade-off studies, new design analysis, record keeping, trend plotting, report generation, and data base filing for structural studies Sample procedures for analysis of tetrahedral trusses with the NASTRAN code are discussed, along with programs for geometric ray tracing, deployable truss beam synthesis analysis, and curve/surface fitting efforts M S K

A85-19493*# Rockwell International Corp , Seal Beach, Calif
THERMAL STORAGE ANALYSIS FOR LARGE MANNED SPACE PLATFORMS
A M LEHTINEN and J A SADUNAS (Rockwell International Corp , Seal Beach, CA) American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 23rd, Reno, NV, Jan 14-17, 1985 11 p refs
(Contract NAS9-16782)
(AIAA PAPER 85-0066)

High electrical power and waste heat rejection is projected for future manned low earth orbit space platforms, such as Space Station The high heat rejection, optical coating degradation, long operating life with minimum maintenance requirements pose a challenging thermal management design problem System optimization, with respect to radiator area and weight, indicate the requirement for thermal storage This paper examines the thermal storage benefits, determines the characteristics as applied to different TMS concepts (e g , centralized, decentralized), and examines the similarities and differences of thermal storage integration with single-phase and two-phase systems for a study baseline 75 kWe low earth orbit platform Author

A85-19553#
GENERALIZED TRANSFORM METHODS BASED FINITE ELEMENT METHODOLOGY - THERMAL/STRUCTURAL DYNAMIC APPLICATIONS
K K TAMMA, C C SPYRAKOS (West Virginia University, Morgantown, WV), and M A LAMBI American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 23rd, Reno, NV, Jan 14-17, 1985 12 p refs
(AIAA PAPER 85-0155)

A method for interfacing interdisciplinary fields to perform thermal/structural analyses with transform methods finite element (TMFE) techniques is outlined The object of the thermal/structural approach is to predict the performance characteristics of complex space structures now in the developmental stage TMFE considers transient effects with Laplace transformations covering both heat transfer and structural mechanics, e g , the arousal of thermally induced oscillations Governing equations are provided for a beam element and sample results are given for simple-supported and cantilever beams, the latter with and without an end mass
M S K

A85-19895
GEOMETRICALLY NONLINEAR ANALYSIS OF SPACE FRAMES BY AN INCREMENTAL ITERATIVE TECHNIQUE
J L MEEK and H. S TAN (Queensland, University, Brisbane, Australia) Computer Methods in Applied Mechanics and Engineering (ISSN 0045-7825), vol 47, Dec 1984, p 261-282 refs

A85-20916
FORMEX CONFIGURATION PROCESSING IN STRUCTURAL ENGINEERING
H NOOSHIN (Surrey, University, Guildford, England) London and New York, Elsevier Applied Science Publishers, 1984 282 p

The concepts of formex algebra are presented in context of the analysis of space structures The discussion of the fundamentals of formex algebra includes some recently evolved ideas, such as the concept of rapportance and a new approach in defining a formex Some new useful functions are described which include rindle, pexum, and medulla functions The discussion also covers formex graphics, node numbering, and formex collation The book is intended for structural engineers, architects, designers, and researchers dealing with any aspect of computer-aided structural evaluation and design V L

A85-21829*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif
TRAJECTORY ANALYSIS OF RADIATIVE HEATING FOR PLANETARY MISSIONS WITH AEROBRAKING OF SPACECRAFT
G P MENEES (NASA, Ames Research Center, Moffett Field, CA) Journal of Spacecraft and Rockets (ISSN 0022-4650), vol 22, Jan -Feb 1985, p 37-45 Previously cited in issue 05, p. 602, Accession no A83-16696 refs

A85-25145*# Virginia Polytechnic Inst and State Univ , Blacksburg
AN ANALYTICAL INVESTIGATION OF SHAPE CONTROL OF LARGE SPACE STRUCTURES BY APPLIED TEMPERATURES
R T HAFTKA (Virginia Polytechnic Institute and State University, Blacksburg, VA) and H M ADELMAN (NASA, Langley Research Center, Interdisciplinary Research Office, Hampton, VA) (Virginia Polytechnic Institute and State University and American Institute of Aeronautics and Astronautics, Symposium on Dynamics and Control of Large Structures, 4th, Blacksburg, VA, June 6-8, 1983, Paper) AIAA Journal (ISSN 0001-1452), vol 23, March 1985, p 450-457 Previously cited in issue 21, p 3098, Accession no A83-43891 refs

N85-12313*# National Aeronautics and Space Administration Langley Research Center, Hampton, Va
EXPERIMENTAL AND PREDICTED HEATING DISTRIBUTIONS FOR BICONICS AT INCIDENCE IN AIR AT MACH 10
C G MILLER, III Nov 1984 118 p refs
(NASA-TP-2334, L-15785, NAS 1 60 2334) Avail NTIS HC A06/MF A01 CSCL 20D

Heating distributions were measured on a 1 9-percent-scale model of a generic aeroassisted vehicle proposed for missions to a number of planets and for use as a moderate lift-drag ratio Earth orbital transfer vehicle This vehicle is spherically blunted, 12 84 deg/7 deg biconic with the fore-cone bent upward 7 deg to provide self-trim capability A straight biconic with the same nose radius and the same half-angles was also tested The free-stream Reynolds numbers based on model length were equal to about 2 x 10(5) or 9 x 10 (5) The angle of attack, referenced to the aft-cone, was varied from 0 deg to 20 deg Heating distributions predicted with a parabolized Navier-Stokes (PNS) code are compared with the measurements for the present Reynolds numbers and range of angles of attack Leeward heating was greatly affected by Reynolds number, with the heating increasing with decreasing Reynolds number for attached flow (low incidence) The opposite was true for separated flow, which occurred when the fore-cone angle of attack exceeded 0 8 times the fore-cone half-angle Windward heating distributions were predicted to within 10 percent with the PNS code Leeward heating distributions were predicted qualitatively for both Reynolds numbers, but quantitative agreement was poorer than on the windward side M G

N85-13895*# National Aeronautics and Space Administration Johnson (Lyndon B) Space Center,
THERMAL MANAGEMENT TECHNOLOGY STATUS
R C PARISH *In* NASA Lewis Research Center Space Power p 189-203 Apr 1984 refs
Avail NTIS HC A14/MF A01 CSCL 20D

The thermal control requirements of a large space station are considered Motivations for advanced thermal technology are discussed Two test programs, designed to evaluate the analytical and theoretical basis from which thermal technology directions are determined, are described R.S F

N85-13900*# Washington Univ , Seattle.
THE LIQUID DROPLET RADIATOR - AN ULTRALIGHTWEIGHT HEAT REJECTION SYSTEM FOR EFFICIENT ENERGY CONVERSION IN SPACE
A. T MATTICK and A. HERTZBERG *In* NASA Lewis Research Center Space Power p 261-274 Apr 1984 refs
Avail NTIS HC A14/MF A01 CSCL 10B

A heat rejection system for space is described which uses a recirculating free stream of liquid droplets in place of a solid surface to radiate waste heat By using sufficiently small droplets (100 micron diameter) of low vapor pressure liquids the radiating droplet sheet can be made many times lighter than the lightest solid surface radiators (heat pipes) The liquid droplet radiator (LDR) is less vulnerable to damage by micrometeoroids than solid surface radiators, and may be transported into space far more efficiently *Analyses are presented of LDR applications in thermal and* photovoltaic energy conversion which indicate that fluid handling components (droplet generator, droplet collector, heat exchanger, and pump) may comprise most of the radiator system mass Even the unoptimized models employed yield LDR system masses less *than heat pipe radiator system masses, and significant improvement* is expected using design approaches that incorporate fluid handling components more efficiently Technical problems (e g , spacecraft contamination and electrostatic deflection of droplets) unique to this method of heat rejectioon are discussed and solutions are suggested M G

N85-13906*# National Aeronautics and Space Administration Johnson (Lyndon B) Space Center,
HEAT REJECTION WORKING GROUP SYNOPSIS
R C PARISH and R. HASLETT (Grumman Aerospace Corp) *In* NASA Lewis Research Center Space Power p 309-316 Apr 1984
Avail NTIS HC A14/MF A01 CSCL 10B

Heat rejection system requirements of specific mission types (space station, planetary exploration, commercial, very high power, and military missions) are discussed Heat pipe radiators, weight and volume reduction, stable coatings, and working fluids are addressed M G

N85-14009# Messerschmitt-Boelkow-Blohm G m b H , Munich (West Germany).
MECHANICAL/THERMAL DESIGN OF A POLARIZATION SENSITIVE REFLECTOR
H J HUETTMANN, T FISCHER, H POPP, and W SCHAEFER *In* ESA Workshop on Mech. Technol for Antennas p 67-72 Sep 1984 refs
(Contract ESTEC-5494/84/NL-GM)
Avail NTIS HC A09/MF A01

Mechanical/thermal design features of a reflector for frequency reuse by orthogonal polarization are outlined The reflector configuration consists of two Kevlar fiber sandwich shells oriented one behind the other and joined by a Kevlar fiber ring The reflector shell surfaces are covered with conductive strip grids which are oriented perpendicularly with respect to each other Further stiffening can be achieved by four ribs The preferred thermal design has a Sun shield in front of the reflector and multilayer insulation on its rearside Author (ESA)

N85-14012# Societe Nationale Industrielle Aerospatiale, Les Mureaux (France)
TECHNOLOGY AND PERFORMANCES OF STRUCTURAL THERMAL MECHANICAL EQUIPMENT USED FOR ANTENNA OF TV.SAT-TDF 1 PROGRAM
G MORIO, B VEREZ, J NESA, J L. PETTEX, S AUCEL, and H DAGEVILLE *In* ESA Workshop on Mech. Technol for Antennas p 83-91 Sep 1984 refs
Avail. NTIS HC A09/MF A01

The mechanical-thermal technologies of the TV SAT-TDF 1 antenna module are described The module is housed in a tower structure, with 2 reflectors (Tx at 12 GHz, Rx at 18 GHz), 2 antenna fine pointing mechanisms with their associated electonics, 2 reflector folding and release mechanisms, 2 reflector deployment and locking mechanisms; and thermal control equipment Criteria assumed to satisfy antenna payload (commonality, AM orientation, reflectors folding according to the fairing volume, folding and kinematic constraints) are described Thermal control concepts, analysis, performances, and alignment techniques are summarized Author (ESA)

N85-14016# Saab-Scania, Linkoping (Sweden)
STRUCTURAL DESIGN AND THERMAL STABILITY OF TELE-X ANTENNA TOWER
B MOERTBERG *In* ESA Workshop on Mech Technol for Antennas p 117-120 Sep 1984
Avail NTIS HC A09/MF A01

The design, analysis and manufacturing of the TELE-X satellite antenna tower are described The tower has to sustain loads during *launch and in-orbit deployments, fulfill stiffness requirements, fulfill* environmental requirements with respect to other subsystems, and fulfill thermal distortion requirements The antenna system is based on a Cassegrain design consisting of a feed, subreflector and main reflector The structure can withstand temperature gradients *of 25 C between structural elements, and 70 C between upper* and lower platform Author (ESA)

N85-14017# Rome Univ (Italy) Dept of Aerospace
ANALYTICAL THERMAL FORMULATIONS FOR ANTENNA DISHES
C ARDUINI *In* ESA Workshop on Mech Technol for Antennas p 125-131 Sep 1984 refs
Avail NTIS HC A09/MF A01

Thermostructural analysis of spaceborne antenna dishes using interactive thermal-structural-control unified analytical formulations is discussed Displacement and temperature are represented by a Taylor series Results which describe how antenna dishes can be thermally analyzed under general hypotheses by a completely analytical radiative-conductive formulation are shown Author (ESA)

N85-15796*# National Aeronautics and Space Administration Langley Research Center, Hampton, Va
SPACE STATION TRUSS STRUCTURES AND CONSTRUCTION CONSIDERATIONS
M. M MIKULAS, JR , S D CROOMES, W SCHNEIDER, H G. BUSH, K NAGY, T PELISCHEK, M S LAKE, and C WESSELSKI Jan 1985 119 p refs Prepared in cooperation with NASA Johnson Space Center
(NASA-TM-86338, NAS 1 15 86338) Avail NTIS HC A06/MF A01 CSCL 22B

Although a specific configuration has not been selected for the Space Station, a gravity gradient stabilized station as a basis upon which to compare various structural and construction concepts is considered The Space Station primary truss support structure is described in detail Three approaches (see sketch A) which are believed to be representative of the major techniques for constructing large structures in space are also described in detail so that salient differences can be highlighted B W

N85-16066*# National Aeronautics and Space Administration Langley Research Center, Hampton, Va
REDUCTION METHOD FOR THERMAL ANALYSIS OF COMPLEX AEROSPACE STRUCTURES
C P SHORE Jan 1985 31 p refs
(NASA-TP-2373, L-15777, NAS 1 60 2373) Avail NTIS HC A03/MF A01 CSCL 20D

A reduction method which combines classical Rayleigh-Ritz modal superposition techniques with contemporary finite-element methods is applied to transient nonlinear thermal analysis of aerospace structures The essence of the method is the use of a few thermal modes from eigenvalue analyses as basis vectors to represent the temperature response in the structure The method is used to obtain approximate temperature histories for a portion of the Shuttle orbiter wing subject to reentry heating and for a large space antenna reflector subject to heating associated with a low Earth orbit The reduction method has excellent potential

for significant size reduction for radiation-dominated problems such as the antenna reflector However, for conduction-dominated problems such as the Shuttle wing, especially those with complex spatial and temporal variations in the applied heating, additional work appears necessary to find alternate sources of basis vectors which will permit significant problem size reductions Author

N85-17012# Office National d'Etudes et de Recherches Aerospatiales, Toulouse (France) Dept d'Etudes et de Recherches en Technologie Spatiale

SPACE ENVIRONMENT SIMULATION TO TEST SATELLITE THERMAL CONTROL COATINGS, VOLUME 1 Final Report [ESSAIS DE SIMULATION D'ENVIRONNEMENT SPATIAL SUR REVETEMENTS DE CONTROLE THERMIQUE DE SATELLITES, TOME 1]

M DUTAT, J MARCO, and A PAILLOUS Paris ESA Oct 1983 138 p refs In FRENCH Report will also be announced as translation (ESA-TT-891-Vol-1) 3 Vol
(Contract ESTEC-4577/81/NL-DG, ESTEC-5144/82/NL-DG)
(CERT-4128-VOL-1, ESA-CR(P)-1870-VOL-1) Avail NTIS HC A07/MF A01

Optical solar reflector coatings were tested in a vacuum chamber by irradiation with electrons, protons and ultraviolet radiation to simulate 5 years of geostationary orbit The effect of contamination from adhesive RTV 566 was studied to explain the performance degradation in OTS2 and other satellites Optical reflectance was measured by spectrometers The variation in solar absorption as a function of time is given for four types of coating material The contaminated samples show a degradation of solar absorption three to four times larger than controls Author (ESA)

N85-17013# Office National d'Etudes et de Recherches Aerospatiales, Toulouse (France) Dept d'Etudes et de recherches en Technologie Spatiale

SPACE ENVIRONMENT SIMULATION TO TEST SATELLITE THERMAL CONTROL COATINGS. VOLUME 2: ANNEX 1 [ESSAIS DE SIMULATION D'ENVIRONMENT SPATIAL SUR REVETEMENTS DE CONTROLE THERMIQUE DE SATELLITES. TOME 2, ANNEXE 1]

Paris ESA 1983 137 p In FRENCH Report will also be announced as translation (ESA-TT-891-Vol-2) 3 Vol
(Contract ESTEC-4577/81/NL-DG, ESTEC-5144/82/NL-DG)
(ESA-CR(P)-1870-VOL-2) Avail NTIS HC A07/MF A01

Optical properties measured in situ at -35C and at various exposure stages up to one year are tabulated for thermal control coatings tested during space environment simulation Results show (1) spectral reflectance for 13 wavelengths, (2) variation with respect to the initial measurement, i e , before irradiation and deposition, (3) solar reflectance including ultraviolet, visible, and infrared radiation, as well as the total spectrum (295 to 4,000 nm), (4) variations of solar reflectance with respect to initial values, (5) solar absorptance (calculated as a complement at 1 00 of solar reflectance in the same wavelength domain), and (6) variations of these solar reflectances with respect to initial values
Transl by A R H

N85-17014# Office National d'Etudes et de Recherches Aerospatiales, Toulouse (France) Dept d'Etudes et de Recherches en Technologie Spatiale

SPACE ENVIRONMENT SIMULATION TO TEST SATELLITE THERMAL CONTROL COATINGS. VOLUME 2: ANNEXES 2, 3, 4 [ESSAIS DE SIMULATION D'ENVIRONMENT SPATIAL SUR REVETEMENTS DE CONTROLE THERMIQUE DE SATELLITES. TOME 2: ANNEXES 2, 3, 4]

Paris ESA 1983 259 p In FRENCH Report will also be announced as translation (ESA-TT-891-Vol-3) 3 Vol
(Contract ESTEC-4577/81/NL-DG, ESTEC-5144/82-NL-DG)
(ESA-CR(P)-1870-VOL-3) Avail NTIS HC A12/MF A01

Initial and post irradiation measurements obtained under vacuum and at -35C are tabulated for satellite thermal control coatings The measurements were obtained before deposition and at various periods after deposition up to 5 08 simulated years
Transl by A R H

N85-17020*# Lockheed Missiles and Space Co , Palo Alto, Calif Thermal Sciences Lab

PASSIVE ORBITAL DISCONNECT STRUT (PODS 3) STRUCTURAL TEST PROGRAM

R T PARMLEY Jan 1985 112 p refs
(Contract NAS2-10848)
(NASA-CR-177325, NAS 1 26 177325) Avail NTIS HC A06/MF A01 CSCL 22B

A passive orbital disconnect strut (PODS-3) was analyzed structurally and thermally Development tests on a graphite/epoxy orbit tube and S glass epoxy launch tube provided the needed data to finalize the design A detailed assembly procedure was prepared One strut was fabricated Shorting loads in both the axial and lateral direction (vs load angle and location) were measured The strut was taken to design limit loads at both ambient and 78 K (cold end only) One million fatigue cycles were performed at predicted STS loads (half in tension, half in compression) with the cold end at 78 K The fatigue test was repeated at design limit loads Six struts were then fabricated and tested as a system Axial loads, side loads, and simulated asymmetric loads due to temperature gradients around the vacuum shell were applied Shorting loads were measured for all tests Author

N85-17323*# OAO Corp , Greenbelt, Md

CAPILLARY PUMP LOOP (CPL) HEAT PIPE DEVELOPMENT STATUS REPORT

Aug 1982 42 p
(Contract NAS5-26660)
(NASA-CR-175273, NAS 1 26 175273) Avail NTIS HC A02/MF A01 CSCL 20D

The capillary pump loop (CPL) was re-introduced as a potential candidate for the management of large heat loads It is currently being evaluated for application in the thermal management of large space structures Test efforts were conducted to establish the feasibility of the CPL heat pipe design B G

N85-17382# Shock and Vibration Information Center (Defense), Washington, D C

THE SHOCK AND VIBRATION DIGEST, VOLUME 16, NO. 11 Monthly Report

J NAGLE-ESHLEMAN, ed Nov 1984 108 p refs
(AD-A148466) Avail SVIC, Code 5804, Naval Research Lab , Washington, D C 20375 CSCL 20K

Publications on design and testing of shock waves, earthquakes and vibration on large are presented Topics discussed include the influence of vibration on composite materials, weightlessness, stimulation, structures, solar panel stiffness, and payloads It is suggested that better techniques to be developed for scale model tests, analytical prediction models, in-orbit testing of structures like solar panels flower on the shuttle, and tabulation of data on damping properties of the new composite materials

N85-21209*# National Aeronautics and Space Administration Johnson (Lyndon B) Space Center,

PARAMETRIC ANALYSIS: SOC METEOROID AND DEBRIS PROTECTION

R KOWALSKI *In its* Orbital Debris p 287-294 Mar 1985 refs
Avail NTIS HC A20/MF A01 CSCL 22B

The meteoroid and man made space debris environments of an Earth orbital manned space operations center are discussed Protective shielding thickness and design configurations for providing given levels of no penetration probability were also calculated Meteoroid/debris protection consists of a radiator/shield thickness, which is actually an outer skin, separated from the pressure wall, thickness by a distance An ideal shield thickness, will, upon impact with a particle, cause both the particle and shield to vaporize, allowing a minimum amount of debris to impact the pressure wall itself A shield which is too thick will crater on the outside, and release small particles of shield from the inside causing damage to the pressure wall Inversely, if the shield is too thin, it will afford no protection, and the backup must provide all necessary

protection It was concluded that a double wall concept is most effective R.J F

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STRUCTURAL DYNAMICS AND CONTROL

Includes modeling, systems identification, attitude and control techniques and systems, surface accuracy measurement and control techniques and systems, sensors, and actuators

A85-10071
THE DECENTRALIZED CONTROL OF LARGE FLEXIBLE SPACE STRUCTURES
G S WEST-VUKOVICH (Dynacon Enterprises, Ltd , Toronto, Canada), E J DAVISON, and P C HUGHES (Toronto, University, Toronto, Canada) IEEE Transactions on Automatic Control (ISSN 0018-9286), vol AC-29, Oct 1984, p 866-879 Research supported by Canada Council, Natural Sciences and Engineering Research Council of Canada. refs
(Contract NSERC-A-4396, NSERC-A-4183)

The decentralized robust servomechanism problem with constant disturbances/set points is considered for large flexible space structures (LFSS) It is shown that for LFSS which have colocated, mutually dual sensors and actuators, the decentralized fixed modes of the system are precisely equal to the centralized fixed modes of the system Simple necessary and sufficient conditions are then obtained for a solution to exist for the robust decentralized servomechanism problem for the system A controller is demonstrated which, for this class of LFSS systems, eliminates the 'spillover problem' A two-hundredth-order numerical example of an LFSS control problem using the Purdue model is included to illustrate the results Author

A85-11082* Jet Propulsion Lab , California Inst of Tech , Pasadena
DYNAMIC ISOLATION OF A SPACECRAFT SCIENCE PLATFORM VIA MOMENTUM COMPENSATION
D BOUSSALIS (California Institute of Technology, Jet Propulsion Laboratory, Guidance and Control Section, Pasadena, CA) IN Modeling and simulation Volume 14 - Proceedings of the Fourteenth Annual Pittsburgh Conference, Pittsburgh, PA, April 21, 22, 1983 Parts 1-2 Research Triangle Park, NC, Instrument Society of America, 1983, p 465-471
(Contract NAS7-100)

The dynamic isolation of a two degree of freedom inertially *stabilized science platform from the spacecrft basebody* is examined The important implications of a momentum compensated platform for pointing performance and cost are discussed, and the concept of a new system called the Integrated Platform Pointing and Attitude Control Subsystem utilizing the above property is presented The results established in this paper are demonstrated by a computer simulation Author

A85-11086* Bendix Corp , Teterboro, N J
COMPARING ATTITUDE CONTROL EFFECTIVENESS FOR ACTUATORS ON TWO BODIES OF A SIX BODY MODEL OF A FLEXIBLE SPACECRAFT WITH THAT FOR ACTUATORS RESTRICTED TO A SINGLE BODY
F D CHICHESTER and I S EMMANUEL (Bendix Corp , Guidance Systems Div , Teterboro, NJ) IN Modeling and simulation Volume 14 - Proceedings of the Fourteenth Annual Pittsburgh Conference, Pittsburgh, PA, April 21, 22, 1983 Parts 1-2 Research Triangle Park, NC, Instrument Society of America, 1983, p 515-519
(Contract NAS8-33979)

A ten rgid body model of a prototype flexible space platform was approximated by a six body model to facilitate comparison of attitude control effectiveness for actuators on two bodies with control effectiveness for actuators restricted to a single body of the same model Actuators and sensors were found to be required on two of the six bodies for effective attitude control Author

A85-11087* Bendix Corp , Teterboro, N J
DEVELOPING SENSITIVITY COEFFICIENTS FOR A STATE VARIABLE MODEL OF A FLEXIBLE SPACECRAFT WITH MODULAR ATTITUDE CONTROL
F. D CHICHESTER (Bendix Corp , Guidance Systems Div , Teterboro, NJ) IN Modeling and simulation Volume 14 - Proceedings of the Fourteenth Annual Pittsburgh Conference, Pittsburgh, PA, April 21, 22, 1983 Parts 1-2 Research Triangle Park, NC, Instrument Society of America, 1983, p 521-525
(Contract NAS8-33979)

The numerical value for the sensitivity coefficient of each scalar state variable with respect to each parameter of a five body model of the rotational dynamics of a flexible spacecraft with modular attitude control is generated The maximum magnitudes of these sensitivity coefficients are arranged in descending order in one table while the final time (steady state) values of these sensitivity coefficients are arranged in order of descending magnitude in a second table Author

A85-12434#
ALLEVIATION OF OBSERVATION SPILLOVER IN CONTINUOUS STRUCTURES
A V METCALFE and J S BURDESS (Newcastle-upon-Tyne, University, Newcastle-upon-Tyne, England) IN International Conference on Recent Advances in Structural Dynamics, 2nd, Southampton, England, April 9-13, 1984, Proceedings Volume 1 Southampton, England, University of Southampton, 1984, p 97-106 refs

The contamination of the input to the observer by observation spillover is a cause of stability problems in complex systems (e g , large-scale space structures) This paper proposes a method for estimating and alleviating such contamination It is suggested that this can be done by augmenting the observer with a further dynamic system which can be described as a disturbance observer Examples demonstrating the application of this approach are presented B J

A85-12442#
THE IMPROVEMENT OF FREE-MODE METHODS IN COMPONENT MODE SYNTHESIS TECHNIQUES AND ITS ACCURACIES
Z. W WANG and M PETYT (Southampton, University, Southampton, England) IN International Conference on Recent Advances in Structural Dynamics, 2nd, Southampton, England, April 9-13, 1984, Proceedings Volume 1 Southampton, England, University of Southampton, 1984, p 221-228 refs

Free-mode methods in component mode synthesis techniques *are improved by the use of the concept of 'positive static' residuals,* which are developed according to the theorems given in this paper The technique of assembly of complicated structures is also presented The convergence of the improved free-mode method is related to the so-called 'eigenfrequency coefficient n', which is generally greater than 1 0 and smaller than 1 4 Author

A85-12455#
APPLICATION OF MODAL SYNTHESIS CONCEPTS TO SPACECRAFT DESIGN VERIFICATION
A BERTRAM (Deutsche Forschungs- und Versuchsanstalt fuer Luft- und Raumfahrt, Institut fuer Aeroelastik, Goettingen, West Germany) IN International Conference on Recent Advances in Structural Dynamics, 2nd, Southampton, England, April 9-13, 1984, Proceedings Volume 2 Southampton, England, University of Southampton, 1984, p 395-414 refs

The modal description of structural dynamics is considered with attention given to modal synthesis methods, coupling conditions, and structural modifications The achievement of the orthogonality *condition and a sufficient convergence* is discussed, the selection of suitable modes, test data requirements, convergence improvement, the consideration of residual terms, and the realistic description of the interface are covered It is concluded that modal

synthesis methods can be very efficient and useful tools in the spacecraft design verification procedure The methods presented here may be suitable even for complex and large spacecraft In addition, it is noted that the applicability of the modal correction method is limited to cases where the mode shapes of the modified structure can be sufficiently described by the modes of the measured configuration The successful application of the modal coupling approach appears to depend on how realistically the coupling conditions were simulated in the test and in the coupling approach B J

A85-12478#
CONTINUUM MODELLING OF DAMPING IN LARGE SPACE STRUCTURES
S ABRATE and C. T SUN (Purdue University, West Lafayette, IN) IN International Conference on Recent Advances in Structural Dynamics, 2nd, Southampton, England, April 9-13, 1984, Proceedings Volume 2 Southampton, England, University of Southampton, 1984, p 877-885 refs

Candidate models for internal damping in large space structures (LSS) composed of periodic lattices are explored analytically Differential models incorporate stress, strain, and their time derivatives as factors, while hysteretic models describe matrices with time-independent damping characteristics The Timoshenko beam model and a continuum model are also possibilities for LSS analytical tools The finite element method models damping in trusses and frames and in terms of equations of motion for all types of modes The lack of experimental data on LSS is stressed, noting the concommitant difficulty in verifying any of the models Sample calculations are provided for the steady-state damping responses of a truss and a cantilevered beam M S K

A85-13023#
AN OPTIMAL SHAPE CONTROL OF A LARGE FLEXIBLE RADIATOR IN SPACE
A DANESI and M SILVI (Roma, Universita, Rome, Italy) International Astronautical Federation, International Astronautical Congress, 35th, Lausanne, Switzerland, Oct 7-13, 1984 10 p
(IAF PAPER 84-64)

Radiator active shape control is evaluated for a laser package transmitting high optical energy flux from geosynchronous orbit to a specific ground or space target The proposed multifeedback control strategy is implemented via a decentralized low-authority control system, while a high-authority system is used to damp the modal behavior of the antenna feed structure supporting the laser package Particular emphasis is placed on a description of the control system configuration and on the role of the control process in reducing the effect of structural flexibility on the radiator pointing accuracy Simulation results show that the proposed active control is capable of improving the antenna pointing accuracy to meet the design requirements B J

A85-13206#
STABILITY OF A RING OF CONNECTED SATELLITES
V V BELETSKII (Akademiia Nauk SSSR, Institut Prikladnoi Matematiki, Moscow, USSR) and E M LEVIN (Akademiia Nauk SSSR, Institut Mashinovedeniia, Moscow, USSR) International Astronautical Federation, International Astronautical Congress, 35th, Lausanne, Switzerland, Oct 7-13, 1984 6 p
(IAF PAPER 84-342)

The stability of a ring of connected satellites is examined for various tether tension laws as functions of the distance between the satellites Maxwsell's theory of stable rotation in such a system when the interactive force between the satellites decreases sufficiently at a certain distance magnitude exists between the satellites formed the basis of the study A control law was examined for adjusting the tension of the tethers It was found that stability is possible if the tension is less than the weight of the tethered satellite divided by the weights of all the other satellites, and tension will decrease with increasing intersatellite spacing The formulas are applied to describing the persistence of the Jovian and Uranian ring systems M S K

A85-13220*# Howard Univ , Washington, D C
ENVIRONMENTAL EFFECTS ON THE DYNAMICS AND CONTROL OF AN ORBITING LARGE FLEXIBLE ANTENNA SYSTEM
R KRISHNA and P M BAINUM (Howard University, Washington, DC) International Astronautical Federation, International Astronautical Congress, 35th, Lausanne, Switzerland, Oct 7-13, 1984 9 p Previously announced in STAR as N84-20627 refs
(Contract NSG-1414)
(IAF PAPER 84-358)

Solar radiation pressure on the vibrating antenna structure, temperature gradients induced by solar heating, and stabilizing gravity-gradient torques were considered when the linear regulator theory was used to obtain orientation and shape control of a hoop/column antenna system being considered for the land mobile satellite system A finite element model of the antenna system which includes all six rigid modes and seven flexible modes was used Results show that the environmental disturbances affect only the rigid modes of the structure The effect of solar radiation pressure interacting with the vibrating system is smaller than the solar radiation pressure acting on the thermally deformed structure To reduce control effect in order to maintain shape and orientation, thermal deformations must be minimized in the preliminary design of the system A R H

A85-13221#
DYNAMICS OF THE ORBITER BASED CONSTRUCTION OF STRUCTURAL COMPONENTS
V J MODI and A M IBRAHIM (British Columbia, University, Vancouver, Canada) International Astronautical Federation, International Astronautical Congress, 35th, Lausanne, Switzerland, Oct 7-13, 1984 34 p Sponsorship Natural Sciences and Engineering Research Council of Canada refs
(Contract NSERC-67-066)
(IAF PAPER 84-359)

A relatively general formulation for studying librational dynamics of a large class of spacecraft during deployment of arbitrarily oriented beam and plate type flexible members has been developed The formulation is applicable to a variety of missions ranging from deployment of antennas, booms and solar panels to manufacturing of trusses for space platforms using the Space Shuttle Here, the procedure is applied to the Space Shuttle based deployment of plate-like members Results suggest substantial influence of the flexural rigidity of the appendages, deployment velocity, initial conditions, and appendage orientation on the system response Deployment maneuvers in conjunction with a typical controlled time history of permissible librational rates suggest flexible plate members to be stable In general, the instability is triggered through roll excitation leading to unbounded yaw due to coupling The results should prove useful in planning of the Orbiter based experiments aimed at studying dynamics and control of flexible, deployable structural components needed in construction of space platforms Author

A85-13245#
DYNAMICAL MODELLING OF A GRAVITY-LOADED RECTANGULAR PLATE AS A TEST CONFIGURATION FOR ATTITUDE CONTROL OF LARGE SPACE STRUCTURES
B SCHAEFER (Deutsche Forschungs- und Versuchsanstalt fuer Luft- und Raumfahrt, Oberpfaffenhofen, West Germany) International Astronautical Federation, International Astronautical Congress, 35th, Lausanne, Switzerland, Oct 7-13, 1984 8 p Sponsorship European Space Research and Technology Centre refs
(Contract ESTEC-5310/82/NL/BI)
(IAF PAPER 84-391)

An analytical study is performed of the design of a structural element which would have dynamic characteristics similar to those employed on large space structures (LSS) The design object is based on a wire-suspended rectangular plate, and the goal is to define control laws which respond to outputs of sensors and actuators on the LSS The analysis was required to define a geometric distribution of suspending cables which would allow

generation of mode shapes expected in LSS Suspension generates pendulous, low-frequency oscillations A Rayleigh-Ritz method is applied to the structural vibrations and the model is extended to rigid body oscillations. Calculations yield the lowest 20 eigenmodes of the structural element M.S K

A85-13249#
ELASTIC WAVES PROPAGATION IN BOUNDED PERIODIC STRUCTURES
S. SGUBINI, F. GRAZIANI, and A AGNENI (Roma, Universita, Rome, Italy) International Astronautical Federation, International Astronautical Congress, 35th, Lausanne, Switzerland, Oct 7-13, 1984. 5 p refs
(IAF PAPER 84-395)

The differences between continuum and periodic models of modular structures are assessed with respect to elastic wave propagation, with particular reference to the use of such models to analyze repetitive lattice grids (used in the design of large space structures) Continuum models appear to be more attractive from the point of view of numerical evaluation, and yield satisfactory solutions for low frequencies But as the frequency increases, they conceal the filtering effect and greatly distort the steady-state response Hence, periodic models are concluded to be more adequate for the simulation of the behavior of modular structures In addition, periodic models involve neither difficult numerical calculations nor excessive computational storage, since recursive algorithms are used. B J

A85-13293#
ROBUST ATTITUDE CONTROL OF A LARGE COMMUNICATION SATELLITE WITH FLEXIBLE SOLAR ARRAYS
J LIANG (Chansha Institute of Technology, Changsha, Hunan, People's Republic of China) International Astronautical Federation, International Astronautical Congress, 35th, Lausanne, Switzerland, Oct 7-13, 1984 10 p refs
(IAF PAPER 84-ST-06)

The controllability and observability of the attitude dynamics equation of a large communication satellite with flexible solar arrays is discussed, and a simple condition of the controllability and observability is presented In order to define a mode suitable for control purposes, the large-dimensional mode is decomposed into a nominal component and a residual component A design procedure for a reduced order control system is investigated, and the robustness and stability of this system to system perturbation and residual modes are analyzed using singular values of the matrices It is shown that by appropriately choosing the feedback gain matrix and the observer gain matrix, the control observation spillover of residual modes can be suppressed in the reduced order control system Some numerical simulation results are presented and a method applicable to the general large space structure control problem is suggested C D

A85-13634*# Massachusetts Inst of Tech , Cambridge
NUMBER AND PLACEMENT OF CONTROL SYSTEM COMPONENTS CONSIDERING POSSIBLE FAILURES
W E VANDER VELDE and C R CARIGNAN (MIT, Cambridge, MA) Journal of Guidance, Control, and Dynamics (ISSN 0731-5090), vol 7, Nov.-Dec 1984, p 703-709 refs
(Contract NAG1-126)

One of the first questions facing the designer of the control system for a large space structure is how many components actuators and sensors - to specify and where to place them on the structure This paper presents a methodology which is intended to assist the designer in making these choices A measure of controllability is defined which is a quantitative indication of how well the system can be controlled with a given set of actuators Similarly, a measure of observability is defined which is a quantitative indication of how well the system can be observed with a given set of sensors Then the effect of component unreliability is introduced by computing the average expected degree of controllability (observability) over the operating lifetime of the system accounting for the likelihood of various combinations of component failures. The problem of component location is resolved by optimizing this performance measure over the admissible set of locations. The variation of this optimized performance measure with number of actuators (sensors) is helpful in deciding how many components to use. Author

A85-13636*# Rensselaer Polytechnic Inst., Troy, N Y
SOME APPLICATIONS OF DIRECT ADAPTIVE CONTROL TO LARGE STRUCTURAL SYSTEMS
I BAR-KANA and H KAUFMAN (Rensselaer Polytechnic Institute, Troy, NY) Journal of Guidance, Control, and Dynamics (ISSN 0731-5090), vol 7, Nov.-Dec 1984, p. 717-724 Previously cited in issue 10, p 1450, Accession no A84-25496 refs
(Contract NSF ECS-80-16173, NAG1-171)

A85-13638*# National Aeronautics and Space Administration Langley Research Center, Hampton, Va.
OPTIMAL DESIGN OF A PASSIVE VIBRATION ABSORBER FOR A TRUSS BEAM
J.-N JUANG (NASA, Langley Research Center, Structural Dynamics Branch, Hampton, VA) (Guidance and Control Conference, Gatlinburg, TN, August 15-17, 1983, Collection of Technical Papers, p 794-804) Journal of Guidance, Control, and Dynamics (ISSN 0731-5090), vol 7, Nov.-Dec 1984, p 733-739 Previously cited in issue 19, p 2816, Accession no A83-41750 refs

A85-13641#
MODAL DECOUPLING CONDITIONS FOR DISTRIBUTED CONTROL OF FLEXIBLE STRUCTURES
D J INMAN (New York, State University, Buffalo, NY) Journal of Guidance, Control, and Dynamics (ISSN 0731-5090), vol 7, Nov.-Dec 1984, p 750-752
(Contract AF-AFOSR-82-0242)

