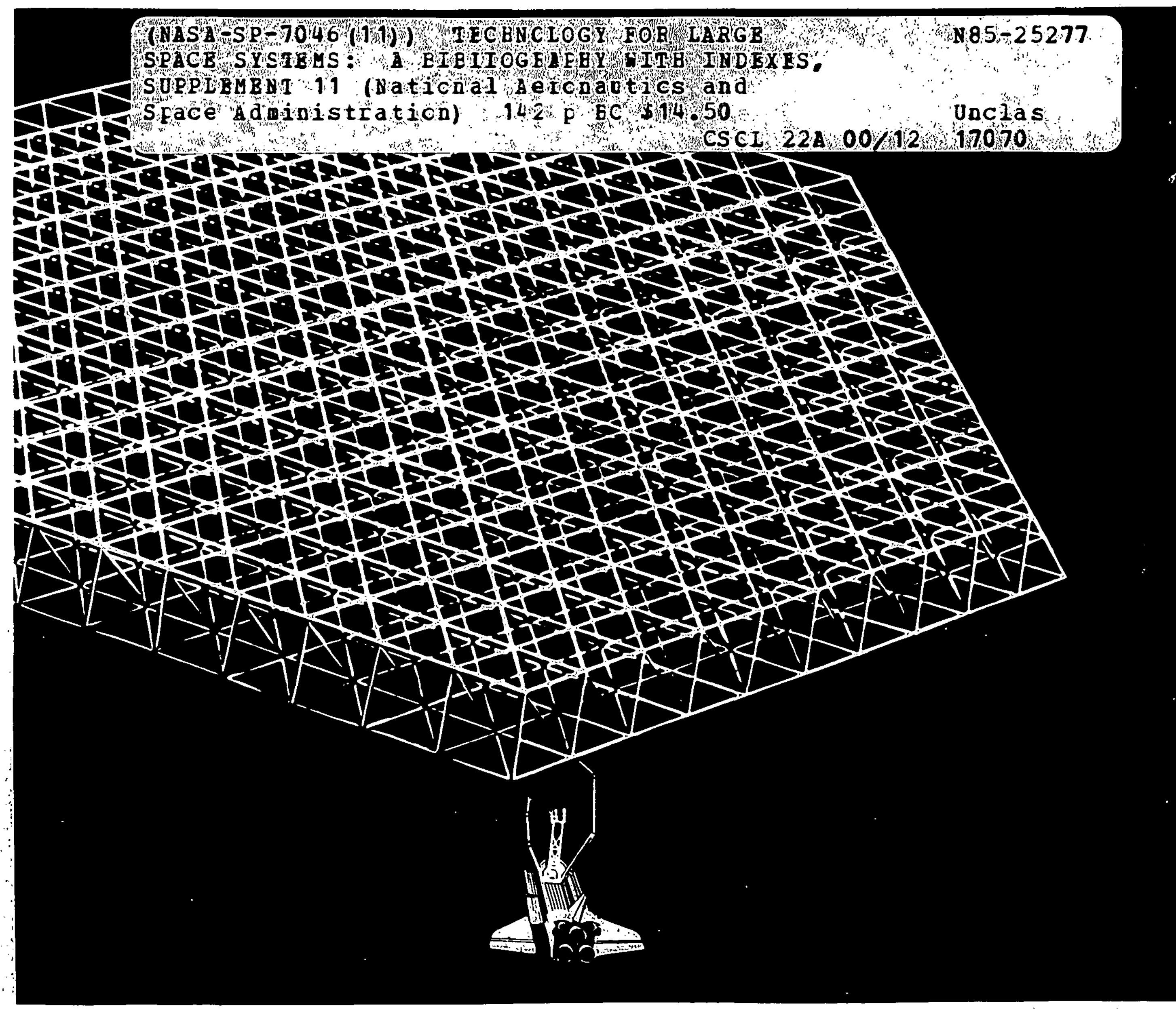
NASA

Technology for Large Space Systems

A Bibliography
with Indexes

NASA SP-7046(11)
January 1985



NASA SP-7046(11) Technology for Large Space Systems A Bibliography with Indexes January 1985

NASA SP-7046(11)

TECHNOLOGY FOR LARGE SPACE SYSTEMS

A BIBLIOGRAPHY WITH INDEXES

Supplement 11

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, 1984 in

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

NASA Scientific and Technical Information Branch 1985
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 ($14.50 domestic; $29.00 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. 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 539 reports, articles and other documents announced between January 1, 1984 and June 30, 1984 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 General category completes the list of subjects addressed by this document.

The selected items are grouped into ten categories as listed in the Table of Contents with notes regarding the scope of each category. These categories were especially selected for this publication and differ from those normally found in *STAR* and *IAA*.

Each entry consists of a standard bibliographic citation accompanied by an abstract where available, and appears with the original accession numbers from the respective announcement journals.

Under each of the ten categories, the entries are presented in one of two groups that appear in the following order:

1) *IAA* entries identified by accession number series A84-10,000 in ascending accession number order;
2) *STAR* entries identified by accession number series N84-10,000 in ascending accession number order.

After the abstract section there are six indexes - subject, personal author, corporate source, contract number, report number, and accession number.

AVAILABILITY OF CITED PUBLICATIONS

IAA ENTRIES (A84-10000 Series)

All publications abstracted in this Section are available from the Technical Information Service, American Institute of Aeronautics and Astronautics, Inc. (AIAA), as follows: Paper copies of accessions are available at $8.50 per document. Microfiche[1] of documents announced in *IAA* are available at the rate of $4.00 per microfiche on demand. Standing order microfiche are available at the rate of $1.45 per microfiche for *IAA* source documents.

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Initially distributed microfiche under the NTIS SRIM (Selected Research in Microfiche) is available at greatly reduced unit prices. For this service and for information concerning subscription to NASA printed reports, consult the NTIS Subscription Section, Springfield, Va. 22161.

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DOMESTIC: NASA and NASA-sponsored documents and a large number of aerospace publications are available to the public for reference purposes at the library maintained by the American Institute of Aeronautics and Astronautics, Technical Information Service, 555 West 57th Street, 12th Floor, New York, New York 10019.

EUROPEAN: An extensive collection of NASA and NASA-sponsored publications is maintained by the British Library Lending Division, Boston Spa, Wetherby, Yorkshire, England for public access. The British Library Lending Division also has available many of the non-NASA publications cited in *Star*. European requesters may purchase facsimile copy or microfiche of NASA and NASA-sponsored documents, those identified by both the symbols # and * from ESA - Information Retrieval Service European Space Agency, 8-10 rue Mario-Nikis, 75738 Paris CEDEX 15, France.

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NASA ACCESSION NUMBER — CORPORATE SOURCE

TITLE

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CONTRACT OR GRANT

REPORT NUMBER — AVAILABILITY SOURCE

N84-18576*# National Aeronautics and Space Administration, Washington, D. C.
SECOND ALL-UNION SEMINAR ON HYDROMECHANICS AND HEAT-MASS TRANSFER IN WEIGHTLESSNESS. ABSTRACTS OF REPORTS: TABLE OF CONTENTS
G. Z. GERSHUNI and Y. M. ZHUKHOVITSKIY Jan. 1984 15 p refs Transl. into ENGLISH of conf. papers, 1981 p 176-186 Seminar held in Perm, USSR, 1981
(Contract NASW-3542)
(NASA-TM-77534; NAS 1.15:77534) Avail: NTIS HC A02/MF A01 CSCL 20D

Abstracts of reports are given which were presented at the Second All Union Seminar on Hydromechanics and Heat-Mass Transfer in Weightlessness. Topics inlcude: (1) features of crystallization of semiconductor materials under conditions of microacceleration; (2) experimental results of crystallization of solid solutions of CDTE-HGTE under conditions of weightlessness; (3) impurities in crystals cultivated under conditions of weightlessness; and (4) a numerical investigation of the distribution of impurities during guided crystallization of a melt. B.W.

TYPICAL CITATION AND ABSTRACT FROM *IAA*

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A84-11811*# Jet Propulsion Lab., California Inst. of Tech., Pasadena.
TECHNOLOGY REQUIREMENTS FOR LARGE FLEXIBLE SPACE STRUCTURES
B. K. WADA, R. E. FREELAND (California Institute of Technology, Jet Propulsion Laboratory, Applied Mechanics Technology Section, Pasadena, CA), and N. F. GARCIA (Lockheed Missiles and Space Co., Inc., Sunnyvale, CA) International Astronautical Federation, International Astronautical Congress, 34th, Budapest, Hungary, Oct. 10-15, 1983. 6 p. refs
(IAF PAPER 83-404)

Research, test, and demonstration experiments necessary for establishing a data base that will permit construction of large, lightweight flexible space structures meeting on-orbit pointing and surface precesion criteria are discussed. Attention is focused on the wrap-rib proof-of-concept antenna structures developed from technology used on the ATS-6 satellite. The target structure will be up to 150 m in diameter or smaller, operate at RF levels, be amenable to packaging for carriage in the Shuttle bay, be capable of being ground-tested, and permit on-orbit deployment and retraction. Graphite/epoxy has been chosen as the antenna ribs material, and the antenna mesh will be gold-plated Mo wire. A 55-m diam reflector was built as proof-of-concept with ground-test capability. Tests will proceed on components, a model, the entire structure, and in-flight. An analytical model has been formulated to characterize the antenna's thermal behavior. The flight test of the 55-m prototype in-orbit offers the chance to validate the analytical model and characterize the control, mechanical, and thermal characteristics of the antenna configuration. M.S.K.

TECHNOLOGY FOR LARGE SPACE SYSTEMS

A Bibliography (Suppl. 11)

JANUARY 1985

01

SYSTEMS

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

A84-11724#
PAYLOAD PLACING USING AN OPERATIONAL SUPPORT PLATFORM
J. J. RUNAVOT and O. GROSJEAN (Centre National d'Etudes Spatiales, Toulouse, France) International Astronautical Federation, International Astronautical Congress, 34th, Budapest, Hungary, Oct. 10-15, 1983. 10 p.
(IAF PAPER 83-44)

Feasibility studies on a space-platform/orbital-maneuvering-vehicle (OMV) method for placing large (greater than 3000-kg) payloads in geosynchronous orbit are reported. This capability is seen as required by current European plans for the period 1990-2005; an alternate procedure currently being evaluated involves the use of an electronuclear tug. The approach considered here comprises a platform on low, near-equatorial orbit and a cryogenically propelled OMV capable of rendezvous, docking, fuel transfer, assembly, and checking. The payload (here, a telecommunications satellite) is launched in two parts by two Ariane-type expendable rockets: the satellite itself first, and then its propulsion unit. If the propellants can be stored on the platform (from earlier operations), the maximum payload in GEO can be about 12.5 tons. This potential plus the greater flexibility and safety of this approach make it more practical, at least with current technology, than the approach using the electronuclear tug. D.G.

A84-11726*# National Aeronautics and Space Administration. Earth Resources Labs., Bay St. Louis, Miss.
OVERVIEW OF NASA SPACE STATION ACTIVITIES
E. L. TILTON, III (NASA, National Space Technology Laboratories, Earth Resources Laboratory, Bay St. Louis, MS) and E. B. PRITCHARD (NASA, Langley Research Center, Hampton, VA) International Astronautical Federation, International Astronautical Congress, 34th, Budapest, Hungary, Oct. 10-15, 1983. 12 p.
(IAF PAPER 83-48)

The architecture, functions, and human activities on-board a space station are discussed. A manned presence is regarded as essential for innovative actions and successful exploitation of weightless conditions. The station itself could be a cluster of modules for habitation, power, operations, docking, experimentation, and storage. Additionally, the station could provide an interface for free-flying platforms and teleoperated satellite services, as well as a base for establishing space-based manufacturing facilities. NASA has projected timelines that include initial development funding in 1987, full capabilities before the year 2000, and initial costs for minimum capabilities of $7.5-9 billion. Architecture, mission requirements, trade-offs, and concepts are currently being defined as a prelude to systems development. Attention is being given to participation by both the DoD and other governments, and to defining the capabilities of the station, including habitability, closed-loop life-support system, the scope of science application and data transfer, and the power requirements. M.S.K.

A84-11731#
APPLICATION OF A COMMON REFLECTOR CONFIGURATION TO A MULTIMISSION SATELLITE OF THE 90'S
C. COUGNET, J. L. PERBOS, P. SAINT-AUBERT (Matra, S.A., Centre Spatiale de Toulouse, Toulouse, France), and G. BERRETTA (ESA, Paris, France) International Astronautical Federation, International Astronautical Congress, 34th, Budapest, Hungary, Oct. 10-15, 1983. 10 p.
(IAF PAPER 83-60)

A telecommunication satellite concept is presented in which a single reflector, common to different payloads, is applied to Ka- and Ku-band European coverage and, as a development for the late 1990s, C-band coverage of Africa. Attention is given to the configurations of the satellite and its antenna, as well as the definition of this mission and its traffic prediction analysis. No insurmountable problems have thus far been encountered in the application of this satellite concept to the mission in question, and a single, long payload-fairing Ariane 4 launch appears to be suitable. O.C.

A84-11793*# National Aeronautics and Space Administration, Washington, D. C.
NASA PRIORITY TECHNOLOGIES
S. R. SADIN (NASA, Office of Aeronautics and Space Technology, Washington, DC) and H. O. SLONE (NASA, Lewis Research Center, Cleveland, OH) International Astronautical Federation, International Astronautical Congress, 34th, Budapest, Hungary, Oct. 10-15, 1983. 10 p.
(IAF PAPER 83-345)

Significant research areas deserving of attention within the NASA Space Research and Technology program are discussed, noting that the program is pursed to strengthen the U.S. technology base, improve low-cost access to space, and to aid in the expanded use of space, including a space station. Study areas being pursued include new Orbiter thermal protection system materials, developing longer-life reusable engines, and providing the technology for orbital transfer vehicle propulsion and aeroassisted braking. Attention is also being given to CFD techniques for entry body and rocket engine design, verifying the feasibility of advanced sensor concepts, defining the technology for large deployable RF antennas, and improving on-board data management systems. Of particular concern is to establish technologies which will enhance and extend a permanent manned presence in space. M.S.K.

A84-11811*# Jet Propulsion Lab., California Inst. of Tech., Pasadena.

TECHNOLOGY REQUIREMENTS FOR LARGE FLEXIBLE SPACE STRUCTURES

B. K. WADA, R. E. FREELAND (California Institute of Technology, Jet Propulsion Laboratory, Applied Mechanics Technology Section, Pasadena, CA), and N. F. GARCIA (Lockheed Missiles and Space Co., Inc., Sunnyvale, CA) International Astronautical Federation, International Astronautical Congress, 34th, Budapest, Hungary, Oct. 10-15, 1983. 6 p. refs

(IAF PAPER 83-404)

Research, test, and demonstration experiments necessary for establishing a data base that will permit construction of large, lightweight flexible space structures meeting on-orbit pointing and surface precesion criteria are discussed. Attention is focused on the wrap-rib proof-of-concept antenna structures developed from technology used on the ATS-6 satellite. The target structure will be up to 150 m in diameter or smaller, operate at RF levels, be amenable to packaging for carriage in the Shuttle bay, be capable of being ground-tested, and permit on-orbit deployment and retraction. Graphite/epoxy has been chosen as the antenna ribs material, and the antenna mesh will be gold-plated Mo wire. A 55-m diam reflector was built as proof-of-concept with ground-test capability. Tests will proceed on components, a model, the entire structure, and in-flight. An analytical model has been formulated to characterize the antenna's thermal behavior. The flight test of the 55-m prototype in-orbit offers the chance to validate the analytical model and characterize the control, mechanical, and thermal characteristics of the antenna configuration. M.S.K.

A84-13330

POTENTIAL MILITARY APPLICATIONS OF SPACE PLATFORMS AND SPACE STATIONS

J. LEVY, E. RADANY, and J. TUTTLE (ORI, Inc., Silver Spring, MD) IN: EASCON '82; Annual Electronics and Aerospace Systems Conference, 15th, Washington, DC, September 20-22, 1982, Conference Record . New York, Institute of Electrical and Electronics Engineers, 1982, p. 269-276.

The potential applicability of space platforms and space stations to perform several military functions is discussed, and the role of man with regard to the station applications is identified. Additional space station concepts for providing military support functions are described, and the usefulness of man in each concept is identified. Author

A84-14762

THE TIROS-BASED ASTEROID MISSION

R. MAEHL (RCA, Astro-Electronics Div., Princeton, NJ) Spaceflight (ISSN 0038-6340), vol. 25, Dec. 1983, p. 430-435.

Mission features for a survey of the physical and chemical properties of asteroids that are candidates for a shift to GEO as raw material supplies for building large space structures are described. Modified Tiros satellites could probe near-earth objects in multiple-rendezvous scenarios, which would also yield data on the evolution of the solar system. Attention would be given to surface morphology, bulk density, density distribution, chemical and mineral composition, and magnetic properties. A mission profile including Shuttle launch, IUS boost, repeated orbits, and a soft landing on a single asteroid is detailed. D.H.K.

A84-15301

MANAGEMENT OF LARGE SPACE PROJECTS; COURSE ON SPACE TECHNOLOGY, TOULOUSE, FRANCE, MAY 3-14, 1982, PROCEEDINGS [LA GESTION DES GRANDS PROJETS SPATIAUX; COURS DE TECHNOLOGIE SPATIALE, TOULOUSE, FRANCE, MAY 3-14, 1982, EXPOSES]

Course sponsored by the Centre National d'Etudes Spatiales. Toulouse, Cepadues-Editions, 1983, 872 p. In French and English.

Topics discussed in an 11-day course on space technology sponsored by CNES to characterize the management techniques involved in the development of large space projects are presented, with attention focused on the production of the Ariane launch vehicle. Consideration is devoted to management of the day-to-day progress of a project that involved ESA, CNES, and European industries. Note is taken of contract features which distributed authority for various management and manufacturing tasks, established production and delivery schedules, specified performances, and characterized interface components. Scheduling techniques included setting margins for delivery dates in order to ameliorate the effects of the delay of delivery of any one subsystem on the project as a whole. Examples are cited from the Ariane, SPOT, and Spacelab projects. M.S.K.

A84-15303

HUMAN ORGANIZATION [ORGANISATION HUMAINE]

M. G. DELMAS (Centre National d'Etudes Spatiales, Toulouse, France) IN: Management of large space projects; Course on Space Technology, Toulouse, France, May 3-14, 1982, Proceedings . Toulouse, Cepadues-Editions, 1983, p. 95-108. In French.

The organizations required for a large space project are discussed, along with several of the tasks involved. A large space project is affected by its international effects, the necessary technical interfaces, the environments in the various countries manufacturing subsystems, and political and industrial limitations. The Telecom I project is cited as an example of a goal with international implications. The participants were the client, the project manager, the industries involved, the work managers, the subcontractors, and the equipment suppliers. It was found that the organization was not amenable to technical hierarchies, and a matrix organization functioned instead. A project head was appointed and supplied with a management structure to administer the work. The project leader coordinated the individual subprograms and reported directly to the governing agency. Simultaneously, a ground station network was established for tracking and controlling the satellite, as well as transmitting signals and receiving data. The human interactions on an organization level were affected by the location of authority, the dynamism of the organization, the relations between the people involved, the management actions, and the experience of the participants. M.S.K.

A84-15304

THE CONTRACT [LE CONTRAT]

M. M. VANHEMS (Centre National d'Etudes Spatiales, Toulouse, France) IN: Management of large space projects; Course on Space Technology, Toulouse, France, May 3-14, 1982, Proceedings . Toulouse, Cepadues-Editions, 1983, p. 121-140. In French.