Meirovitch and Baruh (1982) have proposed a scheme for the optimal control of a certain class of conservative distributed parameter systems without resorting to discretization In particular, they considered the control of self-adjoint conservative systems having known eigensolutions The present investigation has the objective to point out that the results of Meirovitch and Baruh are applicable to a more general class of problems which includes nonconservative forces It is also noted that the necessary conditions are available for the existence of decoupling control laws Decoupling control laws are control laws dependent only on the modal state vector of the decoupled equation G R

A85-13893
A SIGNED SWITCHING TIME BANG-BANG ATTITUDE CONTROL LAW FOR FINE POINTING OF FLEXIBLE SPACECRAFT
S J DODDS (Marconi Space and Defense Systems, Ltd , Satellite Div , Portsmouth, England) and S E WILLIAMSON (Surrey, University, Guildford, England) International Journal of Control (ISSN 0020-7179), vol 40, Oct 1984, p 795-811 Research supported by the Royal Aircraft Establishment

Classical approaches to the control of flexible spacecraft make use of linear control compensators which avoid excitation of the flexure modes on the basis of either (1) notch filter characteristics or (2) simple bandwidth limitation Certain difficulties arise in connection with both approaches Moreover, the classical approaches are not directly applicable with gas jet actuators of fixed control level The problems related to an employment of the classical approaches can be overcome with the aid of the bang-bang control principle, which is considered in the present investigation. In the discussed principle, the flexure modes are actively controlled together with the mean spacecraft attitude and rate. It is pointed out that the developed control law has potential application for high-precision gas jet attitude control systems for spacecraft with several modes of flexural vibration which may have negligible damping G.R

A85-15254
STABILITY OF THE STATIONARY MOTIONS OF A TETHERED SYSTEM OF TWO BODIES IN ORBIT UNDER THE EFFECT OF GRAVITATIONAL AND AERODYNAMIC FORCES [OB USTOICHIVOSTI STATSIONARNYKH DVIZHENII SVIAZKI DVUKH TEL NA ORBITE POD DEISTVIEM GRAVITATSIONNYKH I AERODINAMICHESKIKH SIL]
E M LEVIN Kosmicheskie Issledovaniia (ISSN 0023-4206), vol 22, Sept.-Oct 1984, p 675-682 In Russian refs

The motion of a tethered system of two satellites in geocentric orbit is examined The main satellite is assumed to move in circular orbit at a height of 200-250 km above the earth's surface, while the subsatellite-probe, attached to the main satellite by a thin tether, is assumed to orbit the earth at a height of 100-150 km In the dynamic analysis the subsatellite is considered as a material point, while the tether is considered as an extensible and ponderable flexible filament Aerodynamic forces acting on the probe and tether are considered, and it is noted that the stationary motions of the system consist in its uniform revolution as a rigid body about the earth The stability of these stationary motions is analyzed, and it is shown that constraints imposed on the tether parameters by the stability requirement are more rigorous than constraints on tether strength B J

A85-15745
RECURSIVE LANGRANGIAN DYNAMICS OF FLEXIBLE MANIPULATOR ARMS
W J BOOK (Georgia Institute of Technology, Atlanta, GA) International Journal of Robotics Research (ISSN 0278-3649), vol 3, Fall 1984, p 87-101 Research supported by Carnegie-Mellon University and Georgia Institute of technology refs

Nonlinear equations of motion are developed for flexible manipulator arms consisting of rotary joints that connect pairs of flexible links Kinematics of both the rotary-joint motion and the link deformation are described by 4 x 4 transformation matrices The link deflection is assumed small so that the link transformation can be composed of summations of assumed link shapes The resulting equations are presented as scalar and 4 x 4 matrix operations ready for programming The efficiency of this formulation is compared to rigid-link cases reported in the literature Author

A85-15992
APPLICATION OF DAMPING TO SPACECRAFT STRUCTURES
C V STAHLE and J A STALEY (GE Valley Forge Space Center, Philadelphia, PA) IN Technology vectors, Proceedings of the Twenty-ninth National SAMPE Symposium and Exhibition, Reno, NV, April 3-5, 1984 Covina, CA, Society for the Advancement of Material and Process Engineering, 1984, p 185-194 refs

This paper presents a discussion of the need for and benefits from applying damping treatments to satellite equipment panels to reduce failures due to component vibration during launch anad ground testing Discussions on the use of viscoelastic damping materials for control of spacecraft vibration and the benefits of the resulting improvements in reliability are presented Use of the OCTAVE code to estimate cost savings and improved reliability by using viscoelastic damping in equipment support structures is described Use of finite element/modal strain energy and simpler methods of analysis to develop designs for damping treatments are discussed Results of the paper show that significant improvements in satellite cost and reliability can be achieved by design of damping treatments using currently available materials and analytical tools Author

A85-17054
THE DEVELOPMENT OF A FREQUENCY METHOD FOR THE MATHEMATICAL MODELING OF THE MOTION OF AN ELASTIC SPACE VEHICLE [RAZVITIE CHASTOTNOGO METODA POSTROENIIA MATEMATICHESKOI MODELI DVIZHENIIA UPRUGOGO KOSMICHESKOGO APPARATA]
IU A BOGOMOLOV Aviatsionnaia Tekhnika (ISSN 0579-2975), no 2, 1984, p 16-21 In Russian

In accordance with a current physical model, a space vehicle is treated as a combination of rigid bodies and elastic beams The state of such a system can be described by using sets of hybrid (concentrated and distributed) coordinates Here, a general approach to the mathematical modeling of space vehicles is proposed which is an extension of the method developed by Plimmer (1976) for a limited class of systems The method proposed here can be used for arbitrary stationary linear systems, and in particular, for systems with damping provisions and inertial and gyroscopic cross coupling between channels V L

A85-18331*# National Aeronautics and Space Administration Langley Research Center, Hampton, Va
CLOSED-FORM SOLUTIONS FOR FEEDBACK CONTROL WITH TERMINAL CONSTRAINTS
J-N JUANG (NASA, Langley Research Center, Structural Dynamics Branch, Hampton, VA), J D TURNER, and H M CHUN (Charles Stark Draper Laboratory, Inc , Cambridge, MA) (Virginia Polytechnic Institute and State University and American Institute of Aeronautics and Astronautics, Symposium on Dynamics and Control of Large Flexible Structures, 4th, Blacksburg, VA, June 6-8, 1983, Paper) Journal of Guidance, Control, and Dynamics (ISSN 0731-5090), vol 8, Jan-Feb 1984, p 39-43 Previously cited in issue 12, p 1790, Accession no A84-29471 refs

A85-18337*# Jet Propulsion Lab , California Inst of Tech , Pasadena
HIGH PRECISION ACTIVE NUTATION CONTROL OF A MOMENTUM BIASED SPACECRAFT WITH FLEXIBLE APPENDAGES
R A LASKIN and E H KOPF (California Institute of Technology, Jet Propulsion Laboratory, Pasadena, CA) Journal of Guidance, Control, and Dynamics (ISSN 0731-5090), vol 8, Jan-Feb 1984, p 78-85 NASA-supported research Previously cited in issue 13, p 1844, Accession no A84-30541 refs

A85-18672
CLOSED FORM OPTIMAL CONTROL SOLUTIONS FOR CONTINUOUS LINEAR ELASTIC SYSTEMS
S B SKAAR (Iowa State University of Science and Technology, Ames, IA) Journal of the Astronautical Sciences (ISSN 0021-9142), vol 32, Oct-Dec 1984, p 447-461 refs

A new approach to the optimal control of continuous linear elastic systems is presented Unlike discretization schemes such as the method of assumed modes, the control solutions are exact and have the form of a convergent series of time-varying terms The method makes use of a convolution integral description of the response of points within a flexible system to an arbitrary force or torque input Two example performance indices are considered the integral over time of the control squared, and the integral over time of the time derivative of the control squared Interesting properties of trajectories which result from the minimization of these quantities ae discussed and illustrated using a simple elastic system configuration Author

A85-18692*# Massachusetts Inst of Tech , Cambridge
EXPERIMENTAL MEASUREMENTS OF MATERIAL DAMPING IN FREE FALL WITH TUNABLE EXCITATION
E F CRAWLEY and D G MOHR (MIT, Cambridge, MA) AIAA Journal (ISSN 0001-1452), vol 23, Jan 1985, p 125-131 Research supported by the Aerospace Corp Previously cited in issue 14, p 1985, Accession no A83-32796 refs
(Contract NAGW-21)

A85-19462#
EQUATIONS OF MOTION GOVERNING THE DEPLOYMENT OF A FLEXIBLE LINKAGE FROM A SPACECRAFT
T R KANE (Stanford University, Stanford, CA) and S DJERASSI American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 23rd, Reno, NV, Jan 14-17, 1985 6 p refs
(AIAA PAPER 85-0023)

The equations of motion for the deployment of a flexible linkage from a spacecraft are derived analytically using two theorems associated with the dynamical equations of Kane et al (1983) Generalized speeds are introduced for each body of a generic

n-body system, and the resulting expressions (the sums of generalized active and inertial forces for each generalized speed) are combined with constraint equations A typical linkage-deployment problem is constructed and analyzed, and the results of a numerical simulation are presented graphically T K

A85-19468*# National Aeronautics and Space Administration Marshall Space Flight Center, Huntsville, Ala.
AUTONOMOUS MOMENTUM MANAGEMENT FOR THE CDG PLANAR SPACE STATION
M. HOPKINS (NASA, Marshall Space Flight Center, Huntsville, AL) and E HAHN (Bendix Corp , Guidance Systems Div , Teterboro, NJ) American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 23rd, Reno, NV, Jan 14-17, 1985 11 p refs
(Contract NAS8-35349)
(AIAA PAPER 85-0031)

This paper discusses momentum management for the CDG Planar Space Platform The external torques on the Space Station are assumed to be gravity gradient and aerodynamic with both having bias and cyclic terms The integrals of the cyclic torques are the cyclic momenti which will be stored in the momentum storage actuator Various techniques to counteract the bias torques and center the cyclic momentum were investigated including gravity gradient desaturation by adjusting vehicle attitude, aerodynamic desaturation using solar panels and radiators and the deployment of flat plates at the end of long booms generating aerodynamic torques Author

A85-19528*# National Aeronautics and Space Administration Marshall Space Flight Center, Huntsville, Ala
NASA/MSFC GROUND EXPERIMENT FOR LARGE SPACE STRUCTURE CONTROL VERIFICATION
H B WAITES (NASA, Marshall Space Flight Center, Huntsville, AL), S M SELTZER, and D K TOLLISON (Control Dynamics Co , Huntsville, AL) American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 23rd, Reno, NV, Jan 14-17, 1985 13 p refs
(AIAA PAPER 85-0115)

NASA Marshall Space Flight Center has developed a facility in which closed loop control of Large Space Structures (LSS) can be demonstrated and verified The main objective of the facility is to verify LSS control system techniques so that on-orbit performance can be ensured The facility consists of an LSS test article which is connected to a payload mounting system that provides control torque commands It is attached to a base excitation system which will simulate disturbances most likely to occur for Orbiter and DOD payloads A control computer will contain the calibration software, the reference system, the alignment procedures, the telemetry software, and the control algorithms The total system will be suspended in such a fashion that LSS test article has the characteristics common to all LSS Author

A85-19529#
ON DYNAMICAL FORMULATIONS OF A TETHERED SATELLITE SYSTEM WITH MASS TRANSPORT
F C LIU (Alabama, University, Huntsville, AL) American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 23rd, Reno, NV, Jan. 14-17, 1985 8 p refs
(AIAA PAPER 85-0117)

Two satellites connected by a long flexible tether along the earth radial direction comprise a stable equilibrium state This paper deals with formulations of in-plane motion of the tether connected satellites with a third mass transporting from one satellite to the other Systems of equations of motion formulated by two methods, Lagrange equations and D'Alembert's Principle, are presented and methods for numerical solutions are proposed Initial conditions for inward and outward transfers are derived Author

A85-19595#
EFFICIENT INCLINATION CONTROL FOR GEOSTATIONARY SATELLITES
D D SLAVINSKAS, W. J. BENDEN (AT&T Bell Laboratories, Murray Hill, NJ), and G K JOHNSON American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 23rd, Reno, NV, Jan 14-17, 1985 11 p refs
(AIAA PAPER 85-0216)

Theory and in-orbit experience are presented for an efficient method of inclination control for geostationary satellites Solar perturbations with a period of six months can cause a station-keeping fuel consumption overhead which varies between 2 3 and 4 0 percent The proposed method controls a component of these perturbations while completely avoiding the fuel penalty This is equivalent to a service life extension of three to four months for a typical 10-year satellite Author

A85-19693#
ANALYTICAL AND EXPERIMENTAL RESEARCH IN LARGE SPACE STRUCTURES CONTROL
J -N AUBRUN (Lockheed Research Laboratories, Palo Alto, CA) American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 23rd, Reno, NV, Jan 14-17, 1985 16 p refs
(AIAA PAPER 85-0356)

In the late 1970's, spacecraft concepts with unfavorable dynamics were evolved One problem of immediate concern was related to the interaction between the attitude control system and spacecraft structural modes In the new generation spacecraft, the separation of the controller bandwidth from the structural vibration spectrum could no longer be maintained Research was conducted with the objective to overcome the arising problems An outline is presented of the new methodology developed, taking into account the main approaches to actively control vibrations and handle flexible dynamics in general Attention is given to an optimal control approach, the integrated High Authority Control (HAC)/Low Authority Control (LAC) approach, a model control problem, early experimental demonstrations, and control experiments G R

A85-22584
ACTIVE VIBRATION CONTROL FOR LASERS AND SPACECRAFT
J PEARSON (USAF, Wright Aeronautical Laboratories, Wright-Patterson AFB, OH) IN Deployable optical systems, Proceedings of the Meeting, Los Angeles, CA, January 18, 19, 1983 Bellingham, WA, SPIE - The International Society for Optical Engineering, 1983, p 66-74

Problems in the active vibration control of structural modes in extremely flexible space structures and in precisely pointed optics are identified and addressed by the U S Air Force's Vibration Control of Space Structures program, which has assumed responsibility for sensor/actuator/structure dynamic interaction problems Within the program, benchless laser tests and an airborne laser mirror control development effort are aimed at the active control of high energy laser mirrors System identification and testing matters are the responsibility of the Experimental Modal Analysis and Component Synthesis program and the Large Space Structure Dynamics program On-orbit dynamics testing aboard the NASA Space Shuttle is under consideration O C

A85-22585
STRUCTURAL CONTROL RESEARCH AT AFOSR
A K AMOS (USAF, Office of Scientific Research, Bolling AFB, DC) IN Deployable optical systems, Proceedings of the Meeting, Los Angeles, CA, January 18, 19, 1983 Bellingham, WA, SPIE - The International Society for Optical Engineering, 1983, p 75-80. refs

Attention is given to the U S Air Force Office of Scientific Research Materials and Structures plan, which addresses spacecraft structural mechanics issues generally and those involved in large optical arrays specifically. The program encompasses structural characterization, control of dynamic response, and system optimization and validation Structural dynamics

characterization methods uniquely suited to large flexible spacecraft are actively sought in the program, as are active control methods intimately linked with the vibrational modes of a structure, and combined analytical simulation/experimental data-input methods of validation O C

A85-22586* National Aeronautics and Space Administration, Washington, D C
ACTIVE CONTROL TECHNOLOGY DEVELOPMENT AT NASA
J B DAHLGREN (NASA, Office of Aeronautics and Space Technology, Washington, DC) IN Deployable optical systems, Proceedings of the Meeting, Los Angeles, CA, January 18, 19, 1983 Bellingham, WA, SPIE - The International Society for Optical Engineering, 1983, p 81-87

It is noted that the large space systems deployable by means of the Space Shuttle will have increased flexibility, and therefore unprecedented interaction between control and other subsystems Open loop performance in such systems would be grossly inadequate, prompting active control method development to achieve the required performance levels The structures in question encompass those of projected science and communications platforms, interplanetary space transportation systems, and manned permanent space stations O C

A85-22587* National Aeronautics and Space Administration Langley Research Center, Hampton, Va
STRUCTURAL CONTROL RESEARCH AND EXPERIMENTS AT NASA/LARC
R C MONTGOMERY (NASA, Langley Research Center, Hampton, VA) IN Deployable optical systems, Proceedings of the Meeting, Los Angeles, CA, January 18, 19, 1983 Bellingham, WA, SPIE - The International Society for Optical Engineering, 1983, p 88-97 refs

Research progress in the area of structural dynamics and control using the flexible beam facility at the NASA Langley Research Center is reviewed Particular attention is placed on the progress in adaptive control and reliability improvements using advanced control concepts Both theoretical and experimental results are given to indicate the nature of the work being undertaken In the adaptive control area, emphasis is placed on parameter and system identification and in comparison of competing on-line algorithms Also, results are presented for on-line modal control laws that are interfaced to a parameter identification scheme This provides an on-line distributed adaptive control system In the reliability area, a design process is outlined that incorporates reliability over the design mission life Author

A85-24949
DYNAMIC CHARACTERISTICS OF A SPACE REFLECTOR SUPPORT STRUCTURE
C A MAZZOLA, R J RECK (McDonnell Douglas Astronautics Co, Huntington Beach, CA), and R SHEPHERD (California, University, Irvine, CA) IN International Conference on Space Structures, 3rd, University of Surrey, Guildford, Surrey, England, September 4-14, 1984, Proceedings London and New York, Elsevier Applied Science Publishers, 1984, p 522-527 Research supported by the McDonnell Douglas Astronautics Co refs

The need to provide large reflector structures suitable for use in a variety of space missions prompted the investigation of a representative three-dimensional space truss The finite element model used idealizes the truss members as uniaxial rod elements with pinned end connections In this paper comparisons of natural frequencies and mode shapes for various geometrical configurations and material properties are made The accuracy of the model idealization is verified by comparing results for a uniformly loaded beam situation It is concluded that the technique proposed is viable in the design of large reflector space structures Author

A85-26350#
TORSIONAL VIBRATION OF BOOMS WITH OPEN CROSS SECTION CAUSED BY UNIDIRECTIONAL RADIANT HEATING
M MUROZONO and S SUMI Kyushu University, Technology Reports (ISSN 0023-2718), vol 57, Oct 1984, p 681-688 In Japanese, with abstract in English refs

Long extendible satellite appendage (boom) subjected to solar radiant heating is modeled as a thin-walled long cylinder of split non-overlapping section Tip mass is attached to one end which is free to warp and other is fixed The unidirectional solar radiation is assumed to be normal to the boom's longitudinal axis The equation of thermally-induced torsional vibration of this system is formulated by considering the coupling effect of mechanical and thermal phenomena as one-degree-of-freedom system because it yet demonstrates the basic behavior The characteristic equation is evaluated using the Routh-Hurwitz stability criterion and it is found that the stability characteristics are dependent upon, along with three system parameters, the direction of the radiant heating The boundary curves, which divide the parameter plane into regions of stability and instability according to a direction of radiation, and some typical responses based on the closed-form solution are also included Author

A85-26433#
POLES AND TRANSMISSION ZEROS OF FLEXIBLE SPACECRAFT CONTROL SYSTEMS
T KIDA, Y OHKAMI (National Aerospace Laboratory, Tokyo, Japan), and S SAMBONGI (National Space Development Agency of Japan, Tokyo, Japan) Journal of Guidance, Control, and Dynamics (ISSN 0731-5090), vol 8, Mar.-Apr 1985, p 208-213 refs

A method is presented for numerically determining multivariable poles and zeros of nonspinning flexible space structures consisting of one rigid part and elastic appendages Among many definitions of system zeros, transmission zeros are investigated relating the force/torque input applied at an arbitrary point and the translational/angular displacement output at another point Computation algorithms are obtained for the cases when the modal data are given in terms of constrained modes and unconstrained modes Investigations on duality and equivalency of these two approaches are made, and the relations of the numerical structures of the algorithms to controllability and observability conditions are also clarified The proposed algorithms are demonstrated for a simple numerical model Author

A85-26434#
FLEXURAL VIBRATION OF GRAVITY-STABILIZED, STRUCTURALLY DAMPED, LARGE FLEXIBLE SATELLITES
S K SHRIVASTAVA and P K MAHARANA (Indian Institute of Science, Bangalore, India) Journal of Guidance, Control, and Dynamics (ISSN 0731-5090), vol 8, Mar.-Apr 1985, p 214-222 refs

The stability and response of the in-plane flexural motion of gravity-stabilized, structurally damped, large flexible satellites in circular and eccentric orbits are analyzed Employing the method of strained parameters, the stability analysis shows that the critical damping is sensitive to the satellite inertia ratio It is noted that the orbital eccentricity excites motion in several high and low frequencies and generally descreases the stability of the system An analytical expression for flexural response is obtained using the multiple-scales techniques Finally, stability charts and response are presented for a range of the system parameters Author

A85-26435*# National Aeronautics and Space Administration Langley Research Center, Hampton, Va.
ADAPTIVE MODAL CONTROL OF STRUCTURAL DYNAMIC SYSTEMS USING RECURSIVE LATTICE FILTERS
N SUNDARARAJAN, J P WILLIAMS, and R C MONTGOMERY (NASA, Langley Research Center, Flight Dynamics and Control Div , Hampton, VA) (Guidance and Control Conference, Gatlinburg, TN, August 15-17, 1983, Collection of Technical Papers, p 599-605) Journal of Guidance, Control, and Dynamics (ISSN 0731-5090), vol. 8, Mar -Apr 1985, p 223-229 Previously cited in issue 19, p 2892, Accession no A83-41721 refs

A85-26606
SPECTRAL CHARACTERISTICS OF RADAR ECHOES FROM AIRCRAFT-DISPENSED CHAFF
W J ESTES, R H FLAKE (Texas, University, Austin, TX), and C C. PINSON (Pinson Associates, Inc , Austin, TX) IEEE Transactions on Aerospace and Electronic Systems (ISSN 0018-9251), vol AES-21, Jan 1985, p 8-20 refs
(Contract DAAD07-82-C-0230)

Experimental amplitude and phase measurements of radar echoes from chaff both in the wake of the dispersing aircraft (new chaff) and after the aircraft has left the area (mature chaff) are described UHF and X-band coherent radars are used to obtain experimental data for both continuously-dispensed chaff and discrete chaff units The mean radial velocity nu-0 and the velocity standard deviation sigma-nu of the chaff cloud are estimated from complex-envelope spectral density estimates For mature chaff, sigma-nu ranges from 0 3 to 1 2 per ms. For new chaff, both sigma-nu and nu-0 depend on the position in the wake At 150 m behind the aircraft, sigma-nu varies from 2 0 to 2 7 per ms and at 450 m, sigma-nu varies from 0 8 to 1 5 per ms No apparent correlation between the magnitude of sigma-nu and either radar frequency or chaff type is found An expression is derived which shows the effect of conical scanning on the complex envelope spectral density Author

A85-27238
LQG BALANCING AND REDUCED LQG COMPENSATION OF SYMMETRIC PASSIVE SYSTEMS
PH OPDENACKER and E. A JONCKHEERE (Southern California, University, Los Angeles, CA) International Journal of Control (ISSN 0020-7179), vol 41, Jan 1985, p. 73-109 refs
(Contract NSF ECS-82-12479)

In this paper, a technique for balancing a system in a closed-loop fashion is developed This technique is referred to as 'LQG balancing', for it assumes that the system to be balanced is closed up with a standard LQG feedback loop This paper focuses on LQG balancing of symmetric passive systems, such systems are used to model large vibrating structures with collocated rate sensors and actuators A balancing characterization of reciprocity, passivity and losslessness is provided A new method for reducing both the plant and the LQG compensator is developed It is shown, using a hyperstability argument, that the loop made up with the full plant and any reduced LQG compensator is stable and has acceptable feedback properties Author

A85-28488
EFFECT OF AERODYNAMIC MOMENT ON THE REGIME OF THE GRAVITY GRADIENT STABILIZATION OF THE SALYUT-6 - SOYUZ ORBITAL SYSTEM [VLIIANIE AERODINAMICHESKOGO MOMENTA NA REZHIM GRAVITATSIONNOI ORIENTATSII ORBITAL'NOGO KOMPLEKSA 'SALIUT-6' - 'SOIUZ']
V A. SARYCHEV and V V SAZOROV Kosmicheskie Issledovaniia (ISSN 0023-4206), vol 23, Jan -Feb 1985, p 63-83 In Russian refs

The equations of the rotational motion of the Salyut-6 - Soyuz system under the effect of gravitational and restoring aerodynamic moments admit a natural inclusion of a small parameter the ratio of longitudinal to transverse moments of inertia The Krylov-Bogoliubov method is used to construct the formal two-parameter integral surfaces of these equations describing the oscillations and rotations of the orbital system about the longitudinal axis, approximately directed along the local vertical The motions belonging to these integral surfaces can be considered as nominal unperturbed motions of the system in the regime of gravity gradient stabilization (GGS) It is shown that these surfaces can be unstable due to the effect of the nonpotential component of the aerodynamic moment. Under an appropriate selection of initial conditions of motion, this instability is slight and does not disrupt the GGS, at least over several weeks B J

A85-28903
THE DYNAMICS OF THE ATTITUDE CONTROL AND STABILIZATION SYSTEMS OF SPACECRAFT WITH A CONTROLLED GRAVITY GRADIENT STABILIZER [DINAMIKA SISTEM ORIENTATSII I STABILIZATSII KOSMICHESKIKH APPARATOV S UPPRAVLIAEMYM GRAVITATSIONNYM STABILIZATOROM]
E. M POTAPENKO Akademiia Nauk SSSR, Izvestiia, Mekhanika Tverdogo Tela (ISSN 0572-3299), Jan -Feb 1985, p 22-30 In Russian refs

The paper is concerned with the dynamics of a spacecraft with a controlled gravity gradient stabilizer in the form of a long thin-walled boom having a load at its free end and mounted in a two-degrees-of-freedom controlled suspension at the other end The use of various auxiliary mechanisms for vibration damping, such as flywheels, gyroscopes, jet engines, and electromagnets, is discussed Attention is also given to the effect of the elasticity and deflections of the stabilizer boom on the stability of the spacecraft motion Expressions are obtained allowing the analysis, synthesis, and comparison of the systems under study V L

A85-28906
STABILITY OF THE ROTATION OF A BODY SUSPENDED BY MEANS OF A SYSTEM OF RODS CONNECTED IN SERIES [OB USTOICHIVOSTI VRASHCHENIIA TELA, PODVESHENNOGO POSREDSTVOM SISTEMY POSLEDOVATEL'NO SOEDINENNYKH STERZHNEI]
V A STOROZHENKO Akademiia Nauk SSSR, Izvestiia, Mekhanika Tverdogo Tela (ISSN 0572-3299), Jan -Feb. 1985, p 45-52 In Russian refs

In some of the studies dealing with the stability of the rotational motions of rigid bodies suspended on a string, the string is assumed to have no mass and offer no resistance to torsion In actual design, however, in systems using a string suspension, the string usually transmits rotational motion from an engine to a body For bodies of considerable size, the string has a sufficiently large mass, which should be allowed for in the analysis of the body motion, particularly in the case of high angular velocities A possible implementation of a ponderable nontwisting string is examined V.L

A85-29144#
DISPLACEMENT CONTROL OF FLEXIBLE STRUCTURES USING ELECTROHYDRAULIC SERVO-ACTUATORS
N H MCCLAMROCH (Michigan, University, Ann Arbor, MI) ASME, Transactions, Journal of Dynamic Systems, Measurement, and Control (ISSN 0022-0434), vol 107, March 1985, p 34-39 refs
(Contract NSF CEE-82-07375, F49620-82-C-0089)

A general mathematical approach, involving linear feedback of the measured structural displacements and of the actuator control forces, to the displacement or position control of a nonlinear flexible structure, using electrohydraulic servo actuators, is developed Closed-loop stability is mathematically described, taking account of the special case when the feedback is decentralized It is shown that the use of decentralized force (or pressure) and displacement feedback can stabilize any structure with incremental positive stiffness if the feedback gains are chosen to satisfy certain simple inequalities Attention is also given to proper selection of the feedforward function to achieve zero steady-state error L.T

N85-10098*# Bendix Corp , Teterboro, N J Guidance Systems Div
MODULAR DESIGN ATTITUDE CONTROL SYSTEM Final Report, 1 Oct. 1983 - 31 Aug 1984
F D CHICHESTER 5 Oct 1984 79 p refs
(Contract NAS8-33979)
(NASA-CR-171182, NAS 1 26 171182) Avail NTIS HC A05/MF A01 CSCL 22B

A sequence of single axismodels and a series of reduced state linear observers of minimum order are used to reconstruct inaccessible variables pertaining to the modular attitude control of a rigid body flexible suspension model of a flexible spacecraft The single axis models consist of two, three, four, and five rigid bodies, each interconnected by a flexible shaft passing through the mass centers of the bodies Modal damping is added to each model Reduced state linear observers are developed for synthesizing the inaccessible modal state variables for each modal model M A C

N85-11381*# National Aeronautics and Space Administration, Washington, D C
MEASUREMENT OF THE INERTIAL CONSTANTS OF A RIGID OR FLEXIBLE STRUCTURE OF ARBITRARY SHARE THROUGH A VIBRATION TEST
D ENGRAND and J CORTIAL Aug 1983 23 p refs Transl into ENGLISH from La Rech Aerospatiale (France), no 4, Jul - Aug 1970 p 213-219 Original language doc previously announced in IAA as A70-41408 Transl by Kanner (Leo) Associates, Redwood City, Calif
(Contract NASW-3199)
(NASA-TM-77557, NAS 1 15 77557) Avail NTIS HC A02/MF A01 CSCL 20K

The inertial constants of an aircraft rocket, or of any other structure, are defined without materializing any rotating axis The necessary equipment is very similar to that used normally for ground vibration tests An elastic suspension is used to obtain the total natural modes corresponding to the motions of the structure as a solid From the measurements of the generalized masses of these modes it is possible to compute the inertial constants (1) center of inertia, (2) tensor of inertia, and (3) mass When the structure is not strictly rigid a purification process, based on the mean square method makes it possible to rigidify it at the price of some approximations and a few more measurements Eventual additional masses, that are not parts of the structure, can be taken into account M A C

N85-11382# State Univ of New York, Buffalo Buffalo Amherst Dept of Mechanical and Aerospace Engineering
QUALITATIVE RESULTS FOR DISTRIBUTED SYSTEMS WITH DISCRETE DAMPING AND STIFFNESS WITH APPLICATION TO CONTROL Interim Report, 1 Jul. 1983 - 30 Jun. 1984
D J INMAN 20 Jul 1984 9 p
(Contract AF-AFOSR-0242-82)
(AD-A145525, AFOSR-84-0724TR) Avail NTIS HC A02/MF A01 CSCL 20K

Distributed parameter models of large flexible space structures subject to various control techniques have been studied The main thrust has been to develop qualitative results which are independent of truncation or discretization approaches by treating the fully distributed model Emphasis has been on controlling the transient response of non-conservative linear partial differential equation models of such structures subject to a few point actuators
Author (GRA)

N85-12082# Communications Research Centre, Ottawa (Ontario) Space Technology and Applications Branch
DAMPING SYNTHESIS FOR A SPACECRAFT USING SUBSTRUCTURE AND COMPONENT DATA
K W LIPS and F R VIGERON Aug 1984 88 p refs
(CRC-1365) Avail NTIS HC A05/MF A01

A method for the synthesis of modal damping factors and other modal data for a spacecraft in orbit is demonstrated It is based on input information at the component/substructure level Also, the use of the method and the level of accuracy obtained is illustrated in a case study of the Hermes spacecraft The synthesis procedure is demonstrated for a spacecraft configuration consisting of a central rigid body, solar array substructures, a momentum wheel and a liquid mercury damping device The synthesized spacecraft modal data is obtained by eigenproblem analysis of a system model that is constructed from submodels of the components The system modes are the natural (unconstrained) modes with damping and gyroscopic stiffness accounted for Numerical experiments show that the procedure is not sensitive to errors in or to omission of damping factors of the higher order substructure modes Damping factors for the nutational mode are confirmed by an independent analysis Author

N85-12586*# National Aeronautics and Space Administration Goddard Space Flight Center, Greenbelt, Md
A USER'S GUIDE TO THE FLEXIBLE SPACECRAFT DYNAMICS AND CONTROL PROGRAM
J V FEDOR Jul 1984 151 p refs
(NASA-TM-87389, X-712-84-8, NAS 1 15 87389) Avail NTIS HC A08/MF A01 CSCL 09B

A guide to the use of the Flexible Spacecraft Dynamics Program (FSD) is presented covering input requirements, control words, orbit generation, spacecraft description and simulation options, and output definition The program can be used in dynamics and control analysis as well as in orbit support of deployment and control of spacecraft The program is applicable to inertially oriented spinning, Earth oriented or gravity gradient stabilized spacecraft Internal and external environmental effects can be simulated M G

N85-12931*# Allied Bendix Aerospace, Teterboro, N J Guidance Systems Div
AUTONOMOUS MOMENTUM MANAGEMENT FOR SPACE STATION Final Report, 1 Oct. 1983 - 31 Aug. 1984
E HAHN 15 Oct 1984 70 p refs
(Contract NAS8-35349)
(NASA-CR-174065, NAS 1 26 174065) Avail NTIS HC A04/MF A01 CSCL 22B

Momentum management for the CDG planar space platform is discussed It is assumed that the external torques on the space station are gravity gradient and aerodynamic, both have bias and cyclic terms The integrals of the cyclic torques are the cyclic momenti which will be stored in the momentum storage actuator Techniques to counteract the bias torques and center the cyclic momentum and gravity gradient desaturation by adjusting vehicle attitude, aerodynamic desaturation using solar panels and radiators and the deployment of flat plates at the end of long booms generating aerodynamic torques are investigated E A K

N85-13837 Stanford Univ , Calif
EXPERIMENTS IN CONTROL OF FLEXIBLE STRUCTURES WITH UNCERTAIN PARAMETERS Ph.D. Thesis
D ROSENTHAL 1984 180 p
Avail Univ Microfilms Order No DA8420612

Control requirements for large flexible space structures are difficult to meet in the presence of model uncertainty The control system is particularly sensitive to spacecraft properties when the sensor and actuator used for control are separated by structural flexibility, i e , they are noncolocated A laboratory structure was built which incorporates several aspects of the problem posed by large space structures (1) the laboratory system has extremely low damping ratios in the vibration modes, (2) the system is equipped with noncolocated sensor and actuator, (3) some of the system parameters can be changed abruptly while the system is under closed loop control The laboratory system provides a setting in which suitable control algorithms can be developed and tested, for providing control which is insensitive or robust to plant model errors Controllers were synthesized using gradient search programs Experimental results are presented which indicate the extent to which nominal performance must be traded off to achieve robustness These results are also compared to results that can be obtained using classical control theory and modern optimal control methods Dissert Abstr

N85-13839*# Control Dynamics Co., Huntsville, Ala
LEVEL OF EFFORT
In its Definition of Ground Test for Verification of Large Space Struct. Control p 2-13 Nov 1984 refs
Avail NTIS HC A08/MF A01 CSCL 22B

The generation of a planar model of the ground test experiment structure is examined. This was done by adapting an in-house modal analysis code (Gimbalflex) to allow placement of sensors and actuators at certain locations on the structure The next step in the development of this model was to adapt it for use with the control pole placement algorithm The uncontrollable rigid body mode was removed from the model This uncontrollable mode was due to the pointing of the gimbal Control system design for the planar model was also initiated A digital controller was planned utilizing the Control Pole Placement technique The existence of rate of state feedback was assumed Once this controller and other control algorithms were developed, it became necessary to conduct speed tests A study was then made of additional hardware/software necessary to meet the speed requirement
E R.

N85-13840*# Control Dynamics Co., Huntsville, Ala
ORAL PRESENTATION OF FIRST YEAR FINAL REPORT, APPENDIX A
In its Definition of Ground Test for Verification of of Large Space Struct Control 28 p Nov 1984
Avail NTIS HC A08/MF A01 CSCL 22B

Plans for self contained in-house capability to test Large Space Structures (LSS) and their control prior to flight are presented A ground test facility which demonstrates and validates LSS control theory is defined An experiment is designed which assures a high success rate for flight test A strapdown algorithm is developed Research on the astromast is reported, as is the development of an overall system model
E R

N85-13841*# Control Dynamics Co , Huntsville, Ala
SIMPLIFIED PLANAR MODEL OF GROUND TEST VERIFICATION STRUCTURE, APPENDIX B Monthly Progress Report, 1-31 Oct. 1982
In its Definition of Ground Test for Verification of Large Space Struct Control 2 p Nov 1984
Avail NTIS HC A08/MF A01 CSCL 22B

The planar version of the structure is shown for which a model was developed The model is 12th order including 6 structural modes One mode results from the base translation, one from the gimbal rotation, three from the flex characteristics of the Astromast Boom and gyro package, and one from the tether and tripod The model includes one input, one disturbance and one output which are a control torque at the gimbal, a translational force at the base, and the rotation rate of the Astromast tip, respectively
Author

N85-13842*# Control Dynamics Co , Huntsville, Ala
ELIMINATION OF UNCONTROLLABLE RIGID BODY MODE, APPENDIX C
In its Definition of Ground Test for Verification of Large Space Struct Control 6 p Nov 1984
Avail: NTIS HC A08/MF A01 CSCL 22B

The planar system model is examined which reveals two rigid body modes One is due to the pure translation of the whole experiment assembly and is uncontrollable because the only control input is a torque at the gimbal The other rigid body mode is due to the pointing of the gimbal and is the one for which control is sort. The problem arises from the Vector V2 which relates the control input to the modal coordinates Since its fifth and sixth elements are both nonzero, neither body mode can be thrown away as is The two rigid body modes must be transformed so that one is unaffected by the control input and one is left controllable The uncontrollable mode can then be eliminated from the model for design purposes A process is described to accomplish the elimination of the uncontrollable rigid body mode
E R

N85-13843*# Control Dynamics Co , Huntsville, Ala
SPEED TEST RESULTS AND HARDWARE/SOFTWARE STUDY OF COMPUTATIONAL SPEED PROBLEM, APPENDIX D
In its Definition of Ground Test for Verification of Large Space Struct Control 5 p Nov 1984
Avail NTIS HC A08/MF A01 CSCL 22B

The HP9845C is a desktop computer which is tested and evaluated for processing speed A study was made to determine the availability and approximate cost of computers and/or hardware accessories necessary to meet the 20 ms sample period speed requirements Additional requirements were that the control algorithm could be programmed in a high language and that the machine have sufficient storage to store the data from a complete experiment
E R

N85-13844*# Control Dynamics Co , Huntsville, Ala
SECTION 1. METHOD OF DETERMINING MODE SHAPES AND NATURAL FREQUENCIES OF THE NASA UNMODIFIED TEST STRUCTURE. SECTION 2. CONTINUOUS BEAM CLOSED FROM SOLUTION TO THE NASA-LSS ASTROMAST TORSIONAL VIBRATION, APPENDIX E
In its Definition of Ground Test for Verification of Large Space Struct Control 26 p Nov 1984
Avail NTIS HC A08/MF A01 CSCL 22B

The methods used to determine the lower natural frequencies and their corresponding mode shapes of the NASA-LSS Astromast (Unmodified Test Structure), and the mass integrals associated with the mode shapes are illustrated The test structure is modeled as a cantilever beam with 91 lumped masses and without the tip mass on the free end of the bram This uncouples the torsion and bending modes and allows for them to be determined separately The frequency range was limited to an upper bound of 100 rad/sec (15 92 Hz) In this range from 0 -100 rad/sec, three bending frequencies and one torsion frequency was found
Author

N85-13845*# Control Dynamics Co , Huntsville, Ala.
DEFINITION OF GROUND TEST FOR LARGE SPACE STRUCTURE (LSS) CONTROL VERIFICATION, APPENDIX G
In its Definition of Ground Test for Verification of Large Space Struct Control 44 p Nov 1984
Avail NTIS HC A08/MF A01 CSCL 22B

A Large Space Structure (LSS) ground test facility was developed to help verify LSS passive and active control theories The facility also perform (1) subsystem and component testing, (2) remote sensing and control, (3) parameter estimation and model verification, and (4) evolutionary modeling and control The program is examined as is and looks at the first experiment to be performed in the laboratory
E R

N85-13846*# Control Dynamics Co , Huntsville, Ala
REVIEW OF TECHNICAL PAPERS, APPENDIX H
In its Definition of Ground Test for Verification of Large Space Struct Control 10 p Nov 1984 refs
Avail NTIS HC A08/MF A01 CSCL 22B

Ten (10) papers reviewed deal directly with control systems of large space structures, such as observer designs or closed loop pole placement methods Of the ten papers there are three principle concepts treated observers, closed loop pole placement and a disturbance isolation technique Three of the ten papers were selected for critical review as they embodied the three basic concepts The objectives of the review were (1) Check and verify the equations and derivations, (2) Relate these new techniques to standards in the literature, (3) Identify strengths and weaknesses of the methods, and (4) Determine suitable topics for further study using these methods
Author

N85-13850*# National Aeronautics and Space Administration Langley Research Center, Hampton, Va
AN ASSESSMENT OF INTEGRATED FLYWHEEL SYSTEM TECHNOLOGY
C R KECKLER, ed , R T BECHTEL, ed (NASA Marshall Space Flight Center), and N J GROOM, ed Washington Nov 1984 419 p refs Workshop held in Huntsville, Ala , 7-9 Feb 1984 (NASA-CP-2346, L-15876, NAS 1 55 2346) Avail NTIS HC A18/MF A01 CSCL 10B

The current state of the technology in flywheel storage systems and ancillary components, the technology in light of future requirements, and technology development needs to rectify these shortfalls were identified Technology efforts conducted in Europe and in the United States were reviewed Results of developments in composite material rotors, magnetic suspension systems, motor/generators and electronics, and system dynamics and control were presented The technology issues for the various disciplines and technology enhancement scenarios are discussed A summary of the workshop, and conclusions and recommendations are presented

N85-13854*# Rockwell International Corp , Downey, Calif
DYNAMICS AND CONTROLS WORKING GROUP SUMMARY
R E OGLEVIE *In* NASA Langley Research Center An Assessment of Integrated Flywheel System Technol p 39-48 Nov 1984
Avail NTIS HC A18/MF A01 CSCL 10B

The technology status of the dynamics and controls discipline as it applies to energy storage wheel systems was evaluated No problems were identified for which an adequate solution could not be proposed Design issues that influence control were addressed The dynamics and control aspects associated with the energy storage system concept and its various constituent parts, and the control tasks attendant to large, manned spacecraft are discussed E A K

N85-14019# Rome Univ (Italy) Dipt Aerospaziale
ELASTIC DISPERSION EFFECTS ON DYNAMICS AND CONTROL OF LARGE MODULAR ANTENNAS
F GRAZIANI, S SGUBINI, and A AGNENI *In* ESA Workshop on Mech Technol for Antennas p 141-146 Sep 1984 refs
Avail NTIS HC A09/MF A01

The dispersion equation and the steady state harmonic response of a modular structure were analyzed to study elastic effects such as distortion and filtering on large space antennas The relations between the wave numbers and the frequencies were examined Due to the strong nonlinearity of these relations, phase velocity strongly depends on frequency, so that each harmonic of a wave packet travels with a different speed the packet shape disperses during the propagation (distortion effect) The relations can be linearized, yielding a nondispersive behavior, but only for very small wave numbers Being the eigenvalues related to the wave numbers, the natural frequencies (all belonging to the dispersion curves) tend to congregate (clustering effect) Gaps in the frequency range (stopping bands) for which no frequency corresponds to real wave number, do not allow propagation in these bands (filtering effect) Author (ESA)

N85-14020# European Space Agency European Space Research and Technology Center, ESTEC, Noordwijk (Netherlands)
STUDY OF STRUCTURE CONTROL DYNAMIC INTERACTION FOR RADIO FREQUENCY ANTENNA CONTROL SYSTEMS
D MUZI *In* ESA Workshop on Mech Technol for Antennas p 147-152 Sep 1984 refs
Avail NTIS HC A09/MF A01

Dynamic interaction between spacecraft flexible structural elements and control systems was investigated for a telecommunication satellite configuration Nonlinear time simulations of N/S stationkeeping maneuvers were performed to assess the impact of antenna inertia and flexible modes on the main body attitude control system Simulations were performed using the Dynamic and Control Analysis Package (DCAP), for antennas with diameters of 1 6 and 4 0 m The DCAP results indicate satisfactory performance for the main body and antenna pointing control loop for a small antenna structure with low mass and inertia For large antennas, antenna pointing mechanism stepping can make the antenna-satellite system unstable Author (ESA)

N85-14021# Teldix Luftfahrt-Ausruestungs G m.b H , Heidelberg (West Germany)
HEMISPHERICAL ANTENNA POINTING MECHANISM
W AUER and H SCHULZ *In* ESA Workshop on Mech Technol for Antennas p 153-157 Sep 1984
Avail NTIS HC A09/MF A01

A hemispherical pointing mechanism, including its drive and control electronics, was designed for spaceborne payloads of up to 30 kg, and 1 arcmin pointing accuracy It has 2 axes with a 45 deg (or higher) angle between them for hemispherical coverage Around the azimuth, a first member, which has a provision to turn a second member around an axis which is 45 deg inclined can be rotated A rotation around the latter axis changes elevation and azimuth The same elevation angle can be generated with an equally positive or negative rotational angle from the basic position, but with associated different azimuth angles This ambiguity can be easily resolved by allowing only, for instance, positive rotation between 0 and 90 deg Author (ESA)

N85-14856 Stanford Univ , Calif.
DISTURBANCE PROPAGATION IN STRUCTURAL NETWORKS; CONTROL OF LARGE SPACE STRUCTURES Ph.D. Thesis
A H VONFLOTOW 1984 160 p
Avail Univ Microfilms Order No. DA8420632

It is assumed that large space structures may be modelled as networks of slender structural members interconnecting massive bodies Several types of members are considered Truss-work members may be modelled by equivalent continuum models or by more exact methods based upon the transfer matrix of a single cell Members which are treated with continuum models may be uniform or have slow spatial variation Bodies are modelled as elastic, with a finite number of degrees of freedom The dynamics of such structures are described in two complementary ways A method is developed for deriving exact transcendental transfer functions for arbitrary network topology The network may include any number of members and bodies The method is tested on examples and is found to be computationally stable The dynamics of such structures are also investigated in the time domain via travelling wave mathematics Wave propagation on structural members is described in terms of wave-mode dispersion characteristics and impulse responses Dissert Abstr

N85-15772*# Smithsonian Astrophysical Observatory, Cambridge, Mass
THE INVESTIGATION OF TETHERED SATELLITE SYSTEM DYNAMICS Quarterly Report, 15 Aug. - 30 Nov. 1984
E LORENZINI Nov 1984 90 p refs
(Contract NAS8-36160)
(NASA-CR-171278, NAS 1 26 171278, QPR-1) Avail NTIS HC A05/MF A01 CSCL 22B

Tethered satellite system (TSS) dynamics were studied The dynamic response of the TSS during the entire stationkeeping phase for the first electrodynamic mission was investigated An out of plane swing amplitude and the tether's bowing were observed The dynamics of the slack tether was studied and computer code, SLACK2, was improved both in capabilities and computational speed Speed hazard related to tether breakage or plasma contactor failure was examined Preliminary values of the potential difference after the failure and of the drop of the electric field along the tether axis have been computed The update of the satellite rotational dynamics model is initiated E.A.K

N85-18078# National Aerospace Lab , Tokyo (Japan)
VIBRATION ANALYSIS OF A MULTIPURPOSE PLATFORM
T HANAWA, Y OHKAMI, E NAKAI, and T TADAKAWA Apr 1984 42 p refs In JAPANESE, ENGLISH summary
(NAL-TR-803, ISSN-0389-4010) Avail NTIS HC A03/MF A01

Some results are presented of the vibration analysis for simplified models of a multipurpose geostationary platform For the detailed analysis, the finite element method is widely used, but in a preliminary analysis the method described here is also useful since it is computationally tractable and easy to handle although there are constraints on the configuration complexity. A mission model is described for the proposed platform containing six missions of communication and broadcasting Launch sequences and deployments of the platform, and mass and inertia properties of the constitutent modules are briefly explained The analysis procedure is presented together with the simplifing assumptions and the main results The analysis are performed not only for the final platform of cross type and T-letter configuration but also for the interim stages of construction. The results are shown in figures with numerical tables Author

N85-18360 Virginia Polytechnic Inst and State Univ , Blacksburg
IDENTIFICATION OF VIBRATION PARAMETERS OF FLEXIBLE STRUCTURES Ph.D. Thesis
S RAJARAM 1984 134 p
Avail Univ Microfilms Order No. DA8421888

Several identification methods to determine the best estimates of higher order strucutral models directly from on-orbit vibration experiments are examined The methods presented are relatively immune to the presence of many low frequency modes with repeated or closely spaced natural frequencies, damping, and very high dimensionality. A time domain identification method using transient response, a steady state response method, and mass and stiffness parameters of a vibrating system from measured eigenvalues and eigenvectors were studied All the methods are demonstrated via example problems Numerical results are presented to study the effects of several implementation issues Dissert Abstr

N85-18378*# National Aeronautics and Space Administration Marshall Space Flight Center, Huntsville, Ala
KEYNOTE ADDRESS
R S RYAN *In* Shock and Vibration Information Center The Shock and Vibration Bull 54, Pt 1 p 3-21 Jun 1984 refs
Avail SVIC, Code 5804, Naval Research Lab , Washington, D C 20375 CSCL 20K

Shock and vibration research relative to manned spacecraft is surveyed Past, present, and future research projects are discussed Dynamic response, structural modeling, rotor dynamics, reliability, large space sttructures, and testing are among the topics discussed R J F

N85-18998*# National Aeronautics and Space Administration Marshall Space Flight Center, Huntsville, Ala
NASA-VCOSS DYNAMIC TEST FACILITY
H B WAITES, S M SELTZER (Control Dynamics Co), and G B DOANE, III Feb 1985 21 p refs
(NASA-TM-86491; NAS 1 15 86491) Avail NTIS HC A02/MF A01 CSCL 14B

The Large Space Structure Ground Test Facility under development at the NASA Marshall Space Flight Center in Huntsville, Alabama is described The Ground Test Facility was established initially to test experimentally the control system to be used on the Solar Array flight Experiment. The structural dynamics of the selected test article were investigated, including the fidelity of the associated mathematical model The facility must permit the investigation of structural dynamics phenomena and be able to evaluate candidate attitude control and vibration suppression techniques B W

N85-19012*# Martin Marietta Aerospace, Denver, Colo
OPERATIONAL FITNESS OF BOX TRUSS ANTENNAS IN RESPONSE TO DYNAMIC SLEWING Final Report
E E BACHTELL, S S BETTADAPUR, W A SCHARTEL, and L. A. KARANIAN Jan 1985 100 p
(Contract NAS1-17551)
(NASA-CR-172470; NAS 1 26 172470; MCR-84-594) Avail NTIS HC A05/MF A01 CSCL 22B

A parametric study was performed to define slewing capability of large satellites along with associated system changes or subsystem weight and complexity impacts The satellite configuration and structural arrangement from the Earth Observation Spacecraft (EOS) study was used as the baseline spacecraft Varying slew rates, settling times, damping, maneuver frequencies, and attitude hold times provided the data required to establish applicability to a wide range of potential missions The key elements of the study are (1) determine the dynamic transient response of the antenna system, (2) calculate the system errors produced by the dynamic response, (3) determine if the antenna has exceeded operational requirements at completion of the slew, and if so, (4) determine when the antenna has settled to the operational requirements The slew event is not considered complete until the antenna is within operational limits Author

N85-19014*# National Aeronautics and Space Administration Marshall Space Flight Center, Huntsville, Ala
ACTIVE CONTROL OF LARGE SPACE STRUCTURES: AN INTRODUCTION AND OVERVIEW
G B DOANE, III, D K TOLLISON, and H B WAITES Feb 1985 11 p refs
(NASA-TM-86490, NAS 1 15 86490) Avail NTIS HC A02/MF A01 CSCL 22B

An overview of the large space structure (LSS) control system design problem is presented The LSS is defined as a class of system, and LSS modeling techniques are discussed. Model truncation, control system objectives, current control law design techniques, and particular problem areas are discussed Author

N85-20368*# National Aeronautics and Space Administration Lewis Research Center, Cleveland, Ohio
REPORT OF THE CONSTELLATIONS PANEL
D J BENTS, G VONTIESENHAUSEN (NASA Marshall Space Flight Center), C A LUNDQUIST (Alabama Univ , Huntsville), P SWAN (California Univ , Los Angeles), H L MAYER (Aerospace Corp), M J MANGANO (JPL, California Inst of Tech , Pasadean), S BERGAMASUI (Padua Univ), F BEVILACQUA (Aeritalia), F WILLIAMS (Martin Marietta, New Orleans), G RUM (CNR, Italy) et al *In* NASA Marshall Space Flight Center Appl of Tethers in Space, Vol 2 16 p Mar 1985
Avail NTIS HC A14/MF A01 CSCL 13I

The purpose of a constellation is to provide a mode of distributing space systems in a method that could be advantageous and not eliminating the consolidation/aggregation advantages The applicability of stabilization concepts to various orbital conditions was defined B G

N85-20373*# National Aeronautics and Space Administration Goddard Space Flight Center, Greenbelt, Md
APPLICATION NUMBER 3: USING TETHERS FOR ATTITUDE CONTROL
R M MULLER *In* NASA Marshall Space Flight Center Appl of Tethers in Space, Vol 2 10 p Mar 1985
Avail NTIS HC A14/MF A01 CSCL 13I

Past application of the gravity gradient concept to satellite attitude control produced attitude stabilities of from 1 to 10 degrees The satellite members were rigigly interconnected and any motion in one part of the satellite would cause motion in all members This experience has restricted gravity gradient stabilization to applications that need attitude stability no better than 1 degree A gravity gradient technique that combines the flexible tether with an active control that will allow control stability much better than 1 degree is proposed This could give gravity gradient stabilization much broader application In fact, for a large structure like a space

station, it may become the preferred method Two possible ways of demonstrating the techniques using the Tethered Satellite System (TSS) tether to control the attitude of the shuttle are proposed Then a possible space station tether configuration is shown that could be used to control the initial station It is then shown how the technique can be extended to the control of space stations of virtually any size G L C

N85-21235# Wright State Univ , Dayton, Ohio
MODAL CONTROL OF STRUCTURAL SYSTEMS Final Report, Jun. - Sep. 1983
D F MILLER and W R WELLS Wright-Patterson AFB, Ohio AFWAL Nov 1984 32 p
(Contract F33615-83-C-3000)
(AD-A149734, AFWAL-TR-84-3054) Avail NTIS HC A03/MF A01 CSCL 13M

There is much interest in the practical control of large space structures such as space transportation systems and large communication satellites The control task is normally thought of in terms of maintaining specified shape configurations, orientation and alignment, vibration suppression and pointing accuracy, etc Because of their inherent flexibility, they are generally analyzed as distributed parameter systems which creates difficulties in the design and analysis of controllers for them Modal control techniques have been developed to bypass problems associated with distributed parameter theory Modal control is built upon the notion that certain specified system modes can be controlled by appropriate design of the associated closed-loop eigenvalues This reduces the number of sensors and actuators needed to effect the control of the structure An undesirable phenomenon, referred to as observation and control spillover, can occur if the number of sensors and actuators used is small Spillover refers to the phenomenon in which energy intended to go solely into the controlled modes leaks into the uncontrolled modes This report discusses the control of flexible systems described by a generalized one-dimensional wave equation which relates the structure displacement to the force distribution acting on the structure Optimal control involving the minimization of a quadratic performance index representing control and modal energy content is considered Typically this control formulation leads to a state feedback algorithm GRA

N85-21247 Communications Research Centre, Ottawa (Ontario) Space Technology and Applications Branch
STABILITY ANALYSIS OF FLEXIBLE SPACECRAFT WITH PID CONTROLLER
J DELAFONTAINE Nov 1984 59 p refs
(CRC-1372) Avail Issuing Activity

A graphical method for the design and analysis of a flexible spacecraft controller is presented It can handle as many modes as desired, in constrained or unconstrained form, modal separability is not assumed and the method is exact when the spacecraft axes are uncoupled The definition of a system function, independent of the controller parameters, simplifies the determination of the system stability boundaries It also allows the investigation of the modal separability assumption, resulting in a criterion for its validity Stabilization through structural damping and flexible modes filtering is illustrated using graphs of the system function Closed-form approximations are derived in order to complement the exact, numerical method Extensions to systems with loop delay and nonlinear elements are also included along with applications to the LSAT-1 Roll axis Author

N85-21248*# National Aeronautics and Space Administration Marshall Space Flight Center, Huntsville, Ala
NASA/MSFC GROUND EXPERIMENT FOR LARGE SPACE STRUCTURE CONTROL VERIFICATION
H B WAITES, S M SELTZER (Control Dyamics Co), and D K TOLLISON (Control Dynamics Co) Dec 1984 24 p refs Previously announced in IAA as A85-19528
(NASA-TM-86496, NAS 1 15 86496) Avail NTIS HC A02/MF A01 CSCL 22B

Marshall Space Flight Center has developed a facility in which closed loop control of Large Space Structures (LSS) can be demonstrated and verified The main objective of the facility is to verify LSS control system techniques so that on orbit performance can be ensured The facility consists of an LSS test article which is connected to a payload mounting system that provides control torque commands It is attached to a base excitation system which will simulate disturbances most likely to occur for Orbiter and DOD payloads A control computer will contain the calibration software, the reference system, the alignment procedures, the telemetry software, and the control algorithms The total system will be suspended in such a fashion that LSS test article has the characteristics common to all LSS Author (IAA)

N85-21249*# National Aeronautics and Space Administration Marshall Space Flight Center, Huntsville, Ala
DEFINITION OF GROUND TEST FOR LARGE SPACE STRUCTURE (LSS) CONTROL VERIFICATION
H B WAITES, G B DOANE, III (Control Dynaics Co), and D K TOLLISON (Control Dynamics Co) Nov 1984 36 p
(NASA-TM-86495, NAS 1 15 86495) Avail NTIS HC A03/MF A01 CSCL 22B

An overview for the definition of a ground test for the verification of Large Space Structure (LSS) control is given The definition contains information on the description of the LSS ground verification experiment, the project management scheme, the design, development, fabrication and checkout of the subsystems, the systems engineering and integration, the hardware subsystems, the software, and a summary which includes future LSS ground test plans Upon completion of these items, NASA/Marshall Space Flight Center will have an LSS ground test facility which will provide sufficient data on dynamics and control verification of LSS so that LSS flight system operations can be reasonably ensured Author

N85-21253# Control Dynamics Co , Huntsville, Ala
ACOSS 17 (ACTIVE CONTROL OF SPACE STRUCTURES) Final Technical Report, 1 Feb. 1982 - 31 Jan. 1984
S M SELTZER, H E WORLEY, J R GLAESE, M L BUTLER, V L JONES, and D K TOLLISON Griffiss AFB, N Y RADC Sep 1984 266 p
(Contract F30602-82-C-0053, ARPA ORDER 3654, AF PROJ 3654)
(AD-A150007, CDC-0330284TR-DA09-AC004, RADC-TR-84-186) Avail NTIS HC A12/MF A01 CSCL 22B

This is the Control Dynamics Company final technical report on extended analysis and evaluation of the Control Techniques of Large Space Structures The research effort was primarily aimed at mathematical model development and control systems analysis and design tool development Additional keywords, Spacecraft, Structural mechanics, Experimental design, Control theory, Stability, Damping, Cost analysis, Line of sight, Computations, Flow charting, Computer aided design GRA

06

ELECTRONICS

Includes techniques for power and data distribution, antenna RF performance analysis, communications systems, and spacecraft charging effects

A85-13040*# Jet Propulsion Lab, California Inst of Tech, Pasadena
NASA'S MOBILE SATELLITE COMMUNICATIONS PROGRAM; GROUND AND SPACE SEGMENT TECHNOLOGIES
F NADERI, W J WEBER (California Institute of Technology, Jet Propulsion Laboratory, Pasadena, CA), and G. H KNOUSE (NASA, Washington, DC) International Astronautical Federation, International Astronautical Congress, 35th, Lausanne, Switzerland, Oct. 7-13, 1984 13 p NASA-supported research refs
(IAF PAPER 84-84)

This paper describes the Mobile Satellite Communications Program of the United States National Aeronautics and Space Administration (NASA) The program's objectives are to facilitate the deployment of the first generation commercial mobile satellite by the private sector, and to technologically enable future generations by developing advanced and high risk ground and space segment technologies These technologies are aimed at mitigating severe shortages of spectrum, orbital slot, and spacecraft EIRP which are expected to plague the high capacity mobile satellite systems of the future After a brief introduction of the concept of mobile satellite systems and their expected evolution, this paper outlines the critical ground and space segment technologies Next, the Mobile Satellite Experiment (MSAT-X) is described MSAT-X is the framework through which NASA will develop advanced ground segment technologies An approach is outlined for the development of conformal vehicle antennas, spectrum and power-efficient speech codecs, and modulation techniques for use in the non-linear faded channels and efficient multiple access schemes Finally, the paper concludes with a description of the current and planned NASA activities aimed at developing complex large multibeam spacecraft antennas needed for future generation mobile satellite systems Author

A85-13066#
FACTORS AFFECTING PUSH-BROOM PERFORMANCES IN FUTURE SPACE PLATFORMS
S VETRELLA and A MOCCIA (Napoli, Universita, Naples, Italy) International Astronautical Federation, International Astronautical Congress, 35th, Lausanne, Switzerland, Oct. 7-13, 1984 8 p Research supported by the Consiglio Nazionale delle Ricerche and Ministero della Pubblica Istruzione refs
(IAF PAPER 84-116)

This paper discusses a simulation computer program to evaluate different aspects of a remote sensing platform, with particular reference to a push-broom high resolution system The procedure takes into account the satellite orbital geometry and attitude, the sensor geometric and radiometric characteristics, the digital terrain model, the atmospheric refraction and absorption and the solar illumination Each factor is described with equations and examples in order to identify the principal constraints that affect push-broom performances in future high geometric and radiometric resolution systems Author

A85-13177#
ENGINEERING ASPECT OF THE MICROWAVE IONOSPHERE NONLINEAR INTERACTION EXPERIMENT (MINIX) WITH A SOUNDING ROCKET
M. NAGATOMO (Tokyo, University, Tokyo, Japan), N KAYA (Kobe University, Kobe, Japan), and H MATSUMOTO (Kyoto University, Kyoto, Japan) International Astronautical Federation, International Astronautical Congress, 35th, Lausanne, Switzerland, Oct 7-13, 1984 9 p
(IAF PAPER 84-289)

One type of problem arising in connection with an evaluation of the feasibility of the Solar Power Satellite (SPS) and the definition of suitable SPS designs is related to environmental issues Questions exist, for instance, regarding the interaction between microwave power and the upper atmosphere The present investigation is concerned with the Microwave Ionosphere Nonlinear Interaction Experiment (MINIX), which is a space plasma experiment originally devoted to the research of space plasma physics MINIX is eventually to observe possible effects of a strong microwave field in the ionospheric environment The scientific requirements of the MINIX are discussed, taking into account functional and experimental conditions Attention is also given to rocket characteristics, experimental design, the payload, the inflight experiment configuration, and details concerning the conduction of the experiment G R

A85-13224#
ATTITUDE CONTROL SYSTEM AND COMMUNICATIONS PAYLOAD FOR AN AMATEUR SOLAR SAIL SPACECRAFT
T WILLIAMS (Kingston Polytechnic, Kingston upon Thames, England) and P COLLINS (Imperial College of Science and Technology, London, England) International Astronautical Federation, International Astronautical Congress, 35th, Lausanne, Switzerland, Oct 7-13, 1984 13 p refs
(IAF PAPER 84-363)

This paper describes work performed in continuation of the British Solar Sail Group project to produce a Phase A Design Study for an earth-orbiting, solar sail spacecraft which might realistically be produced by an amateur group It is shown in this paper that the possible disturbance torques acting on a such a spacecraft are different from those experienced by more conventional vehicles, and that they can greatly outweigh the nominal control torques required for optimal steering Thus, these disturbances must be analyzed carefully as a preliminary to serious control system design This paper carries out such an analysis giving bounds on each such disturbance The number of different types of solar pressure-based control actuators is then shown to be greater than is generally believed, and a particularly attractive set chosen for this spacecraft Finally, it is shown that it is feasible to provide a reliable radio link from a ground station to the spacecraft at the distance of the moon within the constraints of an amateur project Author

A85-13640#
SAMPLED DATA CONTROL OF FLEXIBLE STRUCTURES USING CONSTANT GAIN VELOCITY FEEDBACK
N H MCCLAMROCH (Michigan, University, Ann Arbor, MI) Journal of Guidance, Control, and Dynamics (ISSN 0731-5090), vol 7, Nov -Dec. 1984, p 747-750 Research supported by the University of Michigan refs
(Contract F49620-82-C-0089)

A sampled data-controlled flexbile structure can be defined as a distributed parameter system, in which the structure input is the output of an ideal zero order hold and the structure output is sampled The present investigation is concerned with the finite dimensional model M x(two dots) + K x = B u (1) y = C x(dot) (2) The relations include the structural displacement vector x, the force input vector u, and the velocity output vector y The mass matrix M and the structural stiffness matrix K are assumed symmetric and positive definite The input influence matrix B and the output influence matrix C are assumed to be dimensionless Attention is given to several results which can serve as guidelines

for choice of feedback gains and sampling time to guarantee that a sampled data-controlled structure is stable G R

A85-14430
REPORT OF THE STUDENT WORKING GROUP TO THE PANEL ON SATELLITE COMMUNICATIONS
J HANWECK (Madison High School, Vienna, VA) IN EASCON '83, Proceedings of the Sixteenth Annual Electronics and Aerospace Conference and Exposition, Washington, DC, September 19-21, 1983 . New York, Institute of Electrical and Electronics Engineers, 1983, p 27-32

Conclusions drawn by a high school panel regarding applications of space capabilities are reported Weather satellites should be equipped with communications systems for automated severe weather and natural disaster warning systems An internationally oriented system of satellites for air and marine navigational data is required, as are DBS television satellites beaming signals to dwellings with low-cost antennas, and military systems employing all available and some specialized systems Research is required to identify practical alternatives to solar cells for powering spacecraft, frequency use must be made a finer discipline through digital systems, polarization studies to control atmospheric effects, and defining the HF range at which ionization would become a hazard The cost of individual earth stations must be reduced, while satellites must be funded by innovative means, e.g , common stock or through quasi-charitable donations Galaxies of intercommunicating satellites in GEO would permit larger scale missions to be flown, and manned space colonies in LEO, GEO and on the moon would support all R and D activities, industrialization, and exploitation of interplanetary resources M S K

A85-15760
EFFECT OF PHASE FLUCTUATIONS IN AN INCIDENT BEAM ON THE CHARACTERISTICS OF A RECTENNA SYSTEM [O VLIIANII FLUKTUATSII FAZY V PADAIUSHCHEM LUCHE NA KHARAKTERISTIKI REKTENNOI SISTEMY]
G P BOIAKHCHIAN, V A VANKE, and S K LESOTA Radiotekhnika (ISSN 0033-8486), Sept 1984, p 74-76 In Russian refs

The paper presents a theoretical study of the effects of the phase fluctuations of a microwave beam over its cross section as it is transmitted on a space-to-ground path on the characteristics of the rectenna system, particularly the efficiency and the width of the radiation pattern The phase fluctuations are shown to have a significant effect on the rectenna system when the radius of the spatial correlation of the field over the beam cross section is less than 25 times the wavelength The results are pertinent to the study of microwave power transmission in solar satellite power systems. L M

A85-15800* Cleveland State Univ , Ohio
NEAR-OPTIMUM DESIGN OF GAAS-BASED CONCENTRATOR SPACE SOLAR CELLS FOR 80 C OPERATION
C GORADIA, M GHALLA-GORADIA (Cleveland State University, Cleveland, OH), and H CURTIS (NASA, Lewis Research Center, Cleveland, OH) Applied Physics Communications (ISSN 0277-9374), vol 4, no 2-3, 1984, p 97-119 NASA-supported research refs

Using a detailed computer simulation model and reasonable values of optical, geometrical and material parameters from current published literature, parameter optimization studies were performed on two cell geometries, namely, the circular geometry for a Cassegrainian concentrator with 100 AM0, 80 C operation and the rectangular geometry for a venetian blind concentrator with 20 AM0, 80 C operation For each cell geometry, three cell configurations were considered p/n AlGaAs/GaAs, n/p AlGaAs/GaAs, and, n/p GaAs shallow homojunction The studies show the possibility of designing GaAs-based space solar cells with beginning-of-life efficiencies exceeding 22 percent at 20 to 100 AM0, 80 C and probable efficiency degradation of less than 15 percent after a 70 percent reduction in diffusion length in each cell region Author

A85-15812* Jet Propulsion Lab , California Inst of Tech , Pasadena
NUCLEAR-ELECTRIC POWER IN SPACE
V C. TRUSCELLO and H S DAVIS (California Institute of Technology, Jet Propulsion Laboratory, Pasadena, CA) IEEE Spectrum (ISSN 0018-9235), vol 21, Dec 1984, p 58-65

Prospective missions requiring large power supplies that might be satisfied with space nuclear reactors (SNR) are discussed, along with design concepts and problems and other potential high-power space systems Having a minimum economic output of 10 kWe, SNR seem well-suited as the power sources for DBS systems, space-based ATC systems manned planetary missions, an expanding Space Station, materials processing, and outer planets missions SNR avoid the large area problems of solar cell arrays, short lifetimes of thermionic converters, and vibration and heat control in Stirling engines Design problems exist for SNR in the heat transfer and rejection systems, radioactive emissions and degradation of reactor materials, and size The latter is a function of Shuttle payload constaints and raises the possibility of having to load the fuel while in orbit The earliest operational date of SNRs is projected for the early 1990s, if progress is good in the current SP-100 program M S K

A85-16081
ANTENNA ENGINEERING HANDBOOK /2ND EDITION/
R C JOHNSON, ED (Geogia Institute of Technology, Atlanta, GA) and H JASIK, ED (Eaton Corp , AIL Div , Deer Park, NY) New York, McGraw-Hill Book Company, 1984, 1356 p No individual items are abstracted in this volume

Essential principles, methods, and data for solving a wide range of problems in antenna design and application are presented The basic concepts and fundamentals of antennas are reviewed, followed by a discussion of arrays of discrete elements Then all primary types of antennas currently in use are considered, providing concise descriptions of operating principles, design methods, and performance data Small antennas, microstrip antennas, frequency-scan antennas, conformal and low-profile arrays, adaptive antennas, and phased arrays are covered The major applications of antennas and the design methods peculiar to those applications are discussed in detail The employment of antennas to meet the requirements of today's complex electronic systems is emphasized, including earth station antennas, satellite antennas, seeker antennas, microwave-relay antennas, tracking antennas, radiometer antennas, and ECM and ESM antennas Finally, significant topics related to antenna engineering, such as transmission lines and waveguides, radomes, microwave propagation, and impedance matching and broadbanding, are addressed Author

A85-16641
EARTH'S MAGNETIC FIELD PERTURBATIONS AS THE POSSIBLE ENVIRONMENTAL IMPACT OF THE CONCEPTUALIZED SOLAR POWER SATELLITE
M C LEE (Regis College, Weston, MA) and S P KUO (New York, Polytechnic Institute, Farmingdale, NY) Journal of Geophysical Research (ISSN 0148-0227), vol 89, Dec 1, 1984, p 11043-11047 refs
(Contract F19628-83-K-0024, NSF ATM-83-15322, AF-AFOSR-83-0001)
(AD-A149120, AFGL-TR-84-0334)

It is predicted that the earth's magnetic field can be significantly perturbed locally by a microwave beam transmitted from the conceptualized solar power satellite (SPS) at a frequency of 2 45 GHz with incident power density of 230 W/per sq m at the center of the beam The simultaneous excitation of earth's magnetic field fluctuations and ionospheric density irregularities is caused by the thermal filamentation instability of microwaves with scale lengths greater than a few hundred meters Earth's magnetic field perturbations with magnitudes (a few tens of gammas) comparable to those in magnetospheric substorms can be expected Particle precipitation and airglow enhancement are the possible, concomitant ionospheric effects associated with the microwave-induced geomagnetic field fluctuations The present

work adds earth's magnetic field perturbations as an additional effect to those such as ionospheric density irregularities, plasma heating, etc, that should be assessed as the possible environmental impacts of the conceptualized solar power satellite proram Author

A85-18584* Hughes Aircraft Co., El Segundo, Calif
ENVIRONMENTALLY-INDUCED VOLTAGE LIMITATIONS IN LARGE SPACE POWER SYSTEMS
N J. STEVENS (Hughes Aircraft Co, El Segundo, CA) (IEEE, U S Defense Nuclear Agency, U S Department of Energy, and NASA, Annual Conference on Nuclear and Space Radiation Effects, 21st, Colorado Springs, CO, July 23-25, 1984) IEEE Transactions on Nuclear Science (ISSN 0018-9499), vol NS-31, Dec 1984, p 1381-1386 refs
(Contract NAS3-23869)

Large power systems proposed for future space missions imply higher operating voltage requirements which, in turn, will interact with the space plasma environment The effects of these interactions can only be inferred because of the limited data base of ground simulations, small test samples, and two space flight experiments This report evaluates floating potentials for a 100 kW power system operating at 300, 500, 750, and 1000 volts in relation to this data base Of primary concern is the possibility of discharging to space The implications of such discharges were studied at the 500 volt operational setting. It was found that discharging can shut down the power system if the discharge current exceeds the array short circuit current Otherwise, a power oscillation can result that ranges from 2 to 20 percent, depending upon the solar array area involved in the discharge Means of reducing the effect are discussed Author

A85-18608* National Aeronautics and Space Administration Lewis Research Center, Cleveland, Ohio
CHARACTERISTICS OF ARC CURRENTS ON A NEGATIVELY BIASED SOLAR CELL ARRAY IN A PLASMA
D B SNYDER (NASA, Lewis Research Center, Cleveland, OH) (IEEE, U S Defense Nuclear Agency, U S Department of Energy, and NASA, Annual Conference on Nuclear and Space Radiation Effects, 21st, Colorado Springs, CO, July 23-25, 1984) IEEE Transactions on Nuclear Science (ISSN 0018-9499), vol NS-31, Dec 1984, p 1584-1587 Previously announced in STAR as N84-27824 refs

The time dependence of the emitted currents during arcing on solar cell arrays is being studied The arcs are characterized using three parameters the voltage change of the array during the arc (i e, the charge lost), the peak current during the arc, and the time constant describing the arc current This paper reports the dependence of these characteristics on two array parameters, the interconnect bias voltage and the array capacitance to ground It was found that the voltage change of the array during an arc is nearly equal to the bias voltage The array capacitance, on the other hand, influences both the peak current and the decay time constant of the arc Both of these characteristics increase with increasing capacitance Author

A85-19695*# Rockwell International Corp, Downey, Calif.
INTEGRATED POWER AND ATTITUDE CONTROL SYSTEMS FOR SPACE STATION
R. E. OGLEVIE (Rockwell International Corp, Space Station Systems Div, Downey, CA) and D. B EISENHAURE (Charles Stark Draper Laboratory, Inc, Cambridge, MA) American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 23rd, Reno, NV, Jan 14-17, 1985 13 p Research sponsored by the Rockwell International Corp and Charles Stark Draper Laboratory, Inc refs
(Contract NAS1-17633)
(AIAA PAPER 85-0358)

Integrated Power and Attitude Control Systems (IPACS) studies performed over a decade ago established the feasibility of simultaneously storing electrical energy in wheels and utilizing the resulting momentum for spacecraft attitude control. It was shown that such a system possessed many advantages over other contemporary energy storage and attitude control systems in many applications More recent technology advances in composite rotors, magnetic bearings, and power control electronics have triggered new optimism regarding the feasibility and merits of such a system The paper presents the results of a recent study whose focus was to define an advanced IPACS and to evaluate its merits for the Space Station application A system and component design concept is developed to establish the system performance capability A system level trade study, including life-cycle costing, is performed to define the merits of the system relative to two other candidate systems It is concluded that an advanced IPACS concept is not only feasible, but offers substantial savings in mass, and life-cycle cost Author

A85-19713*# National Aeronautics and Space Administration Lewis Research Center, Cleveland, Ohio
THE EFFECT OF PLASMA ON SOLAR CELL ARRAY ARC CHARACTERISTICS
D B SNYDER (NASA, Lewis Research Center, Cleveland, OH) and E TYREE (NASA, Lewis Research Center, Case Western Reserve University, Cleveland, OH) American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 23rd, Reno, NV, Jan 14-17, 1985 10 p Previously announced in STAR as N85-11133 refs
(AIAA PAPER 85-0384)