Features of contracts, negotiations, and other considerations which are germane to the realization of large space projects are described. The justifications, specifications, consultations, selection of suppliers, and negotiating considerations for contracts are outlined. Three types of contracts are used: fixed price, controlled expenses, and incentive contracts with penalty clauses for delays. The contracts must take account of interest, carry a bill of particulars, detail the costs, cite administrative fees and assign duties, and identify suppliers. Price sampling techniques are detailed in terms of units of account, and attention is given to methods of modifying contracts in order to meet new or reformulated requirements, particularly those due to unanticipated cost increases for supplies. M.S.K.

A84-15305

THE PROGRESSION OF PROJECTS [LE DEROULEMENT DES PROJETS]

B. ESTADIEU (Centre National d'Etudes Spatiales, Toulouse, France) IN: Management of large space projects; Course on Space Technology, Toulouse, France, May 3-14, 1982, Proceedings . Toulouse, Cepadues-Editions, 1983, p. 141-165. In French. refs

Milestones and managerial actions which are necessary during various specified phases of a large space project are explored. The space projects are organized by phases to coordinate dispersed work, reduce risk, and for economic purposes such as selecting areas needing the greatest attention. The phases include mission analysis, feasibility analysis, design, manufacture, production, and use. NASA avoids following the phases rigorously in order to maintain flexibility during development. Industrial feedback is required during the different phases, as is constant monitoring of developments carried out in other countries. Reviews are performed at each phase to maintain coherence in the work and assure that the goals are being met or suitably modified. The reviews cover all aspects of the projects. M.S.K.

A84-15310

MANAGEMENT OF LARGE SPACE PROJECTS - QUALITY ASSURANCE OR 'PRODUCT ASSURANCE' [GESTION DES GRANDS PROJETS SPATIAUX - ASSURANCE DE LA QUALITEOU 'ASSURANCE PRODUIT']

A. DE CACQUEREY (Matra, S.A., Toulouse, France) IN: Management of large space projects; Course on Space Technology, Toulouse, France, May 3-14, 1982, Proceedings . Toulouse, Cepadues-Editions, 1983, p. 287-320. In French.

Quality assurance comprises predefined procedures for obtaining products which meet all flight, ground, testing, environmental, and performance specifications. Products for space use are usually not production line items and therefore must be built right the first time, with testing covering all mechanical, electrical, thermal, radiation, and interface performance components. A large amount of written documentation becomes necessary in order to trace the progress of development of all subsystems and ameliorate any adverse effects due to the differing motivations of the industrial sector and other participants engaged in the enterprise. Product assurance is constrained by the large number of interfaces within both the product, which may originate from off-the-shelf, original, and modified designs with subsystems manufactured in diverse places, and the organizations participating in the project. M.S.K.

A84-15325

THE SPACELAB PROGRAM - THE MANAGEMENT OF THE PROGRAM, PROBLEMS ENCOUNTERED AND THE SOLUTIONS ADOPTED [LE PROGRAMME SPACELAB - LA GESTION DU PROGRAMME, LES PROBLEMES RENCONTRES ET LES SOLUTIONS ADOPTEES]

B. R. K. PFEIFFER (ESA, European Space Research and Technology Centre, Noordwijk, Netherlands) IN: Management of large space projects; Course on Space Technology, Toulouse, France, May 3-14, 1982, Proceedings . Toulouse, Cepadues-Editions, 1983, p. 773-838. In French.

The management techniques applied by ESA in the Spacelab (SL) development program are reviewed critically. The history, objectives, and contractual responsibilities of ESA and NASA are summarized, and the SL modules to besupplied by ESA are characterized. The management structure is presented, with discussion of the roles of ESA and industry, the phases of the program, the principal reviews, documentation, verification, ongoing control of specifications, quality control and security, cost control and the evolution of the budget, the geographical distribution of the contracts, delay control, and configuration management. Block diagrams, sample worksheets, graphs, and maps are provided. The problems of the SL program are seen as primarily technical, associated with an insufficient initial technical base, overly diffuse management control, substantial modifications during development, and contractual and economic difficulties arising from the technical problems. It is shown that the management techniques adopted during the second half of the program limited the cost overrun to 40 percent of the original budget and ensured the successful fulfillment of the technical objectives. T.K.

A84-15363

COHERENT ARRAYS OF SEPARATE OPTICAL TELESCOPES IN SPACE PROJECT TRIO

A. LABEYRIE (Centre d'Etudes et de Recherches Geodynamiques et Astronomiques, Saint-Vallier-de-Thiey, Alpes-Maritimes, France), J. KIBBLEWHITE (Cambridge University, Cambridge, England), T. DE GRAAUW, H. ROUSSEL (ESA, European Space Research and Technology Centre, Noordwijk, Netherlands), J. NOORDAM (Dwingeloo, Radiosterrewacht, Dwingeloo, Netherlands), and G. WEIGELT (Erlangen-Nuernberg, Universitaet, Erlangen, West Germany) IN: Very long baseline interferometry techniques; International Colloquium, Toulouse, France, August 31-September 2, 1982, Proceedings . Toulouse, Cepadues-Editions, 1983, p. 477-488.

The present investigation is concerned with optical arrays in space, taking into account floating arrays of three (Trio) or more satellites. 'Floating arrays' consist of independent satellites which carry the optical elements separately but according to a stabilized configuration. It is pointed out that floating optical arrays are superior to rigid structures for large apertures, in the range from 100 m to 10 km. If they are feasible, their intrinsic modularity and flexibility should accelerate the implementation and growth of giant telescopes in space. Attention is given to the employment of different types of satellites, orbits, and pointing procedures, in a large floating optical array. G.R.

A84-15634* Jet Propulsion Lab., California Inst. of Tech., Pasadena.

AN ADVANCED GENERATION LAND MOBILE SATELLITE SYSTEM AND ITS CRITICAL TECHNOLOGIES

F. NADERI (California Institute of Technology, Jet Propulsion Laboratory, Pasadena, CA) IN: NTC '82; National Telesystems Conference, Galveston, TX, November 7-10, 1982, Conference Record . New York, Institute of Electrical and Electronics Engineers, Inc., 1982, p. B1.1.1-B1.1.8. NASA-supported research.

A conceptual design for a Land Mobile Satellite System (LMSS) for the 1990s is presented. LMSS involves small tranceivers accessing satellites directly, with ground reception through small car-top antennas. The satellite would have a large antenna and blanket coverage areas in the UHF. The call may originate from a home, be carried by wire to a gateway, transmitted to satellite on the S-band, converted to UHF on the satellite, and transmitted to the vehicle. The system design is constrained by the number of users in an area during the busiest hours, Shuttle storage, controllability factors, and the total area served. A 55-m antenna has been selected, with 87 spot beams and two 10 MHz UHF bands in the 806-890 MHz band. A 17 dB interbeam isolation level is required, implying that sufficient sub-bands can be generated to assure 8265 total channels. The mobile satellite (MSAT) would have an 83 m mast lower segment, a 34 m upper segment, and a second, 10 m antenna made of a deployable mesh. Various antenna function modes are considered. M.S.K.

A84-15695

SPACE OPERATIONS CENTER COMMUNICATIONS PATH OBSCURATION

J. R. CARL and B. P. LU (Lockheed Engineering and Management Services Co., Inc., Houston, TX) IN: NTC '82; National Telesystems Conference, Galveston, TX; November 7-10, 1982, Conference Record . New York, Institute of Electrical and Electronics Engineers, Inc., 1982, p. F1.2.1-F1.2.5.

Computer assisted techniques were developed to determine the obscuration of a communications path caused by the physical objects that comprise the Space Operations Center (SOC). Of particular interest in this paper is the obscuration of the line-of-sight path from an antenna, mounted somewhere on or in the vicinity of the SOC, to a geosynchronous satellite, such as a Telemetry Data Relay Satellite. The dynamic geometry of this type of problem makes it difficult to visualize, in a complete manner, without the aid of a computer. Blockage is shown graphically by computer-generated displays, and the percentage of time that the path is blocked is calculated. Graphics permit a ready comparison of one antenna location to another. Author

A84-18005#
LOW COST SPACE SCIENCE AND ASTRONOMY PLATFORMS IN ORBIT
P. M. MITCHELL (Martin Marietta Aerospace, New Orleans, LA) and T. C. TAYLOR (Taylor and Associates, Inc., Wrightwood, CA) American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 22nd, Reno, NV, Jan. 9-12, 1984. 12 p. refs
(AIAA PAPER 84-0297)

Design concepts for orbital space-science or astronomy platforms utilizing the STS external propellant tank (ET) as primary structure are presented. It is pointed out that the 68,000-pound, 154-ft-long, 27.5-ft-diameter ET currently attains 98 percent of orbital velocity and could be placed in LEO for little additional cost. General modifications to the ET, such as additional wiring and tubing, the bolt-on aft cargo carrier, an environmental protection system, avionics, and attitude control, are discussed. Hardware for four specific missions is described in detail: a dedicated commercial platform; a life-science platform with growth chambers for algae, marine fauna, or aeroponically grown plants; a large-deployable-reflector platform; and a gamma-ray imaging telescope. Drawings illustrating the design concepts are provided. D.G.

A84-21573
SPACE VEHICLES [O KOSMOLETAKH]
K. FEOKTISTOV and I. BUBNOV Moscow, Izdatel'stvo Molodaia Gvardiia, 1982, 208 p. In Russian.

The Soviet cosmonaut Feoktistov gives an informal, popular sketch of his participation in the Soviet space program. Part of the book consists of a dialogue on space issues conducted with the journalist Bubnov. Topics discussed include the development of the first spacecraft, problems in the planning of the first manned flights and the first space stations, and the future of man in space. B.J.

A84-24628*# National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.
INTEGRATED REQUIREMENTS FOR A SPACE STATION
E. B. PRITCHARD (NASA, Langley Research Center, Hampton, VA) IN: Space station: Policy, planning and utilization; Proceedings of the Symposium, Arlington, VA, July 18-20, 1983 . New York, American Institute of Aeronautics and Astronautics, 1983, p. 23-32.

The time-phased mission set developed for the proposed space station program (including the manned facility, coorbiting and remote free flyers and platforms, orbital maneuvering and transfer systems, and storage and service facilities) by the Space Station Mission Requirements Workshop in May 1983, is presented in figures and tables and discussed. The scientific, commercial, and technology-development proposals are characterized, and the requirements for a station and coorbiting platform at 28.5-deg orbital inclination are listed for the period 1991-2000. Japanese, ESA, and Canadian utilization is considered, special requirements are outlined, and functional characteristics are summarized. Developmental strategies to meet the concerns of the user community are suggested. T.K.

A84-24633*# National Aeronautics and Space Administration, Washington, D. C.
ARCHITECTURAL OPTIONS AND DEVELOPMENT ISSUES
L. E. POWELL (NASA, Washington, DC) IN: Space station: Policy, planning and utilization; Proceedings of the Symposium, Arlington, VA, July 18-20, 1983 . New York, American Institute of Aeronautics and Astronautics, 1983, p. 131-135.

The design options for the space station are discussed in general terms, reflecting the approach taken by the NASA Concept Development Group. Primary aims are flexibility and transparency, to fulfill as many scientific and commercial user requirements as possible and to open the station to as many new users as possible; utilities, facilities, and functional support must be designed to meet these aims. General architecture options considered include the present STS, an extended STS, a limited-duration manned transportation node with unmanned platforms, and a manned station with unmanned platforms and transportation-node capability (OTV, TMS). The latter option is found most promising and developed further, with consideration of the technical challenges involved. T.K.

A84-24634*# National Aeronautics and Space Administration, Washington, D. C.
SPACE STATION ARCHITECTURAL ISSUES AS VIEWED BY THE USER COMMUNITY - APPLICATIONS
W. P. RANEY (NASA, Washington, DC) IN: Space station: Policy, planning and utilization; Proceedings of the Symposium, Arlington, VA, July 18-20, 1983 . New York, American Institute of Aeronautics and Astronautics, 1983, p. 139-141.

Potential applications of the proposed space station are briefly examined. Areas considered include communications (bulk traffic, direct broadcast, and assembly of GEO platforms), earth sciences (repair and refurbishment of long-term spacecraft), and materials processing. The importance of developing a comfortable habitat is stressed. T.K.

A84-25260#
THE FRANCO-GERMAN DBS PROGRAM 'TV-SAT/TDF-1'
R. ARNIM (Eurosatellite GmbH, Munich, West Germany) IN: Communication Satellite Systems Conference, 10th, Orlando, FL, March 19-22, 1984, Technical Papers . New York, American Institute of Aeronautics and Astronautics, 1984, p. 75-83.
(AIAA PAPER 84-0661)

Governmental authorities of Germany and France have jointly awarded a contract to industry for two DBS satellites, to be launched in 1985, which will then serve Germany and France with direct-to-home broadcasting. This paper provides an overview of the background of the Franco-German program, the scope of the program, its technical baseline and configuration, its delivery schedule, its present status, and information on the customer and contractor side. Author

A84-25282#
DEVELOPMENT AND APPLICATION OF NEW TECHNOLOGIES IN THE ESA OLYMPUS PROGRAMME
R. BONHOMME, B. L. HERDAN, and R. STEELS (ESA, Olympus Programme Office, Noordwijk, Netherlands) IN: Communication Satellite Systems Conference, 10th, Orlando, FL, March 19-22, 1984, Technical Papers . New York, American Institute of Aeronautics and Astronautics, 1984, p. 249-262.
(AIAA PAPER 84-0706)

The European Space Agency (ESA) Olympus Program constitutes one of the most ambitious current developments in the communications satellite field. The development program has now been underway for nearly two years. This paper describes a number of the innovative features and new technologies being incorporated in the satellite design. The latest status of design, analysis and test of platform and payload hardware is given together with planning for near-term future activities, and commentary on future prospects for Olympus large spacecraft derivatives. Author

A84-25287#
TELE-X - THE FIRST STEP IN A SATELLITE COMMUNICATIONS SYSTEM FOR THE NORDIC COUNTRIES
L. BACKLUND, L. ANDERSON, A. EKMAN, S. GRAHN, L. JALMARSSON, and L.-I. LUNDSTROM (Svenska Rymdaktiebolaget, Solna, Sweden) IN: Communication Satellite Systems Conference, 10th, Orlando, FL, March 19-22, 1984, Technical Papers . New York, American Institute of Aeronautics and Astronautics, 1984, p. 299-309.
(AIAA PAPER 84-0713)

The development and design of Tele-X, an experimental TV and telecommunications satellite to be launched in 1986 by Sweden, Norway, and Finland, are discussed. The history of the cooperative R&D venture is traced from the beginning of Nordsat studies in 1974 through the 1977 WARC frequency and orbit allocations and the initiation of the Viking research-satellite program and the Tele-X program in the late 1970s. The Tele-X spacecraft and its payload are modified versions of the TV-Sat/TDF-1 satellite design being completed by France and the FRG. Primary services to be provided include TV (using two 230-W TWTA transponders in the 18/12-GHz bands) and data/video communication (using one wide-band and one narrow-band transponder in the 14/12-GHz bands and serving a fully switched digital network at 64 kbit/sec and 2 Mbit/sec). Experimental transmissions at 8, 34, and 140 Mbit/sec will also be undertaken. Block diagrams, drawings, tables of performance data, and a coverage map are included. T.K.

A84-25308#
LAND-MOBILE COMMUNICATIONS SATELLITE SYSTEM DESIGN
M. HORSTEIN (TRW, Inc., TRW Space and Technology Group, Redondo Beach, CA) IN: Communication Satellite Systems Conference, 10th, Orlando, FL, March 19-22, 1984, Technical Papers . New York, American Institute of Aeronautics and Astronautics, 1984, p. 467-475. refs
(AIAA PAPER 84-0753)

Satellite system designs capable of providing land-mobile satellite service to a population of 350,000 radio-telephone subcribers are considered. The problems discussed include frequency allocation, modulation, system sizing, carrier assignment, satellite/gateway links, satellite-link design, and mobile unit antenna design. Data on link noise allocation and satellite-to-mobile and mobile-to-satellite link budgets are presented. A satellite description is briefly given, and the feed-cluster approach to beam formation is summarized. Economic aspects and alternate system designs are also addressed. C.D.

A84-25326*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
NASA'S GEOSTATIONARY COMMUNICATIONS PLATFORM PROGRAM
J. RAMLER (NASA, Lewis Research Center, Cleveland, OH) and R. DURRETT (NASA, Marshall Space Flight Center, Huntsville, AL) IN: Communication Satellite Systems Conference, 10th, Orlando, FL, March 19-22, 1984, Technical Papers . New York, American Institute of Aeronautics and Astronautics, 1984, p. 613-621. refs
(AIAA PAPER 84-0702)

This paper reviews recent trends in communications satellites and explains NASA's current interest in geostationary communications platforms. Large communications platforms capable of supporting multiple payloads with common utilities have been examined in a number of studies since 1974 and appear to offer a number of potential advantages. In 1981, an Industry Briefing and Workshop sponsored by NASA focused on the institutional, operational and technical issues that will influence the implementation of geostationary platforms. The workshop identified numerous issues and problem areas that needed more detailed study. To address the issues/problems identified, a NASA geostationary communications platform program has been developed. This program is described, focusing on the initial studies to be performed. Author

A84-26926
EVOLUTIONARY CONCEPTS FOR A SPACE STATION AND THE RELEVANT UTILISATION POTENTIAL
P. W. SHARP (ERNO Raumfahrttechnik GmbH, Bremen, West Germany) British Interplanetary Society, Journal (Space Technology) (ISSN 0007-084X), vol. 37, April 1984, p. 157-162.

Two basic evolutionary concept approaches for the realisation of a space station are discussed in this paper. They are respectively the US manned station and the European unmanned station. Both concepts as detailed here are currently under investigation; the goal of both programmes is to have an operational system early in the 1990's. Even though no single space discipline can justify the establishment of such a station, it is this author's opinion that both will be built, not in competition but as two compatible systems being part of a larger space infrastructure. The majority of payloads which will utilise the facilities of the space station will be of a scientific nature e.g. life sciences, extraterrestrial research, etc. Only in a few cases - materials science and processing, and space sciences (earth observation) - can possible commercial usage be realised. This, of course, does not exclude the creation of so-called by-products/spin-offs which have been a feature of existing space programmes e.g. pocket computers, microminiaturised solid state electronics, quartz watches, etc. The participation of Europe in developing hardware and facilities for a US Space Station is seen as a major near and long term goal. Author

A84-27945
LEASECRAFT - AN INNOVATIVE SPACE VEHICLE
J. DESKEVICH (Fairchild Space Co., Germantown, MD) IEEE Transactions on Aerospace and Electronic Systems (ISSN 0018-9251), vol. AES-20, Jan. 1984, p. 25-37.