The influence from the ambient plasma on the arc characteristics of a negatively biased solar cell array was investigated The arc characteristics examined were the peak current during an arc, the decay time as the arc terminates, and the charge lost during the arc These arc characteristics were examined in a nitrogen plasma with charge densities ranging from 15,000 to 45,000 cu cm Background gas pressures ranged from 8x1,000,000 to 6x100,000 torr Over these ranges of parameters no significant effect on the arc characteristics were seen Arc characteristics were also examined for three gas species helium, nitrogen and argon The helium arcs have higher peak currents and shorter decay times than nitrogen and argon arcs There are slight differences in the arc characteristics between nitrogen and argon. These differences may be caused by the differences in mass of the respective species Also, evidence is presented for an electron emission mechanism appearing as a precursor to solar array arcs Occasionally the plasma generator could be turned off, and currents could still be detected in the vacuum system When these currents are presented, arcs may occur Author

A85-21835#
PRECISION OF MESH-TYPE REFLECTORS FOR LARGE SPACE-BORNE ANTENNAS
R X MEYER (Aerospace Corp, El Segundo, CA) (Structures, Structural Dynamics and Materials Conference, 23rd, New Orleans, LA, May 10-12, 1982, Collection of Technical Papers Part 1, p 60-65) Journal of Spacecraft and Rockets (ISSN 0022-4650), vol 22, Jan-Feb 1985, p 80-84 Previously cited in issue 13, p. 2029, Accession no A82-30083
(Contract F04701-81-C-0082)

A85-23651* Illinois Univ, Urbana
SATELLITE COMMUNICATION ANTENNA TECHNOLOGY
R MITTRA, ED (Illinois, University, Urbana, IL), W A IMBRIALE, ED (California Institute of Technology, Jet Propulsion Laboratory, Pasadena, CA), and E J MAANDERS, ED (Eindhoven, Technische Hogeschool, Eindhoven, Netherlands) Amsterdam, North-Holland, 1983, 667 p For individual items see A85-23652 to A85-23663

A general overview of current technology in the field of communication satellite antennas is presented. Among the topics discussed are the design of multiple beam systems, frequency reuse, and polarization control of antenna measurements Consideration is also given to contour beam synthesis, dual shaped reflector synthesis, beam shaping, and offset reflector design The applications of the above technologies to present and future generations of communications satellites is considered, with emphasis given to such systems as the Intelsats, the Defense

Satellite Communications System, (DSCS-III), Satellite Business System (SBS), and Comstar I H

A85-23652
THE SYSTEMS BACKGROUND FOR SATELLITE COMMUNICATION ANTENNAS
J C ARNBAK (Eindhoven, Technische Hogeschool, Eindhoven, Netherlands) IN Satellite communication antenna technology Amsterdam, North-Holland, 1983, p 1-51 refs

The major elements of the operational environment of satellite communication antennas are reviewed, including perturbations and stationkeeping in the geostationary orbit, antenna tracking on earth-satellite links, earth-terminal off-axis limitations, satellite link budgets, multiple access and satellite antennas, and the specification of satellite antennas Also given are definitions and formulas which are intended to provide general guidance and show major constraints relevant at all stages of antenna engineering for satellite systems Two main trends in satellite communication antenna technology are noted (1) an increasing impact of general system requirements on the specific design and operational exploitation of antennas in satellite systems, and (2) more emphasis on adaptive, flexible, or multipurpose antenna systems B J

A85-25101
SKY-HOOKS, FISH-WARMERS AND HUB-CAPS - MILESTONES IN SATELLITE COMMUNICATIONS
A W RUDGE (ERA Technology, Ltd , Leatherhead, Surrey, England) IEE Proceedings, Part F - Communications, Radar and Signal Processing (ISSN 0143-7070), vol 132, pt F, no 1, Feb 1985, p 1-12 refs

The present discussion is concerned with the origin of satellite communications, its development and current status, and predictions regarding its future The feasibility of such a communication system had been foreseen by Clarke (1945), who first recognized the peaceful potential of German rocketry, combined with the use of the geostationary orbit, as a basis for a worldwide communication system After the launching of 'Sputnik', Clarke's concept of a 'sky-hook' was first implemented in 1964 with the experimental satellite Syncom The founding of the International Telecommunications Satellite Organization (Intelsat) occurred in the same year Attention is given to the various satellites of Intelsat with their increasing technological capabilities, the satellite industry in North America, developments in the USSR, the situation in the UK and in Western Europe, and advancements in spacecraft technology made by Japan, China, and the world at large Details of spacecraft technology are considered along with ground stations G R

A85-25359* National Aeronautics and Space Administration Langley Research Center, Hampton, Va
WAVELENGTH DIVISION MULTIPLEXING FOR FUTURE SPACE STATION DATA SYSTEMS
H D HENDRICKS and N D MURRAY (NASA, Langley Research Center, Hampton, VA) IN Fiber optics in local area networks, Proceedings of the Meeting, San Diego, CA, August 25, 1983 Bellingham, WA, SPIE - The International Society for Optical Engineering (SPIE Proceedings Volume 434), 1983, p 41-49 refs

A future Space Station will require information network architectures and technologies that are evolvable, adaptive, high performing, and self-correcting and repairing One of the conceptual network configurations involves fiber optic data buses with Wavelength Division Multiplexing (WDM) Discussion of this network concept, components being developed and results on a four-channel WDM star bus will be presented Author

A85-26685
A PLAN FOR CONTROLLING ELECTROSTATIC DISCHARGES ON GEOSYNCHRONOUS SPACECRAFT
K J DEGRAFFENREID and R C EVANS (TRW, Inc , TRW Space and Technology Group, Redondo Beach, CA) IN International Symposium on Electromagnetic Compatibility, 25th, Arlington, VA, August 23-25, 1983, Symposium Record New York, Institute of Electrical and Electronics Engineers, Inc , 1983, p 362-365 refs

Over the past decade, the awareness of electrostatic discharges as a threat to geosynchronous satellite performance has increased significantly Operational anomalies occurring on various satellites have been correlated with the energetic plasma induced disturbances of the geomagnetic substorm environment In the plasma environment of a geomagnetic substorm, geosynchronous satellite elements may differentially charge and, subsequently, arc discharge A suitable electrostatic charge control program is considered along with computerized charging analysis techniques Aspects regarding the charge control of conductive surfaces are discussed, taking into account multilayer blankets, and a graphite fiber reinforced plastic Questions concerning the discharge control of dielectric surfaces are also explored, giving attention to second surface mirrors and solar array design G R

A85-28126* Hughes Aircraft Co , Los Angeles, Calif
AN INVESTIGATION DURING THE SYSTEM TEST PHASE OF THE GOES SPACECRAFT
L A MALLETTE (Hughes Aircraft Co , Space and Communications Group, Los Angeles, CA) IN SOUTHEASTCON '83, Proceedings of the Region 3 Conference and Exhibit, Orlando, FL, April 11-13, 1983 New York, Institute of Electrical and Electronics Engineers, Inc , 1983, p 638-642
(Contract NAS5-24342)

Spurious RF oscillations were noted during the system test phase of the Geostationary Operational Environmental Satellite (GOES) A space qualified data collection platform report (DCPR) transmitter was subsequently found to have a cracked load resistor in its output isolator The failure mechanism was caused by heat from the output power of a 20 watt transmitter being reflected into the DCPR transmitter through a sneak path The reflection from a high VSWR at the rotary joint was not part of the normal operation but was due to unusual circumstances The reliability of the load resistor under normal operation (low VSWR) over the life of the satellite was determined to be high Author

N85-11016*# Auburn Univ , Ala Dept of Electrical Engineering
THE COMPUTER-COMMUNICATION LINK FOR THE INNOVATIVE USE OF SPACE STATION Abstract Only
C C CARROLL *In* NASA Marshall Space Flight Center 2nd Symp on Space Industrialization p 52 Oct 1984
Avail NTIS HC A19/MF A01 CSCL 17B

The potential capability of the computer-communications system link of space station is related to innovative utilization for industrial applications Conceptual computer network architectures are presented and their respective accommodation of innovative industrial projects are discussed To achieve maximum system availability for industrialization is a possible design goal, which would place the industrial community in an interactive mode with facilities in space A worthy design goal would be to minimize the computer-communication management function and thereby optimize the system availability for industrial users Quasi-autonomous modes and subnetworks are key design issues, since they would be the system elements directly effecting the system performance for industrial use R S F

N85-11017*# Turner Broadcasting System, Atlanta, Ga
THE REAL WORLD: THE USER
J KITCHELL *In* NASA Marshall Space Flight Center 2nd Symp on Space Industrialization p 53-59 Oct 1984
Avail NTIS HC A19/MF A01 CSCL 17B

Satellite communication is by far the most advanced of all commercial applications of space technology The past, present, and some future possibilities for the field of public communications

are considered Some serious concerns that are becoming apparent to the user of this technology are examined. Among the specific topics mentioned are digital television, electronic mail, cable television, and systems security R S F

N85-12299*# Martin Marietta Aerospace, Denver, Colo.
POWER SUBSYSTEM AUTOMATION STUDY Final Report
J C TIETZ, D SEWY, C PICKERING, and R. SAUERS Sep 1984 207 p refs
(Contract NAS8-34938)
(NASA-CR-171213, NAS 1 26 171213; MCR-84-596) Avail NTIS HC A10/MF A01 CSCL 09E

The purpose of the phase 2 of the power subsystem automation study was to demonstrate the feasibility of using computer software to manage an aspect of the electrical power subsystem on a space station The state of the art in expert systems software was investigated in this study This effort resulted in the demonstration of prototype expert system software for managing one aspect of a simulated space station power subsystem B W

N85-12933*# Bendix Corp , Teterboro, N J Guidance Systems Div
AUTONOMOUS MOMENTUM MANAGEMENT FOR SPACE STATION, EXHIBIT A Final Report, 1 Oct. 1983 - 31 Aug. 1984
E HAHN 15 Oct 1984 70 p refs
(Contract NAS8-35349)
(NASA-CR-171256, NAS 1 26 171256) Avail. NTIS HC A04/MF A01 CSCL 22B

The report discusses momentum management for the CDG Planar Space Platform The external torques on the Space Station are assumed to be gravity gradient and aerodynamic with both having bias and cyclic terms The integrals of the cyclic torques are the cyclic momenti which will be stored in the momentum storage actuator Various techniques to counteract the bias torques and center the cyclic momentum were investigated including gravity gradient desaturation by adjusting vehicle attitude, aerodynamic desaturation using solar panels and radiators and the deployment of flat plates at the end of long booms generating aerodynamic torques Author

N85-13881*# National Aeronautics and Space Administration, Washington, D C
SPACE STATION POWER SYSTEM
C R BARAONA *In* NASA Lewis Research Center Space Power p 7-14 Apr 1984 refs
Avail NTIS HC A14/MF A01

The strategies, reasoning, and planning guidelines used in the development of the United States Space Station Program are outlined The power required to support Space Station missions and housekeeping loads is a key driver in overall Space Station design conversely, Space Station requirements drive the power technology Various power system technology options are discussed The mission analysis studies resulting in the required Space Station capabilities are also discussed An example of Space Station functions and a concept to provide them is presented The weight, area, payload and altitude requirements on draft and mass requirements are described with a summary and status of key power systems technology requirements and issues R J F

N85-13890*# Boeing Aerospace Co , Seattle, Wash
POTENTIAL OF FLYWHEELS FOR SPACECRAFT ENERGY STORAGE
S GROSS *In* NASA. Lewis Research Center Space Power p 101-113 Apr 1984
Avail NTIS HC A14/MF A01 CSCL 10C

The use of flywheel systems for energy storage in spacecraft is considered Energy density, efficiency, weight, voltage range, life, and reliability of flywheel systems are discussed. R S F

N85-13892*# National Aeronautics and Space Administration Lewis Research Center, Cleveland, Ohio
DYNAMIC POWER SYSTEMS FOR POWER GENERATION
R E ENGLISH *In its* Space Power p 137-149 Apr 1984 refs
Avail NTIS HC A14/MF A01 CSCL 10B

The characteristics of dynamic power systems have considerable potential value, especially for the space station The base of technology that makes these dynamic power systems practical is reviewed The following types of power-generating systems are examined herein organic Rankine cycle, potassium Rankine cycle, Brayton cycle, and Stirling cycle R S F.

N85-14006# TICRA ApS, Copenhagen (Denmark)
ELECTRICAL CONSEQUENCES OF MECHANICAL ANTENNA CHARACTERISTICS
K. PONTOPPIDAN *In* ESA Workshop on Mech Technol for Antennas p 41-47 Sep 1984 refs
Avail NTIS HC A09/MF A01

Reflector antenna surface distortion errors that lead to a best fit paraboloid, and additional random and systematic errors were investigated It is demonstrated that the influence of each type of error is very different in magnitude as well as in the spatial distribution It is also shown that not only the peak gain but also the sidelobe requirement play a decisive role when the acceptable surface accuracy is to be established Author (ESA)

N85-14008# Dornier-Werke G m b H , Friedrichshafen (West Germany)
TECHNOLOGY FOR THE ERS-1 SAR ANTENNA
R WAGNER *In* ESA Workshop on Mech Technol for Antennas p 59-66 Sep 1984 refs
Avail NTIS HC A09/MF A01

The metallization of CFRP waveguides, the Deployable Truss Structure (DTS) and verification in terrestrial environment of the 10 x 1 m SAR antenna of ERS-1 (ESA satellite) are discussed Waveguide metallization was achieved indirectly with metallization of the mandrel prior to CFRP lay-up, and directly, by electroplating of manufactured CFRP components Both techniques proved unsatisfactory, but a surface treatment applied to the metal layer in the indirect technique improves adhesion strength by an order of magnitude, and enables the waveguides to meet requirements The DTS satisfies launch, deployment, and inflight specifications for a 5 panel/2 wing structure Ground tests include analytical simulation of deployment with and without gravity effects, and a gravity compensation technique for tests Author (ESA)

N85-14010# Construcciones Aeronauticas S A , Madrid (Spain) Space Div.
CASA TECHNOLOGICAL EFFORT IN THE FIELD OF ANTENNAS
M A. LLORCA *In* ESA Workshop on Mech Technol for Antennas p 73-75 Sep 1984
Avail NTIS HC A09/MF A01

Shaped reflector and waveguide array antennas for ESA projects were developed The wind scatterometer antenna for ERS-1 (ESA satellite) is described This is a three beam concept consisting of a fixed antenna on top of the synthetic aperture radar, and two deployable, but rigid, antennas situated at either side of the payload Author (ESA)

N85-14018# Rome Univ (Italy)
IN-ORBIT PERFORMANCE OF INTELSAT V COMMUNICATIONS ANTENNAE DEPLOYMENT SYSTEMS
N LOMAS *In* ESA Workshop on Mech Technol for Antennas p 133-139 Sep 1984
Avail NTIS HC A09/MF A01

The INTELSAT hinged antenna deployment system is described, and use of real time telemetry from spacecraft sensors to evaluate the success of the deployments, and the actions taken to correct performance anomalies are discussed Two partial failures were successfully diagnosed using the telemetry from nutation accelerometers and Sun and Earth sensors Both anomalies arose

from conditions where initial clearances in the mechanism were too small to accommodate the thermal distortions encountered in orbit A large increase in the friction torque resulted, which was beyond the capacity of the springs to overcome until temperatures moderated Thermal distortion effects were accounted for in the hinge design, the clearances were correctly adjusted at final assembly and reverified by an inspection and test program, so INTELSAT 5 overcame deployment problems. Author (ESA)

N85-14022# Societe Nationale Industrielle Aerospatiale, Cannes (France)
ARABSAT SPACECRAFT: RX AND TX ANTENNA MECHANISMS
C LONG and C VIDAL *In* ESA Workshop on Mech Technol for Antennas p 159-167 Sep 1984
Avail NTIS HC A09/MF A01

A receive antenna (Rx at 6 GHz) and transmit antenna (Tx at 4 GHz) were developed for the Arabsat communication satellite The Rx antenna has a single hinge line and during launch the reflector dish is restrained against the antiearth panel by two hold-down points Deployment is actuated by springs and regulated by a centrifugal regulator. The Rx antenna mechanisms consist of two motorized rods, hinged on the structure, a driving rod ensuring the required lateral stiffness to the mechanisms in deployed configuration, a centrifugal regulator on the motorized rod, two hold-down points ensured by two pyrotechnical separation nuts, and a latch on each motorized rod to block the reflector in the deployed configuration The position of the Tx antenna in stowed and deployed configuration requires double hinge lines A coupling rod conjugates the rotation of the double hinge line to allow actuation on only one hinge line, and control deployment rate with only one centrifugal regulator Author (ESA)

N85-19326*# Goodyear Aerospace Corp , Litchfield Park, Ariz
INTERLEAVED ARRAY ANTENNA TECHNOLOGY DEVELOPMENT
30 Jan 1985 55 p refs
(Contract NAS9-16430)
(NASA-CR-171845, NAS 1 26 171845, GERA-2702) Avail NTIS HC A04/MF A01 CSCL 09C

This is the third phase of a program to establish an antenna concept for shuttle and free flying spacecraft earth resources experiments using Synthetic Aperture Radar The feasibility of a plated graphite epoxy waveguide for a space antenna was evaluated A quantity of flat panels and waveguides were developed, procured, and tested for electrical and mechanical properties. In addition, processes for the assembly of a unique waveguide array were investigated Finally, trades between various configurations that would allow elevation (range) electronic scanning and that would minimize feed complexity for various RF bandwidths were made B W

N85-20244*# Hydraulic Research Textron, Irvine, Calif Systems Engineering Div
COMPENSATOR DEVELOPMENT AND EXAMINATION OF PERFORMANCE AND ROBUSTNESS
5 Oct. 1984 11 p Prepared for JPL, Pasadena, Calif.
(Contract NAS7-918, JPL-956541)
(NASA-CR-175470, JPL-9950-962, NAS 1 26 175470, REPT-956541-EXTENSION-1) Avail NTIS HC A02/MF A01 CSCL 09A

A compensator was synthesized to minimize the mean square surface error of a wrap rib antenna Two separate cases were considered, one in which the flexible ribs and mesh were given weight, thereby penalizing the actual error of the reflecting area, and the other in which the antenna is considered rigid, thus penalizing only the rigid body rotation The numerical results show that the flexible modes of the antenna have to be included in the performance criterion to obtain a better performance G L C

N85-20348*# National Aeronautics and Space Administration Marshall Space Flight Center, Huntsville, Ala
ELECTRODYNAMIC INTERACTIONS
N H STONE *In its* Appl of Tethers in Space, Vol 1 17 p Mar 1985
Avail NTIS HC A13/MF A01 CSCL 22B

It is apparent that the electrodynamic tether offers new potential for unique scientific experiments which should enhance the understanding of space plasma physics and in particular certain classes of solar system plasma phenomena, and that these science studies will also address a number of key engineering concerns which may open up new power and thrust generation technology that could be a significant factor in future space operations Author

N85-20356*# National Aeronautics and Space Administration Marshall Space Flight Center, Huntsville, Ala
SUMMARY PRESENTATION OF THE ELECTRODYNAMICS INTERACTIONS PANEL
N H STONE *In* NASA Marshall Space Flight Center Appl of Tethers in Space, Vol 1 12 p Mar 1985
Avail NTIS HC A13/MF A01 CSCL 20N

Technological and scientific uses of electrodynamic tethers in space are considered Areas of concern for such applications of electrodynamic tethers are enumerated Thrust and power generation using tethers are discussed R S F

N85-20363*# National Aeronautics and Space Administration Marshall Space Flight Center, Huntsville, Ala
REPORT OF THE ELECTRODYNAMIC INTERACTIONS PANEL
N H STONE, R S TAYLOR (Smithsonian Astrophysical Observatory), S BENFORD (NASA Lewis Research Center), J H BINSACK (MIT), M DOBROWOLNY (CNR, Italy), P FINNEGAN (NASA Lewis Research Center), M. D GROSSI (Smithsonian Astrophysical Observatory), M HUDSON (Martin Marietta, Denver), D INTRILIGATOR (Carmel Research Center), R KAMINSKAS (TRW) et al *In its* Appl of Tethers in Space, Vol. 2 19 p Mar 1985
Avail NTIS HC A14/MF A01 CSCL 20N

A wide range of opportunities is provided by the electrodynamic tether to more fully understand the generation of waves in plasmas, the behavior of field aligned currents, the behavior of large body-space plasma interactions, and for process simulation, using the electrodynamic tether to study processes and phenomena relevant to solar system and astrophysics plasma physics. The electrodynamic tether offers a means of study and experimentation in space which will provide a rich yield in new scientific results and will enhance the understanding of space plasma physics It also has promising technological applications (e g , the generation of electrical power and thrust) which may be highly significant to future space operations Author

N85-20553# Deutsche Forschungs- und Versuchsanstalt fuer Luft- und Raumfahrt, Cologne (West Germany)
CONTROL OF LARGE COLLECTOR ARRAYS: THE SSPS EXPERIENCE
R CARMONA and J G MARTIN 1984 44 p refs
(Contract DE-AC04-76DR-00789)
(DE85-001461, DOE/DR-00789/T4, SSPS-TR-4/84) Avail NTIS HC A03/MF A01

Experience gained in the control of the distributed collector fields at the IEA Small Solar Power Systems project may be of value in the design of control systems for future large arrays The project experience with analog and digital systems is discussed, as are details on the improvements that were made and the lessons learned A priority item in this year's efforts on site is the evaluation of the potential for fully automatic operation, with a suitable control algorithm, of a reliable collector array Preliminary results from dynamic models of the fields in terms of lumped and distributed parameters are given Adaptive controls are discussed. DOE

N85-21252# Lockheed Missiles and Space Co , Palo Alto, Calif
SCATHA (SPACECRAFT CHARGING AT HIGH ALTITUDES) PLASMA INTERACTION EXPERIMENT: SC-3 HIGH ENERGY PARTICLE SPECTROMETER; SC-8 ENERGETIC ION COMPOSITION EXPERIMENT Final Report, 1 Nov. 1975 - 30 Oct. 1984
E G SHELLEY, R D. SHARP, R. W NIGHTINGALE, and J M QUINN 30 Nov 1984 53 p
(Contract N00014-76-C-0444)
(AD-A149728) Avail NTIS HC A04/MF A01 CSCL 22B

This report describes the results of the SC-3 (High Energy Particle Spectrometer) and SC-8 (Energetic Ion Composition Experiment) instruments flown on the SCATHA (Spacecraft Charging at High Altitudes) satellite, launched in January 1979 into a near geosynchronous orbit The instruments measure electrons at energies of 0 05-5 0 MeV, protons of 1-100 MeV, and mass composition of ions in the range E/q=0 1-32 keV/e Both instruments continue to be fully operational at this time. Principal results of the High Energy Particle Spectrometer have addressed radial profiles and energy spectra of energetic particles, the role of energetic particles in the charging and discharging of spacecraft dielectrics, the behavior of trapped electrons at flux levels near the Kennel-Petchek trapping limit, and the precipitation of energetic electrons into the ionosphere The Energetic Ion Composition Experiment has provided the first ion composition data with routine pitch angle coverage in the vicinity of geosynchronous orbit The advances resulting from this instrument can be grouped into four categories (1) plasma injection and transport, (2) detailed structure of near-geosynchronous plasma distributions, (3) interactions between hot plasmas and spacecraft, and (4) global understanding arising from the synthesis of individual results Additional keywords abstracts, literature surveys, electric charge, space charge, particle flux, electron guns, ion guns
Author (GRA)

07

ADVANCED MATERIALS

Includes matrix composites, polyimide films, thermal control coatings, bonding agents, antenna components, manufacturing techniques, and space environmental effects on materials

A85-12395
EFFECTS OF RESIDUAL STRESSES IN POLYMER MATRIX COMPOSITES
H T HAHN (Washington University, St. Louis, MO) Journal of the Astronautical Sciences (ISSN 0021-9142), vol 32, July-Sept 1984, p 253-267 refs
(Contract NSF MEA-81-10777)

Several conventional methods of elastic analysis are reviewed and the effects of residual stresses on polymer matrix composites are determined analytically It is found that residual stresses are caused by the expansional mismatch between the fibers and the matrix The stresses manifest themselves in unusual thermal expansion behavior, premature ply cracking, delamination, and the warping of unsymmetric laminates It is suggested that by optimizing the cure cycle and annealing the homogeneous materials used in the construction of the composite, some reductions in residual stresses are possible I H

A85-13246#
DESIGN PREPARATIONS FOR LARGE SPACE STRUCTURES
H W BERGMANN (Deutsche Forschungs- und Versuchsanstalt fuer Luft- und Raumfahrt, Institut fuer Strukturmechanik, Brunswick, West Germany) International Astronautical Federation, International Astronautical Congress, 35th, Lausanne, Switzerland, Oct. 7-13, 1984 6 p.
(IAF PAPER 84-392)

Progress made on studies of fiber-resin systems response to long-duration exposure to space conditions, writing codes for large space structures (LSS)design and analysis, and comparing code predictions with realistic laboratory data on structures at DFVLR is summarized Carbon-fiber resin elements have been selected as prime LSS elements due to suitable strength, weights and thermal properties Therman cycling and electron bombardment tests run on a variety of samples revealed reductions in the bond strength between the fibers and the matrix, an effect most pronounced with polyimide materials Irradiation produced no marked structural changes except a reddening in color at the surface It is thought that comprehensive predictive codes will be needed to offset the impossibility of satisfactorily performing laboratory tests on LSS models on earth The programs have identified fiber-wound joints as suitable replacements for carbon fiber-metal interfaces, which were shown to deteriorate with thermal cycling M S K

A85-13255#
KEVLAR AND T300 FABRIC PREPREGS - THEIR MATERIAL PROPERTIES AND THEIR USE IN HIGH LOADED AREAS OF A SOLAR ARRAY
W WEISS (Messerschmitt-Boelkow-Blohm GmbH, Munich, West Germany) and H RAPP (Muenchen, Technische Universitaet, Munich, West Germany) International Astronautical Federation, International Astronautical Congress, 35th, Lausanne, Switzerland, Oct 7-13, 1984 23 p refs
(IAF PAPER 84-402)

The mechanical properties of sandwich structures comprising Kevlar and T300 (carbon) fabrics and 3/8 5056 0007 p Al-alloy honeycomb cores are investigated experimentally and applied to finite-element modeling and fabrication of concentric cylindrical structures for the solar arrays of the Intelsat VI communications satellite The results are presented in photographs, drawings, diagrams, and graphs The measured strengths of the sandwiches are found to exceed the calculated values by 60 percent or more, and the facing stiffness is unaffected by radiation T K

A85-13257#
THERMOELASTIC BEHAVIOUR OF SPACE STRUCTURES IN COMPOSITE MATERIALS
L B CREMA, R BARBONI, and A CASTELLANI (Roma, Universita, Rome, Italy) International Astronautical Federation, International Astronautical Congress, 35th, Lausanne, Switzerland, Oct. 7-13, 1984. 13 p refs
(IAF PAPER 84-404)

An evaluation of the mechanical and thermal behavior of Kevlar fabric cured resin epoxy is presented The tensile, compressive, and flexural properties of the material are both theoretically and experimentally investigated The thermal expansion coefficient and the damping properties of the material are discussed C D

A85-13258#
INFLUENCE OF THE LAMINATION AND OF SOME ENVIRONMENTAL EFFECTS ON DAMPING CHARACTERISTICS OF ADVANCED COMPOSITES FOR SPACE STRUCTURES
M MARCHETTI (Roma, Universita, Rome, Italy), F MORGANTI, L MUCCIANTE, and A D NOVELLINO (Selenia S p A , Rome, Italy) International Astronautical Federation, International Astronautical Congress, 35th, Lausanne, Switzerland, Oct 7-13, 1984 26 p Sponsorship Consiglio Nazionale delle Ricerche refs
(Contract CNR-83,02713,07)
(IAF PAPER 84-405)

Experimental data are presented on the damping behavior of graphite/epoxy and Kevlar/epoxy composites extensively used in space structures Experimental results are then compared with the results of an analytical study, with account taken of the cutting direction, lamination topology, fiber type, and laminate thickness A numerical method is developed in order to evaluate the modal damping of structures starting from the unidirectional specific damping capacity This method is an extension of a theory based on the dissipation energy V L

A85-13500
MATERIAL SCIENCES IN SPACE [KOSMICHESKOE MATERIALOVEDENIE]
L L REGEL Itogi Nauki i Tekhniki, Seriia Issledovanie Kosmicheskogo Prostranstva (ISSN 0202-0734), vol 21, 1984, 244 p In Russian refs

Current theoretical and experimental research related to material sciences in space is reviewed. Topics discussed include theoretical considerations concerning the growth of crystals under microgravity conditions, the growth of semiconducting materials from melts and from the vapor phase in space, and the solidification of metals, alloys, composites and glasses in the reduced gravity environment Attention is also given to crystal growth from aqueous solutions in microgravity, the apparatus and instrumentation used in material-science experiments in space, material processing experiments using aircraft and rockets, and crystal growth and solidification under high gravity V L

A85-14163
INFLUENCE OF SIMULATED SPACE ENVIRONMENT ON THE BEHAVIOR OF CARBON-FIBER-REINFORCED PLASTICS WITH +, -45 PLY ORIENTATIONS. II
W HARTUNG and H W BERGMANN Composites Technology Review, vol 6, Fall 1984, p 126-133

Attention is given to the influence of environmental exposure on the mechanical properties of +, -45 deg carbon fiber-reinforced plastic (CFRP) laminates, especially with respect to tensile and compressive strength, longitudinal direction stiffness, and transverse oscillation damping The effects of thermal cycling and electron irradiation on the tested CFRP laminates were evaluated by comparing the initial and residual mechanical properties of the specimens Emphasis is given to the maintenance of identical test conditions and the determination of the extent of degradation O C

A85-15626
REINFORCED PLASTICS/COMPOSITES INSTITUTE, ANNUAL CONFERENCE, 38TH, HOUSTON, TX, FEBRUARY 7-11, 1983, PREPRINTS
New York, Society of the Plastics Industry, Inc , 1984, 847 p For individual items see A85-15627 to A85-15640

Among the topics discussed are automotive applications of sheet molding compounds, the corrosion and creep rupture behavior of reinforced plastics, the characteristics and applications of glass and ceramic additives and fillers, the properties of matrix/reinforcement interfaces, industrial materials evaluation and quality assurance practices, novel resins and processes for pultrusion, oil field applications of reinforced plastics, and sheet molding compound formulation and process control Also covered are economic planning in the reinforced plastics industry, composite storage tanks and pipes, aerospace applications of advanced composites, transportation applications of composites, types and properties of reinforced thermoplastics, marine composite structures manufacture, novel resin systems, and advancements in molding processes O C

A85-15638#
CONTINUOUS GRAPHITE/POLYSULFONE RP THERMOFORMING FOR LARGE SPACE STRUCTURE CONSTRUCTION
D E BECK (Goldsworthy Engineering, Inc , Torrance, CA) IN Reinforced Plastics/Composites Institute, Annual Conference, 38th, Houston, TX, February 7-11, 1983, Preprints New York, Society of the Plastics Industry, Inc , 1984, p 20-C-1 to 20-C-6

The composite beam cap forming systems (CBCFS) has been formulated as a technology demonstrator for large space structure construction Composite triangular truss beams have been selected as a major approach to the fulfillment of system requirements in virtue of their simplicity and efficiency The graphite-reinforced polysulfone composite material employed exhibits a near-zero thermal expansion coefficient in the + or - 250 F space environment In the CBCFS, a composite ribbon is first continuously formed, and then reshaped into a triangular beam cap The CBCFS apparatus weighs less than 200 lbs O C

A85-15977
STRUCTURES AND MATERIALS TECHNOLOGIES FOR SPACECRAFT SYSTEMS AN OVERVIEW
R N GOUNDER (RCA, Astro-Electronics Div , Princeton, NJ) IN Technology vectors, Proceedings of the Twenty-ninth National SAMPE Symposium and Exhibition, Reno, NV, April 3-5, 1984 Covina, CA, Society for the Advancement of Material and Process Engineering, 1984, p 1-9

The role of Structures and Materials disciplines in the development of spacecraft systems is reviewed A discussion of the spacecraft systems requirements for advanced structures and materials is presented Application of materials, design, analysis and test technologies to satellite structures development are outlined by way of specific hardware examples This paper forms an introduction to the individual papers presented at the symposium on Spacecraft Structures and Materials Author

A85-15980
GRAPHITE EPOXY STRUCTURE OF THE SPACE TELESCOPE'S OPTICAL TELESCOPE ASSEMBLY
C T GOLDEN and E E SPEAR (Boeing Aerospace Co , Seattle, WA) IN Technology vectors, Proceedings of the Twenty-ninth National SAMPE Symposium and Exhibition, Reno, NV, April 3-5, 1984 Covina, CA, Society for the Advancement of Material and Process Engineering, 1984, p 33-45

High strength and stiffness, low weight, and a controlled coefficient of thermal expansion approaching zero present significant incentives for the use of graphite/epoxy composite optical equipment structures in space Attention is presently given to the NASA Space Telescope's Metering Truss Structure and Focal Plane Structure Motions of 0 000048 inches over a 200-inch long structure, and optical path alignments of 0 0018 sec within the 1200-lb graphite/epoxy Focal Plane Structure that will support 6000 lb of scientific instruments, have been demonstrated in the thermal environment that will be encountered in space O C

A85-15990
EFFECTS OF SPACE ENVIRONMENTAL CONDITIONS ON GRAPHITE EPOXY COMPOSITES
S SEEHRA, D BENTON, J ROSEN, and R GOUNDER (RCA, Astro Electronics Div , Princeton, NJ) IN Technology vectors, Proceedings of the Twenty-ninth National SAMPE Symposium and Exhibition, Reno, NV, April 3-5, 1984 Covina, CA, Society for the Advancement of Material and Process Engineering, 1984, p 157-168

Graphite-epoxy composites (metallized with varying amounts of vapor-deposited aluminum), thermal protection coating, and sunshield materials were exposed to simulated space environmental conditions The thermophysical, thermooptical, RF,

and mechanical properties were measured Radiation (300 million rads maximum) and thermal components of the environment were simulated by thermal cycling between -175 C and + 50 C. Test results indicate that most properties of the composite materials remained practically unchanged after exposure to the simulated radiation environment. However, the solar absorptivity of the thermal protection coating and sunshield materials increased by a factor of two The mechanical properties of the graphite/epoxy did not change except for a slight decrease in strength at low temperatures and a small increase in the coefficient of thermal expansion Author

A85-15993
ADVANCED ANALYSIS METHODS FOR SPACECRAFT COMPOSITE STRUCTURES
C TRUNDLE, F H CHU, and D W GROSS (RCA, Astro-Electronics Div , Princeton, NJ) IN Technology vectors, Proceedings of the Twenty-ninth National SAMPE Symposium and Exhibition, Reno, NV, April 3-5, 1984 Covina, CA, Society for the Advancement of Material and Process Engineering, 1984, p 195-202 refs

Structural analysis is an essential step in the development and verification of spacecraft composite structures The accuracy and adequacy of the analysis has a direct impact on the success of the design The prediction of the behavior of composite structures often requires special finite element formulation techniques that focus on the composite material characteristics at the lamina level These techniques are significantly more complex than structural analysis for conventional materials This paper discusses the analysis methods presently used at RCA Astro-Electronics for finite element model generation, optimal design, vibration analysis, thermal distortion analysis, and stress analysis of lightweight composite structures for spacecraft applications Computer-aided engineering techniques which are a part of the integrated analysis approach are also discussed Author

A85-16499
EXPERIMENTAL STUDY OF THE EFFECT OF THE TYPE OF STRESS STATE ON PLASTIC STRAIN IN STRUCTURAL MATERIALS AT LOW TEMPERATURES
G. S PISARENKO, A A LEBEDEV, and B I KOVALCHUK (Akademiia Nauk Ukrainskoi SSR, Institut Problem Prochnosti, Kiev, Ukrainian SSR) (International Astronautical Federation, International Astronautical Congress, 34th, Budapest, Hungary, Oct 10-16, 1983) Acta Astronautica (ISSN 0094-5765), vol 11, July-Aug 1984, p 483-488 refs

The apparatus and theoretical models used at the Ukrainian Institute for Problems of Strength to assess the complex load-carrying strengths of materials for rocket and space structures are described Thin-wall tubular specimens are tested with axial force, torque and internal pressure Hydrostatic buckling is applied to membranes and plates, and biaxial tension is forced on cross-shaped specimens. Temperatures from 100-1200 K can be applied The specimens are monitored with extensometer strain gages All tests are performed under preprogrammed computer control Numerical models have been defined for the plastic strain trajectories under loading and the relations between stresses and strains for smooth surfaces on orthotropic media and in structurally unstable materials Sample ultimate strength data are provided for austenitic steel and aluminum alloys M S K

A85-19770#
KINETICS OF OXYGEN INTERACTION WITH MATERIALS
G S ARNOLD and D R PEPLINSKI (Aerospace Corp , Chemistry and Physics Laboratory, El Segundo, CA) American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 23rd, Reno, NV, Jan 14-17, 1985 9 p. Research supported by the Aerospace Corp refs
(Contract F04701-82-C-0083)
(AIAA PAPER 85-0472)

An analysis of the currently available laboratory and flight data on the kinetics of the oxidation of spacecraft materials in low earth orbit is presented Subjects addressed in detail are the dependences of polymer erosion rates on atomic oxygen kinetic energy, flux, and fluence and on materials processing Comments on the impacts of reaction products are presented Author

A85-19771#
ATOMIC OXYGEN SURFACE INTERACTIONS - MECHANISTIC STUDY USING GROUND-BASED FACILITIES
J B CROSS and D A. CREMERS (Los Alamos National Laboratory, Los Alamos, NM) American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 23rd, Reno, NV, Jan 14-17, 1985 18 p refs
(AIAA PAPER 85-0473)

The present investigation is concerned with the mechanism of oxygen atom etching of spacecraft surfaces, taking into account etching which occurs in low-earth orbit due to attack of translationally hot (5 eV) and thermal (less than 0 5 eV) O-atoms Attention is also given to a correlation of these results with the glow phenomenon observed on the Space Shuttle and other satellites, and to a data base for the modeling of spacecraft in the 500 km altitude region The feasibility of producing high-temperature (8000 K) atomic and molecular beams using the Continuous Optical Discharge (COD) technique is demonstrated Extrapolations of the results to a COD generated helium plasma predict that a 5 eV O-atom source could be developed G R

A85-21508
EFFECT OF NEUTRON AND PROTON IRRADIATION ON SOME PROPERTIES OF KAPTON
V SHRINET, U K CHATURVEDI, S K AGRAWAL, V N RAI, and A K NIGAM (Banaras Hindu University, Varanasi, India) IN Polyimides Synthesis, characterization, and applications Volume 1 New York, Plenum Press, 1984, p 555-571 Sponsorship Department of Atomic Energy of India refs
(Contract DAE PROJECT 34/4/81-G)

Surface morphology, dielectric, and photoacoustic characteristics are studied for the case of 25-micron thick Kapton sheets subjected to irradiation by fast reactor neutrons and protons A net enhancement of the dc dielectric constant of about 13 percent is noted after the maximum neutron dose, and is attributed to the enhanced water absorptivity of the material due to neutron-induced radiation damage SEM of the n- and H(+)-irradiated Kapton surfaces respectively show a swollen, rough surface and scattered blisters O C

A85-24672* Rome Air Development Center, Hanscom AFB, Mass
DIELECTRIC MATERIAL IN THE SPACE ENVIRONMENT
A R FREDERICKSON, J A WALL (USAF, Rome Air Development Center, Bedford, MA), D B COTTS (SRI International, Menlo Park, CA), and F L BOUQUET (California Institute of Technology, Jet Propulsion Laboratory, Pasadena, CA) SAMPE Journal (ISSN 0091-1062), vol 21, Mar -Apr 1985, p 12-16 refs

The irradiation encountered in space environments causes high insulation materials to discharge, either through electrical breakdown or surface voltage effect mechanisms Attention is presently given to polymers which, serving as 'leaky' insulators, avoid this problem by means of conduction mechanisms that are acceptable in space applications The class of conductive polymers encompasses polyvinylcarbazole, polyacrylonitrile, Kapton, and polythiazil A testing procedure useful in the qualification of such polymers is outlined O.C

A85-24675
RADIATION EFFECTS IN MATERIALS - FIELD-ION MICROSCOPE CHARACTERIZATIONS
O T INAL (New Mexico Institute of Mining and Technology, Socorro, NM) and W F. SOMMER (Los Alamos National Laboratory, Los Alamos, NM) SAMPE Journal (ISSN 0091-1062), vol 21, Mar -Apr 1985, p 42, 44-46, 48, 49, 95 refs

Atomic-level analyses of radiation effects in metals and alloys, utilizing field ion microscopy (FIM) has shed much light into the various irradiation-induced phenomena exhibited in the form of point defects, point defects clusters and voids of small sizes (less

than 10 nm) The study presented summarized FIM research done on crystalline as well as amorphous materials exposed to explosive shock, laser, and charged (proton) and uncharged (neutron) particle irradiation at room temperature Also included is an in situ study of gaseous plasma-introduced defects on preimaged field emission end forms, to further emphasize the capability of this analysis technique Author

A85-24703* National Aeronautics and Space Administration Langley Research Center, Hampton, Va
A REVIEW OF CONTAMINATION ISSUES ASSOCIATED WITH AN ORBITING SPACE STATION EXTERNAL ENVIRONMENT
A C SMITH (NASA, Langley Research Center, Hampton, VA) Journal of Environmental Sciences (ISSN 0022-0906), vol 28, Jan -Feb. 1985, p 52-55. refs

Techniques for measuring, modeling, and limiting the effluent contamination of external spacecraft and instrument surfaces are reviewed, with an emphasis on their application to the Space Station The major factors addressed by contamination studies are outlined, typical contamination sources are characterized, the critical measurement parameters are defined (molecular column density, background spectral intensity from UV to IR, particle size and velocity distribution, molecular deposition on ambient and cryogenic surfaces, molecular return flux for gaseous species, particulate deposition on surfaces, and optical-surface degradation), and measurement instrumentation is described Contamination limits for quiescent operation periods of the Space Station are proposed, including column density 10 to the 11th/sq cm for H2O + CO2, 10 to the 13th/sq cm for O2 + N2, and 10 to the 10th/sq cm for other species, particle release no greater than 15-micron particle/orbit/0 00001 sr FOV for a 1-m telescope, and surface deposition 4 pg/sq cm sec for 298-K surfaces and 10 pg/sq cm sec for 4-K surfaces T K

A85-25988* National Aeronautics and Space Administration Langley Research Center, Hampton, Va
TOROID JOINING GUN
J D BUCKLEY, R L FOX, and R J SWAIM (NASA, Langley Research Center, Hampton, VA) Society of Automotive Engineers, International Congress and Exposition, Detroit, MI, Feb 25-Mar 1, 1985 13 p refs
(SAE PAPER 850408)

The Toroid Joining Gun is a low cost, self-contained, portable low powered (100-400 watts) thermoplastic welding system developed at Langley Research Center for joining plastic and composite parts using an induction heating technique The device developed for use in the fabrication of large space sructures (LSST Program) can be used in any atmosphere or in a vacuum Components can be joined in situ, whether on earth or on a space platform The expanded application of this welding gun is in the joining of thermoplastic composites, thermosetting composites, metals, and combinations of these materials Its low-power requirements, light weight, rapid response, low cost, portability, and effective joining make it a candidate for solving many varied and unique bonding tasks Author

A85-29730* National Aeronautics and Space Administration Ames Research Center, Moffett Field, Calif
CATALYTIC SURFACE EFFECT ON CERAMIC COATINGS FOR AN AEROASSISTED ORBITAL TRANSFER VEHICLE
D A STEWARD and D B LEISER (NASA, Ames Research Center, Moffett Field, CA) Ceramic Engineering and Science Proceedings (ISSN 0196-6219), vol 5, July-Aug 1984, p 491-505 refs

Surface catalytic efficiencies of glassy coatings were determined from a reaction boundary layer computation and arc-jet data The catalytic efficiencies of the various coatings examined are discussed in terms of their reaction-rate constants These constants are a function of the wall temperature (1290 K to 2000 K) In addition, the advantage of a thermal protection system for a bent biconic, aeroassisted orbital transfer vehicle with a low surface catalytic efficiency is discussed Author

A85-30024
INFLUENCE OF STARTING MATERIAL AND TECHNOLOGICAL PROCESSES ON THE RADIATION RESISTANCE OF SILICON SOLAR CELLS FOR SPACE USE [ROLE DU MATERIAU DE DEPART ET DES PROCESSUS TECHNOLOGIQUES SUR LA TENUE AUX IRRADIATIONS DES PHOTOPILES SOLAIRES AU SILICIUM A USAGE SPATIAL]
M LAGOUIN Toulouse III, Universite, Docteur (3e cycle) Thesis, 1984, 133 p In French refs

The degradation of Si solar-cell layers of thickness 200-480 microns by 1-MeV electron irradiation is investigated experimentally with a focus on the role of raw-material characteristics and processing parameters in the n/p-type cells typically used for satellite solar panels The use of open-circuit, short-circuit, and maximum-power electrical measurements to estimate the bulk minority-carrier lifetime tau(V) is evaluated by comparison with direct measurements, and the technique based on the time evolution of short-circuit current is found to be significantly better than the other methods in tests on samples with B or Ga doping, resistivity 1 or 10 ohm cm, and various levels of O and C impurities The defects responsible for the degradation of the cells are studied by means of both bulk-property measurements and deep-layer transient spectroscopy (summarizing the results of Roux et al , 1983), and the effects of different standard manufacturing steps on tau(V) are explored Graphs, diagrams, and tables are provided T K

N85-11047*# Corning Glass Works, N Y
INORGANIC COMPOSITES FOR SPACE APPLICATIONS
J W MALMENDIER *In* NASA Marshall Space Flight Center 2nd Symp on Space Industrialization p 321-332 Oct 1984
Avail NTIS HC A19/MF A01 CSCL 11D

The development of inorganic composite materials for space applications is reviewed The composites do not contain any organic materials, and therefore, are not subject to degradation by ultraviolet radiation, volatilization of constituents, or embrittlement at low temperatures The composites consist of glass, glass/ceramics or ceramic matrices, reinforced by refractory whiskers or fibers Such composites have the low thermal expansion, refractories, chemical stability and other desirable properties usually associated with the matrix materials The composites also have a degree of toughness which is extraordinary for refractory inorganic materials M A C

N85-11239*# National Aeronautics and Space Administration Marshall Space Flight Center, Huntsville, Ala
AN EVALUATION OF GREASE TYPE BALL BEARING LUBRICANTS OPERATING IN VARIOUS ENVIRONMENTS Final Status Report
E L MCMURTREY Oct 1984 23 p refs
(NASA-TM-86480, NAS 1 15 86480, FSR-8) Avail NTIS HC A02/MF A01 CSCL 11H

Because many future spacecraft or space stations will require mechanisms to operate for long periods of time in environments which are adverse to most bearing lubricants, a series of tests has been completed to evaluate 38 grease type lubricants in R-4 size bearings in five different environments for a 1 year period Four repetitions of each test were made to provide statistical samples These tests were also used to select four lubricants for 5 year tests in selected environments with five repetitions of each test for statistical samples In this completed program, 172 test sets have been completed The three 5 year tests in (1) continuous operation and (2) start stop operation, with both in vacuum at ambient temperatures, and (3) continuous vacuum operation at 93 3 C have been completed In both the 1 year and 5 year tests, the best results in all environments have been obtained with a high viscosity index perfluoroalkylpolyether (PFPE) grease Author

N85-14013# Deutsche Forschungs- und Versuchsanstalt fuer Luft- und Raumfahrt, Brunswick (West Germany) Inst for Structural Mechanics

INFLUENCE OF THERMAL CYCLING ON THE BEHAVIOR OF CFRP MATERIAL FOR SPACE STRUCTURES

W HARTUNG *In* ESA Workshop on Mech Technol for Antennas p 97-101 Sep 1984 refs

Avail. NTIS HC A09/MF A01

The effects of a simulated 10 yr service in geosynchronous orbit on the thermomechanical properties of graphite/fiber composite structures were tested Materials were exposed to 3500 thermal cycles with a temperature range from minus 160 to +100 C The influence of microcracking increases mainly during the first 1000 thermal cycles Strength reduction corresponds to the amount of microcracking It is slight for epoxy-based laminates (3% to 22%). Polyimide based material suffers strength reduction of 40%. The percentage of stiffness degradation at the end of the test is nearly equal to that of strength A slight increase of thermal expansion at the end of thermal cycling reflects increased influence of the matrix due to fiber matrix debonding Poor resistance of polyimide resin against thermal cycling is caused by the too small strain at failure combined with the high curing temperature, resulting in a higher prestress at operating temperatures. Author (ESA)

N85-14014# *Rome Univ (Italy) Dipt Aerospaziale*

THE DIMENSIONAL STABILITY OF ADVANCED COMPOSITE ANTENNA REFLECTORS: ANALYTICAL AND TEST EVALUATION

M MARCHETTI and F. MORGANTI (Selenia S p A , Rome) *In* ESA Workshop on Mech. Technol for Antennas p 103-109 Sep 1984 refs

Avail NTIS HC A09/MF A01

The effects of thermal expansion coefficient of the graphite-epoxy structure, thermal cycling which the structure undergoes at ground and in orbit, and moisture sorption on the dimensional stability of a 4 m diameter reflector 20 to 30 GHz spacecraft antenna were tested A finite element model to predict thermal expansion coefficients (TEC) in sandwich panels was developed Tests suggest that artificial thermal aging helps to stabilize the TEC value of graphite-epoxy composites, compensating ground environment effects, such as moisture, and reducing settling and creep effects in-orbit. Author (ESA)

N85-14015# Construcciones Aeronauticas S A , Madrid (Spain) Space Div

CASA ACTIVITIES IN ANTENNA TECHNOLOGY

M DECASTRONODAL *In* ESA Workshop on Mech Technol for Antennas p 111-116 Sep 1984

Avail NTIS HC A09/MF A01

The technology required to manufacture molded solid reflectors from composite materials for spaceborne applications is outlined An 11 to 14 GHz circular polarization double offset reflector with 2 3 x 3 1 m aperture was designed The reflector dish is a CFRP covered aluminum honeycomb core sandwich, interfacing through 12 fixation points with the truss support structure The design is also used as a basis for Olympus TVB1 satellite reflectors Materials selection and surface coatings for reflectors in the 100 to 300 GHz range are discussed Author (ESA)

N85-17019*# National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md

ANALYSIS OF NONVOLATILE RESIDUE (NVR) FROM SPACECRAFT SYSTEMS

J A COLONY Jan 1985 12 p

(NASA-TM-86184; G-85F0284; NAS 1 15 86184) Avail NTIS HC A02/MF A01 CSCL 07D

Organic contamination on critical spacecraft surfaces can cause electronic problems, serious attenuation of various optical signals, thermal control changes, and adhesion problems. Such contaminants can be detected early by the controlled use of witness mirrors, witness plates, wipe sampling, or direct solvent extraction Each method requires careful control of variables of technique and materials to attain the ultimate sensitivities inherent to that procedure Subsequent chemical analysis of the contaminant sample by infrared and mass spectrometry identifies the components, gives semiquantitative estimates of contaminant thickness, indicates possible sources of the nonvolatile residue (NVR), and provides guidance for effective cleanup procedures Author

N85-19137*# Martin Marietta Aerospace, Denver, Colo.

EVALUATION AND PREDICTION OF LONG-TERM ENVIRONMENTAL EFFECTS OF NONMETALLIC MATERIALS Final Report

H. PAPAZIAN Jan 1985 29 p refs

(Contract NAS8-33578)

(NASA-CR-171353, NAS 1 26 171353, MCR-85-506) Avail NTIS HC A03/MF A01 CSCL 11G

The properties of a number of nonmetallic materials were evaluated experimentally in simulated space environments in order to develop models for accelerated test methods useful for predicting such behavioral changes Graphite-epoxy composites were exposed to thermal cycling Adhesive foam tapes were subjected to a vacuum environment Metal-matrix composites were tested for baseline data Predictive modeling designed to include strength and aging effects on composites, polymeric films, and metals under such space conditions (including the atomic oxygen environment) is discussed The Korel 8031-00 high strength adhesive foam tape was shown to be superior to the other two tested R S F

N85-19519*# Lockheed Missiles and Space Co , Sunnyvale, Calif Space Systems Div

INVESTIGATION OF WELDED INTERCONNECTION OF LARGE AREA WRAPAROUND CONTACTED SILICON SOLAR CELLS Final Report

D R LOTT Aug 1984 42 p Sponsored by NASA Lewis Research Center Prepared for JPL, Pasadena, Calif

(Contract JPL-956020)

(NASA-CR-174438, JPL-9950-975, NAS 1 26 174438, LMSC-D973421) Avail NTIS HC A03/MF A01 CSCL 10A

An investigation was conducted to evaluate the welding and temperature cycle testing of large area 5 9 x 5 9 wraparound silicon solar cells utilizing printed circuit substrates with SSC-155 interconnect copper metals and the LMSC Infrared Controlled weld station An initial group of 5 welded modules containing Phase 2 developmental 5 9 x 5 9 cm cells were subjected to cyclical temperatures of + or 80 C at a rate of 120 cycles per day Anomalies were noted in the adhesion of the cell contact metallization, therefore, 5 additional modules were fabricated and tested using available Phase I cells with demonstrated contact integrity Cycling of the later module type through 12,000 cycles indicated the viability of this type of lightweight flexible array concept This project demonstrated acceptable use of an alternate interconnect copper in combination with large area wraparound cells and emphasized the necessity to implement weld pull as opposed to solder pull procedures at the cell vendors for cells that will be interconnected by welding B W

N85-20019*# General Dynamics/Convair, San Diego, Calif

DEVELOP AND DEMONSTRATE MANUFACTURING PROCESSES FOR FABRICATING GRAPHITE FILAMENT REINFORCED POLYMIDE (GR/PI) COMPOSITE STRUCTURAL ELEMENTS Final Report

V A CHASE and E S. HARRISON Feb 1985 235 p refs

(Contract NAS1-14784)

(NASA-CR-172497, NAS 1.26 172497) Avail NTIS HC A11/MF A01 CSCL 11D

A study was conducted to assess the merits of using graphite/polyimide, NR-150B2 resin, for structural applications on advanced space launch vehicles The program was divided into two phases: (1) Fabrication Process Development, and (2) Demonstration Components The first phase of the program involved the selection of a graphite fiber, quality assurance of the NR-150B2 polyimide resin, and the quality assurance of the graphite/polyimide prepreg In the second phase of the program,

a limited number of components were fabricated before the NR-150B2 resin system was removed from the market by the supplier, Du Pont The advancement of the NR-150B2 polyimide resin binder was found to vary significantly based on previous time and temperature history during the prepregging operation Strength retention at 316C (600F) was found to be 50% that of room temperature strength However, the composite would retain its initial strength after 200 hours exposure at 316C (600F) Basic chemistry studies are required for determining NR-150B2 resin binder quality assurance parameters Graphite fibers are available that can withstand high temperature cure and postcure cycles

Author

N85-20128*# National Aeronautics and Space Administration Langley Research Center, Hampton, Va

PROCESS FOR PREPARING ESSENTIALLY COLORLESS POLYIMIDE FILM CONTAINING PHENOXY-LINKED DIAMINES Patent Application

A K ST CLAIR and T L ST CLAIR, inventors (to NASA) 23 Aug 1984 23 p

(NASA-CASE-LAR-13353-1, NAS 1 71 LAR-13353-1, US-PATENT-APPL-SN-643524) Avail NTIS HC A02/MF A01 CSCL 11B

A polyimide film that is approximately 90% transparent at 500 nm, useful for thermal protective coatings and solar cells, and the processes for preparing the same by thermal and chemical conversion are disclosed An essential feature for achieving maximum optical transparency films requires utilizing recrystallized and/or sublimated specific aromatic diamines and dianhydride monomers and introducing phenoxy or thiophenyl separator groupps and isomeric m,m'- or o,p'-oriented diamines into the polymer molecular structure The incorporation of these groups in the polymer structure serves to separate the chromaphoric centers and reduce the formation of inter-chain and intra-chain charge transfer complexes which normally cause absorptions in the UV-visible range The films may be obtained by hand, brushing, casting or spraying a layer of the polyamic acid solutions onto a surface and thermally converting the applied layer to the polyimide In addition, the polyamic acid solution can be chemically converted to the polyimide, subsequentially dissolved in an organic solvent, and applied as a polyimide film layer with the solvent therein thermally removed

NASA

N85-20371*# National Aeronautics and Space Administration Langley Research Center, Hampton, Va

PULTRUSION PROCESS FOR FABRICATION OF TETHERS (PRELIMINARY CONCEPTS)

I O. MACCONOCHIE and M L WILSON *In* NASA Marshall Space Flight Center Appl of Tethers in Space, Vol 2 15 p Mar 1985

Avail NTIS HC A14/MF A01 CSCL 22B

Three composite materials were manufactured by the pultrusion process, coiled on 24 inch diameter spools for a period of two months, uncoiled and evaluated for memory recall These materials were pultruded to lengths of approximately 150 feet and cross section profiles were maintained at 0 143 inch in thickness by 0 566 inch in width Mechanical properties were studied and results compared The reinforcement material volume percent of each was identical Of the three systems, the Kevlar reinforced composite had the highest specific strength, the lowest flexural modulus, and the lowest memory recall Further evaluations of materials and fabrication technology of pultrusion should be conducted to address some problem areas encountered in this preliminary concept Areas for further study are suggested

M G

N85-21188*# National Aeronautics and Space Administration Johnson (Lyndon B) Space Center,

ORBITAL DEBRIS

D J KESSLER, comp and S Y SU, comp (Lockheed-EMSCO, Houston, Tex) Mar 1985 453 p refs Proc of a Workshop held in Houston, Tex , 27-29 Jul 1982

(NASA-CP-2360, S-532, NAS 1 55 2360) Avail NTIS HC A20/MF A01 CSCL 22A

Earth orbital debris issues and recommended future activities are discussed The workshop addressed the areas of environment definition, hazards to spacecraft, and space object management It concluded that orbital debris is a potential problem for future space operations However, before recommending any major efforts to control the environment, more data are required The most significant required data are on the population of debris smaller than 4 cm in diameter New damage criteria are also required When these data are obtained, they can be combined with hypervelocity data to evaluate the hazards to future spacecraft After these hazards are understood, then techniques to control the environment can be evaluated

N85-21195*# Aerospace Corp , El Segundo, Calif

ASSESSMENT OF SATELLITE COLLISION HAZARDS BY SIMULATED SAMPLING IN SPACE

V A CHOBOTOV *In* NASA Lyndon B Johnson Space Center Orbital Debris p 84-101 Mar 1985 refs

Avail NTIS HC A20/MF A01 CSCL 22A

The origin and distribution of the tracked population of objects and implications for future missions were examined The distribution of the tracked population of objects as a function of altitude and orbital inclination are studied Representative encounter parameters such as the number, relative velocity, and miss distance are determined for circular mission orbits and are used to classify regions of space according to the degree of collision hazard presented Implications for space shuttle and geosynchronous orbits are examined

E A K

N85-21199*# Southwestern Univ , Georgetown, Tex

PRELIMINARY DESIGN OF AN EARTH-BASED DEBRIS DETECTION SYSTEM USING CURRENT TECHNOLOGY AND EXISTING INSTALLATIONS

T H MORGAN *In* NASA Lyndon B Johnson Space Center Orbital Debris p 150-163 Mar 1985

Avail NTIS HC A20/MF A01 CSCL 22A

Assessment of debris hazard requires the determination of debris down to mm sizes for near-Earth orbits and near-stationary points It is necessary to obtain reasonable orbits for a statistically significant sample of the debris population Several ground-based techniques for detection are available Radar detection was used to obtain information of existing debris population Another technique is optical detection The possibilities and application of optical detection with state-of-the-art instrumentation is studied

E A K

N85-21223*# National Aeronautics and Space Administration Johnson (Lyndon B) Space Center,

ENVIRONMENT DEFINITION, SMALL PARTICLES, DIAMETER LESS THAN OR EQUAL TO 1 MM

In its Orbital Debris p 426-429 Mar 1985

Avail NTIS HC A20/MF A01 CSCL 22A

The collection of particles of diameters one millimeter and less far outnumbers the larger particle distribution in orbit These small particles cannot be tracked from ground based radar as can the larger debris, therefore, there is greater uncertainty in their properties The population is growing from contributions due to collisions of larger debris, explosions, and aluminum oxide particles from solid rocket motors The solid rocket motor contribution is the prominent growth parameter, and the input from Space Shuttle deployed upper stages will range between 50,000 and 100,000 pounds per year The environment is important because of the different design problems that will be posed to the engineer and scientist The emphasis shifts from catastrophe deign, probability

versus exposure time, and tracking-avoidance, to a continuous degradation problem Author

08

ASSEMBLY CONCEPTS

Includes automated manipulator techniques, EVA, robot assembly, teleoperators, and equipment installation

A85-13001*# Massachusetts Inst. of Tech., Cambridge
NEUTRAL BUOYANCY EVALUATION OF TECHNOLOGIES FOR SPACE STATION EXTERNAL OPERATIONS
D L AKIN, M L BOWDEN, and J. R SPOFFORD (MIT, Cambridge, MA) International Astronautical Federation, International Astronautical Congress, 35th, Lausanne, Switzerland, Oct 7-13, 1984 8 p refs
(Contract NAGW-21)
(IAF PAPER 84-38)

In order to perform a complete systems analysis for almost any large space program, it is vital to have a thorough understanding of human capabilities in extravehicular activity (EVA) The present investigation is concerned with the most significant results from the MIT Space Systems Lab's neutral buoyancy tests An evaluation of neutral buoyancy is considered along with the tested structures, aspects of learning, productivity, time and motion analysis, and assembly loads Attention is given to EVA assembly with a manned maneuvering unit, teleoperated structural assembly, an integrated control station, a beam assembly teleoperator, and space station proximity operations G R

A85-13017#
A SPACE STATION EXPERIMENT ON LARGE ANTENNA ASSEMBLY AND MEASUREMENT - A FOLLOW-ON STUDY
Y OHKAMI, K MATSUMOTO (National Aerospace Laboratory, Chofu, Tokyo, Japan), T IIDA, K OKAMOTO (Ministry of Posts and Telecommunications, Radio Research Laboratories, Koganei, Tokyo, Japan), A KINPARA (Japan Broadcasting Corp , Technical Research Laboratories, Tokyo, Japan), and I OHTOMO (Nippon Telegraph and Telephone Public Corp , Yokosuka Electrical Communication Laboratory, Yokosuka, Kanagawa, Japan) International Astronautical Federation, International Astronautical Congress, 35th, Lausanne, Switzerland, Oct 7-13, 1984 9 p
(IAF PAPER 84-58)

Results are presented of a follow-on study of a space-station experiment involving the assembly of a large antenna and the carrying out of a series of measurements and operational tests A 10-meter antenna reflector is assumed to be assembled from segments using manipulators operated by a crew inside the pressurized module of the space station Various configurations of the antenna reflector are evaluated to meet the requirements imposed on such instruments as the microwave radiometer, weather radar, and VLBI detector Particular consideration is given to offset/center-feed configurations, segmentation methods, surface control capabilities, compatibility with the STS cargo bay, and scalability to larger reflectors B J

A85-13227#
SERVICE MANIPULATOR SYSTEM FOR MAINTENANCE AND SERVICING OF FUTURE SPACE PLATFORMS
J -L. LACOMBE and T BLAIS (Matra, S.A , Velizy-Villacoublay, Yvelines, France) International Astronautical Federation, International Astronautical Congress, 35th, Lausanne, Switzerland, Oct. 7-13, 1984 11 p Research supported by the European Space Agency and Centre National d'Etudes Spatiales. refs
(IAF PAPER 84-369)

Design features, performance parameters, and numerical models for manipulators (robot arm) which would be used in the maintenance and servicing of orbiting materials processing platforms are described The manipulators could be located on the platform and on the transportation vehicles and placed in service for routine, difficult (only partially programmable), or emergency (reaction time limited) tasks It is assumed that platform designs would assure that only one manipulator be required for a task The models account for adaptation of the arm motions to the local environment, selection of the geometric and kinematical system characteristics, characterization of the manipulator dynamics, architecture and configuration, and different control modes with variable operator involvement Critical areas of further research to realize a European manipulator system are delineated M S K

A85-13229#
SATELLITE GRASPING MANIPULATOR SYSTEM
J J RUNAVOT, M MAURETTE, J M LOPEZ, L PETITJEAN, and M L VILLA (Centre National d'Etudes Spatiales, Toulouse, France) International Astronautical Federation, International Astronautical Congress, 35th, Lausanne, Switzerland, Oct 7-13, 1984 6 p.
(IAF PAPER 84-371)

Progress made on identification of design parameters on missions for European spaceborne manipular systems are outlined The manipulator would be deployed after a chaser sequence to close on a satellite After grappling, a period of time would be needed to damp the relative motion between the two spacecraft The manipulator was found to have 6 DOF, with control laws being necessary to govern joint movement and trajectory in proximity operations A NASTRAN modal analysis is being performed to derive control law and hardware design parameters Gear train lubrication has become recognized as a critical factor Further studies are being pursued on the proximity, optical, and RF sensors A simulation laboratory has been established for examining modeled dynamical situations M S K

A85-19466#
SPACE STATION REMOTE MANIPULATOR REQUIREMENTS DEFINITION
B A LOGAN, JR (Rockwell International Corp , Space Station Systems Div , Downey, CA) American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 23rd, Reno, NV, Jan 14-17, 1985 4 p
(AIAA PAPER 85-0029)

An essential element of the Space Station is the remote manipulator It will be used for assembly of the Space Station from the modules brought up by the National Space Transportation System (NSTS), for handling of payloads/experiments on the Space Station, for grappling and berthing co-orbiting spacecraft (including the orbiter), and for assembly of large space structures The operational and assembly uses are examined to define the requirements that these uses impose on the Space Station remote manipulator These requirements include degrees-of-freedom (such as translation of the mounting base), reach envelope, loads capacity, stopping distance, translational and rotational rates, positioning accuracy, etc Finally, the capabilities of the orbiter remote manipulator system are compared with the requirements of the Space Station remote manipulator Author

A85-20400#
SYNERGY IN SPACE - MAN-ROBOT COOPERATION
S WALTERS Mechanical Engineering (ISSN 0025-6501), vol 107, Jan. 1985, p 26-37

The forecast of U S national space strategy for the next 25 years and beyond, as announced by President Reagan in October, 1983, is concerned with the permanent occupation of space by man In connection with plans for the implementation of such an occupation, NASA has considered the concept of a 'flotilla' with a manned base in the center, a utility core, a modular laboratory, and an orbital service station The presence of man and machines, in particular computer-linked machines, is to provide possibilities for the continuous exploitation of space. Studies have identified automation, robotics, and machine intelligence systems (ARAMIS) as an important contributor to the productivity of orbital factories Attention is given to aspects of 'telepresence', plans for 1995

and beyond, the orbital maneuvering vehicle (OMV), OMV applications, the support of materials-processing platforms, telepresence technology, a stereo-optic vision system, manipulator arms, end-effectors, communications, and long-term plans and goals G R

N85-14492*# CAE Electronics Ltd, Montreal (Quebec)
SIX DEGREES OF FREEDOM CONTROL WITH EACH HAND? Abstract Only
M L KING *In* NASA Ames Research Center 20th Ann Conf on Manual Control, Vol 1 p 91 Sep 1984
Avail NTIS HC A99/MF A01 CSCL 05H

For some time man has made six degree of freedom inputs to a pair of dextrous manipulators using both hands simultaneously by the use of the master/slave concept The advent of the microprocessor has the potential to make the master/slave concept redundant by replacing the master with a mathematical model All spacecraft to date, including the space shuttle, that were flown in six degrees of freedom were controlled by using both hands, the left hand controlling translation and the right rotation Almost inevitably the same principle was applied to the CANADARM At the instigation of NASA the development of a device whereby both translation and rotation could be combined allowing full control with one hand was developed The development and testing of the device, and the extension of its application into spaceflight control are described Also the concept of an adaptable workstation for multi-manipulator and spacecraft flight control is discussed B G

N85-16178*# Stanford Univ, Calif
PRECISE CONTROL OF FLEXIBLE MANIPULATORS Final Report, Mar. 1983 - Jun. 1984
R H CANNON, JR, T O BINDFORD, and E SCHMITZ Sep 1984 53 p refs Original contains color illustrations
(Contract NAG1-322)
(NASA-CR-174210, NAS 1 26·174210) Avail NTIS HC A04/MF A01 CSCL 05H

The design and experimental testing of end point position controllers for a very flexible one link lightweight manipulator are summarized The latest upgraded version of the experimental set up, and the basic differences between conventional joint angle feedback and end point position feedback are described A general procedure for application of modern control methods to the problem is outlined The relationship between weighting parameters and the bandwidth and control stiffness of the resulting end point position closed loop system is shown It is found that joint rate angle feedback in addition to the primary end point position sensor is essential for adequate disturbance rejection capability of the closed loop system The use of a low order multivariable compensator design computer code, called Sandy is documented A solution to the problem of control mode switching between position sensor sets is outlined The proof of concept for endpoint position feedback for a one link flexible manipulator was demonstrated The bandwidth obtained with the experimental end point position controller is about twice as fast as the beam's first natural cantilevered frequency, and comes within a factor of four of the absolute physical speed limit imposed by the wave propagation time of the beam E A.K

N85-16963*# National Aeronautics and Space Administration Johnson (Lyndon B) Space Center,
THE SPACE SHUTTLE ORBITER REMOTE MANIPULATOR POSITIONING MECHANISM
J H HARDEE *In its* Space Shuttle Tech Conf, Pt 2 p 883-891 Jan 1985
Avail NTIS HC A23/MF A01 CSCL 22B

The major subassemblies of the Manipulator Positioning Mechanism (MPM) are described and illustrated The Space Shuttle Orbiter design provides that the MPM may be mounted on either left or right sides of the payload bay, or both sides if two are flown This MPM is provided for the purpose of securing the remote arm in stowed position during lift-off, boost, and landing It also provides the deploy, latch and unlatch capabilities of the Remote Manipulator System arm R J F

N85-16964*# Spar Aerospace Ltd, Toronto (Ontario)
AN OVERVIEW OF THE SPACE REMOTE MANIPULATOR SYSTEM
T. H USSHER and K H DOETACH *In* NASA Johnson Space Center Space Shuttle Tech Conf, Pt 2 p 892-904 Jan 1985 refs
Avail NTIS HC A23/MF A01 CSCL 22B

An overview of the system requirements and performance of the Shuttle Remote Manipulator System (SRMS) is given Data on some of the mechanical design considerations that were necessary during the development program are presented The operational success of both the Orbiter and the SRMS during flights of Space Transportation System-2, -3, and -4 is ample evidence that the SRMS performed as expected and as desired. While some minor improvements were made in the follow-on production systems, one of which was delivered and two of which are currently under construction, the system design did not change significantly Thus, information given is applicable to all the manipulator systems R J F

N85-19015*# National Aeronautics and Space Administration Langley Research Center, Hampton, Va
SWING-ARM BEAM ERECTOR (SABER) CONCEPT FOR SINGLE ASTRONAUT ASSEMBLY OF SPACE STRUCTURE
J J WATSON, W L HEARD, JR, and J K JENSEN (Kentron International, Inc) Mar 1985 32 p refs
(NASA-TP-2379, L-15886, NAS 1 60 2379) Avail NTIS HC A03/MF A01 CSCL 22B

Results are presented of tests conducted to evaluate a mobile work station/assembly fixture concept that would mechanically assist an astronaut in the on-orbit manual assembly of erectable truss-beams The concept eliminates astronaut manual translation by use of a motorized work platform with foot restraints The tests involved assembly of a tetrahedral truss-beam by a test subject in simulated zero gravity (neutral bouyancy in water) A three-bay truss-beam was assembled from 30 aluminum struts with quick-attachment structural joints The results show that average on-orbit assembly rates of 2 1 struts per minute can be expected for struts of the size employed in these tests Author

N85-21666# Carnegie-Mellon Univ, Pittsburgh, Pa Lab for Autonomous Mobile Robots
A FUNCTIONAL VEHICLE FOR AUTONOMOUS MOBILE ROBOT RESEARCH Interim Report
G PODNAR, K DOWLING, and M BLACKWELL Apr 1984 80 p Sponsored in part by the Office of Naval Research
(AD-A150052, CMU-RI-TR-84-28) Avail NTIS HC A05/MF A01 CSCL 14B

Neptune is a tethered vehicle built for autonomous mobile robot research Included are the design considerations, the resulting design, and details of the mechanical structure and electrical control system Detail is sufficient to enable replication or adaptation by others A discussion of the performance with respect to the design considerations is also included GRA

N85-22230*# Berry Coll, Mount Berry, Ga Dept of Physics
EVALUATION OF OMV RANGING AND DOCKING SYSTEMS
M W MCDONALD *In* Alabama Univ. Res Rept 1984 NASA/ASEE Summer Faculty Fellowship Program
(NASA-CR-171317) 18p Jan 1985 refs
Avail NTIS HC A99/MF E03 CSCL 22A

The Orbital Maneuvering Vehicle (OMV) will serve as a shuttle-based or permanent space station-based vehicle designed to rendezvous and soft dock with various other free-flying space vehicles for purposes of inspection, support, and retrieval This study is concerned primarily with the eventual need for the OMV to rendezvous and dock softly with the Edwin P Hubble Space Telescope (ST) Utilizing the available capabilities of the large microwave anechoic chamber facility at Marshall Space Flight Center for simulating docking target vehicle motions in a free-space

environment, a program is being devised for benchmark testing of rendezvous and docking sensor systems proposed for use on the OMV A testing regimen suitable for evaluating the accuracy and tracking agility in sensing range, range rate, and angle information at close ranges (0 R 30m) has been developed G L C

09

PROPULSION

Includes propulsion concepts and designs utilizing solar sailing, solar electric, ion, and low thrust chemical concepts

A85-12519#
BIPROPELLANT PROPULSION IN THE NEW GENERATION OF SATELLITES AND UPPER STAGES: THE ROLE OF BPD DIFESA-SPAZIO IN THIS FIELD - MANUFACTURING FACILITIES AND TECHNOLOGY [LA PROPULSIONE A BIPROPELLENTE NELLA NUOVA GENERAZIONE DI SATELLITI E UPPER STAGES: RUOLO DELLA BPD DIFESA-SPAZIO IN QUESTO CAMPO - IMPLANTISTICA E TECNOLOGIA]
A. FABRIZI, G BAIOCCHI, M LIGUTTI, and A PETRIVELLI (BPD Difesa-Spazio, Direzione Sviluppo e Ricerche, Colleferro, Italy) IN International Scientific Conference on Space, 23rd, Rome, Italy, March 24, 25, 1983, *Proceedings* . Rome, Rassegna Internazionale Elettronica Nucleare ed Aerospaziale, 1984, p. 275-286 In Italian

The development of integrated storable-liquid-propellant propulsion systems (ISPS) for satellites and upper stages at BPD Difesa-Spazio is surveyed and illustrated with drawings, diagrams, and a plan of the assembly plant The flexibility and performance of ISPS are shown to make them well suited for LEO-GEO transfer missions, either as satellite propulsion or as upper stage for larger payloads (for example in the weight-class gap between the STS PAM-A and IUS) The ISPSs developed for the ESA L-Sat and for Italsat and proposed for an ESA STS-compatible upper propulsion stage and an ESA large multipurpose platform (comprising one ISPS, one service module, and three payload modules, to be assembled in LEO with the STS manipulator arm after STS launch and propelled to GEO by the ISPS) are characterized, and the assembly facility at Colleferro (including a class 30,000 and a class 100,000 cleanroom) is described T K

A85-12520#
IRIS SPINNING STAGE - A PERIGEE STAGE FOR SATELLITES UP TO 900 KG TO BE LAUNCHED FROM THE SPACE SHUTTLE WITH THE IRIS SYSTEM [IRIS SPINNING STAGE - UNO STADIO DI PERIGEO PER SATELLITI FINO A 900 KG DA LANCIARE DALLO SPACE SHUTTLE CON IL SISTEMA IRIS]
G. SOLPANELLI and G BALDI (BPD Difesa-Spazio, Direzione Sviluppo e Ricerche, Colleferro, Italy) IN International Scientific Conference on Space, 23rd, Rome, Italy, March 24, 25, 1983, Proceedings . Rome, Rassegna Internazionale Elettronica Nucleare ed Aerospaziale, 1984, p 287-299. In Italian

The design of the IRIS Spinning Stage (ISS), the propulsion unit which with the reusable airborne support systems and the ground-support equipment comprises the IRIS GTO-injection system, is presented and illustrated with drawings The ISS includes payload attachment and separation fittings, a thermal-control system, electronic systems (power supply, sequencer, and nutation control); telemetry (2K baud, 5-W, 2 2-2 3 GHz, with 80 analog and 48 digital channels), and an end-burning-configuration HTPB-1813 solid-fuel motor providing maximum total impulse 4 49 MN sec with burn time 79 sec and propellant weight 1574 kg The ISS is scheduled to achieve operational status by the end of 1986 T K

A85-12926
THE STATE OF THE ART SOLAR SAIL AND THE INTERSTELLAR PRECURSOR MISSION
G. L. MATLOFF (Pratt Institute, Brooklyn, NY) British Interplanetary Society, Journal (Interstellar Studies) (ISSN 0007-084X), vol 37, Nov 1984, p 491-494 refs

Current designs for interplanetary solar sailing, such as those of the World Space Foundation, could be modified to boost interstellar precursor probes on long-duration interstellar trajectories. In this paper, the utilization of the thinnest current Kapton sail for this application is examined A performance envelope is generated using a modification of the previously published sail performance optimization program for optimistic and pessimistic sail thermal assumptions and payloads in the range of 10-100 kg Many configurations can boost interstellar medium probes capable of reaching Alpha Centauri in 7000-9000 years Results derived from a three-dimensional interactive computer graphics package are presented for thermal and stress effects on the sail-cable combination Author

A85-13000#
DESIGN AND TECHNOLOGY TRENDS ON LARGE SOLAR ARRAYS FOR SPACE STATIONS
W WESTPHAL and J RATH (Telefunken AG, Wedel, West Germany) International Astronautical Federation, International Astronautical Congress, 35th, Lausanne, Switzerland, Oct 7-13, 1984 14 p
(IAF PAPER 84-37)

New design and technology requirements for large solar arrays operating in the environment of a space station are reviewed, with particular attention given to blanket/solar cell assemblies, structures and mechanisms, and special maintenance-related devices It is shown that the overall configuration and system concept are largely dictated by the operational environment of a space station Both the indefinite service life of a space station and its growing power requirements call for a design that would incorporate the following features replaceability and add-on capability made possible by a modular design of functional units, versatility of the system configuration, design testability by the Space Shuttle in a low earth orbit, and configuration control capability V L.