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

A84-29043* National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.
ENVIRONMENTAL CONTROL AND LIFE SUPPORT FOR AN EVOLUTIONARY SPACE STATION
P. D. QUATTRONE (NASA, Ames Research Center, Moffett Field, CA) and R. A. WYNVEEN (Life Systems, Inc., Cleveland, OH) AIAA, SAE, ASME, AIChE, and ASMA, Intersociety Conference on Environmental Systems, 13th, San Francisco, CA, July 11-13, 1983. 18 p. refs
(SAE PAPER 831108)

The requirements for the Space Station are being defined. The Environmental Control/Life Support System (ECLSS) is one of its 13 systems. The ECLSS is further divided into five functional categories. Major ones are the Air Revitalization and Water Reclamation Systems. The paper presents ECLSS performance requirements, average design loads and fluids interfaces. The major cost savings of regenerable ECLSS techniques versus the open loop approach are quantified. Issues impacting ECLSS design are cited. Priority regenerable ECLSS developments are reviewed including the Electrochemical CO2 Concentrator, Static Feed Electrolyzer and Automated Control/Monitor Instrumentation. Baseline and alternative approaches are cited. The ECLSS planning issues are reviewed including functional boundaries, planning schedule, technology maturity definition and technology gaps. The paper concludes with a review of water electrolysis as a Space Station utility impacting ECLSS design. Author

A84-29044* National Aeronautics and Space Administration. Lyndon B. Johnson Space Center, Houston, Tex.
SYSTEMS ENGINEERING ASPECTS OF A PRELIMINARY CONCEPTUAL DESIGN OF THE SPACE STATION ENVIRONMENTAL CONTROL AND LIFE SUPPORT SYSTEM
C. H. LIN and M. S. MEYER (NASA, Johnson Space Center, Houston, TX) AIAA, SAE, ASME, AIChE, and ASMA, Intersociety Conference on Environmental Systems, 13th, San Francisco, CA, July 11-13, 1983. 19 p.
(SAE PAPER 831109)

The systems engineering aspects of developing a conceptual design of the Space Station Environmental Control and Life Support System (ECLSS) are discussed. Topics covered include defining system requirements and groundrules for approach, formulating possible cycle closure options, and establishing a system-level mass balance on the essential materials processed in oxygen and water cycles. Consideration is also given to the performance of a system trade-off study to determine the best degree of cycle closure for the ECLSS, and the construction of a conceptual design of the ECLSS with subsystem performance specifications and candidate concepts. For the optimum balance between development costs, technological risks, and resupply penalties, a partially closed cycle ECLSS option is suggested. C.M.

A84-29046* National Aeronautics and Space Administration. Lyndon B. Johnson Space Center, Houston, Tex.
INTEGRATED WATER MANAGEMENT SYSTEM - DESCRIPTION AND TEST RESULTS
N. C. ELDEN, H. E. WINKLER, D. F. PRICE (NASA, Johnson Space Center, Houston, TX), and R. P. REYSA (Boeing Aerospace Co., Houston, TX) AIAA, SAE, ASME, AIChE, and ASMA, Intersociety Conference on Environmental Systems, 13th, San Francisco, CA, July 11-13, 1983. 13 p. refs
(SAE PAPER 831111)

Water recovery subsystems are being tested at the NASA Lyndon B. Johnson Space Center for Space Station use to process waste water generated from urine and wash water collection facilities. These subsystems are being integrated into a water management system that will incorporate wash water and urine processing through the use of hyperfiltration and vapor compression distillation subsystems. Other hardware in the water management system includes a whole body shower, a clothes washing facility, a urine collection and pretreatment unit, a recovered water post-treatment system, and a water quality monitor. This paper describes the integrated test configuration, pertinent performance data, and feasibility and design compatibility conclusions of the integrated water management system. Author

A84-29047* Boeing Aerospace Co., Houston, Tex.
HYPERFILTRATION WASH WATER RECOVERY SUBSYSTEM - DESIGN AND TEST RESULTS
R. P. REYSA (Boeing Aerospace Co., Houston, TX), D. F. PRICE (NASA, Johnson Space Center, Houston, TX), T. OLCOTT (Lockheed Missiles and Space Corp., Palo Alto, CA), and J. L. GADDIS (Clemson University, Clemson, SC) AIAA, SAE, ASME, AIChE, and ASMA, Intersociety Conference on Environmental Systems, 13th, San Francisco, CA, July 11-13, 1983. 12 p. refs
(SAE PAPER 831112)

The Hyperfiltration Wash Water Recovery (HWWR) subsystem, designed to offer low-power high-volume wash water purification for extended mission spacecraft, is discussed in terms of preprototype design and configuration. Heated wash water collected from the shower, hand wash, and laundry flows into a temperature-controlled (374 K) waste storage tank. Two parallel 25 micron absolute filters at the tank outlet remove large particles from the feed stream. A positive displacement feed pump delivers wash water to the hyperfiltration module at a constant flow rate of 0.20 lpm with discharge pressure variations from 4181-7239 Kpa. The hyperfiltration membrane module is a single-pass design including 36 porous stainless steel tubes, and is designed to provide an approximate water recovery rate of 90 percent. Permeate and brine water flows are monitored by flow meters, and removal of urea and ammonia is achieved by adding 15 percent NaOCl solution to the permeate fluid stream. An alternate module design using two diameters of tubing (allowing a smaller pressure drop and a larger membrane area) gave a superior predicted performance over the first module with larger tubing throughout. J.N.

A84-29054
ELECTROCHEMICAL AND STEAM-DESORBED AMINE CO2 CONCENTRATION SUBSYSTEM COMPARISON
D. B. HEPPNER and F. H. SCHUBERT (Life Systems, Inc., Cleveland, OH) AIAA, SAE, ASME, AIChE, and ASMA, Intersociety Conference on Environmental Systems, 13th, San Francisco, CA, July 11-13, 1983. 11 p. refs
(SAE PAPER 831120)

A comparative study has been conducted for the continuous Electrochemical Depolarized CO2 Concentration (EDC) and amine resin bed cyclic absorption/desorption systems which may furnish CO2 removal for a regenerative space station environmental control and life support system, with attention to the sizing of their respective subsystems. The analysis includes identification of subsystem boundaries, which are defined as the hardware required for the replacement of the nonregenerable substances otherwise employed in the space station system. It is found that the EDC concept has a far lower equivalent weight than the alternative. O.C.

A84-29056
PHASE CHANGE WATER RECOVERY TECHNIQUES - VAPOR COMPRESSION DISTILLATION AND THERMOELECTRIC/MEMBRANE CONCEPTS
F. H. SCHUBERT (Life Systems, Inc., Cleveland, OH) AIAA, SAE, ASME, AIChE, and ASMA, Intersociety Conference on Environmental Systems, 13th, San Francisco, CA, July 11-13, 1983. 17 p. refs
(SAE PAPER 831122)

The Vapor Compression Distillation (VCD) and thermoelectric/membrane evaporation concepts, both of which involve phase change recovery processes and attempt to minimize the energy input/unit mass of water recovered by using heat released by condensation as energy for further evaporation, are being considered for the recovery of water from urine and other waste waters in a space station regenerative life support system. Comparisons between these alternatives are conducted in light of configurational and subsystem schematics, component sizing considerations, and projected operational characteristics. The thermoelectric concept is found to be 26 percent heavier, with 56 percent higher total equivalent weight and more than twice the energy/unit mass of water recovered by the alternative VCD process. O.C.

A84-29666#
SERVICING VEHICLE FOR SATELLITES AND PLATFORMS IN LOW EARTH ORBITS [WARTUNGSFAHRZEUG FUER SATELLITEN UND PLATTFORMEN IN NIEDRIGEN ERDUMLAUFBAHNEN]
W. KLEINAU (Messerschmitt-Boelkow-Blohm GmbH, Ottobrunn, West Germany) Deutsche Gesellschaft fuer Luft- und Raumfahrt, Jahrestagung, Munich, West Germany, Oct. 17-19, 1983. 58 p. In German.
(DGLR PAPER 83-102)

A report is presented of studies which were conducted by two German aerospace companies. A scenario for the time period from 1988 to 2000 is considered, and the concept of an Interorbital Transfer and Logistics Vehicle (IOTLV) for applications involving the low earth orbit (LEO) is presented. The IOTLV is based on existing European technology, and a modular concept has been employed. A description is given of the individual modules of the 'Modular Orbital Operations Systems' (MOOS). Six types of vehicles can be obtained for more than 16 identified missions by using six modules in appropriate combinations. The modules include the Modular Orbital Propulsion System (MOPS), the Modular Auxiliary Tank System (MATS), the Modular Orbital Servicing System (MOSS), the Modular Equipment and Avionics System (MEAS), the Modular Orbital Reentry System (MORS), and the Modular Orbital Crew Cabin (MOCC). It is pointed out that the modular IOTLV is cost effective with respect to total costs and yearly maximum costs. The development can be easily assigned to different European countries and firms. It is estimated that the transfer stage could be available in 1989 and the servicing vehicle in 1990. G.R.

A84-29853* National Aeronautics and Space Administration. Lyndon B. Johnson Space Center, Houston, Tex.
HABITABILITY DESIGN ELEMENTS FOR A SPACE STATION
M. C. DALTON (NASA, Johnson Space Center, Houston, TX) IN: Space manufacturing 1983; Proceedings of the Sixth Conference, Princeton, NJ, May 9-12, 1983 . San Diego, CA, Univelt, Inc., 1983, p. 9-26.
(AAS PAPER 83-200)

Habitability in space refers to the components, characteristics, conditions, and design parameters that go beyond but include the basic life sustaining requirements. Elements of habitability covered include internal environment, architecture, mobility and restraint, food, clothing, personal hygiene, housekeeping, communications, and crew activities. All elements are interrelated and need to be treated as an overall discipline. Designing for a space station is similar to designing on earth but with 'space rules' instead of ground rules. It is concluded that some habitability problems require behavioral science solutions. C.M.

A84-29858
REUSABLE COMMERCIAL SPACE PROCESSING PLATFORMS
D. E. KOELLE (Messerschmitt-Boelkow-Blohm GmbH, Ottobrunn, West Germany) IN: Space manufacturing 1983; Proceedings of the Sixth Conference, Princeton, NJ, May 9-12, 1983 . San Diego, CA, Univelt, Inc., 1983, p. 119-133.
(AAS PAPER 83-208)

The paper deals with the new concept of reusable Shuttle platforms: it describes their special features and the specific applications. The first demonstration of this concept is performed by the SPAS-01 platform developed by MBB as commercial venture, launched on STS-07. Reusable platforms provide advantages for commercial space processing operations. They provide an essential cost reduction compared to previous alternatives, together with extended operation periods (several months) and high microgravity level. The characteristics of the EURECA platform are given and a commercial version (OMNI-SPAS) of similar performance is discussed. Finally, economic and cost aspects are dealt with for reusable platforms as well as for future permanent space platforms. Author

N84-12026*# National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.
RESEARCH AND TECHNOLOGY, 1983 Annual Report
Nov. 1983 96 p
(NASA-TM-85702; NAS 1.15:85702) Avail: NTIS HC A05/MF A01 CSCL 05B

Highlights of major accomplishments and applications made during the past year illustrate the broad range of research and technology activities at the Langley Research Center. Advances are reported in the following areas: systems engineering and operation; aeronautics; electronics; space applications; aircraft and spacecraft structures; composite structures; laminar flow control; subsonic transport aircraft; and supersonic fighter concepts. Technology utilization efforts described cover a hyperthermia monitor, a lightweight composite wheelchair; and a vehicle ride quality meter. A.R.H.

N84-14234# Committee on Science and Technology (U. S. House).
NASA'S SPACE STATION ACTIVITIES
Washington GPO 1983 161 p Hearing before the Subcomm. on Space Sci. and Appl. of the Comm. on Sci. and Technol., 98th Congr., 1st Sess., no. 37, 2 Aug. 1983
(GPO-27-393) Avail: Subcommittee on Space Science and Applications

The status, plans, and activities associated with NASA's space station effort are reviewed. N.W.

N84-15171*# Teledyne Brown Engineering, Huntsville, Ala. Payload Missions Integration Div.
PAYLOAD MISSIONS INTEGRATION Progress Report, 19 Sep. - 11 Nov. 1983
28 Nov. 1983 52 p
(Contract NAS8-32712)
(NASA-CR-170949; NAS 1.26:170949; PMIC-MA03-469-29; PO-83-506) Avail: NTIS HC A04/MF A01 CSCL 22B

Spacelab missions 1 to 3, OSTA partial payloads, Astro-1 mission, premission definition, and mission peculiar equipment support structure are discussed. Author

N84-15172*# National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.
AN ALTERNATE CONCEPT FOR EXPANDING MAN'S PRESENCE IN SPACE
W. R. HOOK and R. S. OSBORNE Feb. 1983 43 p refs
(NASA-TM-84617; NAS 1.15:84617) Avail: NTIS HC A03/MF A01 CSCL 22A

A logical next step after shuttle is a manned orbital service system (MOSS) consisting of a two-man crew module mated with a propulsion module. The resulting spacecraft would remain in low Earth orbit for months or years at a time conducting civil or military satellite servicing, experimental, or applications missions while being periodically supplied and refueled by Shuttle flights from the ground. The system would accumulate experience invaluable to the design of future large and more expensive spacecraft. Key features of the vehicle are versatility and mobility. With Centaur-type propulsion and a large payload, the MOSS could leave an initial orbit of 370 km (200 nmi) altitude and inclinations up to 56 deg, make a plane change of up to + or - 14 deg, reach altitudes to 5500 km (2970 nmi), and then return the payload to the original orbit altitude and inclination. Obviously, the size of the performance envelope varies with the payload and propulsion-unit selected. The MOSS can reach orbits and perform tasks not possible with Shuttle alone or with the much larger space stations currently being proposed. Author

N84-15179*# National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.
CAPTURE-EJECTOR SATELLITES
I. O. MACCONOCHIE, C. H. ELDRED, and J. A. MARTIN Oct. 1983 23 p refs Previously announced in IAA as A82-43265
(NASA-TM-85686; NAS 1.15:85686) Avail: NTIS HC A02/MF A01 CSCL 22B

A satellite in the form of a large rotating rim which can be used to boost spacecraft from low-Earth orbit to higher orbits is described. The rim rotates in the plane of its orbit such that the lower portion of the rim is traveling at suborbital velocity, while the upper portion is travelling at greater than orbital velocity. Ascending spacecraft or payloads arrive at the lowest portion of the rim at suborbital velocities, where the payloads are released on a trajectory for higher orbits; descending payloads employ the reverse procedure. Electric thrusters placed on the rim maintain rim rotational speed and altitude. From the standpoint of currently known materials, the capture-ejector concept may be useful for relatively small velocity increments. Author

N84-17211*# National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.
STEP EXPERIMENT REQUIREMENTS
M. L. BRUMFIELD, comp. Jan. 1984 347 p refs Workshop held in Hampton, Va., 28 Jun. - 1 Jul. 1983
(NASA-CP-2294; L-15733; NAS 1.55:2294) Avail: NTIS HC A15/MF A01 CSCL 22B

A plan to develop a space technology experiments platform (STEP) was examined. NASA Langley Research Center held a STEP Experiment Requirements Workshop on June 29 and 30 and July 1, 1983, at which experiment proposers were invited to present more detailed information on their experiment concept and requirements. A feasibility and preliminary definition study was conducted and the preliminary definition of STEP capabilities and experiment concepts and expected requirements for support services are presented. The preliminary definition of STEP capabilities based on detailed review of potential experiment requirements is investigated. Topics discussed include: Shuttle on-orbit dynamics; effects of the space environment on damping materials; erectable beam experiment; technology for development of very large solar array deployers; thermal energy management process experiment; photovoltaic concentrater pointing dynamics and plasma interactions; vibration isolation technology; flight tests of a synthetic aperture radar antenna with use of STEP.

N84-17212*# National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.
SPACE TECHNOLOGY EXPERIMENTS PLATFORM (STEP) OVERVIEW
J. E. HARRIS *In its* STEP Expt. Requirements p 1-12 Jan. 1984
Avail: NTIS HC A15/MF A01 CSCL 22B

The Space Technology Experiments Platform (STEP) concept is summarized. It is shown that STEP is the enabling link between the research community and the space environment made accessible by the Space Transportation System (STS). The constituent elements of the research community are identified, the pertinent space environment attributes are listed, and the major guidelines applicable to establishing the specific STEP configuration are identified. E.A.K.

N84-17213*# National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.
STEP MECHANICAL SYSTEMS
O. H. BRADLEY, JR. *In its* STEP Expt. Requirements p 13-34 Jan. 1984
Avail: NTIS HC A15/MF A01 CSCL 22B

The key elements in the STEP system are depicted including the Spacelab pallet, a modular interface structure, and pallet mounted electronics. Several concepts for potential experiments are illustrated. E.A.K.

N84-17215*# National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.
STEP EXPERIMENT INTEGRATION
J. C. MOORMAN *In its* STEP Expt. Requirements p 47-54 Jan. 1984
Avail: NTIS HC A15/MF A01 CSCL 22B

The space technology experiments platform (STEP) integration was examined. Topics include: experiment design, fabrication, and assembly; experiment performance and environmental testing; STEP compatibility testing; STEP experiment integration; STS/payload requirements definition documentation. E.A.K.

N84-17218*# National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.
DEPLOYABLE BEAM FLIGHT EXPERIMENT (MAST)
B. R. HANKS and J. L. ALLEN, JR. *In its* STEP Expt. Requirements p 103-120 Jan. 1984 refs
Avail: NTIS HC A15/MF A01 CSCL 22B

Improvement of technology of space systems control is discussed. Future space systems such as large antennas or a space station may have dimensions on the order of 30 m to 200 m, yet their basic structures may be relatively lightweight and flexible, making ground tests for loads, controls analyses, and design verifications questionable if not impossible. Abandoning the extensive ground test and analysis verification program that led to the success of previous spacecraft is not a sensible option; making it meaningful using current technology will require inefficient, ultraconservative structure and control designs. New test methods are outlined. E.A.K.

N84-17220*# Astro Research Corp., Carpinteria, Calif.
THE STEP/STACBEAM EXPERIMENT TECHNOLOGY DEVELOPMENT FOR VERY LARGE SOLAR ARRAY DEPLOYERS
R. SAMUELS *In* NASA. Langley Research Center STEP Expt. Requirements p 135-146 Jan. 1984 refs
Avail: NTIS HC A15/MF A01 CSCL 22B

The Stacking Triangular Articulated Compact Beam (STACBEAM) is discussed with reference to structural testing experiments afforded by ground simulation and the Space Technology Experiments Platform (STEP). The STACBEAM lends itself to a deployment technique which offers a radical improvement in flexible blanket solar array technology. A system for deployment and support of a solar array blanket is described which consists of the blanket, its containment structure, the support structure and its deployer, the blanket stiffening battens, and the deployable boom standoffs. In operation, the blanket is pulled out and supported by the STACBEAM which packages next to the folded blanket. Since the STACBEAM does not rotate during extension, complete control of the blanket is maintained during extension. Deployment of this system occurs one bay at a time in a sequential manner. The deployer provides sufficient rigidity so that beam stiffness is not degraded during the deployment process. M.G.

N84-17221*# Massachusetts Inst. of Tech., Cambridge. Space Systems Lab.
GENERAL REQUIREMENTS FOR SHUTTLE FLIGHT EXPERIMENTS
E. F. CRAWLEY *In* NASA. Langley Research Center STEP Expt. Requirements p 147-154 Jan. 1984
Avail: NTIS HC A15/MF A01 CSCL 22A

Requirements and guiding principles for flight space structures experiments are defined. Shuttle mid-deck experiments, Space Technology Experiments Platform (STEP) tests, and the EVA Assembly of Structures Experiment (EASE) are addressed. M.G.

N84-17231*# McDonnell-Douglas Astronautics Co., Huntington Beach, Calif.
STEP FLIGHT EXPERIMENTS LARGE DEPLOYABLE REFLECTOR (LDR) TELESCOPE
F. C. RUNGE *In* NASA. Langley Research Center STEP Expt. Requirements p 257-278 Jan. 1984
Avail: NTIS HC A15/MF A01 CSCL 03A

Flight testing plans for a large deployable infrared reflector telescope to be tested on a space platform are discussed. Subsystem parts, subassemblies, and whole assemblies are discussed. Assurance of operational deployability, rigidization, alignment, and serviceability will be sought. R.J.F.

N84-17232*# National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.
LARGE DEPLOYABLE ANTENNA FLIGHT EXPERIMENT FOR THE SPACE TECHNOLOGY EXPERIMENTS PLATFORM (STEP)
B. C. TANKERSLY (Harris Corp.) and T. G. CAMPBELL *In its* STEP Expt. Requirements p 279-300 Jan. 1984
Avail: NTIS HC A15/MF A01 CSCL 22B

Spaceborne experiments to test the deployment reliability of large space antennas are discussed. Retraction, reflector surface tolerance, thermal distortion, electromagnetic performance, and dynamic controls are discussed. R.J.F.

N84-17233*# Jet Propulsion Lab., California Inst. of Tech., Pasadena.
THE 55-METER-STRUCTURE FLIGHT EXPERIMENT
J. A. GARBA, R. FREELAND, B. K. WADA, K. J. OKEEFE (Lockheed Missile and Space Co., Sunnyvale, Calif.), and A. WOODS (Lockheed Missile and Space Co., Sunnyvale, Calif.) *In* NASA. Langley Research Center STEP Expt. Requirements p 301-310 Jan. 1984
Avail: NTIS HC A15/MF A01 CSCL 22B

The verification and demonstration of the structural performance related parameters for large flexible space structures are discussed.

The objectives are to verify the deployment repeatability of static surface contour, to demonstrate the feasibility of in-flight static shape correction, to verify predicted shape in a zero gravity thermal environment, to determine zero gravity structural dynamic characteristics, and to verify the instrumentation and excitation system for in-flight measurements. R.J.F.

N84-17234*# National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.
LARGE INFLATED-ANTENNA SYSTEM
W. F. HINSON and L. S. KEAFER *In its* STEP Expt. Requirements p 311-324 Jan. 1984 refs
Avail: NTIS HC A15/MF A01 CSCL 22B

It is proposed that for inflatable antenna systems, technology feasibility can be demonstrated and parametric design and scalability (scale factor 10 to 20) can be validated with an experiment using a 16-m-diameter antenna attached to the Shuttle. The antenna configuration consists of a thin film cone and paraboloid held to proper shape by internal pressure and a self-rigidizing torus. The cone and paraboloid would be made using pie-shaped gores with the paraboloid being coated with aluminum to provide reflectivity. The torus would be constructed using an aluminum polyester composite that when inflated would erect to a smooth shell that can withstand loads without internal pressure. R.J.F.

N84-17237*# Department of Communications, Ottawa (Ontario). Directorate of Space Mechanics.
FLIGHT TEST OF A SYNTHETIC APERTURE RADAR ANTENNA USING STEP
D. G. ZIMCIK, F. R. VIGERON, and S. AHMED *In* NASA. Langley Research Center STEP Expt. Requirements p 339-354 Jan. 1984
Avail: NTIS HC A15/MF A01 CSCL 17I

To establish confidence in its overall performance, credible information on the synthetic aperture radar antenna's mechanical properties in orbit must be obtained. However, the antenna's size, design, and operating environment make it difficult to simulate operating conditions under 1-g Earth conditions. The Space Technology Experiments Platform (STEP) offers a timely opportunity to mechanically qualify and characterize the antenna design in a representative environment. The proposed experimental configuration would employ a half-system of the full-scale RADARSAT antenna which would be mounted on the STEP platform in the orbiter cargo bay such that it could be deployed and retracted in orbit (as shown in this figure). The antenna would be subjected to typical environmental exposures while an array of targets and sensors on the antenna support structure and reflecting surface are observed and monitored. In particular, the typical environments would include deployment and retraction, dynamic response to vehicle thruster or base exciter inputs, and thermal soak and transient effects upon entering or exiting Earth eclipse. The proposed experiment would also provide generic information on the properties of large space structures in space and on techniques to obtain the desired information. R.J.F.

N84-17248*# Martin Marietta Aerospace, Denver, Colo.
TECHNOLOGY NEEDS OF ADVANCED EARTH OBSERVATION SPACECRAFT Final Report
J. J. HERBERT, J. R. POSTUCHOW, and W. A. SCHARTEL Washington NASA Jan. 1984 261 p
(Contract NAS1-16756)
(NASA-CR-3698; NAS 1.26:3698; MCR-81-630) Avail: NTIS HC A12/MF A01 CSCL 22B

Remote sensing missions were synthesized which could contribute significantly to the understanding of global environmental parameters. Instruments capable of sensing important land and sea parameters are combined with a large antenna designed to passively quantify surface emitted radiation at several wavelengths. A conceptual design for this large deployable antenna was developed. All subsystems required to make the antenna an autonomous spacecraft were conceptually designed. The entire package, including necessary orbit transfer propulsion, is folded to package within the Space Transportation System (STS) cargo bay. After separation, the antenna, its integral feed mast, radiometer receivers, power system, and other instruments are automatically deployed and transferred to the operational orbit. The design resulted in an antenna with a major antenna dimension of 120 meters, weighing 7650 kilograms, and operating at an altitude of 700 kilometers. Author

N84-17947# National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.
SPLINE-BASED ESTIMATION TECHNIQUES FOR PARAMETERS IN ELLIPTIC DISTRIBUTED SYSTEMS
H. T. BANKS (Brown Univ.), P. L. DANIEL (Southern Methodist Univ.), and E. S. ARMSTRONG Jun. 1983 19 p
(Contract AF-AFOSR-0198-81; AF PROJ. 2304)
(NASA-TM-85439; NAS 1.15:85439; AD-A135109; LCDS-83-22; AFOSR-83-0926TR) Avail: NTIS HC A02/MF A01 CSCL 12A

Parameter and state estimation techniques are discussed for an elliptic system arising in a developmental model for the antenna surface in the Maypole Hoop/Column antenna. A computational algorithm based on spline approximations for the state and elastic parameters is given and numerical results obtained using this algorithm are summarized. Author (GRA)

N84-18116# Committee on Science and Technology (U. S. House).
NATIONAL AERONAUTICS AND SPACE ADMINISTRATION ACT, 1985
Washington GPO 1984 10 p A bill referred to the Comm. on Sci. and Technol., 98th Congr., 2nd Sess., 8 Feb. 1984
Avail: US Capitol, House Document Room

Appropriations to the National Aeronautics and Space Administration for research and development, space flight, control and data communications, construction of facilities, and research and program management, and for other purposes were authorized. Author

N84-18265*# Boeing Aerospace Co., Seattle, Wash.
SPACE STATION NEEDS, ATTRIBUTES AND ARCHITECTURAL OPTIONS STUDY. VOLUME 1: EXECUTIVE STUDY Final Report
21 Apr. 1983 69 p refs
(Contract NASW-3680)
(NASA-CR-173334; NAS 1.26:173334; D180-27477-1-VOL-1)
Avail: NTIS HC A04/MF A01 CSCL 22B

Mission identification and validation, the benefits of a manned presence in space; attributes and architectures; time-phased mission and system requirements imposed on the space station; orbit selection; space station architectural options; technology selection; and program planning are addressed. N.W.

N84-18266*# Boeing Aerospace Co., Seattle, Wash.
SPACE STATION NEEDS, ATTRIBUTES AND ARCHITECTURAL OPTIONS STUDY. VOLUME 2: MISSION ANALYSIS Final Report
21 Apr. 1983 412 p refs
(Contract NASW-3680)
(NASA-CR-173333; NAS 1.26:173333; D180-27477-2-VOL-2)
Avail: NTIS HC A18/MF A01 CSCL 22B

Space environment studies, astrophysics, Earth environment, life sciences, and material sciences are discussed. Commercial communication, materials processing, and Earth observation missions are addressed. Technology development, space operations, scenarios of operational capability, mission requirements, and benefits analysis results for space-produced gallium arsenide crystals, direct broadcasting satellite systems, and a high inclination space station are covered. N.W.

N84-18267*# Boeing Aerospace Co., Seattle, Wash.
SPACE STATION NEEDS, ATTRIBUTES AND ARCHITECTURAL OPTIONS STUDY. VOLUME 3: REQUIREMENTS
21 Apr. 1983 57 p refs
(Contract NASW-3680)
(NASA-CR-173332; NAS 1.26:173332; D180-27477-3-VOL-3)
Avail: NTIS HC A94/MF A01 CSCL 22B

A typical system specification format is presented and requirements are compiled. A Program Specification Tree is shown showing a high inclination space station and a low inclination space station with their typical element breakdown, also represented along the top blocks are the interfaces with other systems. The specification format is directed at the Low Inclination space station. Author

N84-18268*# Boeing Aerospace Co., Seattle, Wash.
SPACE STATION NEEDS, ATTRIBUTES AND ARCHITECTURAL OPTIONS STUDY. VOLUME 4: ARCHITECTURAL OPTIONS, SUBSYSTEMS, TECHNOLOGY AND PROGRAMMATICS Final Report
21 Apr. 1983 207 p refs
(Contract NASW-3680)
(NASA-CR-173331; NAS 1.26:173331; D180-27477-4-VOL-4)
Avail: NTIS HC A10/MF A01 CSCL 22B

Space station architectural options, habitability considerations and subsystem analyses, technology, and programmatics are reviewed. The methodology employed for conceiving and defining space station concepts is presented. As a result of this approach, architectures were conceived and along with their supporting rationale are described within this portion of the report. Habitability consideration and subsystem analyses describe the human factors associated with space station operations and includes subsections covering (1) data management, (2) communications and tracking, (3) environmental control and life support, (4) manipulator systems, (5) resupply, (6) pointing, (7) thermal management and (8) interface standardization. A consolidated matrix of subsystems technology issues as related to meeting the mission needs for a 1990's era space station is presented. Within the programmatics portion, a brief description of costing and program strategies is outlined. Author

N84-18269*# Boeing Aerospace Co., Seattle, Wash.
SPACE STATION NEEDS, ATTRIBUTES AND ARCHITECTURAL OPTIONS STUDY. FINAL EXECUTIVE REVIEW
5 Apr. 1983 126 p refs
(Contract NASW-3680)
(NASA-CR-173335; NAS 1.26:173335; D180-27477-6) Avail: NTIS HC A07/MF A01 CSCL 22B

Identification and validation of missions, the benefits of manned presence in space, attributes and architectures, space station requirements, orbit selection, space station architectural options, technology selection, and program planning are addressed. N.W.

N84-18270*# Grumman Aerospace Corp., Bethpage, N.Y.
SPACE STATION NEEDS, ATTRIBUTES AND ARCHITECTURAL OPTIONS. PART 1: SUMMARY Final Briefing Report
9 Apr. 1983 150 p refs Prepared in cooperation with COMSAT General and General Electric
(Contract NASW-3685)
(NASA-CR-175382; NAS 1.26:175382; SA-SSP-RP009-PT-1)
Avail: NTIS HC A07/MF A01 CSCL 22B

Candidate missions for the space station were subjected to an evaluation/filtering process which included the application of budgetary constraints and performance of benefits analysis. Results show that the initial space station should be manned, placed in a 28.5 deg orbit, and provide capabilities which include a space test facility, satellite service, a transport harbor, and an observatory. A space industrial park may be added once further development effort validates the cost and expanding commercial market for space-processed material. Using the space station as a national space test facility can enhance national security, as well as commercial and scientific interests alike. The potential accrued gross mission model benefit derived from these capabilities is $5.9B without the industrial park, and $9.3B with it. Other benefits include the lowering of acquisition costs for NASA and DoD space assets and a basis for broadening international participation. A.R.H.

N84-18271*# McDonnell-Douglas Astronautics Co., Huntington Beach, Calif.
SPACE STATION NEEDS, ATTRIBUTES AND ARCHITECTURAL OPTIONS: SUMMARY BRIEFING Final Report
Apr. 1983 120 p refs
(Contract NASW-3687)
(NASA-CR-173328; NAS 1.26:173328; MDC-H0180A) Avail: NTIS HC A06/MF A01 CSCL 22B

Computerized data sorting and analysis techniques were used with a data base accumulated in over 20 years of space station studies to evaluate candidate missions and select a final model of 88 missions. The social, cultural, scientific, technical, and commercial benefits to be accrued from each mission were identified. Requirements were determined for satellite servicing; payload placement and retrieval; refueling; repair; testing; assembly; and construction. Missions drivers determined include crew, remote manipulating system, external parts, instrumentation, extravehicular activity/manned maneuvering unit, and voice/video equipment. User interest for commercial applications were determined. Variable architecture based on a modular concept with multi-use elements is proposed. A.R.H.

N84-18272*# TRW Space Technology Labs., Redondo Beach, Calif.
SPACE STATION NEEDS, ATTRIBUTES AND ARCHITECTURAL OPTIONS STUDY. FINAL REVIEW EXECUTIVE SUMMARY BRIEFING
5 Apr. 1983 136 p refs
(Contract NASW-3681)
(NASA-CR-173674; NAS 1.26:173674) Avail: NTIS HC A07/MF A01 CSCL 22B

User needs and mission requirements, architecture and mission implementation, and program costs and benefits are discussed. Author

N84-18273*# Martin Marietta Aerospace, Bethesda, Md. Space and Electronics Systems Div.
SPACE STATION NEEDS, ATTRIBUTES AND ARCHITECTURAL OPTIONS STUDY. BRIEFING MATERIAL: FINAL REVIEW AND EXECUTIVE SUMMARY
Apr. 1983 70 p refs Sponsored in part by Department of Defense
(Contract NASW-3686)
(NASA-CR-173321; NAS 1.26:173321; SOC-SE-02-02) Avail: NTIS HC A04/MF A01 CSCL 22B

Advantages and disadvantages were assessed for configuration options for a modular 14' diameter space station, a modular aft cargo carrier and a shuttle derived vehicle. Early, intermediate, and mature configurations were defined as well as power requirements, heat rejection, hydrazine usage, and the external scavenging concept. Subsystems were analyzed for propulsion, attitude control, data processing, and communications. Areas of uncertainties, associated costs and benefits, and the cost by phase of the modular and shuttle derived vehicle configurations were identified. Technologies assessed included solar vs nuclear; gravity gradient vs active control; heat pipe radiators vs fluid loops; distributed processors vs centralized, and modular vs shuttle derived configuration. It was determined that the early space station architecture should include: (1) reusable OTV with aerobraking; (2) TMS with telepresence services; (3) OTV/TMS refueling and servicing capability; and (4) attached research laboratories for life sciences and materials processing. A.R.H.

N84-18274*# Rockwell International Corp., Downey, Calif. Shuttle Integration and Satellite Systems Div.
SPACE STATION NEEDS, ATTRIBUTES, AND ARCHITECTURAL OPTIONS STUDY Final Executive Summary Briefing
6 Apr. 1983 79 p
(Contract NASW-3683)
(NASA-CR-173327; NAS 1.26:173327; SSD-83-0037) Avail: NTIS HC A05/MF A01 CSCL 22B

Recommended program architecture; missions and requirements, programmatic evolution; space station architecture, technology, and cost; and space station attributes and benefits are discussed. N.W.

N84-18275*# General Dynamics/Convair, Fort Worth, Tex.
SPACE STATION NEEDS, ATTRIBUTES AND ARCHITECTURAL OPTIONS. SUMMARY OF MAJOR STUDY ACTIVITIES AND RESULTS. SPACE STATION PROGRAM OBSERVATIONS Final Briefing Report
O. STEINBRONN and D. CHARHUT 5 Apr. 1983 136 p refs
(Contract NASW-3682)
(NASA-CR-173345; NAS 1.26:173345) Avail: NTIS HC A07/MF A01 CSCL 22B

Space station study logic, commercial applications, total mission set space station system, mission requirements, free flyer missions, a baseline time phased mission set, and space systems architecture are discussed. N.W.

N84-18277*# National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.
SPACE STATION TECHNOLOGY, 1983
R. L. WRIGHT, ed. and C. R. MAYS, ed. Feb. 1984 189 p
Workshop held in Williamsburg, Va., 28-31 Mar. 1983
(NASA-CP-2293; L-15732; NAS 1.55:2293) Avail: NTIS HC A09/MF A01 CSCL 22B

This publication is a compilation of the panel summaries presented in the following areas: systems/operations technology; crew and life support; EVA; crew and life support: ECLSS; attitude, control, and stabilization; human capabilities; auxillary propulsion; fluid management; communications; structures and mechanisms; data management; power; and thermal control. The objective of the workshop was to aid the Space Station Technology Steering Committee in defining and implementing a technology development program to support the establishment of a permanent human presence in space. This compilation will provide the participants and their organizations with the information presented at this workshop in a referenceable format. This information will establish a stepping stone for users of space station technology to develop new technology and plan future tasks.

N84-18278*# Boeing Aerospace Co., Seattle, Wash.
SYSTEMS/OPERATIONS TECHNOLOGY
G. R. WOODCOCK *In* NASA. Langley Research Center Space Station Technol., 1983 p 1-24 Feb. 1984
Avail: NTIS HC A09/MF A01 CSCL 22B

The deliberations of the Systems/Operations Technology Panel are summarized. The first real question that arose was to develop an understanding of what systems/operations technology is. A relativelynew discipline in the NASA technology organization, necessitates the definition of the objectives. Two objectives were established: (1) to make new things possible, and (2) to make existing capabilities cost less or work better. Making new things possible is not really applicable in the case of a space station. Both Salyut 7 and Skylab indicate that space stations are possible with existing (not necessarily new) technology. There was a concern on the part of some of the penelists that work better might mean higher performance, and that is not necessarily the case at all. Work better may mean simply to provide better service to the users of the space station at lower cost. The panel felt this to be a more realistic viewpoint. As evidenced from interaction with users (and all of the contractors found this basically to be true), the users want low cost, no schedule constraints, and no hassles. Author

N84-18279*# Texas Woman's Univ., Houston.
CREW AND LIFE SUPPORT: EVA
R. S. JOHNSTON *In* NASA. Langley Research Center Space Station Technol., 1983 p 25-32 Feb. 1984
Avail: NTIS HC A09/MF A01 CSCL 22B

Four general recommendations by the EVA subpanel are listed as follows: 1) EVA design standard document needs to be dveloped in the next 6 to 12 months and updated as technology progresses. 2) NASA needs to couple EVA design personnel closer to the user community. 3) there appears to be a lack of centralized NASA responsibility for the EVA community. 4) Panel activity should continue to promote exchange of information and understanding of user problems, and to stimulate technology activity. Author

N84-18280*# General Dynamics Corp., San Diego, Calif.
CREW AND LIFE SUPPORT: ECLSS
G. DRAKE *In* NASA. Langley Research Center Space Station Technol., 1983 p 33-40 Feb. 1984
Avail: NTIS HC A09/MF A01 CSCL 22B

The schedule NASA has proposed has four main elements. The focal point of all the life support activity is demonstrator for the initial space station. The demonstrator is composed of items that are ready for Phase C and D development. Technical options are scheduled during the early years to provide alternatives because the capability to substitute must be maintained. Growth technology and supporting research and technology (SR&T) will continue throughout the program life, and as new items emerge, the space station capability will be updated. Author

N84-18282*# Little (Arthur D.), Inc., Cambridge, Mass.
HUMAN CAPABILITIES
W. AUGERSON *In* NASA. Langley Research Center Space Station Technol., 1983 p 61-83 Feb. 1984
Avail: NTIS HC A09/MF A01 CSCL 22B

In conclusion, habitability is more than just life support and there is a substantial technology application void. Habitability needs both visibility and responsibility in the space station program to ensure the optimum use of man in space. In the area of work technology, IVA and EVA teleoperators and robotics should be considered as tools and not competitors. A generic work station is a contemporary of the early space stations. Flexibility of a future space station requires this. Author

N84-18283*# Aerojet-General Corp., Sacramento, Calif.
AUXILIARY PROPULSION
S. D. ROSENBERG *In* NASA. Langley Research Center Space Station Technol., 1983 p 85-87 Feb. 1984
Avail: NTIS HC A09/MF A01 CSCL 22B

When man is put in the loop, almost anything can happen. Caution must be exercised in permitting life cycle costs analysis to control technology investment. One of the ways of reducing cost is to stay with the old tried and true technology. However, when requirements of a permanent space station are considered (15-year life, the issues associated with health monitoring, maintenance, and repair), the conclusion is that very little, if anything, is really state of the art. Before investing in old technologies to make them comply with the requirements of a permanent space station, the question of whether or not it is worth putting the money there as opposed to advancing the state of the art should be considered. Program managers and system designers must not make the mistake of selecting old technologies in the belief that they are state of the art. Author