A85-13021#
IN-ORBIT LASER REGENERATION OF THE RADIATION DAMAGED SOLAR ARRAYS
V POULEK (Ceskoslovenska Akademie Ved, Fyzikalni Ustav, Prague, Czechoslovakia) International Astronautical Federation, International Astronautical Congress, 35th, Lausanne, Switzerland, Oct 7-13, 1984 7 p refs
(IAF PAPER 84-62)

Technological developments targeted at permitting laser annealing of space radiation-damaged solar cells on spin-stabilized satellites are outlined The concept is feasible because solar cell defects can be removed by laser temperatures of 200-400 C, while the transfer of heat to the cell panel structure results in structural temperatures below 100-200 C The structures are not damaged at temperatures under 200 C Tests with a 2 J/sq cm laser beam with a 1 msec pulse shone on Si solar cells revealed no damage to soldered panel connections Future tests on cells irradiated in orbit are recommended If implemented, the technology would consist of a deployable laser-directing boom to guide the beam perpendicular to the satellite surface, tracing a spiral pattern that eventually covers the entire surface A semiconductor laser would draw 10 V, which could be supplied directly from the panels without power conversion M S K.

A85-13191#
THE CHALLENGE OF ADVANCED SPACE TRANSPORTATION AND PROPULSION SYSTEMS
V R LARSON (Rockwell International Corp , Rocketdyne Div , Canoga Park, CA) International Astronautical Federation, International Astronautical Congress, 35th, Lausanne, Switzerland, Oct 7-13, 1984 32 p refs
(IAF PAPER 84-310)

In connection with trends related to developments concerning space transportation, space missions, and the utilization of space, challenges arise The present investigation is concerned with these challenges, taking into account aspects of system definition and economic evaluation In an examination of the current situation, it is found that for a reduction of space transportation costs it would be most beneficial to lower the cost for the boost (earth-to-LEO) phase A 50 percent reduction in this phase would reduce LEO (low-earth-orbit) cost to the 500 to 750 U S $/lb range Space missions are discussed, taking into account requirements, projections of future flights, the replacement market (GEO satellites), competing technologies and future growth, and large space stations Attention is also given to propulsion conceps, expendable and reusable LEO-to-GEO transfer vehicles, space transfer economics, and planetary and other scientific space missions G R

A85-13282*# National Aeronautics and Space Administration Johnson (Lyndon B) Space Center,
TETHERED PROPELLANT RESUPPLY TECHNIQUE FOR SPACE STATIONS
K. R KROLL (NASA, Johnson Space Center, Houston, TX) International Astronautical Federation, International Astronautical Congress, 35th, Lausanne, Switzerland, Oct 7-13, 1984 8 p
(IAF PAPER 84-442)

One of the primary functions of the space station is related to the propellant resupply of orbital transfer vehicles, orbital maneuvering vehicles, and satellites Difficulties arise in the case of an acquisition of cryogenic propellants by means of a use of zero-gravity techniques The use of the 'tethered propellant resupply technique' is, therefore, considered A study is being conducted to determine the feasibility, design requirements, and operational limitations of this technique Attention is given to aspects of gravity feed, transfer method selection, requirements related to the orbital transfer vehicle, hazard clearance, attitude control, depot operations, end mass velocity, the microgravity laboratory, and concept evaluation activities G R

A85-15874#
SIMULATION OF REUSABLE CISLUNAR SPACE TRANSPORTATION SYSTEMS WITH SPECIAL CONSIDERATION OF CHEMICAL PROPULSION [SIMULATION WIEDERVERWENDBARER RAUMTRANSPORTSYSTEME IM CISLUNAREN RAUM UNTER BESONDERER BERUECKSICHTIGUNG CHEMISCHER ANTRIEBE]
R RESS Berlin, Technische Universitaet, Fachbereich Verkehrswesen, Dr -Ing Dissertation, 1983, 188 p In German refs

The design of a multicomponent space transportation system to support such missions as nuclear-waste disposal, GEO solar-power-satellite construction, and lunar mining or manufacturing is investigated by means of computer simulations involving reusable chemically propelled spacecraft The simulation comprises mission, spacecraft, facilities, management, production, and cost models and is based on currently available technologies and current costs The main requirements for the system are supply of a lunar station and transport of 100 Gg/yr or more from earth or moon to GEO, with a system life of about 60 yr, and it is found that they are best met by a two-stage 9 5 Gg ballistic launcher, three types of shuttle vehicles, and space stations in GEO and lunar orbit to provide the shuttles with H2 and O2, respectively Up to 730 launches and 1000 shuttle flights (on each route) per year at costs of $30-50/kg for earth-Leo, $100-150/kg for earth GEO, anad $40-60/kg for moon-GEO predicted T K

A85-16439*# National Aeronautics and Space Administration Lewis Research Center, Cleveland, Ohio
PERFORMANCE CAPABILITIES OF THE 12-CENTIMETER XENON ION THRUSTER
M MANTENIEKS and M SCHATZ (NASA, Lewis Research Center, Cleveland, OH) IN International Electric Propulsion Conference, 17th, Tokyo, Japan, May 28-31, 1984, Proceedings Tokyo, Japan Society for Aeronautical and Space Sciences, 1984, p 506-523 Previously announced in STAR as N84-27825 refs

The 8- and 12-cm mercury ion thruster systems were developed primarily to provide N-S station keeping of satellites with masses up to about 1800 to 3600 kg respectively The on-orbit propulsion requirements of recently proposed Large Space Systems (LSS) are beyond the thrust capabilities of the baseline 8- and 12-cm thruster systems This paper presents a characterization of the performance capabilities of the 12-cm Xenon ion thruster to enable an evaluation of its application to LSS auxiliary propulsion requirements With minor thruster modifications and simplifications the thrust was increased to 64 mN, a factor of six over the baseline 12-cm mercury thruster performance The thruster was operated over a range of specific impulse of about 2000 to 4000 seconds and at total efficiencies up to 68 0 percent The operating levels reached in this study were found to be close to the operating limits of the thruster design in terms of perveance, grid breakdown voltage and thruster component temperatures such as those of the magnets and cathode baffle Author

A85-16448#
DESIGN AND BENEFITS OF PULSED MPD THRUSTER ORBIT TRANSFER VEHICLES
L K RUDOLPH (Martin Marietta Aerospace, Denver, CO) IN International Electric Propulsion Conference, 17th, Tokyo, Japan, May 28-31, 1984, Proceedings Tokyo, Japan Society for Aeronautical and Space Sciences, 1984, p. 590-599 refs
(Contract F04611-82-C-0049)

Two detailed orbit transfer vehicle (OTV) point designs have been completed for pulsed self-field MPD thruster systems The first design is for a 200 kWe nuclear-powered reusable OTV capable of delivering a 20,000 kg payload to geosynchronous orbit (GEO) The second design is for a 50 kWe solar-powered expendable OTV capable of delivering 5,000 kg to GEO These OTVs were compared to similar advanced LO2/LH2 chemical OTVs Although both MPD thruster OTVs have lower launch masses and simpler mission operational requirements, overall life cycle cost estimates indicate that higher power levels or larger payloads are necessary for MPD thruster OTVs to be competitive Author

A85-18671* Aerospace Corp , Los Angeles, Calif
OPTIMAL LOW-THRUST, THREE-BURN ORBIT TRANSFERS WITH LARGE PLANE CHANGES
K P ZONDERVAN (Aerospace Corp , Performance Analysis Dept , Los Angeles, CA), L J WOOD (California Institute of Technology, Jet Propulsion Laboratory, Navigation Systems Section, Pasadena, CA), and T K CAUGHEY (California Institute of Technology, Pasadena, CA) Journal of the Astronautical Sciences (ISSN 0021-9142), vol 32, Oct -Dec 1984, p 407-427 refs

Optimal low-thrust, three-burn solutions have been obtained for orbit transfers between a 28 5-degree inclined low earth orbit and a series of 63 4-degree inclined circular orbits as well as a series of 63 4-degree inclined elliptical orbits with twelve hour periods Solutions have also been obtained for orbit transfers between 97-degree inclined orbits and a 57-degree inclined low earth orbit Thrust to weight ratios as low as 0 02 were considered A hybrid nonlinear programming method was used to obtain the solutions Analysis of the optimal steering during various burns reveals a natural division of the steering strategies into two categories based on whether a burn results in a change predominantly in semi-major axis or orbit plane The similarity of these optimal steering strategies to previously obtained simple near-optimal steering strategies is discussed Author

A85-19561#
SOLAR CONCENTRATOR FOR SPACE POWER GENERATION
J E LINDSAY and C S NERHEIM (Washington, University, Seattle, WA) American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 23rd, Reno, NV, Jan 14-17, 1985 7 p refs
(AIAA PAPER 85-0164)

A solar collector of Cassegrainian type, designed to collect over 1000 kilowatts of solar energy, is presented When combined with energy storage, a dynamic energy conversion cycle, and a liquid droplet radiator for heat rejection, the system has great potential for space station applications. Wrapped ribs provide the supporting structure for the mirrors, and the reflective surface is to be aluminized Kapton An opening at the base of the large mirror provides the entrance to energy storage Located at this opening is a conic concentrator to enhance the energy gathering capability of the system The component and total mass of a typical system is computed Computerized ray tracing is used to examine the interaction between the structural and optical aspects of the mirror system The aiming accuracy of the configuration is very sensitive to vibrations of the secondary mirror The effects of these on the focusing power of the mirrors is investigated, and the maximum allowable displacement is determined Author

A85-19660#
THE LOW COST DEVELOPMENT, TEST, AND PRODUCTION OF A COMMERCIAL STS UPPER STAGE: TOS
T W WHITE, B E THOMPSON, and J R GRUBBS (Martin Marietta Aerospace, Denver, CO) American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 23rd, Reno, NV, Jan 14-17, 1985 8 p. Research supported by the Orbital Sciences Corp.
(AIAA PAPER 85-0313)

The Space Transportation System (STS) has to compete for commercial payload launches with a variety of expendable launch vehicles (ELVs) Many of these payloads have to be placed into a final orbit which cannot be provided by the Shuttle Orbiter An upper stage booster is, therefore, needed The Transfer Orbit Stage (TOS) is being developed to satisfy this need at a competitive user cost The requirements for the development and test program for the TOS system are related to a 'minimum cost - minimum risk' approach In this context, the use of existing flight qualified 'off the shelf' hardware is to be maximized Attention is given to a TDS system description, the development test objectives, and the TOS test program results G R

A85-19714#
CIRCUIT TRANSIENTS DUE TO NEGATIVE BIAS ARCS ON A HIGH VOLTAGE SOLAR ARRAY IN LOW EARTH ORBIT
R N METZ (Colby College, Waterville, ME) American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 23rd, Reno, NV, Jan 14-17, 1985 7 p refs
(AIAA PAPER 85-0385)

Arcing to negatively biased, exposed solar cell interconnects on solar arrays placed in plasma environments has been well established in laboratory tests and inferred from space data Such arcing may cause damaging interference with the operation of electrical power systems in spacecraft planned to be driven with high voltage solar arrays A simple analytical model has been developed to estimate the effects of negative bias arcs on solar array power system performance Solar cell characteristics, plasma interactions and power system features are modeled approximately by a linear, lumped element transient circuit and the time domain equations are solved Exact numerical results for solar array common-mode and load voltage transients are calculated for typical conditions Acceptable load transients are found for a range of arc current amplitudes and time constants Author

A85-19715*# *System Science and Software, San Diego, Calif*
COMPUTER SIMULATION OF PLASMA ELECTRON COLLECTION BY PIX-II
M J MANDELL, I KATZ, G A. JONGEWARD (System Science and Software, La Jolla, CA), and J C. ROCHE (NASA, Lewis Research Center, Cleveland, OH) American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 23rd, Reno, NV, Jan 14-17, 1985 9 p refs
(Contract NAS3-23881)
(AIAA PAPER 85-0386)

A wake model was defined for the NASCAP/LEO finite element model for the plasma interaction experiment (PIX-II) launched to study the interaction between high-voltage large solar arrays with the space plasma environment The cell surface model considers the individual cells, distances between interconnects, and the fraction of surface covered by interconnects Account is taken of the electrostatic potential around the spacecraft, which travels at 7500 mps, over five times the speed of thermal ions Ram ions are produced ahead of the array and the wake ion density is described with a geometric shadowing model The model correctly predicted the currents in high and low bias voltages when compared to orbital data The panel snapover, however, was projected to occur at 100 V and instead occurred at 300 V, which indicates that the snapover state is bistable Finally, a low potential was both predicted and measured in the wake M S K

A85-19744#
OPTIMAL ELECTRIC PROPULSION ORBIT TRANSFER VEHICLE DESIGN AND OPERATIONAL EFFECTIVENESS
L W MADDOX (USAF, Colorado Springs, CO), M M MEKARU, W C ELROD, and W E WIESEL (USAF, Institute of Technology, Wright-Patterson AFB, OH) American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 23rd, Reno, NV, Jan 14-17, 1985 12 p refs
(AIAA PAPER 85-0431)

An analysis methodology for examining electric propulsion technologies for spacecraft and making comparisons with other propulsion systems is described Attention is focused on a reusable electric orbit transfer vehicle (EOTV) with specific impulses (Isp) of 1000-10,000 sec capable of moving large payloads to GEO The technique involves design optimization for different electric thruster technologies followed by a simulated fly-off among systems with a 20 yr operational lifetime Optimization is carried out using the sequential unconstrained optimization technique, taking into account the input power vs Isp and exhaust velocity relationship and input power vs thrust Sample predictions are made for the EOTV, IUS, Centaur-G, and a reusable bipropellant vehicle The EOTV is found to have the lowest life cycle cost/kg for payloads delivered to GEO M S K

A85-22444#
FINITE MULTIPLE BURN ORBIT TRANSFER ERROR ANALYSIS VIA COVARIANCE MATRIX
W YANG Chinese Society of Astronautics, Journal, no 4, 1984, p 30-43 In Chinese, with abstract in English refs

The finite multiple burn method is used for the transfer from Space Shuttle low earth orbit to the geostationary orbit with low accelerations In this case, the study of orbit transfer insertion error becomes very complicated Generally speaking, an analytical method via covariance matrix is not suitable, and a semianalytical metod or digital method must be employed It is pointed out after detailed discussion that it is feasible for perigee burns to adopt a semianalytical method, and for apogee burn to adopt an analytical method in order to save computation time. The paper describes the propagation matrices of perigee burns, apogee burn, and coast phase, and also provides a transfer matrix for orbit element error. In addition, the flow chart and verification methods of the program are discussed in detail Finally, an example is given Author

A85-23393*# Aerojet Techsystems Co , Sacramento, Calif
INTEGRATABLE PROPULSION SYSTEMS FOR THE SPACE STATION
S D ROSENBERG, D C JUDD (Aerojet TechSystems Co , Sacramento, CA), and P W GARRISON (California Institute of Technology, Jet Propulsion Laboratory, Pasadena, CA) Journal of Propulsion and Power (ISSN 0748-4658), vol 1, Jan -Feb 1985, p 65-69 NASA-supported research Previously announced in STAR as N84-29933 refs

Oxygen/hydrogen propulsion system options for space station orbit maintenance and attitude control were developed and evaluated relative to monopropellant and storable bipropellant propulsion systems Space station propulsion requirements were analyzed with reference to such considerations as station size, altitude, power, crew size, and orbit transfer vehicle and orbital maneuvering vehicle servicing requirements The evolutionary growth of oxygen/hydrogen bipropellant propulsion as an integral part of several interrelated space station functions, e g , life support, power, and thermal management was considered Propellant resupply evolves from resupply based on transport of liquid oxygen and liquid hydrogen to water The advantages of the operation of the space station based on an oxygen/hydrogen economy are presented and discussed Author

A85-23394*# Los Alamos Scientific Lab , N Mex
DESIGN OF A NUCLEAR ELECTRIC PROPULSION ORBITAL TRANSFER VEHICLE
D BUDEN (Los Alamos National Laboratory, Los Alamos, NM) and P W GARRISON (California Institute of Technology, Jet Propulsion Laboratory, Pasadena, CA) Journal of Propulsion and Power (ISSN 0748-4658), vol 1, Jan -Feb 1985, p 70-76 Previously cited in issue 17, p 2443, Accession no A84-37655 refs

A85-23990
THE COST EFFECTIVENESS AND OPTIMAL PARAMETERS OF AN ELECTRIC ROCKET PROPULSION SYSTEM FOR AN INTERORBITAL TRANSPORT VEHICLE [EKONOMICHESKAIA EFFEKTIVNOST' I OPTIMAL'NYE PARAMETRY ELEKTRORAKETNOI DVIGATEL'NOI USTANOVKI DLIA MEZHORBITAL'NOGO TRANSPORTNOGO APPARATA]
D D SEVRUK, V K SHININ, and A F. SHTYRLIN Aviatsionnaia Tekhnika (ISSN 0579-2975), no 3, 1984, p 65-69 In Russian refs

The cost effectiveness of using an electric propulsion system for an interorbital transport vehicle for cargo delivery from a low near-earth orbit to a geostationary orbit is analyzed For given power plant parameters, characteristic velocity, and initial mass of the vehicle, the parameters of the electric propulsion system are optimized with respect to minimum cost per unit load It is shown that the use of an electric propulsion system can reduce the cost of cargo delivery to a geostationary orbit by a factor of 1 5-3 2 in comparison with a liquid-propellant engine V L

A85-24788*# National Aeronautics and Space Administration Langley Research Center, Hampton, Va
ORBIT ON DEMAND - IN THIS CENTURY IF PUSHED
J A MARTIN (NASA, Langley Research Center, Space Systems Div , Hampton, VA) Aerospace America (ISSN 0740-722X), vol 23, Feb 1985, p 46-48

Performance requirements and design features of the next generation of manned launch vehicles are discussed The vehicles will launch within minutes of demand and will have a several-day turnaround time Launch and landing sites will have minimal facilities Baseline requirements comprise carriage and return of a 5000 lb, 7 ft diam, 15 ft long payload, a 160 n mi polar orbit, a 200 fps on-orbit delt-V capability, provisions for two men for 24 hr, an 1100 n mi cross range option, 500 flights/vehicle, land on 10,000 ft runways, and be acceptable passing over populated areas Significant advances are needed in propulsion and fuel systems, lightweight durable structures and airbreathing acceleration engines Trade-offs have yet to be fully explored among the number of stages and horizontal or vertical take-off M S K

A85-24793#
NUCLEAR REACTORS FOR SPACE POWER
D BUDEN Aerospace America (ISSN 0740-722X), vol 23, Feb 1985, p 66-69

The growth in power demands for spacecraft, especially outer planet missions, is driving the development of space nuclear power systems Nuclear reactors could also be used to process lunar materials to take advantage of order of magnitude lower fuel requirements to move construction components off the moon instead of the earth Larger, more powerful broadcast satellites which lower the GEO station space demand could use nuclear power, as could navigational systems, orbital transfer vehicles and a manned Mars mission The SP-100 design is currently undergoing parametric evaluation before engineering studies begin Safety concerns are concentrated on preventing fissioning until the reactor is on-orbit and keeping the active or discarded reactor out of the atmosphere until the radioactivity has decayed to levels defined by international standards M S K

A85-25796
UNLIMITED POWER FOR OUR SPACE VEHICLES
L G CHIDESTER (*Lockheed Missiles and Space Co , Inc*, Sunnyvale, CA) Space Solar Power Review (ISSN 0191-9067), vol 4, no 3, 1983, p 211-228

Photovoltaic solar arrays which derive their energy from the sun and provide the electrical power needed on long life space vehicles are examined Present spacecraft solar arrays provide in the range of 1-5 kW, however, lightweight flexible arrays with reduced cost and increased performance are being developed to provide serveral hundred kilowatts of power The state of the art of solar cell technology, Lockheed's development efforts on new solar arrays, and the upcoming NASA Solar Array Flight Experiment are described The experiment package includes a huge 4 x 32 m flexible solar array, a structure and mechanism for moving it out of the shuttle cargo bay, and a complete data acquisition system to record operational data during ascent and on-orbit operations Space Shuttle applications and three array concepts, developed for space power sources in the 300 kW to 1 MW range, are considered Examples of cost and efficiency improvements being worked on include transparent arrays, multi-bandgap solar cells, thin-film solar cells, and improved concentrator systems Photos of the presently used solar arrays and drawings of the array concepts are presented M D

A85-25797
THE MAXIMUM EFFICIENCY OF AN ISOLATED SOLAR ENERGY CONVERSION DEVICE IN SPACE
C G ADLER and J W BYRD (East Carolina University, Greenville, NC) Space Solar Power Review (ISSN 0191-9067), vol 4, no 3, 1983, p 231, 232

The conversion efficiency of radiant energy to work is considered Interest in energy-conversion devices isolated in space has prompted consideration of optimum location of these systems to maximize the work extracted It is found that optimizing the extraction of work is better characterized by a global efficiency defined in terms of the power extracted, the effective temperature of the sun, and the area of the receiver The global efficiency has a peak which occurs at about 1 5 sun radii from the center of the sun Author

A85-25828
ON THE POTENTIAL PERFORMANCE OF NON-NUCLEAR INTERSTELLAR ARKS
G L MATLOFF (Pratt Institute, Brooklyn, NY) British Interplanetary Society, Journal (Interstellar Studies) (ISSN 0007-084X), vol 38, March 1985, p 113-119 refs

Previous publications which have presented various aspects of non-nuclear interstellar flight, are reviewed These papers have demonstrated the utility of optimized hyperthin or perforated solar sails deployed behind occulters during close perihelion passes

limited only by sail internal thermal constraints, multiple sail missions, and electric propulsion during the pre-perihelion trajectory leg After accounting for the acceleration tolerance of the human occupants, trip times substantially less than 1000 years are possible for one-way missions to Alpha Centaun of payloads of 5 million kg or larger This paper extends this analysis and considers utilization of the Light Sail Windmill as a 'storage battery' and electric propulsion for the early post-perihelion trajectory leg of the mission The Light Sail Windmill's energy storage capability will also be useful for on-board power during the long-interstellar cruise phase of the mission Appropriate combination of various propulsive techniques reveals that trip times of less than 800 years may ultimately be feasible Author

N85-12071*# Battelle Columbus Labs, Ohio
PRELIMINARY ANALYSIS OF SPACE MISSION APPLICATIONS FOR ELECTROMAGNETIC LAUNCHERS Final Technical Report
L. A. MILLER, E E RICE, R W EARHART, and R J CONLON 30 Aug 1984 326 p refs
(Contract NAS3-23354)
(NASA-CR-174067, NAS 1.26 174067) Avail NTIS HC A15/MF A01 CSCL 22A

The technical and economic feasibility of using electromagnetically launched EML payloads propelled from the Earth's surface to LEO, GEO, lunar orbit, or to interplanetary space was assessed Analyses of the designs of rail accelerators and coaxial magnetic accelerators show that each is capable of launching to space payloads of 800 KG or more A hybrid launcher in which EML is used for the first 2 KM/sec followed by chemical rocket stages was also tested A cost estimates study shows that one to two EML launches per day are needed to break even, compared to a four-stage rocket Development models are discussed for (1) Earth orbital missions, (2) lunar base supply mission, (3) solar system escape mission; (4) Earth escape missions, (5) suborbital missions, (6) electromagnetic boost missions, and (7) space-based missions Safety factors, environmental impacts, and EML systems analysis are discussed Alternate systems examined include electrothermal thrustors, an EML rocket gun, an EML theta gun, and Soviet electromagnetic accelerators A R H

N85-13371*# United Technologies Corp, South Windsor, Conn Power Systems Div
REGENERATIVE FUEL CELL ENERGY STORAGE SYSTEM FOR A LOW EARTH ORBIT SPACE STATION
R E MARTIN, J. GAROW, and K B MICHAELS Aug 1984 146 p refs
(Contract NAS3-22234)
(NASA-CR-174802, NAS 1 26 174802, FCR-6128) Avail NTIS HC A07/MF A01 CSCL 10B

Results of a study to define the charactenstics of a regenerative fuel cell energy storage system for a large space station operating in low earth orbit (LEO) are presented The regenerative fuel cell system employs an alkaline electrolyte fuel cell with the option of employing either an alkaline or a solid polymer electrolyte electrolyzer R.S F

N85-13860*# Rockwell International Corp, Downey, Calif Shuttle Integration and Satellite Systems Div
PERSPECTIVES ON ENERGY STORAGE WHEELS FOR SPACE STATION APPLICATION
R E OGLEVIE *In* NASA Langley Research Center An Assessment of Integrated Flywheel System Technol p 117-127 Nov 1984 refs
Avail NTIS HC A18/MF A01 CSCL 10B

Several of the issues of the workshop are addressed from the perspective of a potential Space Station developer and energy wheel user Systems' considerations are emphasized rather than component technology The potential of energy storage wheel (ESW) concept is discussed The current status of the technology base is described Justification for advanced technology development is also discussed The study concludes that energy storage in wheels is an attractive concept for immediate technology development and future Space Station application. B.W

N85-13896*# TRW, Inc, Redondo Beach, Calif
SPACE POWER MANAGEMENT AND DISTRIBUTION STATUS AND TRENDS
G M REPPUCCI, J J BIESS, and L INOUYE *In* NASA Lewis Research Center Space Power p 205-218 Apr. 1984 refs
Avail NTIS HC A14/MF A01 CSCL 10B

An overview of space power management and distribution (PMAD) is provided which encompasses historical and current technology trends The PMAD components discussed include power source control, energy storage control, and load power processing electronic equipment The status of distribution equipment comprised of rotary joints and power switchgear is evaluated based on power level trends in the public, military, and commercial sectors. Component level technology thrusts, as driven by perceived system level trends, are compared to technology status of piece-parts such as power semiconductors, capacitors, and magnetics to determine critical barriers R S F

N85-16292*# Life Systems, Inc, Cleveland, Ohio.
ENGINEERING MODEL SYSTEM STUDY FOR A REGENERATIVE FUEL CELL: STUDY REPORT
B J CHANG, F H SCHUBERT, A J KOVACH, and R A WYNVEEN Sep 1984 91 p refs
(Contract NAS3-21287)
(NASA-CR-174801, NAS 1 26 174801, LSI-TR-376-30) Avail NTIS HC A05/MF A01 CSCL 10A

Key design issues of the regenerative fuel cell system concept were studied and a design definition of an alkaline electrolyte based engineering model system or low Earth orbit missions was completed Definition of key design issues for a regenerative fuel cell system include gaseous reactant storage, shared heat exchangers and high pressure pumps A power flow diagram for the 75 kW initial space station and the impact of different regenerative fuel cell modular sizes on the total 5 year to orbit weight and volume are determined System charactenstics, an isometric drawing, component sizes and mass and energy balances are determined for the 10 kW engineering model system An open loop regenerative fuel cell concept is considered for integration of the energy storage system with the life support system of the space station Technical problems and their solutions, pacing technologies and required developments and demonstrations for the regenerative fuel cell system are defined E A K

N85-16302*# Lockheed Missiles and Space Co, Sunnyvale, Calif
DEMONSTRATION OF TRANSPARENT SOLAR ARRAY MODULE DESIGN Final Report
G J PACK Sep 1984 79 p Prepared for JPL
(Contract JPL-956608)
(NASA-CR-174257, NAS 1 26 174257, LMSC-D973437) Avail NTIS HC A05/MF A01 CSCL 10A

This report discusses the design, development, fabrication and testing of IR transparent solar array modules. Three modules, consisting of a baseline design using back surface reflector cells, and two modules using gridded back contact, IR transparent cells, were subjected to vacuum thermal balance testing to verify analytical predictions of lower operating emperature and increased efficiency As a result of this test program, LMSC has verified that a significant degree of IR transparency can be designed into a flexible solar array Test data correlates with both steady state and transient thermal analysis Author

N85-16989*# National Aeronautics and Space Administration Lewis Research Center, Cleveland, Ohio
OTV PROPULSION ISSUES
Washington Apr 1984 296 p refs Conf held in Cleveland, 3-4 Apr 1984
(NASA-CP-2347, E-2171, NAS 1 55 2347) Avail NTIS HC A13/MF A01 CSCL 22B

The statistical technology needs of aero-assist maneuvering, propulsion, and usage of cryogenic fluids were presented Industry panels discussed the servicing of reusable space based vehicles and propulsion-vehicle interation

N85-16997*# National Aeronautics and Space Administration Lewis Research Center, Cleveland, Ohio
OTV PROPULSION TECNOLOGY PROGRAMMATIC OVERVIEW
L. P COOPER *In its* OTV Propulsion Issues p 97-102 Apr 1984 refs
Avail NTIS HC A13/MF A01 CSCL 22B

An advanced orbit transfer vehicles (OTV) which will be an integral part of the national space transportation system to carry men and cargo between low Earth orbit and geosynchronous orbit will perform planetary transfers and deliver large acceleration limited space structures to high Earth orbits is reviewed The establishment of an advanced propulsion technology base for an OTV for the mid 1990's is outlined The program supports technology for three unique engine concepts Work is conducted to generic technologies which benefit all three concepts and specific technology which benefits only one of the concepts Concept and technology definitions to identify propulsion innovations, and subcomponent research to explore and validate their potential benefits are included E A K

N85-16999*# Aerojet Technical Systems Co , Sacramento, Calif
AEROJET ADVANCED ENGINE CONCEPT
L SCHOENMAN *In* NASA Lewis Research Center OTV Propulsion Issues p 113-125 Apr 1984 refs
Avail NTIS HC A13/MF A01 CSCL 20H

The future orbit transfer vehicle (OTV) requirements which dictate the need for a highly versatile, highly reliable, reusable propulsion module are discussed To attain maximum operational economy, space-basing is essential This requires a reusable, maintenance free engine The design features of this space based engine are defined A new engine cycle and its advantages allow all the maintenance goals to be attained Rubbing contact and interpropellant seals and purges are eliminated when GO2 is used to drive the LO2 pump The TPA design has only one moving part The use of both GH2 and GO2 to drive the turbines lowers the turbine temperatures in addition lower GH2 temperatures and pressures improve chamber cooling and longer life The use of GO2 as a turbine drive fluid is addressed Space based engines require an integrated control and health monitoring system to improve system reliability and eliminate all scheduled maintenance It is concluded that all OTV propulsion requirements can be fulfilled with a single engine The technological developments required to demonstrate that engine are outlined E A K

N85-17004*# Jet Propulsion Lab , California Inst of Tech , Pasadena
ACTIVE COOLING REQUIREMENTS FOR PROPELLANT STORAGE
G A KLEIN *In* NASA Lewis Research Center OTV Propulsion Issues p 165-177 Apr 1984 refs
Avail NTIS HC A13/MF A01 CSCL 21I

Recent NASA and DOD mission models have indicated future needs for orbital cryogenic storage and supply systems Two thermal control systems which show the greatest promise for improving propellant storage life were evaluated One system was an open cycle thermodynamic vent type with a refrigeration system for partial hydrogen reliquefaction located at the LH2 tank and a vapor cooled shield for integrated and non-integrated tank designs to reduce boiloff The other was a closed system with direct refrigeration at the LH2 tank A reversed Brayton cycle unit was baselined for the propellant processor It is concluded that (1) reliquefaction systems are not attractive for minimizing propellant boiloff, (2) open cycle systems may not be economically attractive for long term storage, (3) a number of refrigeration systems are available to assist in the long term storage of cryogenic propellants, and (4) shields can significantly improve the performance of mechanical coolers R S F

N85-17006*# National Aeronautics and Space Administration Johnson (Lyndon B) Space Center,
PROPELLANT TRANSFER: TETHERED DEPOT
K KROLL *In* NASA Lewis Research Center OTV Propulsion Issues p 191-206 Apr 1984 refs
Avail NTIS HC A13/MF A01 CSCL 21I

Spacebasing of orbital transfer vehicles at a space station requires a depot that safely and efficiently stores and transfers the resupply propellants In order to transfer propellants, a method effectively acquire only liquid and vent only gas must exist A method that produces a low gravity to settle propellants would bypass these weaknesses, while allowing ground-like operations This low gravity can be passively produced using gravity gradient techniques A satellite with a large length to diameter ratio, such as a depot attached to a space station with a tether, stabilizes along on Earth radial because of an outward acceleration proportional to the distance from the satellite's center of gravity Analysis indicates that liquid can be setteled with relatively short tether lengths The feasibility, design requirements, and operational limitations of a tethered refueling depot were investigated with special emphasis on slosh control R S F

N85-17008*# National Aeronautics and Space Administration Lewis Research Center, Cleveland, Ohio
VEHICLE/ENGINE INTEGRATION
L P COOPER, T J VINOPAL (Boeing Aerospace Co , Seattle), D E FLORENCE (General Electric Corp , Fairfield, Conn), R W MICHEL (Aerojet TechSystems Co), J R BROWN (Pratt and Whitney Aircraft, East Hartford, Conn), R P BERGERON (Rockwell International Corp , Pittsburg), and V A WELDON *In its* OTV Propulsion Issues p 229-245 Apr 1984 refs
Avail NTIS HC A13/MF A01 CSCL 22B

VEHICLE/ENGINE Integration Issues are explored for orbit transfer vehicles (OTV's) The impact of space basing and aeroassist on VEHICLE/ENGINE integration is discussed The AOTV structure and thermal protection subsystem weights were scaled as the vehicle length and surface was changed It is concluded that for increased allowable payload lengths in a ground-based system, lower length-to-diameter (L/D) is as important as higher mixture ration (MR) in the range of mid L/D ATOV's Scenario validity, geometry constraints, throttle levels, reliability, and servicing are discussed in the context of engine design and engine/vehicle integration R.S F

N85-17009*# Rockwell International Corp , Richardson, Tex.
ORBITAL TRANSFER VEHICLE PROPULSION ISSUES
R P BERGERON and V A WELDON *In* NASA Lewis Research Center OTV propulsion Issues p 246-251 Apr 1984 refs
Avail NTIS HC A13/MF A01 CSCL 22B

The development of a reusable and space-based orbital transfer vehicle (OTV) necessitates an integral approach toward structural and propulsion subsystems design A single engine installation necessitates moving the engine further aft and/or relocation of the engine gimbal point to accommodate vehicle control requirements Penalties associated with gimbal point relocation without increasing stage length or modifying typical advanced engine concepts, as well as a method for minimizing such penalties, are presented for a single engine toroidal tank OTV configuration Alternative integrated vehicle structure/engine concepts are also presented for multi-engine configurations Features of these potential concepts are given which indicate the need for substantial additional study of feedline gimbal alternatives before firmly establishing advanced engine design The issue of vehicle/engine integration is addressed in three areas interfaces (physical and

functional), installation requirements, and reliability apportionment (i e , number of engines required to assure mission completion).
R S F

N85-19018# National Aerospace Lab , Tokyo (Japan)
PARTIAL BLEED EXPANDER CYCLE FOR LOW THRUST LOX/LH2 ROCKET ENGINE
Y. WAKAMATSU, A KANMNURI, and K TOKI (Inst. of Space and Astronautical Science) Sep 1984 13 p refs
(NAL-TR-837T, ISSN-0389-4010) Avail NTIS HC A02/MF A01

The expander cycle or the coolant bleed cycle LOX/LH2 engine is considered suitable for use with the orbit transfer vehicle and the upper stage of a conventional rocket because of their simplicity of engine system However, these engine cycles generally require a thrust chamber with a high expansion area ratio in order to obtain a high performance and necessarily require a High Altitude Test Facility even in the initial phase of development A new engine cycle called the 'Partial Bleed Expander (PBE) cycle is proposed In the PBE cycle, only the turbopump of one propellant (usually LH2) is driven in the expander cycle and a portion of fuel is bled to drive the turbopump of the other propellant (usually LOX) The bled fuel may be utilized for dump cooling or film cooling From the calculation of the PBE cycle, it was clear that the PBE cycle can perform at a level close to that of the expander cycle with the bleeding rate resulting in minimum ISp loss B W