N84-18284*# Martin Marietta Corp., Denver, Colo.
FLUID MANAGEMENT
D. FESTER *In* NASA. Langley Research Center Space Station Technol., 1983 p 89-94 Feb. 1984
Avail: NTIS HC A09/MF A01 CSCL 22B

The Fluid Management Panel's assessment of the technology is summarized. Since a baseline space station was not defined as a reference guide and the results of the eight contracted space station studies were not available as input, the assessment focused on technology and not programmatics. The ground rules that were key to the deliberations and guided the assessment are: (1) The space station will be operational in 1991, and (2) A space-based OTV will be operational in 1992. Thus, the capability to transport, transfer, and resupply all fluids, including those for the OTV, is required in the initial space station. The only evolutionary aspect is the refinement of capability. Fluid management includes fluid transport to orbit, liquid storage/supply, fluid transfer/resupply, and integral thermal control. Author

N84-18285*# TRW Electronic Systems Group, Redondo Beach, Calif.
COMMUNICATIONS
G. J. BONELLE *In* NASA. Langley Research Center Space Station Technol., 1983 p 95-108 Feb. 1984
Avail: NTIS HC A09/MF A01 CSCL 22B

Communications in any system is one of the last technologies to be considered, and sometimes it is considered too late to impact the system. This was somewhat the impression on reviewing the NASA budget for two mission scenarios for the space station. However, that budget fortunately was well spent, and the money was spent to get the most benefit per dollar. Another thing that is very often forgotten is that technology is not produced in a vacuum. In fact, in conducting independent research and development (IR&D), the first phase is to define the requirements which must be time phased, becuase very often the conditions will change during the life of the system. From the requirements, a set of architectures that are at least representative of that era are produced. If the exact requirements were not established, at least boundaries are set on the requirements for that architecture. When this is completed, then the technology that is really needed is defined. The major criticism of the work that was presented to the panel is the lack of a firm set of requirements. Author

N84-18287*# McDonnell-Douglas Astronautics Co., Huntington Beach, Calif.
DATA MANAGEMENT
G. LOVE *In* NASA. Langley Research Center Space Station Technol., 1983 p 137-154 Feb. 1984
Avail: NTIS HC A09/MF A01 CSCL 22B

The following tasks were prioritized: software acquisition management plan; space station flight data system architectural study; space station user data system interface; automation of software development process; automation of software testing; distributed data base management; ADA (automated data acquisition) evaluation and transition and planning; network operating system software; fault tolerant computer validation methodology for onboard data management system; systems integration; artificial intelligence/expert systems; space station data network concept; space station standard interface protocols; space station data networks systems; integrated software development facility; and language trade studies. Author

N84-18288*# Lockheed Missiles and Space Co., Sunnyvale, Calif.
POWER
R. CORBETT *In* NASA. Langley Research Center Space Station Technol., 1983 p 155-163 Feb. 1984
Avail: NTIS HC A09/MF A01 CSCL 22B

The space station requires an increase in power or energy of at least several orders of magnitude compared to previous space missions. With the requirement up in the range of 10 kilowatt hours, this obviiously requires the development of new technology. Although the power area is very well integrated in the spacecraft itself, it represents a diverse set of components necessary for energy conversion, electronics, and energy distribution. Considerable work is ongoing at NASA Lewis in the power devices development area, including transformers, large area solid-state chips, transistors, and fast recovery diodes. This work is oriented toward eventual application to both AC and DC power conversion approaches. In the energy storage area, there are many options available to fit into the space station representing various degrees of risk and leverage combination, such as the near-term integral-pressure-vessel nickel hydrogen battery, an advanced Ni-H2 battery concept, and the regenrative hydrogen-oxygen system utilizing essentially the Shuttle orbiter type of fuel cell. Author

N84-18290*# Lockheed Missiles and Space Co., Sunnyvale, Calif.
SPACE STATION NEEDS, ATTRIBUTES AND ARCHITECTURAL OPTIONS. VOLUME 4, ATTACHMENT 1: TASK 2 AND 3 MISSION IMPLEMENTATION AND COST Final Study Report
22 Apr. 1983 393 p refs
(Contract NASW-3684)
(NASA-CR-173330; NAS 1.26:173330; LMSC-D889718-VOL-4-ATTACH-1) Avail: NTIS HC A17/MF A01 CSCL 22B

Mission scenario analysis and architectural concepts, alternative systems concepts, mission operations and architectural development, architectural analysis trades, evolution, configuration, and technology development are assessed. N.W.

N84-18291*# Lockheed Missiles and Space Co., Sunnyvale, Calif.
SPACE STATION NEEDS, ATTRIBUTES AND ARCHITECTURAL OPTIONS. VOLUME 2, ATTACHMENT 2: SUPPORTING DATA AND ANALYSIS REPORTS Final Study Report
22 Apr. 1983 174 p refs
(Contract NASW-3684)
(NASA-CR-173329; NAS 1.26:173329; LMSC-D889718-VOL-2-ATTACH-2) Avail: NTIS HC A08/MF A01 CSCL 22B

Architectural impact analysis, configuration concepts evaluation, CADAM draining file, EVA technology needs and manned system technology requirements are provided. N.W.

N84-18292*# Lockheed Missiles and Space Co., Sunnyvale, Calif.
SPACE STATION NEEDS, ATTRIBUTES AND ARCHITECTURAL OPTIONS. VOLUME 1: EXECUTIVE SUMMARY NASA Final Presentation Report
5 Apr. 1983 368 p refs
(Contract NASW-3684)
(NASA-CR-172792; NAS 1.26:172792; LMSC-D889718-VOL-1)
Avail: NTIS HC A16/MF A01 CSCL 22B

The uses alignment plan was implemented. The existing data bank was used to define a large number of station requirements. Ten to 20 valid mission scenarios were developed. Architectural options as they are influenced by communications operations, subsystem evolvability, and required technology growth are defined. Costing of evolutionary concepts, alternative approaches, and options, was based on minimum design details. N.W.

N84-18293*# Lockheed Missiles and Space Co., Sunnyvale, Calif.
SPACE STATION NEEDS, ATTRIBUTES AND ARCHITECTURAL OPTIONS. VOLUME 1, ATTACHMENT 1: EXECUTIVE SUMMARY NASA Final Study Report
22 Apr. 1983 281 p refs
(Contract NASW-3684)
(NASA-CR-173337; NAS 1.26:173337; LMSC-D889718-VOL-1-ATTACH-1) Avail: NTIS HC A13/MF A01 CSCL 22B

User alignment plan, physical and life sciences and applications, commercial requirements national security, space operations, user needs, foreign contacts, mission scenario analysis and architectural concepts, alternative systems concepts, mission operations architectural development, architectural analysis trades, evolution, configuration, and technology development are discussed. N.W.

N84-18294*# Lockheed Missiles and Space Co., Sunnyvale, Calif.
SPACE STATION NEEDS, ATTRIBUTES AND ARCHITECTURAL OPTIONS. VOLUME 1, ATTACHMENT 2: SUPPORTING DATA AND ANALYSIS REPORTS Final Study Report
22 Apr. 1983 402 p refs
(Contract NASW-3684)
(NASA-CR-173336; NAS 1.26:173336; LMSC-D889718-VOL-1-ATTACH-2) Avail: NTIS HC A18/MF A01 CSCL 22B

Reference space station evolution, a contact list, a data base, scenarios, and subcontractor reports are considered. N.W.

N84-18296*# Grumman Aerospace Corp., Bethpage, N.Y.
SPACE STATION NEEDS, ATTRIBUTES AND ARCHITECTURAL OPTIONS. VOLUME 2, BOOK 1, PART 1: MISSION REQUIREMENTS Final Technical Report
20 Apr. 1983 210 p refs
(Contract NASW-3685)
(NASA-CR-173312; NAS 1.26:173312; SA-SSP-RP008-VOL-2-BK-1-PT-1) Avail: NTIS HC A10/MF A01 CSCL 22B

The baseline mission model used to develop the space station mission-related requirements is described as well as the 90 civil missions that were evaluated, (including the 62 missions that formed the baseline model). Mission-related requirements for the space station baseline are defined and related to space station architectural development. Mission-related sensitivity analyses are discussed. A.R.H.

N84-18297*# Grumman Aerospace Corp., Bethpage, N.Y.
SPACE STATION NEEDS, ATTRIBUTES AND ARCHITECTURAL OPTIONS. VOLUME 2, BOOK 1, PART 2, TASK 1: MISSION REQUIREMENTS Final Technical Report
20 Apr. 1983 239 p refs
(Contract NASW-3685)
(NASA-CR-173313; NAS 1.26:173313; SA-SPP-RP008-VOL-2-BK-1-PT-2) Avail: NTIS HC A11/MF A01 CSCL 22B

Mission areas analyzed for input to the baseline mission model include: (1) commercial materials processing, including representative missions for producing metallurgical, chemical and biological products; (2) commercial Earth observation, represented by a typical carry-on mission amenable to commercialization; (3) solar terrestrial and resource observations including missions in geoscience and scientific land observation; (4) global environment, including representative missions in meteorology, climatology, ocean science, and atmospheric science; (5) materials science, including missions for measuring material properties, studying chemical reactions and utilizing the high vacuum-pumping capacity of space; and (6) life sciences with experiments in biomedicine and animal and plant biology. A.R.H.

N84-18298*# Grumman Aerospace Corp., Bethpage, N.Y.
SPACE STATION NEEDS, ATTRIBUTES AND ARCHITECTURAL OPTIONS. VOLUME 2, BOOK 1, PART 3: MANNED SPACE STATION RELEVANCE TO COMMERCIAL TELECOMMUNICATIONS SATELLITES Final Technical Report
20 Apr. 1983 77 p refs
(Contract NASW-3685)
(NASA-CR-173314; NAS 1.26:173314; SA-SSP-RP008-VOL-2-BK-1-PT-3) Avail: NTIS HC A05/MF A01 CSCL 22B

A document containing a forecast of satellite traffic and revelant technology trends to the year 2000 was prepared which includes those space station capabilities and characteristics that should be provided to make the station useful to commercial satellite owners. The document was circulated to key representative organizations within the commercial telecommunications satellite and related communities of interest, including spacecraft manufacturers, commercial satellite owners, communications carriers, networks and risk insurers. The prospectus document is presented as well as the transmittal letter and the mailing list of the people and companies that were asked to review it. Key commercial telecommunications comments are summarized the actual response letters from the industry are included. A.R.H.

N84-18299*# Grumman Aerospace Corp., Bethpage, N.Y.
SPACE STATION NEEDS, ATTRIBUTES AND ARCHITECTURAL OPTIONS. VOLUME 2, BOOK 1, PART 4: PAYLOAD ELEMENT MISSION DATA SHEETS Final Technical Report
20 Apr. 1984 299 p refs
(Contract NASW-3685)
(NASA-CR-173315; NAS 1.26:173315; SA-SSP-RP008-VOL-2-BK-1-PT-4) Avail: NTIS HC A13/MF A01 CSCL 22B

Data sheets are presented for 11 internal payloads, 30 externally mounted payloads, and 46 free flyers. The importance of the space station to each payload element is rated on a scale of 1 to 10. The type of experiment noncommercial science and applications, commercial, technological, and operational is indicated and the payload and its objectives are described. Space is provided for noting requirements for power; data/communication; thermal environment; equipment physical characteristics; crew size; and service and maintenance. A.R.H.

N84-18300*# Grumman Aerospace Corp., Bethpage, N.Y.
SPACE STATION NEEDS, ATTRIBUTES AND ARCHITECTURAL OPTIONS. VOLUME 2, BOOK 2, PART 1: MISSION IMPLEMENTATION CONCEPTS Final Technical Report
20 Apr. 1983 188 p refs
(Contract NASW-3685)
(NASA-CR-173316; NAS 1.26:173316; SA-SSP-RP008-VOL-2-BK-2-PT-1) Avail: NTIS HC A09/MF A01 CSCL 22B

The overall configuration and modules of the initial and evolved space station are described as well as tended industrial and polar platforms. The mass properties that are the basis for costing are summarized. User friendly attributes (interfaces, resources, and facilities) are identified for commercial; science and applications; industrial park; international participation; national security; and the external tank option. Configuration alternates studied to determine a baseline are examined. Commonality for clustered 3-man and 9-man stations are considered as well as the use of tethered platforms. Requirements are indicated for electrical, communication and tracking; data management Subsystem requirements for electrical, data management, communication and tracking, environment control/life support system; and guidance navigation and control subsystems are identified. A.R.H.

N84-18301*# Grumman Aerospace Corp., Bethpage, N.Y.
SPACE STATION NEEDS, ATTRIBUTES AND ARCHITECTURAL OPTIONS. VOLUME 2, BOOK 2, PART 2, TASK 2: INFORMATION MANAGEMENT SYSTEM Final Technical Report
20 Apr. 1983 315 p refs Prepared in cooperation with General Electric Corp.
(Contract NASW-3685)
(NASA-CR-173317; NAS 1.26:173317; SA-SSP-RP008-VOL-2-BK-2-PT-2) Avail: NTIS HC A14/MF A01 CSCL 22B

Missions to be performed, station operations and functions to be carried out, and technologies anticipated during the time frame of the space station were examined in order to determine the scope of the overall information management system for the space station. This system comprises: (1) the data management system which includes onboard computer related hardware and software required to assume and exercise control of all activities performed on the station; (2) the communication system for both internal and external communications; and (3) the ground segment. Techniques used to examine the information system from a functional and performance point of view are described as well as the analyses performed to derive the architecture of both the onboard data management system and the system for internal and external communications. These architectures are then used to generate a conceptual design of the onboard elements in order to determine the physical parameters (size/weight/power) of the hardware and software. The ground segment elements are summarized. A.R.H.

N84-18302*# Grumman Aerospace Corp., Bethpage, N.Y.
SPACE STATION NEEDS, ATTRIBUTES AND ARCHITECTURAL OPTIONS. VOLUME 2, BOOK 2, PART 3: COMMUNICATION SYSTEM Final Technical Report
20 Apr. 1983 64 p refs
(Contract NASW-3685)
(NASA-CR-173318; NAS 1.26:173318; SA-SSP-RP008-VOL-2-BK-2-PT-3) Avail: NTIS HC A04/MF A01 CSCL 22B

Preliminary results of the study of the architecture and attributes of the RF communications and tracking subsystem of the space station are summarized. Only communications between the space station and other external elements such as TDRSS satellites, low-orbit spacecraft, OTV, MOTV, in the general environment of the space station are considered. The RF communications subsystem attributes and characteristics are defined and analyzed key issues are identified for evolution from an initial space station (1990) to a year 2000 space station. The mass and power characteristics of the communications subsystem for the initial space station are assessed as well as the impact of advanced technology developments. Changes needed to the second generation TDRSS to accomodate the evolutionary space station of the year 2000 are also identified. A.R.H.

N84-18303*# Grumman Aerospace Corp., Bethpage, N.Y.
SPACE STATION NEEDS, ATTRIBUTES AND ARCHITECTURAL OPTIONS, VOLUME 2, BOOK 2, PART 4: INTERNATIONAL REPORTS Final Technical Report
20 Apr. 1983 172 p refs
(Contract NASW-3685)
(NASA-CR-173319; NAS 1.26:173319; SA-SSP-RP008-VOL-2-BK-2-PT-4) Avail: NTIS HC A08/MF A01 CSCL 22B

The capabilities of the European Space Agency's SPAS and EURECA platforms for reference payload accommodation are considered. The instrument pointing subsystem, the position and hold mount, and the antenna pointing mechanism developed by Dornier are described. Relevant payloads for the space station are summarized and space station accommodation aspects are discussed. A.R.H.

N84-18304*# Grumman Aerospace Corp., Bethpage, N.Y.
SPACE STATION NEEDS, ATTRIBUTES AND ARCHITECTURAL OPTIONS, VOLUME 2, BOOK 3: COST AND PROGRAMMATICS Final Technical Report
20 Apr. 1983 79 p refs
(Contract NASW-3685)
(NASA-CR-173320; NAS 1.26:173320; SA-SSP-RP008-VOL-2-BK-3) Avail: NTIS HC A05/MF A01 CSCL 22B

The cost and programmatic considerations which integrate mission requirements and architectural options into a cohesive system for exploitation of space opportunities within affordable limits are discussed. The mission requirements, baseline architecture, a top level baseline schedule, and acquisition costs are summarized. The work breakdown structure (WBS) used to structure the program, and the WBS dictionary are included. The costing approach used, including the operation of the primary costing tool, the SPACE cost model are described. The rationale for the choice of cost estimating relationships is given and costs at the module level are shown. Detailed costs at the subsystem level are shown. The baseline schedule and annual funding profiles are provided. Alternate schedules are developed to provide different funding profiles. Alternate funding sources are discussed and foreign and contractor participation is outlined. The results of the benefit analysis are given and the accrued benefits deriving from an implemented space station program are outlined. A.R.H.

N84-19377*# General Dynamics/Convair, Fort Worth, Tex.
DEFINITION OF TECHNOLOGY DEVELOPMENT MISSIONS FOR EARLY SPACE STATIONS ORBIT TRANSFER VEHICLE SERVING. PHASE 2, TASK 1: SPACE STATION SUPPORT OF OPERATIONAL OTV SERVICING
Dec. 1983 245 p refs
(Contract NAS8-35039)
(NASA-CR-170984; NAS 1.26:170984; GDC-SP-83-067) Avail: NTIS HC A11/MF A01 CSCL 22A

Representative space based orbital transfer vehicles (OTV), ground based vehicle turnaround assessment, functional operational requirements and facilities, mission turnaround operations, a comparison of ground based versus space based tasks, activation of servicing facilities prior to IOC, fleet operations requirements, maintenance facilities, OTV servicing facilities, space station support requirements, and packaging for delivery are discussed. N.W.

N84-20435*# Engineering and Economics Research, Inc., Vienna, Va. Data and Operations Subcommittee.
STARLAB GROUND SYSTEM GUIDELINES DOCUMENT Final Report
F. J. HAWKINS Jan. 1984 132 p refs Sponsored in part by National Research Council of Canada and Australian Department of Science and Technology
(Contract NAS5-27617)
(NASA-CR-175192; NAS 1.26:175192) Avail: NTIS HC A07/MF A01 CSCL 05B

Starlab science objectives, ground system considerations, space shuttle sortie, space platform/station, mission planning, and remote facilities are addressed. N.W.

N84-20604*# Smithsonian Astrophysical Observatory, Cambridge, Mass.
A LARGE-AREA GAMMA-RAY IMAGING TELESCOPE SYSTEM Final Report, 24 Mar. - 1 Sep. 1983
D. G. KOCH Aug. 1983 100 p refs
(Contract NAS2-3743)
(NASA-CR-175435; NAS 1.26:175435) Avail: NTIS HC A05/MF A01 CSCL 22A

The concept definition of using the External Tank (ET) of the Space Shuttle as the basis for constructing a large area gamma ray imaging telescope in space is detailed. The telescope will be used to locate and study cosmic sources of gamma rays of energy greater than 100 MeV. Both the telescope properties and the means whereby an ET is used for this purpose are described. A parallel is drawn between those systems that would be common to both a Space Station and this ET application. In addition, those systems necessary for support of the telescope can form the basis for using the ET as part of the Space Station. The major conclusions of this concept definition are that the ET is ideal for making into a gamma ray telescope, and that this telescope will provide a substantial increase in collecting area. S.L.

N84-20610*# Michigan State Univ., East Lansing. Dept. of Botany and Plant Pathology.
THE ALPHA-HELIX CONCEPT: INNOVATIVE UTILIZATION OF THE SPACE STATION PROGRAM. A REPORT TO THE NATIONAL AERONAUTICAL AND SPACE ADMINISTRATION REQUESTING ESTABLISHMENT OF A SENSORY PHYSIOLOGY LABORATORY ON THE SPACE STATION Final Report
R. S. BANDURSKI and N. SINGH 17 Oct. 1983 71 p refs
(Contract NASW-3748)
(NASA-CR-175436; NAS 1.26:175436) Avail: NTIS HC A04/MF A01 CSCL 22B

A major laboratory dedicated to biological-medical research is proposed for the Space Platform. The laboratory would focus on sensor physiology and biochemistry since sensory physiology represents the first impact of the new space environment on living organisms. Microgravity and the high radiation environment of space would be used to help solve the problems of prolonged sojourns in space but, more importantly, to help solve terrestrial problems of human health and agricultural productivity. The emphasis would be on experimental use of microorganisms and small plants and small animals to minimize the space and time required to use the Space Platform for maximum human betterment. The Alpha Helix Concept, that is, the use of the Space Platform to bring experimental biomedicine to a new and extreme frontier is introduced so as to better understand the worldly environment. Staffing and instrumenting the Space Platform biomedical laboratory in a manner patterned after successful terrestrial sensory physiology laboratories is also proposed. Author

N84-21586*# Arizona State Univ., Tempe. Dept. of Geology.
FEASIBILITY STUDY TO CONDUCT WINDBLOWN SEDIMENT EXPERIMENTS ABOARD A SPACE STATION *Final Report*
R. GREELEY and J. D. IVERSEN (Iowa State Univ., Ames) 30 Aug. 1983 36 p refs Original contains color illustrations
(Contract NASW-3741)
(NASA-CR-175434; NAS 1.26:175434) Avail: NTIS HC A03/MF A01 CSCL 22A

A feasibility study was undertaken to determine if a suitable apparatus could be designed to analyze aeolian processes for operation in space and to assess the feasibility of conducting meaningful experiments to address key aspects of aeolian processes. To meet this objective a prototype apparatus was fabricated and some limited experiments were run to determine its suitability for this application. At least three general types of experiments were devised that could be carried out aboard a space station: threshold studies, swirl (dust devil) experiments, and analyses of windblown particle trajectories. How experiments in a zero-g environment could advance knowledge of aeolian processes was studied. M.A.C.

N84-21623# *Consulenze Generali Roma (Italy).*
PROPOSALS FOR ADDITIONS, MODIFICATIONS, AND NEW EXPERIMENTAL METHODS. PART 1: GROUND TESTS. PART 2: FLIGHT TESTS
U. PONZI *In its* Study on Syn. and Characterization of Large Space Systems, Phase 2. Part 3: Expt. Design Verification Tech. te] p 170-428 Dec. 1982 refs
Avail: NTIS HC A19/MF A01

The adaptation of ground test techniques to analysis of large space structures (LSS) is discussed using Space Construction Automated Fabrication Experiment Definition Study data. Analysis of gravitational effects is emphasized, and the difficulties and practical consequences in reducing scale when composite materials are involved are considered. The evolution of flight tests from aircraft to space applications is reviewed. Modeling of LSS is treated. Parameter identification approaches are compared with methods which consider the model/system performance/error problem as a whole. Identification algorithms and error representations are appended. Author (ESA)

02

ANALYSIS AND DESIGN TECHNIQUES

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

A84-11930
SOME ASPECTS OF SIMULATION STUDIES IN SPACECRAFT DYNAMICS
V. J. MODI (British Columbia, University, Vancouver, Canada) IN: World Congress on System Simulation and Scientific Computation, 10th, Montreal, Canada, August 8-13, 1982, Proceedings. Volume 3 . Montreal, International Association for Mathematics and Computers in Simulation, 1983, p. 204-206. refs

It is pointed out that numerous investigations involving active and passive stabilization procedures and accounting for internal as well as external forces have been carried out on the assumption that satellites are rigid. Since modern space vehicles carry lightweight, flexible deployable members, this assumption can no longer be made. Summaries are given of the papers presented at the 10th IMACS Congress. The question whether the availability of computers has tended to stifle fundamental mathematical inquiries leading to elegant analytical answers is addressed. C.R.

A84-11946* Jet Propulsion Lab., California Inst. of Tech., Pasadena.
MODEL ERROR ESTIMATION FOR DISTRIBUTED SYSTEMS DESCRIBED BY ELLIPTIC EQUATIONS
G. RODRIGUEZ (California Institute of Technology, Jet Propulsion Laboratory, Pasadena, CA) IN: World Congress on System Simulation and Scientific Computation, 10th, Montreal, Canada, August 8-13, 1982, Proceedings. Volume 3 . Montreal, International Association for Mathematics and Computers in Simulation, 1983, p. 371-373. NASA-supported research. refs

A function space approach is used to develop a theory for estimation of the errors inherent in an elliptic partial differential equation model for a distributed parameter system. By establishing knowledge of the inevitable deficiencies in the model, the error estimates provide a foundation for updating the model. The function space solution leads to a specification of a method for computation of the model error estimates and development of model error analysis techniques for comparison between actual and estimated errors. The paper summarizes the model error estimation approach as well as an application arising in the area of modeling for static shape determination of large flexible systems. Author

A84-16841
A HEURISTIC METHOD FOR THE DESIGN OF MINIMUM WEIGHT TRUSSES USING DISCRETE MEMBER SIZES
D. F. YATES, T. B. BOFFEY, and A. B. TEMPLEMAN (Liverpool, University, Liverpool, England) Computer Methods in Applied Mechanics and Engineering (ISSN 0045-7825), vol. 37, March 1983, p. 37-55.

This paper describes a heuristic method for obtaining an approximate solution to the problem of determining the minimum weight design of a structural truss using only a discrete set of commercially available member gauges. The method treats constraints on joint deflection as well as constraints on member stress and gauge. A sufficient condition for convergence of the method to a global optimum is derived together with both an a priori and an a posteriori bound on the approximate solution. Finally, the results obtained from applying the method to several test problems are reported. Author

A84-19108
ALGORITHMS AND COMPUTATIONAL ASPECTS PERTAINING TO BLOCK DIAGONAL DOMINANCE METHODS FOR DESIGN OF DECENTRALIZED FEEDBACK COMPENSATION
W. H. BENNETT (U.S. Navy, Naval Research Laboratory, Washington, DC) and J. S. BARAS (Maryland, University, College Park, MD) IN: Conference on Decision and Control, 21st, Orlando, FL, December 8-10, 1982, Proceedings. Volume 1 . New York, Institute of Electrical and Electronics Engineers, 1982, p. 479-484. refs

Reference is made to a study by Bennett and Baras (1979), in which the idea of a block diagonally dominant transfer function matrix is used to provide criteria for the design of decentralized feedback control. Computer implementable algorithms are developed here for determining the block diagonal dominance condition. Consideration is given to numerical stability in developing the algorithms. It is suggested that the algorithms be implemented in an interactive computing environment. At present, these algorithms are being integrated into an interactive package that will be used to assess feasibility of some large space structure decentralized control schemes. C.R.

A84-19129
MATRIX(X) - APPLICATION TO LARGE SPACE STRUCTURE CONTROL DESIGN PROBLEMS
C. GREGORY, JR., S. SHAH, and R. WALKER (Integrated Systems, Inc., Palo Alto, CA) IN: Conference on Decision and Control, 21st, Orlando, FL, December 8-10, 1982, Proceedings. Volume 2 . New York, Institute of Electrical and Electronics Engineers, 1982, p. 912-917. refs

Matrix(X) is a computer-aided-design system for performing the steps in the control design cycle starting from system modeling to data analysis, identification, control synthesis, and simulation. In addition to a powerful matrix interpreter, the package features a user-friendly environment that involves device-independent graphics, state-of-the-art numerical algorithms for reliable computations, and user-transparent file management. A description is given of the design and application of Matrix(X) user interface and numerical algorithms for large space structures. It is pointed out that for large space structure problems, the bulk of the information involved in evaluating a control design tends to obscure the significant performance effects unless the results are summarized graphically in a way that allows the analyst to quickly obtain an overview of the system performance. Selected graphical overview results for different aspects of the design, such as eigenvalue locations, controllability/observability, modal cost, and rms errors, are illustrated. C.R.

A84-19887#
A COMPARISON OF LINEAR AND GEOMETRICALLY NONLINEAR FINITE ELEMENT ANALYSES APPLIED TO LARGE SPACE STRUCTURES
A. E. CONAWAY (Alabama, University, Tuscaloosa, AL) American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 22nd, Reno, NV, Jan. 9-12, 1984. 7 p. refs
(AIAA PAPER 84-0069)

Many of the projects which are being considered to utilize the special characteristics of the space environment for some application require for their implementation a structure in space, which, in a number of cases, may be very large. One important problem regarding such structures is related to limitations on weight. The resulting fairly 'flimsy' configurations require special systems for the control of motion in response to dynamic loads. The design of these control systems requires information regarding the structure's mode shapes and natural frequencies. NASA employs currently numerical methods based on linear behavior of the structure to derive this information. However, it is entirely possible that such a linear approach is not adequate because of nonlinear effects. The considered project had as the objective to develop a means of nonlinear analysis for a structure modeled as having an applied static load. It is found that a dependence on linear assumptions might lead to inefficient control systems. G.R.

A84-21564
FOR THE FIRST TIME [VPERVYE]
A. IVANOV Moscow, Moskovskii Rabochii, 1982, 289 p. In Russian.

The author gives a personal account of his work as a spacecraft designer during the early years of the Soviet space program. Particular consideration is given to the beginnings of the Soviet space program; the launching of the first animal (the dog Laika) into space; the flights of Luna 1, 2, and 3; and the first manned flight. B.J.

A84-22131*# Teledyne Brown Engineering, Huntsville, Ala.
SPACE PLATFORM ACCOMMODATIONS
W. BAILEY (Teledyne Brown Engineering, Base Programs Div., Huntsville, AL) and M. E. NEIN (NASA, Marshall Space Flight Center, Advanced Systems Office, Huntsville, AL) Journal of Spacecraft and Rockets (ISSN 0002-4650), vol. 20, Nov.-Dec. 1983, p. 546-552.

Previously cited in issue 23, p. 3590, Accession no. A82-46489

A84-25259#
UNFURLABLE OFFSET ANTENNA DESIGN FOR MULTIPURPOSE APPLICATIONS
W. SCHAEFER, F. DRACHENBERG, H. HERBIG, R. SCHAELLIG (Messerschmitt-Boelkow-Blohm GmbH, Ottobrunn, West Germany), A. FESTA, A. ROEDERER (ESA, European Space Research and Technology Centre, Noordwijk, Netherlands), and K. PONTOPPIDAN (TICRA A/S, Copenhagen, Denmark) IN: Communication Satellite Systems Conference, 10th, Orlando, FL, March 19-22, 1984, Technical Papers . New York, American Institute of Aeronautics and Astronautics, 1984, p. 64-74.
(AIAA PAPER 84-0659)

A European aerospace company has been awarded a contract by the European Space Agency (ESA) for the development of a European technological capability in the area of unfurlable antennas. Such antennas are to be employed by the next generation of ESA communication satellites. The present investigation is concerned with the results obtained during the first phase of the project. During the second phase, the hardware is being developed for the selected concept, and the final design of a Technology Demonstration Model (TDM) of the antenna reflector will be produced. Attention is given to mission examples for large offset deployable antennas, requirements and interfaces for antennas, the unfurlable reflector concepts, a thermo-structural analysis of the two different reflector concepts, and the selection of the optimum concept. G.R.

A84-25525* Brown Univ., Providence, R. I.
PARAMETER IDENTIFICATION IN CONTINUUM MODELS
H. T. BANKS (Brown University, Providence, RI; Southern Methodist University, Dallas, TX) and J. M. CROWLEY (U.S. Air Force Academy, Colorado Springs, CO) IN: American Control Conference, San Francisco, CA, June 22-24, 1983, Proceedings. Volume 3 . New York, Institute of Electrical and Electronics Engineers, 1983, p. 997-1001. refs
(Contract NSF MCS-82-05335; AF-AFOSR-81-0198; DAAG29-79-C-0161; NAS1-15810; NAS1-16394)

Approximation techniques for use in numerical schemes for estimating spatially varying coefficients in continuum models such as those for Euler-Bernoulli beams are discussed. The techniques are based on quintic spline state approximations and cubic spline parameter approximations. Both theoretical and numerical results are presented. Previously announced in STAR as N83-28934 M.G.

A84-25551* National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.
STATIC SHAPE FORMING FOR AN ELECTROSTATICALLY CONTROLLED MEMBRANE MIRROR
J. N. JUANG (NASA, Langley Research Center, Hampton, VA) and W. HUANG (Martin Marietta Aerospace, Denver, CO) IN: American Control Conference, San Francisco, CA, June 22-24, 1983, Proceedings. Volume 3 . New York, Institute of Electrical and Electronics Engineers, 1983, p. 1310-1316. refs

A design concept is described permitting the static construction of a flexible membrane reflector for use in a radiometer spacecraft. The scheme utilizes electrostatic forces to actively shape the membrane toward a specified reflector surface with a required degree of precision. The formulations of the required electrostatic attractive forces, and stress and strain distributed in the membrane are presented in this paper in terms of curvilinear coordinates. An example is given to illustrate a variety of spherical membrane characteristics associated with different boundary conditions. Author

N84-10114*# McDonnell-Douglas Technical Services Co., Inc., Huntsville, Ala.
A DEFINITION OF STS ACCOMMODATIONS FOR ATTACHED PAYLOADS
F. L. ECHOLS and P. A. BROOME Sep. 1983 125 p refs
(Contract NAS8-32350)
(NASA-CR-172223; NAS 1.26:172223) Avail: NTIS HC A06/MF A01 CSCL 22B

An input to a study conducted to define a set of carrier avionics for supporting large structures experiments attached to the Space Shuttle Orbiter is reported. The 'baseline' Orbier interface used in developing the avionics concept for the Space Technology Experiments Platform, STEP, which Langley Research Center has proposed for supporting experiments of this sort is defined. Primarily, flight operations capabilities and considerations and the avionics systems capabilities that are available to a payload as a 'mixed cargo' user of the Space Transportation System are addressed. Ground operations for payload integration at Kennedy Space Center, and ground operations for payload support during the mission are also discussed. Author

N84-14233*# Grumman Aerospace Corp., Bethpage, N.Y.
ORBITER-BASED CONSTRUCTION EQUIPMENT STUDY. THE HPA/DTA TECHNOLOGY ADVANCEMENT PLAN
Oct. 1983 15 p refs
(Contract NAS9-16468)
(NASA-CR-174605; NAS 1.26:174605; DRL-T-1701; DRD-SE957T) Avail: NTIS HC A02/MF A01 CSCL 22B

Satellite berthing mechanism, umbilicals for fluid and electrical interfaces, EVA service platform, and large mass berthing mechanism are discussed. Author

N84-14759# Erno Raumfahrttechnik G.m.b.H., Bremen (West Germany).
SOFTWARE QUALITY ASSURANCE SPACELAB EXPERIENCE AND FUTURE TRENDS
R. DAVENPORT *In* ESA Software Eng. p 235-241 Aug. 1983 refs
Avail: NTIS HC A13/MF A01

The quality assurance plan used when developing the command and data management software subsystem to support the functions of Spacelab in flight; automatic test equipment software subsystem to support the functions needed for ground checkout of Spacelab; and support software subsystem to generate and maintain a common data base and to provide a generation mechanism for software for the other two subsystems, is outlined. The software problem reports, unit development folders, verification control document, test data folder, acceptance data package, and certificate of acceptance are described. Trends in developing automated software quality assurance tools are reviewed. Author (ESA)

N84-16427*# National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.
SURFACE ACCURACY MEASUREMENT SENSOR TEST ON A 50-METER ANTENNA SURFACE MODEL
R. B. SPIERS, E. E. BURCHER, C. W. STUMP, C. G. SAUNDERS, and G. F. BROOKS (Kentron International, Inc.) Jan. 1984 32 p refs
(NASA-TM-85689; NAS 1.15:85689) Avail: NTIS HC A03/MF A01 CSCL 20N

The Surface Accuracy Measurement Sensor (SAMS) is a telescope with a focal plane photo electric detector that senses the lateral position of light source targets in its field of view. After extensive laboratory testing the engineering breadboard sensor system was installed and tested on a 30 degree segment of a 50-meter diameter, mesh surface, antenna model. Test results correlated well with the laboratory tests and indicated accuracies of approximately 0.59 arc seconds at 21 meters range. Test results are presented and recommendations given for sensor improvements. S.L.

N84-17225*# Rockwell International Corp., Seal Beach, Calif. Shuttle Integration and Satellite Systems Div.
LOW CONCENTRATION RATIO SOLAR ARRAY STRUCTURAL CONFIGURATION
S. J. NALBANDIAN *In* NASA. Langley Research Center STEP Expt. Requirements p 185-198 Jan. 1984 refs
Avail: NTIS HC A15/MF A01 CSCL 10A

The design and structural properties of a low concentration ratio solar array are discussed. The assembled module consists of six interconnected containers which are compactly stowed in a volume of 3.24 m(3) for delivery to orbit by the shuttle. The containers deploy in accordian fashion into a rectangular area of 19.4 x 68 meters and can be attached to the user spacecraft along the longitudinal centerline of the end container housing. Five rotary incremental actuators requiring about 8 watts each will execute the 180-degree rotation at each joint. Deployable masts (three per side) are used to extend endcaps from the housing in both directions. Each direction is extended by three masts requiring about 780 watts for about 27 minutes. Concentrator elements are extended by the endcaps and are supported by cable systems that are connected between the housings and endcaps. These power generating elements contain reflector panels which concentrate light onto the solar panels consisting of an aluminum radiator with solar cells positioned within the element base formed by the reflectors. A flat wire harness collects the power output of individual elements for transfer to the module container housing harnesses. M.G.

N84-17284# Contraves Corp., Zurich (Switzerland).
STUDY ON LARGE, ULTRALIGHT LONG-LIFE STRUCTURES IN SPACE, PHASE 2C Final Report
M. C. BERNASCONI Paris ESA 2 Jul. 1983 84 p refs
(Contract ESTEC-5156/82/NL-PB(SC))
(TM-EKR3; ESA-CR(P)-1796) Avail: NTIS HC A05/MF A01

A design of an inflatable, space rigidized structure (ISRS) offset antenna reflector, its manufacturing approach, and the development of a light weight, inflatable stabilization torus to be used for this design are described. A structural concept for a 12 m aperture offset reflector was defined. A continuous fabrication method for the stabilization torus was identified. Instruments for the torus design which relate the mass added by the torus complex and the pressure level, necessary for stabilization purposes were prepared. Tests with an unreinforced simulacrum of the inflatable reflector, which validate the proposed pressure prediction formulas, were performed. A development plan, leading to a ground demonstration of the ISRS technology for large expandable structures is presented. Author (ESA)

N84-18457# British Aerospace Dynamics Group, Stevenage (England). Space and Communications Div.
DESIGN AND DEVELOPMENT OF AN ADVANCED SOLAR ARRAY DRIVE MECHANISM
J. S. SHEPPARD *In* ESA First European Space Mech. and Tribology Symp. p 19-26 Dec. 1983 refs
Avail: NTIS HC A10/MF A01

The design and development of a solar array drive capable of transferring 7kW of power or more is described. Results of functional performance and environmental tests encompassing L-SAT/Olympus qualification levels are summarized. The drive consists of power slip ring, bearing support, drive actuator, and pyro/signal slip ring modules. Thermal vacuum, accelerated life test, and vibration tests are satisfactory. Author (ESA)

N84-18475# British Aerospace Dynamics Group, Stevenage (England). Space and Communications Div.
BAE REACTION WHEELS FOR OLYMPUS
G. J. STURTIVANT *In* ESA First European Space Mech. and Tribology Symp. p 187-192 Dec. 1983 refs
Avail: NTIS HC A10/MF/ A01

The design philosophy and achievements of the Olympus reaction wheel are presented. The design incorporates a compliant bearing preload arrangement which reduces the launch phase loads applied to the bearings. The fiber optic commutation sensor system

is described, together with the four-phase brushless, ironless dc electric motor which achieves a very low output torque ripple.
Author (ESA)

N84-20621 Purdue Univ., Lafayette, Ind.
ANALYSIS OF LARGE SPACE STRUCTURES Ph.D. Thesis
S. ABRATE 1983 182 p
Avail: Univ. Microfilms Order No. DA8400322

Typically, large space structures are latticed beams or plates made up of a very large number of elements assembled in a periodic pattern with overall dimensions possibly measured in miles. Efficient dynamic models are needed for design optimization, and control problems. Harmonic wave propagation analysis is used to determine the limits of applicability of the simple continuum models. Several equivalent continuum models are developed and evaluated comparatively. The range of validity of these continuum models is established in terms of wavelength. The presence of modes which are not predicted by the simple models is detected by considering a typical cell of the original structure. Procedures for including damping in the simple models are presented. Viscous, hysteretic, and a three parameter type damping models are discussed. The analysis of geometrically nonlinear trusses is performed, and the continuum beam models are shown to be efficient and accurate for both static and dynamic problems. Dissert. Abstr.