N85-20000*# Rockwell International Corp , Downey, Calif Space Transportation Systems Div
SPACE TRANSPORTATION SYSTEM (STS) PROPELLANT SCAVENGING SYSTEM STUDY. VOLUME 1: TECHNICAL REPORT Final Report
Jan 1985 293 p refs 3 Vol
(Contract NAS9-16994)
(NASA-CR-171848-VOL-1, NAS 1 26 171848-VOL-1, DRL-T-1811-VOL-1, STS-84-0570-VOL-1) Avail NTIS HC A13/MF A01 CSCL 22B

The objectives are to define the most efficient and cost effective methods for scavenging cryogenic and storable propellants and then define the requirements for these scavenging systems For cryogenic propellants, scavenging is the transfer of propellants from the Shuttle orbiter external tank (ET) and/or main propulsion subsystems (MPS) propellant lines into storage tanks located in the orbiter payload bay for delivery to the user station by a space based transfer stage or the Space Transportation System (STS) by direct insertion For storable propellants, scavenging is the direct transfer from the orbital maneuvering subsystem (OMS) and/or tankage in the payload bay to users in LEO as well as users in the vicinity of the Space Station B G

N85-20001*# Rockwell International Corp , Downey, Calif Space Transportation Systems Div
SPACE TRANSPORTATION SYSTEM (STS) PROPELLANT SCAVENGING SYSTEM STUDY. VOLUME 2: SUPPORTING RESEARCH AND TECHNOLOGY REPORT Final Report
Jan 1985 17 p 3 Vol
(Contract NAS9-16994)
(NASA-CR-171849-VOL-2, NAS 1 26.171849-VOL-2, DRL-T-1811-VOL-2, STS-85-0570-VOL-2) Avail NTIS HC A02/MF A01 CSCL 22B

The technology effort required for the development of a propellant scavenging system is identified For a cryogenic propellant system, the development tests identified are for a cryogenic capillary acquisition system for zero-g feedout capability and for definition of existing Space Transformation System (STS) performance capabilities. For a storable propellant system, the development tests identified are for three major components required in the system a propellant pump, a helium compressor, and a zero leakage fluid disconnect Author

N85-20002*# Rockwell International Corp , Downey, Calif Space Transportation Systems Div
SPACE TRANSPORTATIOIN SYSTEM (STS) PROPELLANT SCAVENGING SYSTEM STUDY. VOLUME 3: COST AND WORK BREAKDOWN STRUCTURE-DICTIONARY Final Report
Jan 1985 43 p 3 Vol
(Contract NAS9-16994)
(NASA-CR-171850-VOL-3, NAS 1 26.171850-VOL-3, DRL-T-1811-VOL-3, STS-84-0570-VOL-3) Avail NTIS HC A03/MF A01 CSCL 22B

Fundamentally, the volumes of the oxidizer and fuel propellant scavenged from the orbiter and external tank determine the size and weight of the scavenging system The optimization of system dimensions and weights is stimulated by the requirement to minimize the use of partial length of the orbiter payload bay Thus, the cost estimates begin with weights established for the optimum design Both the design, development, test, and evaluation and theoretical first unit hardware production costs are estimated from parametric cost weight scaling relations for four subsystems. For cryogenic propellants, the widely differing characteristics of the oxidizer and the fuel lead to two separate tank subsystems, in addition to the electrical and instrumentation subsystems Hardwares costs also involve quantity, as an independent variable, since the number of production scavenging systems is not firm For storable propellants, since the tankage volume of the oxidizer and fuel are equal, the hardware production costs for developing these systems are lower than for cryogenic propellants Author

N85-20376*# Air Force Wright Aeronautical Labs , Wright-Patterson AFB, Ohio
THE SATELLITE SAIL
J PEARSON *In* NASA Marshall Space Flight Center Appl of Tethers in Space, Vol 2 6 p Mar 1985
Avail NTIS HC A14/MF A01 CSCL 02B

It is proposed to suspend an airfoil from the Space Shuttle by a long tether into the upper atmosphere to provide a horizontal force on the Shuttle, thereby changing its orbital plane most efficiently The airfoil would need high-temperature skin and tether, and remotely controlled flaps to adjust its angle of attack The airfoil could also be used as a hypersonic facility to measure aerodynamic characteristics at extreme altitudes and velocities This use would require a vertical lift force to counteract the drag force and prevent the Shuttle orbit from decaying too rapidly during the aerodynamic measurements Author

N85-20862# Los Alamos Scientific Lab , N Mex Advanced Energy Conversions Systems
OPENING UP THE FUTURE IN SPACE WITH NUCLEAR POWER
D BUDEN and J ANGELO, JR (Florida Inst of Technology, Melbourne) 1985 22 p refs Presented at the 2nd Symp on Space Nucl Power Systems, Albuquerque, N Mex
(Contract W-7405-ENG-36)
(DE85-002411, LA-UR-84-3388, CONF-850103-2) Avail NTIS HC A02/MF A01

Man's extraterrestrial development is dependent on abundant power For example, space based manufacturing facilities are projected to have a power demand of 300 kWe by the end of this century, and several megawatts in the early part of next millenium The development of the lunar resource base will result in power needs ranging from an initial 100 kW(e) to many megawatts Human visits to Mars could be achieved using a multimegawatt nuclear electric propulsion system or high thrust nuclear rockets Detailed exploration of the solar system will also be greatly enhanced by the availability of large nuclear electric propulsion systems All of these activities will require substantial increases in space power - hundreds of kilowatts to many megawatts The use of nuclear energy to support humanity's expansion into space is explained and applications are given
DOE

N85-21231*# National Aeronautics and Space Administration Lewis Research Center, Cleveland, Ohio
ADVANCED RESEARCH AND TECHNOLOGY PROGRAMS FOR ADVANCED HIGH-PRESSURE OXYGEN-HYDROGEN ROCKET PROPULSION
S J MARSIK and S F MOREA (NASA Marshall Space Flight Center) 1985 14 p refs Proposed for presentation at the 1985 JANNAF Propulsion Meeting, San Diego, Calif, 9-12 Apr 1985
(NASA-TM-86969, E-2495, NAS 1 15 86969) Avail NTIS HC A02/MF A01 CSCL 20H

A research and technology program for advanced high pressure, oxygen-hydrogen rocket propulsion technology is presently being pursued by the National Aeronautics and Space Administration (NASA) to establish the basic discipline technologies, develop the analytical tools, and establish the data base necessary for an orderly evolution of the staged combustion reusable rocket engine The need for the program is based on the premise that the USA will depend on the Shuttle and its derivative versions as its principal Earth-to-orbit transportation system for the next 20 to 30 yr The program is focused in three principal areas of enhancement (1) life extension, (2) performance, and (3) operations and diagnosis Within the technological disciplines the efforts include rotordynamics, structural dynamics, fluid and gas dynamics, materials fatigue/fracture/life, turbomachinery fluid mechanics, ignition/combustion processes, manufacturing/producibility/nondestructive evaluation methods and materials development/evaluation An overview of the Advanced High Pressure Oxygen-Hydrogen Rocket Propulsion Technology Program Structure and Working Groups objectives are presented with highlights of several significant achievements Author

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GENERAL

Includes either state-of-the-art or advanced technology which may apply to Large Space Systems and does not fit within the previous categories Publications of conferences, seminars, and workshops are covered in this area

A85-10261*# Tel-Aviv Univ (Israel)
A CASE FOR GOHREM - GEOSYNCHRONOUS ORBIT HIGH RESOLUTION EARTH MONITORING
J. OTTERMAN (Tel Aviv University, Tel Aviv, Israel), V V SALOMONSON, D ATLAS, W SHENK, M S MAXWELL (NASA, Goddard Space Flight Center, Greenbelt, MD), and D E PITTS (NASA, Johnson Space Center, Houston, TX) IN International Symposium on Remote Sensing of Environment, 17th, Ann Arbor, MI, May 9-13, 1983, Proceedings Volume 3 Ann Arbor, MI, Environmental Research Institute of Michigan, 1984, p 1125-1135 refs

Although the constant viewing geometry of the geostationary orbit simplifies quantitative monitoring of study areas, the high satellite altitude, in conjunction with the need for high spatial resolution, leads to large and complex sensors and spacecraft State-of-the-art linear array detectors and a telescope of 1 m diameter and 10 m focal length can meet the requirements in question, which include a scan rate of the ground of at least 25 km/sec, the ability to cover a 150 X 150-km scene every several minutes, and an instantaneous field of view of 50 m in the visible portion of the spectrum and 1000 m in the IR O C

A85-12927
SPACE GREENHOUSE DESIGN
N E LEGGETT and J A FIELDER British Interplanetary Society, Journal (Interstellar Studies) (ISSN 0007-084X), vol 37, Nov 1984, p 495-498

This paper presents a design of a plant growth chamber system for a zero gravity environment This growth chamber system is designed to be installed in a pressurized room within a freely falling generation-travel starship, an interplanetary spacecraft, or an orbiting space colony The growth chamber system will provide fresh vegetables and oxygen replenishment for the occupants of the vehicle or colony In this system, the growing plants are potted in sealed boxes that protect the roots from light and supply the roots with a sustaining aerosol of water and nutrients The leaves and stems of the plants extend outside of the boxes where they are exposed to fluorescent light Both the physical configuration and the biological attributes of the system are presented for the guidance of the reader Author

A85-12979#
COST EFFECTIVE LAUNCH TECHNOLOGY FOR COMMUNICATIONS SATELLITES
T C TAYLOR (Taylor and Associates, Inc , Wrightwood, CA) and A OVERMAN International Astronautical Federation, International Astronautical Congress, 35th, Lausanne, Switzerland, Oct 7-13, 1984 10 p refs
(IAF PAPER 84-04)

The present investigation is concerned with the possibility to reduce the costs for placing satellites in orbit by making use of an 'Air Launch' system It is pointed out that the launching of rockets to orbit from aircraft in flight has been done successfully It is suggested to modify the existing technology for the purpose of launching communications satellites and other payloads to orbit Thus, the Air Launch Concept combines aircraft and missile technologies to produce a method of transport to orbit A heavy lift cargo aircraft is employed to fly a rocket and the satellite payload to a specific location at the service ceiling of the aircraft Attention is given to aspects of cost reduction, commercial and technical benefits, the anticipated market, and technical details G R

A85-12981#
LAY-OUT OF A RE-USABLE RE-ENTRY VEHICLE REQUIRED IN A FUTURE EUROPEAN LOW EARTH ORBIT SCENARIO
H T UEBELHACK (Dornier System GmbH, Friedrichshafen, West Germany) and J FAVE (ONERA, Chatillon-sous-Bagneux, Hauts-de-Seine, France) International Astronautical Federation, International Astronautical Congress, 35th, Lausanne, Switzerland, Oct 7-13, 1984 6 p
(IAF PAPER 84-06)

The design concept of a reusable unmanned semiballistic-reentry spacecraft to provide raw materials and return processed materials from a European automated space production facility in LEO is presented and illustrated with drawings, diagrams, graphs, and tables of parameters A typical mission scenario includes Ariane launch, rendezvous and docking for sample exchange, center-of-mass trimming by adjustment of the load after dedocking, updating of inertial systems, deorbiting to a ballistic arc by means of four 400-N thrusters, atmospheric flight from 100-km altitude at path angle 4 deg, lift/drag ratio 0 2, and maximum deceleration 5 g, and final deceleration and landing using three-stage drogue and main-parachutes, an air-bag system, and landing gears T K

A85-12994#
SPACE STATION RELATED INVESTIGATIONS IN EUROPE
W WIENSS (ERNO Raumfahrttechnik GmbH, Bremen, West Germany) and E VALLERAIN (Aeritalia S p A , Turin, Italy) International Astronautical Federation, International Astronautical Congress, 35th, Lausanne, Switzerland, Oct 7-13, 1984 29 p.
(IAF PAPER 84-28)

Studies pertaining to the definition of Europe's role in the Space Station program are described, with consideration given to such elements as pressurized modules as laboratories for materials processing and life sciences, unpressurized elements, and service vehicles for on-orbit maintenance and repair activities Candidate elements were selected against such criteria as clean interfaces, the satisfaction of European user needs, new technology items, and European financial capabilities, and their technical and programmatic implications were examined Different scenarios were

considered, ranging from a fully Space-Station-dependent case to a completely autonomous, free-flying man-tendable configuration Recommendations on a collaboration between Europe and the United States are presented B.J

A85-13114*# National Aeronautics and Space Administration, Washington, D.C
ASSESSMENT OF MEDICAL RISK IN SPACE FLIGHT
A NICOGOSSIAN, P RAMBAUT, and S POOL (NASA, Washington, DC) International Astronautical Federation, International Astronautical Congress, 35th, Lausanne, Switzerland, Oct. 7-13, 1984 5 p refs
(IAF PAPER 84-189)

Among the various manned space missions expected during the next 10 years are flights of up to 6 months duration in low earth orbit as well as short excursions to geosynchronous orbit. Research activities are described which cover the full spectrum of physiological and psychological problems presented by such flights as well as by ongoing Shuttle flights This paper includes a summary of the major technical thrusts needed for habitation in space It concludes that there is a high probability of developing countermeasures that will alleviate the neurophysiological and cardiovascular effects encountered during Shuttle flights and that the resolution of musculoskeletal, psychological and radiobiological problems will also prove possible Author

A85-13141#
TOS AND AMS - AMERICA'S NEW CAPABILITIES IN SPACE TRANSPORTATION
D W THOMPSON (Orbital Sciences Corp, Vienna, VA) International Astronautical Federation, International Astronautical Congress, 35th, Lausanne, Switzerland, Oct 7-13, 1984 11 p
(IAF PAPER 84-220)

The arrangements with NASA in the form of Memorandums of Understanding and contracts with a private company to produce a line of transfer orbit stages (TOS) apogee and maneuvering stages (AMS) are described, along with the hardware features TOS/AMS will provide GEO and other high orbit boosts from LEO The company subcontracts the hardare development to aerospace firms already building hardware for the Shuttle Financing of the expenses has been done through limited partnerships TOS is intended for payloads with masses between those handled by the PAM and Centaur boost motors Design features include reaction thrusters, laser-gyroscope avionics, solid propellants, and a gimballed nozzle The AMS uses hypergolic fuels and is actually a modified MX missile fourth stage A joint TOS/AMS configuration is suitable for boosting planetary missions from LEO Details of the airborne and grounds support systems of the two boosters are provided M S K

A85-13148#
AN ECONOMIC ANALYSIS OF HUMANS AND MACHINES FOR SPACE CONSTRUCTION
D G STUART (MIT, Cambridge, MA) International Astronautical Federation, International Astronautical Congress, 35th, Lausanne, Switzerland, Oct 7-13, 1984 17 p
(IAF PAPER 84-232)

Cost-driving factors associated with the personnel/teleoperators necessary for the construction of large space structures are outlined The structures would be in a 260 km LEO Construction workers would be humans in pressurized suits, humans in EVA and teleoperators working from a Shuttle base, and free-flying teleoperators A line-item cost input was used, based on historical data, to perform the calculations, which included all ground-support costs Attention was focused on a baseline mission to construct a 725 m diam microwave radiometer for earth remote sensing The strongest cost driver was the productivity of the human construction crew, followed by launch costs and the learning curve Teleoperators were projected to be 1/3-4/5 as productive as humans Further research is, however, needed to more finely hone the predictions of the capabilities of teleoperators M S K

A85-13259#
SPACE AS MOTIVATIONAL PROPULSION
L. W DAVID (National Space Institute, Washington, DC) International Astronautical Federation, International Astronautical Congress, 35th, Lausanne, Switzerland, Oct. 7-13, 1984 12 p refs
(IAF PAPER 84-407)

Several student activities for motivating continued intellectual efforts directed at space-related fields are described The long duration exposure facility, deployed from the Orbiter in 1984 and due to be retrieved in 1985, contained bags containing a total of 9 million tomato seeds shielded from radiation to varying degrees The seeds will be distributed to students from grades 5 to university level for experimentation An amateur space telescope is being constructed by 700 participants in 15 countries under the guidance of university faculty and optics engineers Test components will be flown in Getaway Special cannisters and then used in the flight hardware Reception of images from the 175 lb telescope will be possible anywhere on the planet for $400-500 worth of equipment The Solar Mesosphere Explorer is monitored by university students interfacing with NASA tracking network NASA has initiated a Young Astronauts program to encourage interest in space and participation in science projects and math Finally, discussions are underway between NASA and an entrepreneur to devise a module that will permit dozens of tourists to fly on a 3 day mission at the same time at a cost of $2-3 million per seat M S K

A85-13276*# National Aeronautics and Space Administration, Washington, D C
APPLICATIONS OF SPACE TETHERS
I BEKEY (NASA, Office of Space Flight, Washington, DC) International Astronautical Federation, International Astronautical Congress, 35th, Lausanne, Switzerland, Oct 7-13, 1984 10 p
(IAF PAPER 84-436)

The dynamics of orbiting tethered bodies are reviewed and several practical aplications are examined Two tethered masses in orbit will seek a local vertical orientation and a stable equilibrium, with energy transferred to the 'upper' object The tether tensions are provided by accelerations as low a 0 0004 g, permitting long tethers an relatively large masses at the ends The Shuttle can send a payload into a transfer orbit by placing it at the upper end of the tether, unreeling the tether, then releasing the tether and thereby imparting the excess energy to the satellite while the Orbiter falls to a lower perigee A 10 ton payload could be unreeled on a 148 km tether, released to a 12 n mi apogee, and the Orbiter would be in full deorbit Similarly, the Orbiter can tether down to deorbit form the Space Station, boosting the Station to a higher orbit. The station can then unreel a large satellite, release it to a higher orbit, thereby returning to the stations original orbit Unreeling a wire 10 km from the Space station and having the wire cut the earth's magnetic field lines, then closing the contact between the upward and lower ends of the wire, can, with modifications, either provide power or thrust without propellants for the Station M S K.

A85-14426
EASCON '83; PROCEEDINGS OF THE SIXTEENTH ANNUAL ELECTRONICS AND AEROSPACE CONFERENCE AND EXPOSITION, WASHINGTON, DC, SEPTEMBER 19-21, 1983
Conference and Exposition sponsored by IEEE, American Satellite Co, BDM Corp, et al New York, Institute of Electrical and Electronics Engineers, 1983, 508 p For individual items see A85-14427 to A85-14469

Numerous topics pertinent to earth and space-based segments of space remote sensing, computer/software systems, military command, control and communications, data processing, and telecommunications technologies are discussed Attention is given to potential Space Station configurations and uses, NASA advanced satellite communications technology development, systems for surveillance-detection from space and earth, and artificial intelligence software tools Fail safe/fault tolerant electronic systems are described, as are survivable communications,

distributed data bases and data base management systems, and a standard local area network for military operations Consideration is also devoted to hardware for powering DBS transmitters and multi-beam antennas for communications satellites M S K

A85-15509#
A RECTILINEAR GUIDANCE STRATEGY FOR SHORT ORBITAL TRANSFERS
S A STERN (Colorado, University, Boulder, Martin Marietta Aerospace, Denver, CO) Journal of Spacecraft and Rockets (ISSN 0022-4650), vol 21, Nov -Dec 1984, p 542-545 Research supported by the Martin-Marietta Aerospace refs

The solutions to Clohessy-Wiltshire equations of motion have been approximated for short transfer times For such transfers, these solutions describe decoupled rectilinear trajectories that are easy to implement The bounds over which this rectilinear approximation holds are explored Separate normalized error functions then are derived for both in-plane and out-of-plane motion From these error functions transfer time limits are derived Further it is shown that in-plane motion diverges from straight-line paths much more rapidly than out-of-plane motion Rectilinear guidance strategies are of importance to terminal rendezvous and extravehicular as well as satellite servicing operations Author

A85-15976
TECHNOLOGY VECTORS; PROCEEDINGS OF THE TWENTY-NINTH NATIONAL SAMPE SYMPOSIUM AND EXHIBITION, RENO, NV, APRIL 3-5, 1984
Symposium and Exhibition sponsored by the Society for the Advancement of Material and Process Engineering Covina, CA, Society for the Advancement of Material and Process Engineering (Science of Advanced Materials and Process Engineering Series Volume 29), 1984, 1615 p. For individual items see A85-15977 to A85-16000, A85-16002, A85-16003, A85-16006 to A85-16009, A85-16011, A85-16013 to A85-16015, A85-16017 to A85-16070

Among the topics discussed are structures and materials technologies for spacecraft systems, room temperature-cure structural adhesives, computer-controlled filament winding, thermomechanical criteria for the selection of encapsulation materials, the behavior of woven graphite/epoxy composite at very high strain rates, spacecraft structure damping, the finite element analysis of joints involving graphite/epoxy tubes and metallic fittings, materials properties data base computerization, the elastic stiffness of biaxial and triaxial woven fabric composites, and damage accumulation and fracture initiation in composite laminates Also discussed are the compatibility of resin properties with high strength carbon fibers, a systematic approach to the development of resins for damage-tolerant composites, adhesive-bonded noise suppression structures for aircraft, continuous systems for the production of hot melt adhesives, creep behavior in kevlar/epoxy composites, braided fabric properties and applications, UV-curing resin systems for electronics, composite springs, martensitic transformations and the shape-memory effect, fine-grained superplastic materials, polyphenylene sulfide-based composites, thick-wall kevlar/epoxy pressure vessels, thermoplastic composite matrices with improved solvent resistance, electrically conducting composites, composite applications in sporting goods, metal moisture barriers for composites, and cost-effective tape-laying techniques O C

A85-16302
FUTURE PROSPECTS IN SPACE ENVISAGED BY A FORUM OF EUROPEAN SPACE COMPANIES
M TOUSSAINT (Eurospace, Paris, France) (European Space Symposium, 18th, London, England, June 8, 9, 1983) British Interplanetary Society, Journal (Space Technology) (ISSN 0007-084X), vol 37, Dec 1984, p 537-540

In June 1980, Eurospace, the Association of the European space industry, presented a paper based on a set of proposals for a European long term space program A study of this paper shows that the effort devoted by Europe to space activities was decreasing The current situation (1983) is compared with the situation three years earlier It is found that the ESA budget is slightly higher than in 1979 However, little attention has been paid to proposals regarding large space platforms and recoverable launchers Now the Future Prospects Group representing the industrial interest in Eurospace has been set up, and the progress of this group is discussed Attention is given to the level of Europe's space activities in a worldwide context, the mean annual value of governmental and commercial markets accessible to the European space industry, developments in the communication market, the Ariane market, the development of a new generation of launchers for 1992, and the space industrialization market G R

A85-16305
AN UNMANNED PLATFORM AS AN INITIAL CAPABILITY IN SPACE
T J SHESKIN (Cleveland State University, Cleveland, OH) British Interplanetary Society, Journal (Space Technology) (ISSN 0007-084X), vol 37, Dec 1984, p 555-558 refs

An automated, unmanned space platform is proposed as a lower risk, lower cost alternative to a permanently manned space station Many operations on a space platform are performed by telepresence controlled from the ground A space platform is supported by 20-day visits by the Space Shuttle every two months Mission requirements for a space station are analyzed Advantages and limitations of a space platform are identified A space platform is shown to be capable of performing almost all of the missions intended for a space station, at a lower cost, although some missions will be completed more slowly Author

A85-16881
THE GERMAN REMOTE SENSING PROGRAM [DAS DEUTSCHE ERDERKUNDUNGSPROGRAM]
H STRUB (Bundesministerium fuer Forschung und Technologie, Unterabteilung Luftfahrt und Weltraum, Bonn, West Germany) Zeitschrift fuer Flugwissenschaften und Weltraumforschung (ISSN 0342-068X), vol 8, Sept -Oct 1984, p 293-296 In German

A short survey gives the objectives and present state of the national program, which is part of the German Space Program The program involves close international cooperation within ESA and with NASA Discussion of future planning of projects and research fields shows the advantages of cooperation between classical type satellites and elements of the future space station A national basis for earth observation is an additional requirement for the future and will be best secured by further extension to the German Remote Sensing Data Center at DFVLR Author

A85-17573* National Aeronautics and Space Administration, Washington, D C
THE NASA MLA PROGRAM
K J ANDO (NASA, Washington, DC) IN 1983 International Geoscience and Remote Sensing Symposium (IGARSS '83), San Francisco, CA, August 31-September 2, 1983, Digest Volume 2 New York, Institute of Electrical and Electronics Engineers, Inc , 1983, 6 p refs

The NASA Multispectral Linear Array (MLA) program is structured to provide for the evolutionary development of advanced sensor concepts, technologies, and scientific basis for future remote sensing missions Program elements include the development of multispectral visible and shortwave infrared (SWIR) detector arrays, optics and on-board signal processing technologies, sensor design studies, and supporting research The research consists of advanced airborne sensor development with data acquisitions, field measurements, and supporting science studies At the present time, two instrument concepts, including an imaging spectrometer, are in development as payloads for a series of Shuttle remote sensing research flights beginning as early as 1987 Progressively more advanced capability instruments suitable for extended duration Shuttle, free flyer, and space platform missions in the 1990's are also being studied Author

A85-19795*# National Aeronautics and Space Administration, Washington, D C
SPACELAB HITCHHIKER, A QUICK REACTION CARRIER
E. F JAMES, J. E. MOYE, and R L. LOHMAN (NASA, Washington, DC) American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 23rd, Reno, NV, Jan 14-17, 1985 8 p
(AIAA PAPER 85-0504)

It is pointed out that NASA is developing a new way to get payloads into orbit in a short time and at a low cost. The 'Spacelab Hitchhiker' is the carrier program which will accomplish this objective The Spacelab Hitchhiker carrier is a Shuttle payload The primary application of the considered program will be related to science and technology payloads Attention is given to the Hitchhiker concept, details regarding the Hitchhiker-G and Hitchhiker-M, aspects of integration and operations, Orbiter resources and STS interfaces, the conduction of Hitchhiker flights as 'flights of opportunity', questions of payload selection, and organizational interfaces G R.

A85-21826*# National Aeronautics and Space Administration Langley Research Center, Hampton, Va
A SURVEY OF AEROASSISTED ORBIT TRANSFER
G D WALBERG (NASA, Langley Research Center, Hampton, VA) Journal of Spacecraft and Rockets (ISSN 0022-4650), vol 22, Jan -Feb 1985, p 3-18 Previously cited in issue 20, p 3158, Accession no A82-40291 refs

A85-21831*# National Aeronautics and Space Administration Langley Research Center, Hampton, Va
CHEMICAL NONEQUILIBRIUM EFFECTS ON FLOWFIELDS FOR AEROASSISTED ORBITAL TRANSFER VEHICLES
J L SHINN and J. J JONES (NASA, Langley Research Center, Space Systems Div , Hampton, VA) Journal of Spacecraft and Rockets (ISSN 0022-4650), vol. 22, Jan -Feb 1985, p 54-59 Previously cited in issue 05, p 602, Accession no. A83-17913 refs

A85-22576
DEPLOYABLE OPTICAL SYSTEMS; PROCEEDINGS OF THE MEETING, LOS ANGELES, CA, JANUARY 18, 19, 1983
J S FENDER, ED (USAF, Weapons Laboratory, Kirtland AFB, NM) Meeting sponsored by SPIE - The International Society for Optical Engineering Bellingham, WA, SPIE - The International Society for Optical Engineering (SPIE Proceedings Volume 383), 1983, 105 p For individual items see A85-22577 to A85-22587

Among the topics discussed are deployable reflector configurations, the alignment and phasing of deployable telescopes, reflector antenna structure design concepts, a point spread function for a segmented mirror system, the use of a multiple order radial grating shearing interferometer for mirror segment alignment, the design of an extended retroreflector that is insensitive to tube bend, and novel techniques for the fusion bonding and replication of large glass reflectors Also discussed are holographic figure sensing for large primary mirrors, active vibration control for lasers and spacecraft, the results of recent structural control research at the U S Air Force's Office of Scientific Research, active control technology development at NASA, and structural control research and experiments at NASA O C

A85-23824#
LOOKING BACK ON THE PAST - THE DECISION OF EUROPE TO PARTICIPATE IN THE POST-APOLLO PROGRAM [RETOUR SUR LE PASSE - LA DECISION DE L'EUROPE DE PARTICIPER AU PROGRAMME POST-APOLLO]
R FRAYSSE (ESA, Bureau de Coordination et de Controle des Projets, Paris, France) ESA Bulletin (ISSN 0376-4265), no 40, Nov. 1984, p 61-65 In French

The process by which the European space community agreed on its participation in the NASA post-Apollo program is examined in a historical review covering the period 1970-1973 The ambitious goals and unrealistically low cost estimates of the originally planned program are outlined, the preliminary proposals of the European agencies and their strict limitation by NASA (to the laboratory module that became Spacelab) during the first half of 1972 are recounted, the provisions of the final decision of December 1972, are summarized (including commitment to Spacelab, creation of ESA, development of the L III launcher, and rationalization of the satellite programs), and the resulting agreement with NASA is characterized The implications of this history for the present discussion of ESA participation in the Space Station are indicated in the form of open questions T K

A85-24654
THE POTENTIAL OF SOLAR POWER SATELLITES FOR DEVELOPING COUNTRIES
N JASENTULIYANA and R A LUDWIG (United Nations, Outer Space Affairs Div , New York, NY) Space Solar Power Review (ISSN 0191-9067), vol 4, 1983, p 291-300 refs

The basic political, economic and technical aspects of a solar power satellite system (SPS) for the Third World are briefly discussed It is shown that the development of a SPS system could contribute significantly to economic growth in developing countries by reducing the costs of energy to a level commensurate with the rest of the world Attention is given to the INTELSAT program as a model of a satellite system which serves the economic interests of the Third World without compromising the economic interests of the more developed nations I H

A85-24787#
WHEN SPACECRAFT GET CHARGED UP, THEY HAVE MINDS OF THEIR OWN
E J LERNER Aerospace America (ISSN 0740-722X), vol 23, Feb 1985, p 38, 40, 42, 83

The problems and solutions pursued in development of a flight model discharge system (FMDS) for eliminating the arcing that occurs in satellites are described The charges arise from particle bombardment and the lack of sufficient conductive particles in the space environment Potentials up to 10 kV build up between insulated conductors and eventually arc discharge and can upset or destroy on-board electronic systems After detecting the charge build-up the FMDS generates a plasma to conduct the charge to space or the spacecraft exterior The device carries on on-board template data base for comparisons with normal charging events to permit functional charging events to continue Difficulties are still being encountered in producing plasma quickly enough to prevent discharges M.S K

A85-24790*# National Aeronautics and Space Administration. Langley Research Center, Hampton, Va
ORBIT-ON-DEMAND VEHICLES - MISSION POSSIBLE, BUT ONE-DAY TURNAROUND?
T A TALAY, W. D. MORRIS (NASA, Langley Research Center, Hampton, VA), and R W LEMESSURIER (Kentron International, Inc , Hampton, VA) Aerospace America (ISSN 0740-722X), vol 23, Feb 1985, p 54-57

The next generation launch-on-demand manned orbital vehicles will ideally be able to perform plane change maneuvers for rendezvous Plane-changes of, e g , 11 deg, will require a 3000 fps on-orbit maneuver velocity Any plane-change capabilities beyond 800 fps rapidly increase the necessary vehicle weight Sensitivity studies of the payload weight/vehicle weight, the presence or absence of air-breathing engines, high acceleration, etc , indicated that advances are required in the payload stowage pallet, thermal protection system, fault detection electronics, line-replaceable units, and accessibility to realize one-day turnaround The spacecraft would also need autonomous systems checks and launch from minimum support sites reached by air ferry A horizontal take-off, two-stage subsonic launch vehicle so far offers the lowest weight, maximum flexibility and minimum support combination of all configurations under consideration.
M S K

A85-24794#
SOLAR CELLS FOR TOMORROW'S SPACECRAFT
P A ILES and K S LING (Applied Solar Energy Corp , City of Industry, CA) Aerospace America (ISSN 0740-722X), vol 23, Feb 1985, p 70-72, 77

Solar cells and arrays for providing power to spacecraft are undergoing several developmental changes in various directions The main inpetus is for better efficiencies and longer life, larger surface areas, lower weight and larger arrays Back surface reflectors and field technologies are being studied, along with wraparound contacts, modified back surfaces, thinner cells (50-100 microns), surface texturing and AR coatings The cells are still sliced from ingots and contacts and other appurtenances are added by vapor deposition Trials with concentrator arrays and GaAs cells are planned to obtain higher efficiencies and better radiation hardening GaAs cells can be grown epitaxially but require greater surface preparations than Si cells Finally, the manufacturing infrastructure for GaAs cells has yet to be established M S K

A85-26369#
INTELSAT'S TWENTIETH ANNIVERSARY - TWO DECADES OF INNOVATION IN GLOBAL COMMUNICATIONS
R R COLINO (International Telecommunications Satellite Organization, Washington, DC) ITU Telecommunication Journal (ISSN 0497-137X), vol 52, Jan 1985, p 22-31

It is pointed out that the world's global satellite communications revolution began with a study conducted by Clarke (1945), who provided a detailed description of a network of three geosynchronous communications satellites However, Clarke had considered a need for manned space stations, because of maintenance requirements related to the use of radio tubes This difficulty regarding the implementation of Clarke's concept was eliminated by the invention of the transistor Following the launch of Sputnik in 1957, and the launch of the world's first communications satellite in 1958, the use of satellites for effective international satellite communications was considered by the World Administrative Radio Conference in 1959, and the International Telecommunications Satellite Organization (Intelsat) was established in 1964 Attention is given to Intelsat's accomplishments, patterns of innovation in connection with the growth in Intelsat traffic and technological advances, and future developments regarding Intelsat over the next 20 years G R

A85-26385#
FLIGHT OPERATION CONSIDERATIONS FOR AN AERO-BRAKED OTV
W H WILLCOCKSON (Martin Marietta Aerospace, Denver, CO) American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 23rd, Reno, NV, Jan 14-17, 1985 12 p
(AIAA PAPER 85-0220)

A description of design features and flight-operation principles of ground-based and space-based orbit transfer vehicles (OTV), scheduled for operation by the early 1990's, is presented The ground-based cryogenic stage has a four-propellant tank configuration mounted atop a single 15,000-lb thrust engine, a 6,500-lb dry weight, and 51,000-lb liquid fuel capacity The space-based system is similar in its general features to the ground-based system, but has a dry weight of 11,000 lbs and a 94,000-lb capacity for COX/hydrogen fuel Consecutive phases of the passive-payload delivery to a geosynchronous orbit via aft cargo carrier are detailed, including the boost phase, navigation, aeroentry, deployment, and recovery It is noted that a considerable efficiency increase can be achieved through the aeroentry L.T

A85-26770#
TEN YEARS AFTER THE LAUNCH OF ANS - LOOKING BACK IN PERSPECTIVE [10 JAAR NA DE ANS LANCERING - TERUGBLIK EN PERSPEKTIEF]
P F J LINSSEN (Nederlands Instituut voor Vliegtuigontwikkeling en Ruimtevaart, Delft, Netherlands) Ruimtevaart, vol 33, Aug -Oct 1984, p 123-129 In Dutch

Netherlands space activities since the launch of the first national satellite ANS in 1974 are surveyed, and future plans are discussed Topics examined include the successful operation of ANS (despite the fact that it did not attain its planned circular orbit), the scientific accomplishments of the US-UK-Netherlands IRAS program, potential social benefits of space projects (remote-sensing information, improved search and rescue capability, manufacturing, and telecommunications), and the political consequences of the decision to participate actively in space development For the future, full cooperation in ESA plans (scientific missions, continued communications and remote-sensing development, a new generation of Ariane launchers, and the Columbus contribution to the NASA Space Station), active support on a national level, and national projects of a commercial and/or scientific nature are recommended T K

A85-27973
ASTRONOMERS, CONGRESS, AND THE LARGE SPACE TELESCOPE
P A HANLE (National Air and Space Museum, Washington, DC) Sky and Telescope (ISSN 0037-6604), vol 69, April 1985, p 300-305

The Hubble Space Telescope (HST) project was initiated near the end of the Apollo program and immediately encountered fiscal contraints Planned as a long-term facility, the HST had to be continually justified to the public, astronomers and Congress from 1973 onward Budgetary restraints caused design reductions which for a while threatened the practicality of the HST and changed it from a pressurized, manned unit to an automatic mode, teleoperated, intermittently visited spacecraft It is noted that numerous exaggerations were made of both the power of the HST for scientific research and the total support of the astronomical community during promotion of the HST program, although the HST is the most powerful visual wavelength telescope ever to be built due to its unique operating environment NASA's consistent and steadily more detailed definitions of the design features and missions of the HST proved to be a decisive factor in repeated requests for information by funding committees who were deliberating in the presence of severe fiscal difficulties M S K

N85-10789*# National Aeronautics and Space Administration Langley Research Center, Hampton, Va
HUMAN RESPONSE TO VIBROACOUSTIC ENVIRONMENTS OF SPACE VEHICLES
K F WILLSHIRE Oct 1984 37 p refs Presented at the 108th Meeting of the Acoust Soc of Am , Minneapolis, 8-12 Oct 1984
(NASA-TM-86316, NAS 1 15 86316) Avail NTIS HC A03/MF A01 CSCL 05H

To insure efficient utilization of the system, space station design and operations will require special habitability considerations for the occupants and crew because of the relatively long duration missions Of particular concern is the environment in which the personnel will live and work, and how it affects both the performance and comfort of the occupants Current criteria do not consider possible effects of reduced gravity, long duration, and confinement Preliminary to developing space station vibroacoustic habitability criteria, the adequacy of criteria for other space vehicles has been reviewed In this paper, responses to the noise and vibration environments of both Skylab and Shuttle are discussed Some astronauts have reported sleep interference, communication interference, distraction, and general annoyance as noise related complaints In addition, information from the Russian Salyut missions, as well as similar based situtations (e g , submarines), is reviewed Author

N85-11023*# Microgravity Research Associates, Inc , Coral Gables, Fla
PRODUCING GALLIUM ARSENIDE CRYSTALS IN SPACE
R L RANDOLPH *In* NASA Marshall Space Flight Center 2nd Symp on Space Industrialization p 82-86 Oct 1984
Avail NTIS HC A19/MF A01 CSCL 20B