N84-21607*# National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, Ala.
TETHERS IN SPACE: BIRTH AND GROWTH OF A NEW AVENUE TO SPACE UTILIZATION
G. VONTIESENHAUSEN Feb. 1984 33 p refs
(NASA-TM-82571; NAS 1.15:82571) Avail: NTIS HC A03/MF A01 CSCL 22B

The evolution of the ideas of tether applications in space are traced from its origin in the last century past a dormant period of sixty-five years to the mid-seventies. At that time as a consequence of major revival efforts, NASA entered into serious investigations of the theoretical and practical feasibility of a large number of tethered concepts in space. These efforts culminated in the establishment of the Tethered Satellite System Project now at NASA in the advanced development phase. Extensive planning efforts are described, first, through a Tether Applications in Space Workshop which generated additional concepts and provided overall assessments and recommendations to NASA, and then through a NASA inter-center Tether Applications in Space Task Group which generated a four year program plan in the areas of further studies, technology, work and science and applications of tethers in space. An outlook into the future of tether applications that approaches some of the goals of the early visionaries is offered. Author

N84-21620# Consulenze Generali Roma (Italy).
STUDY ON SYNTHESIS AND CHARACTERIZATION OF LARGE SPACE SYSTEMS, PHASE 2. PART 3: EXPERIMENTAL DESIGN VERIFICATION TECHNIQUES Final Report
C. ARDUINI and U. PONZI Paris ESA Dec. 1982 428 p refs 5 Vol.
(Contract ESTEC-4348/80/NL-AK(SC))
(ESA-CR(P)-1779-VOL-5) Avail: NTIS HC A19/MF A01

Ground and flight tests of large space structures are discussed. Thermal balance tests, thermal cycle tests, the effects of scale reductions, and gravitational effects are considered. Static, dynamic, and modal structural analysis techniques are reviewed.

N84-21624# Consulenze Generali Roma (Italy).
STUDY ON SYNTHESIS AND CHARACTERIZATION OF LARGE SPACE SYSTEMS, PHASE 2. PART 1: ASSESSMENT OF DESIGN VERIFICATION ANALYTICAL METHODS. VOLUME 1: MECHANICAL DESIGN Final Report
C. ARDUINI and U. PONZI Paris ESA Dec. 1982 480 p refs 5 Vol.
(Contract ESTEC-4348/80/NL-AK(SC))
(ESA-CR(P)-1779-VOL-1) Avail: NTIS HC A21/MF A01

Softwares for large spacecraft structural dynamic/control dynamic verification are reviewed. The ASKA, NASTRAN, SPAR, DISCOS, and N-BOD programs are described. Decoupling, substructuring, and the effects of structural symmetry are discussed. For mechanical design verification, orbital flight conditions replace launch stresses tolerance as the main criterion. For thermal design, verifying thermal deformations is paramount for large space structures. Software for design verification of these structures should integrate thermal and mechanical parameters into an interactive scheme. Author (ESA)

N84-21625# Consulenze Generali Roma (Italy).
STUDY ON SYNTHESIS AND CHARACTERIZATION OF LARGE SPACE SYSTEMS, PHASE 2. PART 1: ASSESSMENT OF DESIGN VERIFICATION ANALYTICAL METHODS. VOLUME 2: THERMAL DESIGN Final Report
C. ARDUINI and U. PONZI Paris ESA Dec. 1983 411 p refs 5 Vol.
(Contract ESTEC-4348/80/NL-AL(SC))
(ESA-CR(P)-1779-VOL-2) Avail: NTIS HC A18/MF A01

Thermal design verification of large space systems through software evaluation was studied. The analytical methods were summarized with special emphasis on the Lockheed orbital heat rate package, the thermal radiation analysis system, NASTRAN thermal analyzer, and the simplified shuttle payload thermal analyzer. Basic concepts of thermodynamic modeling and structural characteristics were included along with the relevant equilibrium equations. M.A.C.

N84-22179*# National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.
COMPUTER-AIDED GEOMETRY MODELING
J. N. SHOOSMITH, comp. and R. E. FULTON, comp. Washington Mar. 1984 387 p refs Symp. held in Hampton, Va., 20-22 Apr. 1983
(NASA-CP-2272; L-15618; NAS 1.55:2272) Avail: NTIS HC A17/MF A01 CSCL 12A

Techniques in computer-aided geometry modeling and their application are addressed. Mathematical modeling, solid geometry models, management of geometric data, development of geometry standards, and interactive and graphic procedures are discussed. The applications include aeronautical and aerospace structures design, fluid flow modeling, and gas turbine design.

N84-22191*# National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.
INTERACTIVE GEOMETRY MODELING OF SPACE STATION CONCEPTUAL DESIGNS Abstract Only
D. D. DERYDER, M. J. FEREBEE, JR., and M. L. MCMILLIN *In its* Computer-Aided Geometry Modeling p 101-102 Mar. 1984
Avail: NTIS HC A17/MF A01 CSCL 09B

With the advent of a serious interest in the design and implementaton of a low-Earth orbit, manned space station, the need has arisen to rapidly synthesize, characterize, and analyze many conceptual designs. Because the manual generation and analysis of a mathematical design model could consume many man-months, an interactive modeling and analysis capability is sought. This poster session will demonstrate the activities and current capabilities at NASA LaRC that could support the modeling analysis of space station conceptual designs. Author

N84-22224*# National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.
MATHEMATICAL SYNTHESIZATION OF COMPLEX STRUCTURES
L. B. GARRETT *In its* Computer-Aided Geometry Modeling p 389-398 Mar. 1984 refs
Avail: NTIS HC A17/MF A01 CSCL 12A

A mathematical synthesization approach for rapidly modeling and analyzing complex structures comprised of hundreds or thousands of repeating individual structural members, interconnecting hardware, and other components was described. The techniques are applicable to any structure with repeating structural members. The capabilities are embodied within the Interactive Design and Evaluation of Advanced Spacecraft (IDEAS) computer-aided design system. IDEAS has a full range of integrated spacecraft modeling, design, analysis, performance, and cost estimating capabilities which include about 40 technical program and executive, data base, and file management systems. With IDEAS, a single user at an interactive terminal can create, design, analyze, and conduct parametric studies of Earth orbiting spacecraft in a timely, cost-efficient manner. The system is particularly useful in the conceptual design phases of advanced space missions when a multiplicity of concepts must be evaluated. The IDEAS interactive finite-element modeling capabilities are discussed. The mathematical synthesization programs were structured not only to provide a detailed finite-element model of the structure but also to automatically perform the many auxiliary computations needed to analyze the spacecraft in its orbital operational environment. M.A.C.

03

STRUCTURAL CONCEPTS

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

A84-10141*# California Univ., Los Angeles.
APPROXIMATIONS METHOD FOR SPACE FRAME SYNTHESIS
W. C. MILLS-CURRAN, R. V. LUST, and L. A. SCHMIT (California, University, Los Angeles, CA) (Structures, Structural Dynamics and Materials Conference, 23rd, New Orleans, LA, May 10-12, 1982, Collection of Technical Papers, Part 2, p. 187-200) AIAA Journal (ISSN 0001-1452), vol. 21, Nov. 1983, p. 1571-1580. refs
(Contract NSG-1490)

Previously cited in issue 13, p. 2109, Accession no. A82-30149

A84-11922
ANALYSIS AND DESIGN OF LEAF-SPRING FLEXIBLE JOINTS FOR DRIVING GYROSCOPIC ROTORS
J. L. SCIESZKO and W. M. MANSOUR (Rio de Janeiro, Universidade Federal, Rio de Janeiro, Brazil) IN: World Congress on System Simulation and Scientific Computation, 10th, Montreal, Canada, August 8-13, 1982, Proceedings. Volume 2 . Montreal, International Association for Mathematics and Computers in Simulation, 1983, p. 155, 156.

The present investigation is concerned with the development of algorithms for the exact solution of the nonlinear mathematical model which governs the static performance of the flexible joint employed to drive gyroscopic rotors. The constructed mathematical model takes into account the relationships between the internal forces and the deflections in each leaf. The model has nonlinear characteristics. The derived computing algorithm was implemented in a routine to evaluate the stress levels and buckling loads for the joints. Attention is given to the case where the two leaves are identical, and some typical plots. G.R.

A84-21517#
THE BEAM-LIKE BEHAVIOR OF SPACE TRUSSES
J. D. RENTON (Oxford University, Oxford, England) AIAA Journal (ISSN 0001-1452), vol. 22, Feb. 1984, p. 273-280. refs

A general approach is developed for determining the overall elastic behavior of space trusses. This is done by casting the matrix equations for pin-ended bars in a suitable algebraic form and using them to construct the finite difference equations for the truss under examination. Characteristic solutions of the homogeneous form of these equations are found in terms of simple polynomial functions. These correspond to the resultant forces and moments applied to the truss. All other modes decay toward these characteristic deflections. This means that the internal loads in the truss can be estimated from the resultant applied loading, even when the truss is not statically determinate. Also, the characteristic response yields elastic properties akin to the axial, torsional, bending, and shear stiffness of beams, although in some cases these effects are coupled. Values for a number of common space trusses are listed. It is also shown how the method may be used to give the natural frequencies of vibration of such structures. Author

A84-22153#
DESIGN AND DEVELOPMENT OF THE INTELSAT V GRAPHITE-EPOXY CENTRAL THRUST TUBE
N. BARBERIS (Ford Aerospace and Communications Corp., Palo Alto, CA), M. ZILANI, and C. GABRIEL (SocieteNationale Industrielle Aerospatiale, Cannes, France) (Structures, Structural Dynamics and Materials Conference, 23rd, New Orleans, LA, May 10-12, 1982, Collection of Technical Papers. Part 2, p. 594-602) Journal of Spacecraft and Rockets (ISSN 0022-4650), vol. 21, Jan.-Feb. 1983, p. 55-60. Research sponsored by the International Telecommunications Satellite Organization.

Previously cited in issue 13, p. 2030, Accession no. A82-30189

A84-22859#
LOCAL STABILITY OF SANDWICH STRUCTURES WITH THIN FIBRE REINFORCED FACE SKINS FOR SPACE APPLICATION
H. BANSEMIR and K. PFEIFER (Messerschmitt-Boelkow-Blohm GmbH, Munich, West Germany) Society for the Advancement of Material and Process Engineering, Technology Conference on Engineering with Composites, 3rd, London, England, Mar. 14-16, 1983, Paper. 32 p.
(MBB-UD-381-83-OE)

Sandwich structures with thin carbon and aramid epoxy face skins are used in the INTELSAT V, INTELSAT VI, OTS and EXOSAT solar arrays. Structural instability of these structures can manifest itself in a number of different modes. The ultimate compressive stresses are defined by wrinkling stresses. These are related to a mode with short wave lengths in the face sheets. A theory of general stability is derived and the theoretical stresses are compared with test values. Author

A84-22965* Hughes Aircraft Co., Los Angeles, Calif.
WELDED SOLAR CELL INTERCONNECTION
E. J. STOFEL, E. R. BROWNE, R. A. MEESE, and G. J. VENDURA (Hughes Aircraft Co., Space and Communications Group, Los Angeles, CA) IN: Photovoltaic Specialists Conference, 16th, San Diego, CA, September 27-30, 1982, Conference Record . New York, Institute of Electrical and Electronics Engineers, 1982, p. 45-50.
(Contract JPL-956038)

The efficiency of the welding of solar-cell interconnects is compared with the efficiency of soldering such interconnects, and the cases in which welding may be superior are examined. Emphasis is placed on ultrasonic welding; attention is given to the solar-cell welding machine, the application of the welding process to different solar-cell configurations, producibility, and long-life performance of welded interconnects. Much of the present work has been directed toward providing increased confidence in the reliability of welding using conditions approximating those that would occur with large-scale array production. It is concluded that there is as yet insufficient data to determine which of three methods (soldering, parallel gap welding, and ultrasonic welding) provides the longest-duration solar panel life. B.J.

A84-23366#
OPTIMIZATION OF SHALLOW TRUSSES AGAINST LIMIT POINT INSTABILITY
M. P. KAMAT (Virginia Polytechnic Institute and State University, Blacksburg, VA), N. S. KHOT, and V. B. VENKAYYA (USAF, Flight Dynamics Laboratory, Wright-Patterson AFB, OH) AIAA Journal (ISSN 0001-1452), vol. 22, March 1984, p. 403-408. refs

The problem of the maximization of the critical load (limit point instability) of shallow space trusses of constant volume or weight is considered. Exact solutions being possible in simple cases, a detailed investigation of the question of the uniqueness of the optimum designs for two- and four-bar shallow truss problems is carried out. The optimized trusses satisfy the constant-strain energy density criteria and the load maximization problem is verified to be the dual of the minimization of the total potential energy. Author

A84-25258#
A DEPLOYABLE 30/20 GHZ MULTIBEAM OFFSET ANTENNA
B. ABT (Dornier System GmbH, Friedrichshafen, West Germany) and H. WOLLENHAUPT (ANT Nachrichtentechnik GmbH, Backnang, West Germany) IN: Communication Satellite Systems Conference, 10th, Orlando, FL, March 19-22, 1984, Technical Papers . New York, American Institute of Aeronautics and Astronautics, 1984, p. 54-63. Research supported by the Bundesministerium fuer Forschung und Technologie.
(AIAA PAPER 84-0658)

This paper presents the results of a feasibility study for the design of a 30/20 GHz multibeam satellite antenna with bandwidth of 2.5 GHz and for a continuous coverage of West Germany, including West Berlin. The required dual offset Cassegrain reflector system has a precision deployable (rigid panels) main reflector with a diameter of 4.7 m. The continuous coverage requires an edge gain of at least 47 dB. To maintain a high decoupling between the individual earth stations in different zones, a pointing accuracy of better than 0.3 deg RMS has to be achieved. This can only be realized by a closed loop RF-tracking system with a low power consumption pointing mechanism. Author

A84-29862
THE DEVELOPMENT OF A COMPOSITE BEAM BUILDING MACHINE FOR ON-SITE CONSTRUCTION OF LARGE SPACE STRUCTURES
W. B. GOLDSWORTHY (Goldsworthy Engineering, Inc., Torrance, CA) IN: Space manufacturing 1983; Proceedings of the Sixth Conference, Princeton, NJ, May 9-12, 1983 . San Diego, CA, Univelt, Inc., 1983, p. 177-182. refs
(AAS PAPER 83-217)

Composites will be favored for beam construction in space for two reasons. The first is the need for materials of low density and high strength in projects where the cost of trannsportation will be dominant. The second is the requirement that the material have a zero thermal coefficient of expansion. An outline is presented of material selection and the development of prototype feasibility demonstration equipment for continuously producing, in space, triangular truss beams 1-1/2 meters on a side with closed beam caps. C.R.

N84-10175*# Rockwell International Corp., Downey, Calif. Shuttle Integration and Satellite Systems Div.
DEVELOPMENT OF DEPLOYABLE STRUCTURES FOR LARGE SPACE PLATFORM SYSTEMS. VOLUME 1: EXECUTIVE SUMMARY Final Report
H. S. GREENBERG Oct. 1983 27 p refs
(Contract NAS8-34677)
(NASA-CR-170913; NAS 1.26:170913; SSD-83-0094-1-VOL-1)
Avail: NTIS HC A03/MF A01 CSCL 22B

The preponderance of study effort was devoted toward the deployable platform systems study which culminated in the detailed design of a ground test article for future development testing. This design is representative of a prototype square-truss, single-fold building-block design that can construct deployable platform structures. This prototype design was selected through a comprehensive and traceable selection process applied to eight competitive designs. The selection process compared the competitive designs according to seven major selection criteria, i.e., design versatility, cost, thermal stability, meteoroid impact significance, reliability, performance predictability, and orbiter integration suitability. In support of the foregoing, a materials data base, and platform systems technology development needs were established. An erectable design of an OTV hangar was selected and recommended for further design development. This design was selected from five study-developed competitive single-fold and double-fold designs including hard-shell and inflatable designs. Also, two deployable manned module configurations, i.e., a hard-shell and an inflatable design were each developed to the same requirements as the composite of two Space station baseline habitat modules. N.W.

N84-10176*# Rockwell International Corp., Downey, Calif. Shuttle Integration and Satellite Systems Div.
DEVELOPMENT OF DEPLOYABLE STRUCTURES FOR LARGE SPACE PLATFORMS. VOLUME 2: DESIGN DEVELOPMENT Final Report
H. S. GREENBERG Oct. 1983 183 p refs
(Contract NAS8-34677)
(NASA-CR-170914; NAS 1.26:170914; SSD-83-0094-2-VOL-2)
Avail: NTIS HC A09/MF A01 CSCL 22B

Design evolution, test article design, test article mass properties, and structural analysis of deployable platform systems are discussed. Orbit transfer vehicle (OTV) hangar development, OTV hangar concept selection, and manned module development are discussed. Deployable platform systems requirements, material data base, technology development needs, concept selection and deployable volume enclosures are also discussed. N.W.

N84-11199 Columbia Univ., New York.
ACTUATOR PLACEMENT CONSIDERATIONS FOR THE CONTROL OF LARGE SPACE STRUCTURES Ph.D. Thesis
R. E. LINDBERG 1982 126 p refs
Avail: Univ. Microfilms Order No. DA8307603

The problem of actuator placement for the control of distributed parameter systems such as large flexible space structures is considered. Focus is placed first on the concept of the degree of controllability. The behavior of the degree of controllability and its approximation is considered via application to simple problems for which the exact value may be computed. The upper bound approximation is found to be particularly exact for harmonic systems and an acceptable approximation for lightly damped systems. A method is proposed for avoiding the unacceptable behavior of the approximation in the neighborhood of a problem containing repeated roots. The divergence of the upper bound approximation in the problem of a double integral plant motivates the development of a new lower bound approximation based on discretization of the continuous time system. Dissert. Abstr.