The production of high quality crystals in space is a promising near-term application of microgravity processing. Gallium arsenide is the selected material for initial commercial production because

of its inherent superior electronic properties, wide range of market applications, and broad base of on-going device development effort Plausible product prices can absorb the high cost of space transportation for the initial flights provided by the Space Transportation System. The next step for bulk crystal growth, beyond the STS, is planned to come later with the use of free flyers or a space station, where real benefits are foreseen The use of these vehicles, together with refinement and increasing automation of space-based crystal growth factories, will bring down costs and will support growing demands for high quality GaAs and other specialty electronic and electro-optical crystals grown in space Author

N85-11032*# European Space Agency, Paris (France) Space Transportation Systems
EUROPEAN RETRIEVABLE CARRIER (EURECA) AND EVOLUTIONARY SPACE CARRIER FOR MICROGRAVITY, EARTH OBSERVATION AND TECHNOLOGY DEMONSTRATION
R MORY and G SEIBERT *In* NASA Marshall Space Flight Center 2nd Symp on Space Industrialization p 147-168 Oct 1984
Avail NTIS HC A19/MF A01 CSCL 22B

The Spacelab relatively short stay-time in orbit has led to consideration of the European Retrievable Carrier (EURECA) concept as a reusable carrier The EURECA concept is a free-flying carrier of experiments which is launched and recovered by the space shuttle It is commensurate with the size of payloads that can be economically developed in Europe and combines the advantages of Spacelab (high mass and power capability, recovery) with those of a free flyer (extended operating time in a non-polluted environment) The launch of the first EURECA mission is scheduled for October 1987 The Eureca spacecraft will be deployed from the Shuttle cargo bay in orbit, will operate in a free-flying mode for about six months, and will then be retrieved, together with its payloads, returned to Earth by the Space Shuttle and prepared for the next mission The first mission of EURECA is dedicated to research in the fields of life sciences and material sciences The experimental hardware of the first mission consist of a variety of processin chambers for crystal growth and equipment for biological investigations viz plant growth and protein crystallization, and there is the possibility to perform experiments in the field of exobiology M G

N85-11056*# TRW Space Technology Labs, Redondo Beach, Calif
SATELLITE SERVICING: A BUSINESS OPPORTUNITY? Abstract Only
R E WONG and E H MEDLER *In* NASA. Marshall Space Flight Center 2nd Symp on Space Industrialization p 370 Oct 1984
Avail NTIS HC A19/MF A01 CSCL 05A

The possibilities of satellite servicing as a business opportunity are examined The service rate which a user must be charged to yield a reasonable return is derived and then compared against the market's willingness to pay that rate Steps taken to provide the basis from which the service rate could be derived include (1) constructing a hypothetical on orbit servicing business offering both on orbit and associated ground services, (2) estimating the total on orbit service business potential by analyzing mission models to the year 2000, and (3) setting up ground rules to bound the conduct of the business Using this basic information service demand (business volume) cost to set up the business, costs for operation and maintenance tax rates and desired rate of return are estimated to determine the user charge Sensitivity of the service rate to various parameters are also assessed The time span for the business venture runs from 1986 through 2000 with service to 1991 provided via the orbiter and by a space station beyond 1991 This point analysis shows about five years of negative cash flow, with steady profits thereafter

N85-11057*# Booz-Allen and Hamilton, Inc., Arlington, Va.
DOING BUSINESS IN SPACE: HOW TO GET THERE FROM HERE
P W WOOD and P. M STARK *In* NASA. Marshall Space Flight Center 2nd Symp on Space Industrialization p 371-382 Oct. 1984
Avail NTIS HC A19/MF A01 CSCL 05A

A step by step process is described through which an existing enterprise or an entrepreneurial venture can initiate and carry out a new space venture. Throughout this process the business and technical aspects must be advanced in parallel with each other Each depends on the other for its continued success, and companies may be unable to complete the venture if one or the other is neglected The existing NASA programs and the experience of early trailblazers provide sufficient examples and opportunities for other firms to undertake new ventures with confidence With the introduction of NASA's Commercial Space Policy, both the opportunities and the ease with which ventures can be carried out should increase significantly M A C

N85-12075*# *General Research Corp*, McLean, Va
PROCEEDINGS OF A WORKSHOP ON APPLICATIONS OF TETHERS IN SPACE, EXECUTIVE SUMMARY Final Report
1 Dec 1983 70 p Proc held in Williamsburg, Va, 15-17 Jun 1983 3 Vol
(Contract NAS8-35403)
(NASA-CR-171195, NAS 1 26 171195) Avail NTIS HC A04/MF A01 CSCL 22B

The objectives were to identify potential applications for tethers in space, develop a first order assessment of the feasibility and benefits of tether applications, recommend future actions necessary to enable tether applications, including required technology advancements, and stimulate industry and government planners to consider the unique properties of tethers in designs for future missions B G

N85-12076*# General Research Corp, McLean, Va
PROCEEDINGS OF A WORKSHOP ON THE APPLICATIONS OF TETHERS IN SPACE, VOLUME 1 Final Report
1 Dec 1983 294 p Proc held in Williamsburg, Va, 15-17 Jun 1983 3 Vol
(Contract NAS8-35403)
(NASA-CR-171196, NAS 1 26 171196) Avail NTIS HC A13/MF A01 CSCL 22B

Project overview, tether deployment, satellite system description, tether fundamentals, science applications, electrodynamic interactions, transportation, artificial gravity, and constellations, were described B G

N85-12077*# General Research Corp, McLean, Va
PROCEEDINGS OF A WORKSHOP ON APPLICATIONS OF TETHERS IN SPACE, VOLUME 2 Final Report
1 Dec 1983 315 p refs Proc held in Williamsburg, Va, 15-17 Jun 1983 3 Vol
(Contract NAS8-35403)
(NASA-CR-171197, NAS 1 26 171197) Avail NTIS HC A14/MF A01 CSCL 22B

The panel conclusions for each of the following panels (science applications, electrodynamic interactions, transportation applications, artificial gravity, constellations, and technology and test) are given B G

N85-12921*# Martin Marietta Corp, Bethesda, Md
SELECTED TETHER APPLICATIONS IN SPACE: AN ANALYSIS OF FIVE SELECTED CONCEPTS Final Report
31 Jul 1984 206 p
(Contract NAS8-35499)
(NASA-CR-171222, NAS 1 26 171222) Avail NTIS HC A10/MF A01 CSCL 22B

Ground rules and assumptions, operations, orbit considerations/dynamics, tether system design and dynamics, functional requirements, hardware concepts, and safety factors are examined for five scenarios tethered effected separation of

an Earth bound shuttle from the space station, tether effected orbit boost of a spacecraft (AXAF) into its operational orbit from the shuttle, an operational science/technology platform tether deployed from space station, a tether mediated rendezvous involving an OMV tether deployed from space station to rendezvous with an aerobraked OTV returning to geosynchronous orbit from a payload delivery mission, and an electrodynamic tether used in a dual motor/generator mode to serve as the primary energy storage facility for space station A R H

N85-13473*# McDonnell-Douglas Astronautics Co , Huntington Beach, Calif
THE HUMAN ROLE IN SPACE. VOLUME 1: EXECUTIVE SUMMARY Final Report
Oct 1984 27 p 3 Vol
(Contract NAS8-35611)
(NASA-CR-171223, NAS 1 26 171223, MDC-H1295-VOL-1, DR-4-VOL-1) Avail NTIS HC A03/MF A01 CSCL 05H

The role and degree of direct involvement of humans required in future space missions were investigated Criteria for allocating functional activities between humans and machines were established The technology requirements, economics, and benefits of the human presence in space were investigated R S F

N85-13847*# National Aeronautics and Space Administration Marshall Space Flight Center, Huntsville, Ala
GROUND TEST EXPERIMENT FOR LARGE SPACE STRUCTURES, APPENDIX I
D K TOLLISON (Control Dynamics Co) and H B WAITES *In* Control Dyn Co Definition of Ground Test for Verification of Large Space Struct Control 4 p Nov 1984
Avail NTIS HC A08/MF A01 CSCL 22B

Marshall Space Flight Center has developed a Large Space Structure (LSS) ground test verification experiment facility having adequate fidelity and flexibility to accommodate the demands of LSS control theory testing The first experiment is in the subsystem verification and integration phase This test employs the ASTROMAST, a lightweight S glass composite deployable beam structure, as the test article and is cited to prove out centralized and distributed sensor control strategies Author

N85-13880*# National Aeronautics and Space Administration Lewis Research Center, Cleveland, Ohio
SPACE POWER
Washington Apr 1984 322 p refs Workshop held in Cleveland, 10-12 Apr 1984
(NASA-CP-2352, E-2305, NAS 1 55 2352) Avail NTIS HC A14/MF A01 CSCL 22B

Appropriate directions for the applied research and technology programs that will develop space power systems for U S future space missions beyond 1995 are explored Spacecraft power supplies, space stations, space power reactors, solar arrays, thermoelectric generators, energy storage, and communication satellites are among the topics discussed

N85-16981*# Wyle Labs , Inc , El Segundo, Calif
COMMERCE LAB: MISSION ANALYSIS AND PAYLOAD INTEGRATION STUDY Interim Progress Report
6 Dec 1984 91 p
(Contract NAS8-36109)
(NASA-CR-171272, NAS 1 26 171272) Avail NTIS HC A05/MF A01 CSCL 22A

The needs of an aggressive commercial microgravity program are identified, space missions are defined, and infrastructural issues are identified and analyzed A commercial laboratory, commerce lab, is conceived to be one or more an array of carriers which would fly aboard the space shuttle and accommodate microgravity science experiment payloads Commerce lab is seen as a logical transition between currently planned space shuttle missions and future microgravity missions centered around the space station R S F

N85-16993*# National Aeronautics and Space Administration Langley Research Center, Hampton, Va
PERFORMANCE ASSESSMENT OF AERO-ASSISTED ORBITAL TRANSFER VEHICLES
R W POWELL, T A TALAY, A W WILHITE, J J REHDER, N H WHITE, J C NAFTEL, H W STONE, J P ARRINGTON, and R S MCCANDLESS *In* NASA Lewis Research Center OTV Propulsion Issues p 41-56 Apr 1984 refs
Avail NTIS HC A13/MF A01 CSCL 22B

Aero-assisted orbital transfer vehicles are analyzed The aerodynamic characteristics over the flight profile and three- and six-degree-of-freedom performance analyses were determined The important results, to date, are (1) the aerodynamic preliminary analysis system, an interactive computer program, used to predict the aerodynamics (performance, stability, and control) for these vehicles, (2) the performance capability, e g , maximum inclination change, maximum heating rate, and maximum sensed acceleration, can be determined using continuum aerodynamics only, (3) guidance schemes can be developed that allow for errors in atmospheric density prediction, mispredicted trim angle of attack, and off-nominal atmospheric interface conditions, even for vehicles with a low lift-to-drag ratio, and (4) multiple pass trajectories can be used to reduce the maximum heating rate B G

N85-16998*# National Aeronautics and Space Administration Marshall Space Flight Center, Huntsville, Ala
DRIVES AND BENEFITS OVERVIEW
S D MCINTYRE *In* NASA Lewis Research Center OTV Propulsion Issues p 103-112 Apr. 1984 refs
Avail NTIS HC A13/MF A01 CSCL 22B

The major technology issues for an advanced orbital transfer vehicles (OTV) engine to be used in conjunction with a space based, reusable orbit transfer vehicle are discussed The results of the space station studies as they relate to the OTV and the ground rules and guidelines for a reusable OTV vehicle study are reviewed The technology drives and benefit categories such as mission versatility, increased reliability or reduced cost are presented The technology drivers and the associated benefits are covered with regard to relative significance and impact on the ongoing OTV engine technology program It is recommended that because of the broad range of mission requirements and the long term potential cost benefits a new engine is needed for the space based reusable OTV E A K

N85-17010*# Martin Marietta Aerospace, Bethesda, Md
SPACE BASED OTV SERVICING
J G MCALLISTER *In* NASA Lewis Research Center OTV Propulsion Issues p 255-272 Apr 1984 refs Sponsored in part by Pratt and Whitney Aircraft
Avail NTIS HC A13/MF A01 CSCL 22A

Space based servicing of an orbit transfer vehicle (OTV) was previously outlined in sufficient detail to arrive at OTV and support system servicing requirements Needed space station facilities and their functional requirements were identified The impact of logistics and space serviceable design on the OTV design is detailed herein RL10 derivative rocket engine inspection task times are enumerated R S F

N85-17551*# Houston Univ , Tex Dept of Mechanical Engineering
CHARACTERIZATION OF HEAT TRANSFER IN NUTRIENT MATERIALS Final Report, 30 Apr. 1971 - 31 Dec. 1984
L C WITTE 7 Jan 1985 6 p
(Contract NAS2-11676)
(NASA-CR-171841, NAS 1 26 171841) Avail NTIS HC A02/MF A01 CSCL 06H

The processing and storage of foodstuffs in zero-g environments such as in Skylab and the space shuttle were investigated Particular attention was given to the efficient heating of foodstuffs The thermophysical properties of various foods were cataloged and critiqued The low temperature storage of biological samples as well as foodstuffs during shuttle flights was studied Research

and development requirements related to food preparation and storage on the space station are discussed. R S F

N85-20174# Joint Publications Research Service, Arlington, Va
WEST EUROPE REPORT: SCIENCE AND TECHNOLOGY
19 Feb 1985 141 p refs Transl into ENGLISH from various Chinese articles
(JPRS-WST-85-008) Avail NTIS HC A07/MF A01

News items, abstracts, and scientific reports on aspects of science and technology including advanced materials, aerospace engineering, civil aviation, computers, factory automation, microelectronics, and scientific and industrial policy

N85-20339*# National Aeronautics and Space Administration Marshall Space Flight Center, Huntsville, Ala
APPLICATIONS OF TETHERS IN SPACE, VOLUME 1
A. C CRON, comp (General Research Corp , McLean, Va) Washington Mar 1985 283 p refs Workshop held in Williamsburg, Va , 15-17 Jun 1983 2 Vol
(Contract NAS8-35403)
(NASA-CP-2364, M-475, NAS 1 55 2364) Avail NTIS HC A13/MF A01 CSCL 13I

The tethered satellite system is described including tether fundamentals Applications of very long tethers in space to a broad spectrum of future space missions are explored Topics covered include science, transportation, constellations, artificial gravity, technology and test, and electrodynamic interactions Recommendations to NASA are included

N85-20345*# National Aeronautics and Space Administration Marshall Space Flight Center, Huntsville, Ala
TETHER FUNDAMENTALS
C RUPP *In its* Appl of Tethers in Space, Vol 1 15 p Mar 1985
Avail NTIS HC A13/MF A01 CSCL 13I

Forces on tethered satellites, tether tension as a function of the effective mass, and parameters of candidate tether materials are examined Illustrations show stabilization control law, tethered satellite deployment and retrieval, angular momentum, electric motor effect reboost, a very long tether phenomenon, shuttle tethered satellite effects on the orbiter; artificial gravity, tethered satellite rendezvous docking relative velocity, and scaling up from the shuttle/TSS Limitations of the tethered satellite system and of tether properties as well as cost/benefits trades for future applications are considered A R H

N85-20353*# National Aeronautics and Space Administration Langley Research Center, Hampton, Va
TECHNOLOGY AND TEST
P SIEMERS *In* NASA Marshall Space Flight Center Appl of Tethers in Space, Vol 1 5 p Mar 1985
Avail NTIS HC A13/MF A01 CSCL 13I

The status of tether-related technology is discussed together with the program that should be initiated to develop the technology required by the tethered satellite system Successful tethering during the Gemini program is mentioned Technology areas which appear to have application to tethered systems are identified, including electrodynamics, atmospherics, and aerothermodynamics R S F

N85-20359*# *Martin Marietta Corp , Denver, Colo*
SUMMARY PRESENTATION OF THE CONSTELLATIONS PANEL
F. WILLIAMS *In* NASA Marshall Space Flight Center Appl of Tethers in Space, Vol 1 11 p Mar 1985
Avail NTIS HC A13/MF A01 CSCL 22A

Tethered multiple spacecraft configurations are discussed relative to low Earth orbit, geosynchronous Earth orbit, and one, two, or three dimensional configurations Attitude control, pointing, and stabilization of such tethered systems are addressed R S F

N85-20360*# National Aeronautics and Space Administration Langley Research Center, Hampton, Va
SUMMARY PRESENTATION OF THE TECHNOLOGY AND TEST PANEL
P SIEMERS *In* NASA Marshall Space Flight Center Appl of Tethers in Space, Vol 1 11 p Mar 1985
Avail NTIS HC A13/MF A01 CSCL 22A

Tether related technology issues were investigated along with potential applications Several of the applications do not derive necessarily from nor are they related to a technology issue Tether designs must concern itself with length requirements (whether the tether is to be flexible or stiff) and what the environmental impact is on the particular material that is proposed for the tether As far as tether manufacturing techniques, a lot of technology related work is required to develop cost effective manfacturing capabilities for the future tether There are techniques that are used on the ground now However, after some of the proposed applications are determined to be feasible, it may be that the best way to manufacture the tether is to pretend the satellite is a spider and allow it to spin its own web in space The technology required to developed tapered tethers was considered Definition of the taper, where the center of that taper should be, and the taper's relation to the end masses are all of concern R S F

N85-20361*# National Aeronautics and Space Administration Marshall Space Flight Center, Huntsville, Ala
APPLICATIONS OF TETHERS IN SPACE, VOLUME 2
A C CRON, comp (General Research Corp , McLean, Va) Washington Mar 1985 319 p refs Workshop held in Williamsburg, Va , 15-17 Jun 1983 2 Vol
(Contract NAS8-35403)
(NASA-CP-2365, M-476, NAS 1 55 2365) Avail NTIS HC A14/MF A01 CSCL 13I

Topics discussed include tethered satellites, tether deployment, satellite systems, science applications, electrodynamic interactions, transportation applications, artificial gravity, constellations, and technology and testing

N85-20364*# Aeritalia S p A , Torino (Italy)
REPORT OF THE TRANSPORTATION PANEL
E. VALLERANI, M W HUNTER (Lockheed Missiles and Space Co), P M BAINUM (Howard Univ), V J MODI (British Columbia Univ), K A FAYMON (NASA Lewis Research Center), B CHANG (Space Communication Company), S LEWIS (NASA Johnson Space Center), J YGLESIAS (NASA Johnson Space Center), L EDWARDS (NASA, Washington), R J ADORNATO (Grumman Aerospace) et al *In* NASA Marshall Space Flight Center Appl of Tethers in Space, Vol 2 56 p Mar 1985
Avail NTIS HC A14/MF A01 CSCL 22A

Tether applications for space transportation are covered (1) payload boast, (2) upper stage boost, (3) E T deboost, (4) shuttle deboost, (5) shuttle docking , (6) payload and OTV boost, (7) OTV payload boost, (8) lunar assist and eccentricity change, (9) aeromaneuvering by remote sail or kite, (10) electrodynamic deceleration, and (11) lunar and planetary applications The first seven transfer momentum between two masses at the tether tips, and the remaining for use tethers for controlled interaction with the environment B G

N85-20370*# National Aeronautics and Space Administration Langley Research Center, Hampton, Va
REPORT OF THE TECHNOLOGY AND TEST PANEL
P SIEMERS, S GRAFF (JPL, California Inst of Tech , Pasadena), H COMPTON, R J DUCKETT, C BUONJIOLNO (CNR, Italy), G. WOOD, D R TENNEY, D D LANG (NASA Johnson Space Center), K. SUTTON (Analytical Mechanics Associates), P FLANAGAN et al *In* NASA Marshall Space Flight Center Appl of Tethers in Space, Vol 2 27 p Mar 1985
Avail NTIS HC A14/MF A01 CSCL 13I

The state of technology relative to the Tethered Satellite System (TSS) was reviewed The technology areas which could benefit from the TSS were defined To support TSS design studies it is necessary to develop tether dynamic model computer codes for

definition of mission and tether requirements Present major codes are very elaborate, expensive to run, and not very user friendly An additional technology concern was related to the manufacturing of tethers The development of complex tethers (nonconducting-taper/double taper long 100 km, conducting-embedded conduction, fiber optics, and superconducting) and their applications to space stations requires the development of manufacturing capabilities for both Earth-based as well as space-based systems B G

N85-20372*# National Aeronautics and Space Administration Langley Research Center, Hampton, Va
INSTRUMENTATION FOR APPLICATION NUMBER 1: MASS SPECTROMETRIC ANALYSIS OF THE BOUNDARY LAYER ASSOCIATED WITH THE TETHERED SATELLITE
G M WOOD *In* NASA Marshall Space Flight Center Appl of Tethers in Space, Vol 2 18 p Mar 1985 refs
Avail NTIS HC A14/MF A01 CSCL 22B

Knowledge about the boundary layer associated with high enthalpy flow fields has mostly been derived from measurements of physical properties To further this understanding, the chemistry of the gaseous layer must be studied as well This requires that instrumentation and measurement methods be developed that can analyze the gases while having a minimal effect on the flow field and composition Because of its sensitivity and ability to identify species, the mass spectrometer is the most promising instrument for this application, although other spectroscopic methods are being evaluated as well There are, however, several non-trivial problems that must be solved in order to apply the mass spectrometer, including the obtaining of a representative sample from near the model surface These problems are being addressed in a research program to develop qualitative and quantitative measurement methods to examine the gas chemistry in several large hot-gas blowdown facilities, and to study the aerodynamics of the boundary layer associated with models in these facilities and in instrumented hypersonic vehicles These methods can also be applied to the tethered satellite, which will provide a unique opportunity to obtain aerothermodynamic data that is unaltered by effects from the test facility M G

N85-21197*# Air Force Satellite Control Facility, Sunnyvale, Calif
GEOSYNCHRONOUS SATELLITE COLLISION AVOIDANCE Abstract Only
W FRASER *In* NASA Lyndon B Johnson Space Center Orbital Debris p 133 Mar 1985
Avail NTIS HC A20/MF A01 CSCL 22A

The increases in the number of satellite systems, the growing dependency on these systems, and the potentially hazardous conjunctions in space, dictates careful management of satellite positions The potential for satellite collision increases as more objects are placed in orbit At geosynchronous altitudes active satellites maintain fixed longitudinal station-keeping control while inactive satellites and debris generally drift around the globe or oscillate about two geopotential stable points Portions of the total objects in geosynchronous orbit are tracked by ground stations while a significant number of additional pieces of space debris regularly pass through geosynchronous orbit altitudes The probability of an operational satellite colliding with another satellite or a piece of space debris will increase in the number of space objects, their sizes, and on-orbit lifetimes E A K

N85-21198*# General Electric Co , Fairfield, Conn
IN SITU ORBITAL DEBRIS EXPERIMENT CONCEPTS
S. L NESTE *In* NASA Lyndon B Johnson Space Center Orbital Debris p 134-149 Mar 1985 refs
Avail NTIS HC A20/MF A01 CSCL 22A

Implementation of the radar, lidar and passive optical remote sensing concepts for measuring space debris from an Earth orbiting platform was investigated Each system was compared for their requirements on the host platform, their performance relative to the space debris measurement program and the estimated cost of developing each concept into a flight instrument It is found that the radar and lidar systems offer the greatest versatility and accuracy since they control the direction, intensity and duration of the energy incident on the target object The performance of the passive optical system is determined by the capability of the detector and by the baseline separation of the telescopes, which requires the use of an on-orbit deployment mechanism The passive optical concept provides the largest total event rae, and includes significant detections of particle sizes greater than 10 cm to allow correlation with ground based observations of the larger particles The event rate for the radar system is relatively constant with particle while the lidar system is slightly biased toward the smaller sizes These event rate differences result from a combination of the debris flux size distribution and the variation of sensitive detection area with particle size for the three concepts E A K

N85-21213*# Texas Univ , Austin. Dept of Aerospace and Engineering Mechanics
THE LONG TERM BEHAVIOUR OF EARTH ORBITS AND THE IMPLICATIONS FOR DEBRIS CONTROL
A C MUELLER *In* NASA Lyndon B Johnson Space Center Orbital Debris p 332-348 Mar 1985 refs
Avail NTIS HC A20/MF A01 CSCL 03C

GEO orbits with inclinations which remain less than 45 degrees are very stable Although the inclination of the orbital plane may vary as much as 15 degrees over a period of about 50 years, the orbit altitude will always remain within a few hundred kilometers of geosynchronous altitude, GEO orbits with inclinations greater than 45 degrees exhibit remarkable instabilities ir the eccentricity due to gravitational resonance Over a period of a century the eccentricity can reach such a large value that reentry is a possibility The combined effects of the Sun, Moon, and oblate Earth play a significant role in determining the lifetime of a GEO transfer orbit Depending on the initial orientation of the orbital plane with respect to the Sun and Moon, lifetimes may vary from under 6 months to over several hundred years Transfer orbits with inclinations over 45 degrees show strong instabilities in the perigee altitude resulting in generally short lifetimes of less than a few years All transfer orbits can be designed to decay within one year if the initial perigee altitude is less than 231 km However, there are restrictions on orbit plane placement and time of year of launch Author

N85-21214*# National Aeronautics and Space Administration Goddard Space Flight Center, Greenbelt, Md
DEBRIS IN THE GEOSTATIONARY ORBIT RING, THE ENDLESS SHOOTING GALLERY: THE NECESSITY FOR A DISPOSAL POLICY
D H SUDDETH *In* NASA Lyndon B Johnson Space Center Orbital Debris p 349-364 Mar. 1985
Avail NTIS HC A20/MF A01 CSCL 03C

NASA is considering establishing a policy for the limitation of the physical crowding of the geostationary orbit. The proposed policy is intended to address the following issues (1) deal only with geostationary altitudes, (2) illustrate the unique value and usefulness of the geostationary orbit ring, (3) describe the orbital dynamics as simply as possible, (4) describe the current spacecraft and debris situation, (5) briefly review current industry and agency policies, (6) project future trends of physical crowding with the present nonpolicy, (7) propose solutions that can be implemented in the near future, and (8) use previous work as much as desirable G L C

N85-21215*# National Aeronautics and Space Administration, Washington, D C
THE INTERNATIONAL ENVIRONMENT UNISPACE '82 AND THE ITU: A RELATIONSHIP BETWEEN ORBIT-SPECTRUM RESOURCE ALLOCATION AND ORBITAL DEBRIS
D OLMSTEAD *In* NASA Lyndon B Johnson Space Center Orbital Debris p 372-378 Mar 1985
Avail NTIS HC A20/MF A01 CSCL 05D

The 1985 Space WARC will examine and potentially modify the current geostationary orbit spectrum resource allocation methodology Discussions in this international political environment

could likely associate the geostationary orbital debris issue with the politicized issue of orbit spectrum allocation. G L C

N85-21414*# National Academy of Sciences - National Research Council, Washington, D C Commission on Engineering and Technical Systems.
COMPUTER INTEGRATION OF ENGINEERING DESIGN AND PRODUCTION: A NATIONAL OPPORTUNITY Final Report
Oct. 1984 73 p
(Contract NASW-3811)
(NASA-CR-175483, NAS 1 26 175483, PB85-128429) Avail NTIS HC A04/MF A01 CSCL 13H

The National Aeronautics and Space Administration (NASA), as a purchaser of a variety of manufactured products, including complex space vehicles and systems, clearly has a stake in the advantages of computer-integrated manufacturing (CIM). Two major NASA objectives are to launch a Manned Space Station by 1992 with a budget of $8 billion, and to be a leader in the development and application of productivity-enhancing technology At the request of NASA, a National Research Council committee visited five companies that have been leaders in using CIM Based on these case studies, technical, organizational, and financial issues that influence computer integration are described, guidelines for its implementation in industry are offered, and the use of CIM to manage the space station program is recommended GRA

N85-21659*# General Research Corp , McLean, Va
APPLICATIONS OF TETHERS IN SPACE Executive Summary
A C CRON 1985 69 p Workshop held in Williamsburg, Va , 15-17 Jun 1983
(Contract NAS8-35408)
(NASA-CP-2366, NAS 1 55 2366) Avail NTIS HC A04/MF A01 CSCL 22A

The proceedings of the first workshop on applications of tethers in space are summarized The workshop gathered personalities from industry, academic institutions and government to discuss the relatively new area of applied technology of very long tethers in space to a broad spectrum of future space missions A large number of tethered concepts and configurations was presented covering electrodynamic interaction tethers, tethered transportation through angular momentum exchange, tethered constellations, low gravity utilization, applicable technology, and tethered test facilities. Specific recommendations were made to NASA in each area Author

N85-22234*# Tennessee Technological Univ., Cookeville Dept of Civil Engineering.
DEBRIS IMPACT ON EARTH-ORBITING SPACECRAFT
D G SMITH *In* Alabama Univ Res. Rept 1984 NASA/ASEE Summer Faculty Fellowship Program (NASA-CR-171317) 15p Jan 1985 refs
Avail NTIS HC A99/MF E03 CSCL 22A

The accumulation of Earth-orbiting space debris leads to important new design considerations Some 5,000 orbiting objects, many of them explosion fragments, are currently being tracked and future collision of these objects with each other is predicted These collisions will occur at high velocities Each collision will be explosive, ejecting thousands, of new orbiting objects, in turn increasing the frequency of future collisions The debris population may thus become self-regenerative, and the future flux of orbiting debris will exceed that of meteoroids As a result, a large space structure in Earth-orbit for several years has a significant probability of impact by debris objects As a design problem, debris impact is significantly different from meteoroid impact. Protection against such large objects may require structural measures The consideration of debris impact in the design of large, Earth-orbiting spacecraft is recommended E.A.K

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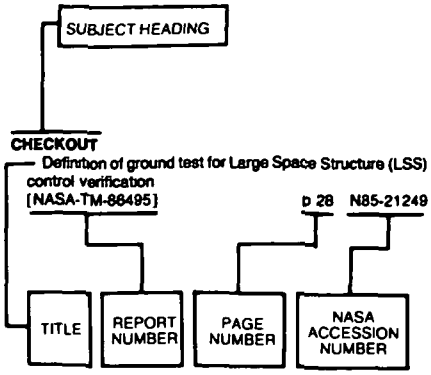

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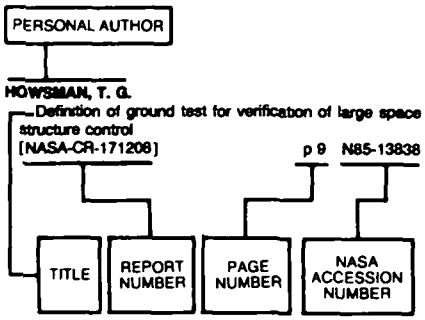

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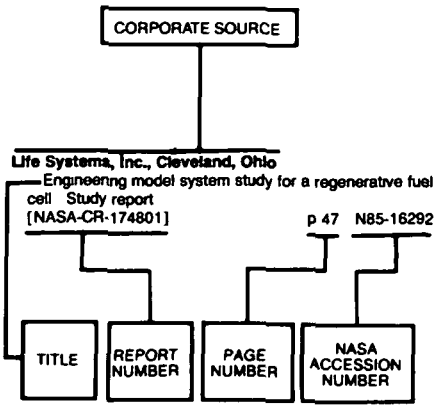

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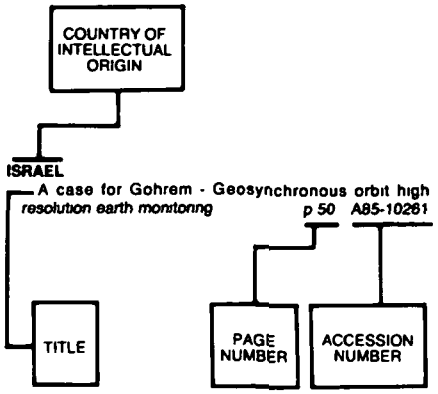

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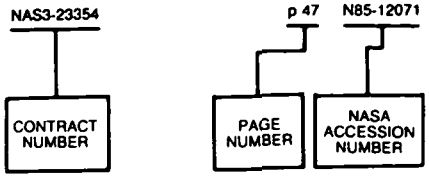

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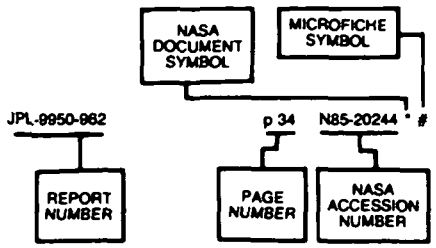

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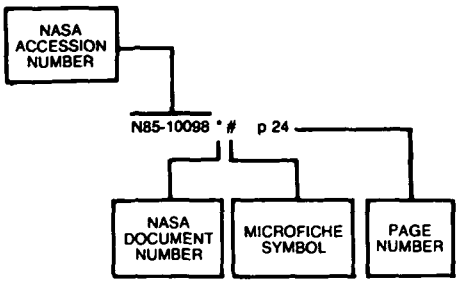

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E14	38 50	77 00
E15	42 00	84 00
E16	46 00	92 00
E17	50 00	100 00
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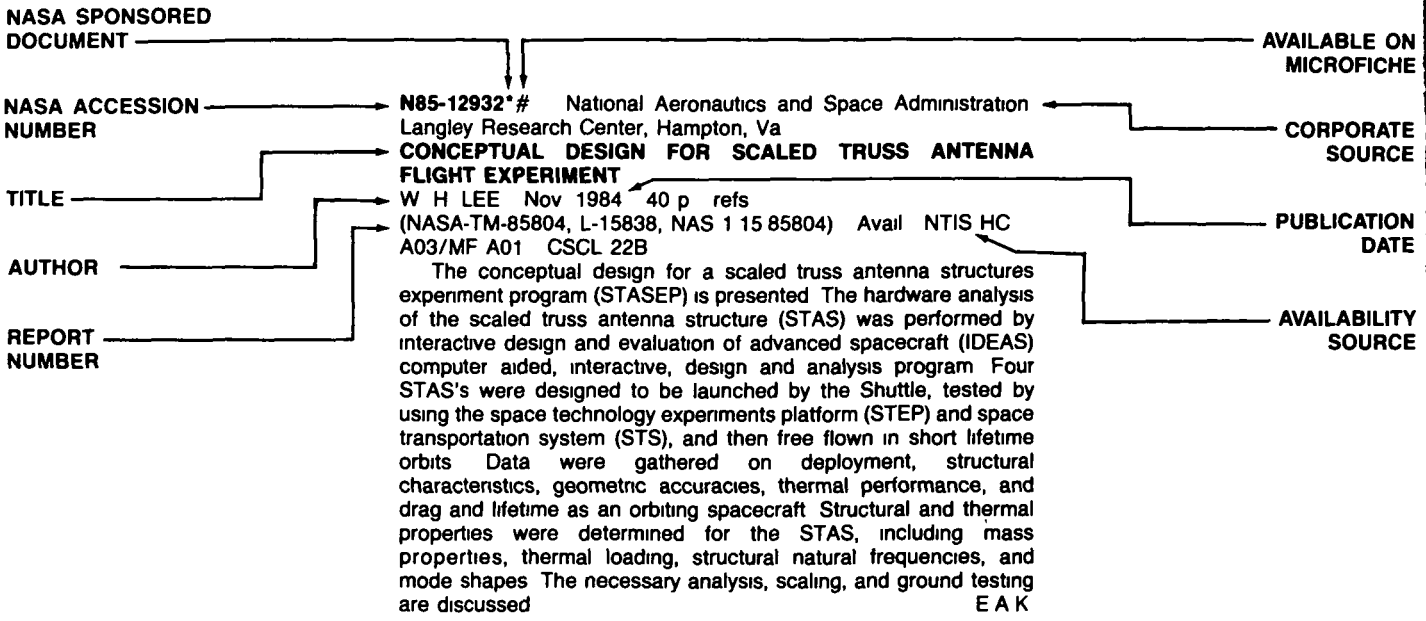

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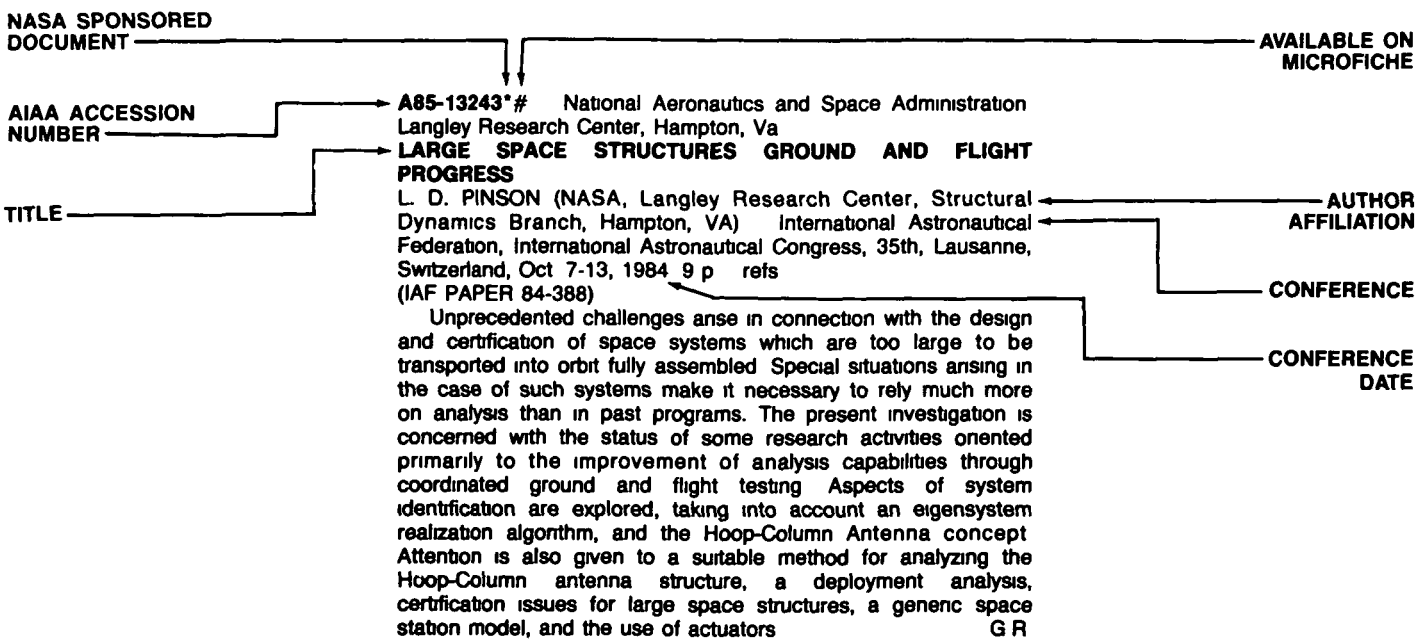

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16. Abstract

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