N84-14561 Nebraska Univ., Lincoln.
NEW ELEMENTS FOR ANALYSIS OF SPACE FRAMES WITH TAPERED MEMBERS Ph.D. Thesis
Y. W. LEE 1983 204 p
Avail: Univ. Microfilms Order No. DA8314904

The closed forms of the linear stiffness matrix, geometric stiffness matrix, displacement functions and equivalent nodal loads are developed for analyses of space structures containing linearly tapered members with cross sections of thin-walled tubes, solid rectangles and I-sections. The series expansion forms of these are also developed because they avoid numerical failure in structural analyses under extremely small taper. The cross sectional properties are closely approximated by the ordering process if the geometric properties along the member do not follow a simple power law. Then, solutions are obtained by direct integration of the differential equations for displacements and the moment area theorem. The elements presented can be used for the linear stability and the large deflection analysis of tapered and prismatic members. Dissert. Abstr.

N84-17226*# Rockwell International Corp., Downey, Calif. Shuttle Integration and Satellite Systems Div.
DEVELOPMENT OF TEST ARTICLE BUILDING BLOCK (TABB) FOR DEPLOYABLE PLATFORM SYSTEMS
H. S. GREENBERG and R. T. BARBOUR *In* NASA. Langley Research Center STEP Expt. Requirements p 199-210 Jan. 1984
Avail: NTIS HC A15/MF A01 CSCL 22B

The concept of a Test Article Building Block (TABB) is described. The TABB is a ground test article that is representative of a future building block that can be used to construct LEO and GEO deployable space platforms for communications and scientific payloads. This building block contains a main housing within which the entire structure, utilities, and deployment/retraction mechanism are stowed during launch. The end adapter secures the foregoing components to the housing during launch. The main housing and adapter provide the necessary building-block-to-building-block attachments for automatically deployable platforms. Removal from the shuttle cargo bay can be accomplished with the remote manipulator system (RMS) and/or the handling and positioning aid (HAPA). In this concept, all the electrical connections are in place prior to launch with automatic latches for payload attachment provided on either the end adapters or housings. The housings also can contain orbiter docking ports for payload installation and maintenance. M.G.

N84-18286*# General Electric Co., Philadelphia, Pa.
STRUCTURES AND MECHANISMS
D. PURDY *In* NASA. Langley Research Center Space Station Technol., 1983 p 109-135 Feb. 1984
Avail: NTIS HC A09/MF A01 CSCL 22B

Structures, materials, and mechanisms is one of the older technologies in the aerospace business. The Structures, Materials, and Mechanisms Panel was divided into the four basic categories that fit the overall responsibilities of the panel: materials, mechanisms, structural design, and analysis. Author

N84-18680*# Old Dominion Univ., Norfolk, Va. Dept. of Mechanical Engineering and Mechanics.
COMPONENT MODE SYNTHESIS AND LARGE DEFLECTION VIBRATIONS OF COMPLEX STRUCTURES Final Report, 1 Nov. 1982 - 31 Oct. 1983
C. MEI Feb. 1984 16 p refs
(Contract NAG1-301)
(NASA-CR-173338; NAS 1.26:173338) Avail: NTIS HC A02/MF A01 CSCL 20K

The accuracy of the NASTRAN modal synthesis analysis was assessed by comparing it with full structure NASTRAN and nine other modal synthesis results using a nine-bay truss. A NASTRAN component mode transient response analysis was also performed on the free-free truss structure. A finite element method was developed for nonlinear vibration of beam structures subjected to harmonic excitation. Longitudinal deformation and inertia are both included in the formula. Tables show the finite element free vibration results with and without considering the effects of longitudinal deformation and inertia as well as the frequency ratios for a simply supported and a clamped beam subjected to a uniform harmonic force. A.R.H.

N84-19395*# National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.
A MANNED-MACHINE SPACE STATION CONSTRUCTION CONCEPT
M. M. MIKULAS, JR., H. G. BUSH, R. E. WALLSOM, J. T. DORSEY, and M. D. RHODES Feb. 1984 33 p refs
(NASA-TM-85762; NAS 1.15:85762) Avail: NTIS HC A03/MF A01 CSCL 22B

A design concept for the construction of a permanent manned space station is developed and discussed. The main considerations examined in developing the design concept are: (1) the support structure of the station be stiff enough to preclude the need for an elaborate on-orbit system to control structural response, (2) the station support structure and solar power system be compatible with existing technology, and (3) the station be capable of growing in a systematic modular fashion. The concept is developed around the assembly of truss platforms by pressure-suited astronauts operating in extravehicular activity (EVA), assisted by a machine (Assembly and Transport Vehicle, ATV) to position the astronauts at joint locations where they latch truss members in place. The ATV is a mobile platform that is attached to and moves on the station support structure using pegs attached to each truss joint. The operation of the ATV is described and a number of conceptual configurations for potential space stations are developed. Author

N84-19899# Concordia Univ., Montreal (Quebec). Dept. of Mechanical Engineering.
COMPUTER AIDED SYNTHESIS OF A SATELLITE ANTENNA STRUCTURE WITH PROBABILISTIC CONSTRAINTS
V. K. JHA (SPAR Aerospace Ltd.), T. S. SANKAR, and R. B. BHAT *In* Shock and Vibration Inform. Center The Shock and Vibration Bull., part 3 p 79-89 May 1983 refs
Avail: SVIC, Code 5804, Naval Research Lab., Washington, D.C. 20375 CSCL 20M

The satellite antenna structures have to be designed to withstand the severe environmental conditions encountered by the satellite without failure, and hence they have to be designed with very strict reliability requirements. At the same time these structures should be as light as possible, in weight, to minimize the cost of launching the satellites into space. A computer aided design procedure capable of meeting these design requirements in presented. The procedure involves synthesis of a finite element analysis program capable of analyzing complex structures and a state of the art optimization algorithm into one unified design system. This system is used for designing antenna structures subjected to random excitations and having design requirements specified in a probabilistic manner. An approach is presented to handle probabilistic design requirements. The design of a typical satellite antenna structure realized using the proposed design procedure is presented. Starting from the best guessed design, a saving of 43% in weight is demonstrated. The proposed system is very versatile and the possibilities of extending it for designing other complex structures are also discussed. M.G.

N84-21608*# National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.
OPERATIONAL MODULES FOR SPACE STATION CONSTRUCTION
L. R. JACKSON, P. L. MOSES (Kentron International, Inc.), S. J. SCOTT (Kentron International, Inc.), and M. L. BLOSSER Apr. 1984 34 p refs
(NASA-TM-85772; NAS 1.15:85772) Avail: NTIS HC A03/MF A01 CSCL 22B

Identification of an effective space construction concept is a current objective of NASA studies. One concept, described in this memorandum, consists of repetitive use of operational modules, which minimizes on-orbit stay time for the shuttle. A space station constructed of operational modules may benefit from fabrication and system checkout in ground-based facilities, and since the modules are the primary structure of the space station, a minimum of additional structure, and trips and on-orbit stay time of the shuttle are required. Author

N84-21615# Consulenze Generali Roma (Italy).
FINITE ELEMENT FORMULATIONS FOR TENSIONED MEMBERS
S. SGUBINI *In its* Study on Syn. and Characterization of Large Space Systems, Phase 2. Part 2: Proposals for Additions, Modifications and New Anal. Methods, Vol. 1 p 277-360 Dec. 1982 refs
Avail: NTIS HC A16/MF A01

The geometrical stiffness matrices are evaluated for typical structures, and the effects of shear deformations and rotary inertia on large space structure design are discussed. In plane and longitudinal deformations, and beam torque moment coupling with all other displacements are considered. Analysis shows that these effects are small, but not negligible. Evaluation of the geometrical stiffness matrix of a square section beam reveals that axial and shear force effects can be of the same order of magnitude with slender beams. Author (ESA)

N84-21914# *Technische Univ., Hanover (West Germany). Inst. fuer Statik.*
GEOMETRICALLY NONLINEAR ANALYSIS OF BEAM-IN-SPACE STRUCTURES Thesis
G. LUMPE 15 Dec. 1982 107 p refs In GERMAN; ENGLISH summary
(MITT-28; ISSN-0073-0300) Avail: NTIS HC A06/MF A01

A finite element concept for complex beam-in-space structures based on large displacement and small strain theory is developed. Derivation of a beam theory from the three dimensional theory with consistent approaches and error estimations combined with separation of rigid body motion and actual deformation allowed the derivation of a simple tangent stiffness matrix which takes into account geometrically nonlinear effects. The magnitude of error is a function of element length. The rotation of each cross section is described by an orthogonal tensor as a rotation about one skew axis to avoid nonsymmetric stiffness matrices. The range of application includes hinge fitting combination, shear deformation, and hindered torsion. For cable-roll-connections, a simple algorithm which overcomes the difficult kinematic relations of cable rolls by energetical considerations is presented. Efficiency of the computation method is demonstrated by the example of a tower crane. Author (ESA)

N84-22225*# National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.
GEOMETRIC MODELING OF LARGE SPACE ANTENNA DEPLOYMENT Abstract Only
J. NAZEMETZ (Oklahoma State Univ.), K. SAGE (Kentron International), R. L. GATES (Computer Services Corp.), and D. D. DERYDER *In its* Computer-Aided Geometry Modeling p 399 Mar. 1984
Avail: NTIS HC A17/MF A01 CSCL 09B

A dynamic visualization of large antenna deployment was created to be used as a precursor to further analysis of the structure as it is being deployed. The configuration chosen for this investigation was a box-truss structure consisting of a large reflector 60 meters wide by 120 meters long with a 120-meter mast. The entire space structure is folded and compressed into a container 17.8 meters long by 3.75 meters in diameter for transportation to orbit by the Space Transportation System (STS). A geometric model of this structure was created using an interactive solid modeling package. The building blocks of the structure are boxes and cylinders which are put together to form elements connected by joints and hinges. The elements, joints, and hinges make up the box-truss structure. The geometric model was then passed to the MOVIE.BYU software package. The 'utility' module of this program was used to manipulate the elements of the structure to represent 13 different stages of deployment. The 'animate' command was then used to create a smooth sequence between stages. Each step in the sequence was recorded on magnetic tape and a short movie was produced. M.A.C.

04

STRUCTURAL AND THERMAL ANALYSIS

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

A84-10224
SPACECRAFT THERMAL CONTROL, DESIGN, AND OPERATION
H. E. COLLICOTT, ED. (Boeing Co., Seattle, WA) and P. E. BAUER, ED. (McDonnell Douglas Astronautics Co., St. Louis, MO) New York, American Institute of Aeronautics and Astronautics (Progress in Astronautics and Aeronautics. Volume 86), 1983, 371 p.

Requirements and challenges concerning military spacecraft thermal management are considered along with a Shuttle Orbiter thermal control postflight evaluation, the orbital test satellite thermal experience after 3 1/2 years in orbit, the thermal design and experiment thermal integration of the long duration exposure facility, and satellite thermal design and analyses for expendable and Shuttle launch environments. Topics related to subsystem and components are discussed, taking into account the thermo-mechanical design and analysis system for a 76-in. parabolic antenna reflector, the thermodynamic optimization of a cryogenic storage system for minimum boiloff, and a molecular absorption cryogenic cooler for liquid hydrogen propulsion system. Subjects concerned with material properties and interfaces are explored along with finite-element analysis techniques. A description of heat pipes is also provided, giving attention to osmotic pumped heat pipes for large space platforms, the development of a double-wall artery high-capacity heat pipe, and the Marangoni effect. No individual items are abstracted in this volume G.R.

A84-10440
THERMAL CONTROL OF TUBULAR COMPOSITE STRUCTURES IN SPACE ENVIRONMENT
R. D. KARAM (Fairchild Space Co., Germantown, MD) IN: Composite structures 2; Proceedings of the Second International Conference, Paisley, Scotland, September 14-16, 1983 . London, Applied Science Publishers, 1983, p. 235-248. refs

Thermal control of spacecraft tubular composites is discussed. The equations used to calculate orbital temperatures are presented with a description of the design techniques which limit temperature excursions and associated distortions. Laminate fiber orientation is related to heat transfer characteristics, and it is shown that orientations selected to yield high axial strength and least thermal deformations will generally lead to excessive fin effect heat losses. A perforation procedure is proposed to eliminate in-plane deflections in a space environment independently of laminate construction. The lamination sequence may then be optimized to meet strength and heat loss requirements. Author

A84-11814#
THERMO-MECHANICAL BEHAVIOUR OF CFRP TUBES FOR SPACE STRUCTURES
G. REIBALDI (ESA, Mechanical Systems Div., Noordwijk, Netherlands) International Astronautical Federation, International Astronautical Congress, 34th, Budapest, Hungary, Oct. 10-15, 1983. 16 p. refs
(IAF PAPER 83-417)

Relationships between the coefficient of thermal expansion (CTE), thermal cycling, and microcracking were obtained experimentally for carbon fiber reinforced tubes considered by the ESA as candidates for space structural components. Tests were performed on the mechanical properties, outgassing, thermal expansion, fast thermal cycling tolerance, and microcracking, and also on the long-term durability of the tubes to all the test stresses. The CTE decreased with decreasing temperature and increases in thermal cycling. The variation in the CTS decreased with increased thermal cycling, after which the material became more homogeneous. Microcracks appeared after thermal cycling and the density of microcracks also increased in proportion to the number of thermal cycles. CTE decreased with increases in the number of microcracks, while the mechanical properties remained relatively constant independent of the number of thermal cycles. More extensive tests are recommended to validate the CFRP tubes for 30,000 thermal cycles expected to be encountered by the EURECA free-flying platform in a 500-600 km orbit. M.S.K.

A84-14050* National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.

BUCKLING AND VIBRATION OF ANY PRISMATIC ASSEMBLY OF SHEAR AND COMPRESSION LOADED ANISOTROPIC PLATES WITH AN ARBITRARY SUPPORTING STRUCTURE

M. S. ANDERSON (NASA, Langley Research Center, Structural Concepts Branch, Hampton, VA), F. W. WILLIAMS (University of Wales Institute of Science and Technology, Cardiff, Wales), and C. J. WRIGHT (british Aerospace PLC, Bristol, England) International Journal of Mechanical Sciences (ISSN 0020-7403), vol. 25, no. 8, 1983, p. 585-596. refs

(Contract NCCW-000002)

The computer program designated 'VIPASA', which accurately treats buckling and vibration in prismatic plate assemblies with a response that varies sinusoidally in the longitudinal direction, has been found to be limited by the production of an in-plane shear loading of component plates that produces skewed mode shapes. These do not conform to desired support conditions. This problem is presently overcome through a coupling of the VIPASA stiffness matrices for different wavelength responses by means of the Lagrangian Multipliers method. The theory extends to supports at arbitrary locations, and even to the support provided by any elastic structure. The generality and capabilities of VIPASA have been retained in the computer program designated 'VICON', which permits constraints and a supporting structure consisting of any number of transverse beam columns. O.C.

A84-17850#

WEIGHT CHARACTERISTICS OF FUTURE SPACECRAFT THERMAL MANAGEMENT SYSTEMS

J. W. SHEFFIELD (Missouri-Rolla, University, Rolla, MO) and V. J. VAN GRIETHUYSEN (USAF, Wright Aeronautical Laboratories, Wright-Patterson AFB, OH) American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 22nd, Reno, NV, Jan. 9-12, 1984. 6 p. refs

(AIAA PAPER 84-0054)

This paper presents the results of an investigation on the weight characteristics of future spacecraft thermal management systems. The sensitivity of the thermal management system weight to the performance requirements of both evolutionary and revolutionary spacecraft missions has been studied. A numerical analysis modeling the transient heat flow through the thermal management system was performed. The performance parameters included the peak thermal load, the peak-to-average thermal load ratio and length of peak load. In addition the sensitivity of the thermal management system weight to the choice of phase change material for heat storage was determined via a heat of fusion parametric analysis. Author

A84-17853#

STRUCTURAL PARAMETER IDENTIFICATION FOR FLEXIBLE SPACECRAFT

S. L. HENDRICKS, S. M. HAYES, and J. L. JUNKINS (Virginia Polytechnic Institute and State University, Blacksburg, VA) American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 22nd, Reno, NV, Jan. 9-12, 1984. 5 p. USAF-supported research. refs

(AIAA PAPER 84-0060)

A system identification procedure applicable to large flexible spacecraft is presented. An iteration scheme is used to obtain best estimates for a small set of key system parameters so that the predicted natural frequencies and damping factors agree with measured values. Numerical simulations are presented based on an actual test structure under development at the Charles Stark Draper Laboratories. Author

A84-17910#

SPACECRAFT THERMAL DESIGN USING INTERACTIVE GRAPHICS

M. S. CROUTHAMEL (RCA Advanced Technology Laboratories, Camden, NJ) American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 22nd, Reno, NV, Jan. 9-12, 1984. 8 p.

(AIAA PAPER 84-0143)

This paper describes the thermal analysis of a geosynchronous communications satellite in launch configuration. PATRAN was used as the interactive solid geometry modeler. Some PATRAN models were coupled to the TRASYS thermal radiation analyzer to determine radiative couplings and environmental inputs. Other PATRAN models were coupled to SINDA to determine conductive couplings and thermal masses. Finally, the TRASYS and SINDA inputs from PATRAN were combined to determine transient and steady-state temperature distributions. Author

A84-17911*# Washington Univ., Seattle.

RADIATION-CONDUCTION INTERACTION IN LARGE SPACE STRUCTURES

A. F. EMERY, H. R. MORTAZAVI, and S. O. SMITH (Washington, University, Seattle, WA) American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 22nd, Reno, NV, Jan. 9-12, 1984. 9 p. refs

(Contract NAG1-41)

(AIAA PAPER 84-0144)

The effects of a penumbra due to the long wave radiation emitted by the earth or to solar energy reflected from the earth on temperature distributions, deflections and stresses in plates are studied to determine their importance in the design of space structures. An examination of the state of stress in a thin plate exposed to the sun suggests that deflections are only slightly modified by the penumbra, but that stresses in the vicinity of the shadow line are more affected. Even with the smoothing due to the penumbra, these stresses should be considered in the design of space structures. A simple relationship is given by which albedo viewfactors can be easily derived from the direct viewfactor, thus simplifying the radiation analysis. Author

A84-21284#

MULTI-MEGAWATT SPACE POWER THERMAL MANAGEMENT SYSTEM REQUIREMENTS

R. T. TAUSSIG (Mathematical Sciences Northwest, Inc., Bellevue, WA) American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 22nd, Reno, NV, Jan. 9-12, 1984. 7 p.

(AIAA PAPER 84-0056)

Multi-megawatt space power systems will require a novel approach to manage the enormous amounts of waste heat generated. Mission constraints such as average and peak power requirements, power system duty cycle, on-board end use power requirements, and mission lifetime, orbit parameters, maneuver and attitude control accelerations, speed of deployment, and other related requirements are used to define the amounts, temperatures, and temporal duration of waste heat production. These quantities are then applied to the design and optimization of a thermal management system based on a thermal bus. Applications include 100 kw to 1 MW space platforms and burst mode missions requiring up to several hundred MW of electric power. Author

A84-28237
THERMAL-MECHANICAL BEHAVIOR OF GRAPHITE/MAGNESIUM COMPOSITES
B. J. MACLEAN and M. S. MISRA (Martin Marietta Aerospace, Denver, CO) IN: Mechanical behavior of metal-matrix composites; Proceedings of the Symposium, Dallas, TX, February 16-18, 1982 . Warrendale, PA, The Metallurgical Society of AIME, 1983, p. 195-212. refs

Continuous-filament, graphite-reinforced magnesium composites exhibit exceptional unidirectional mechanical properties fo their weight. For aerospace applications requiring high modulus, light-weight, thermal deformation-resistant materials, Gr/Mg promises substantial payoffs, and is compared to other more conventional materials. Single-ply and 3-ply VSB32/AZ91C/AZ31B panels and single ply VS0054/AZ91C/AZ31B panels were evaluated. NDI techniques of X-radiography, ultrasonic C-scan, and liquid penetrant were used to assess filament collimation, face sheet disbonds, and sheet tears or pitting, respectively. Ambient temperature tensile testing yielded longitudinal elastic modulus values predicted by the rule-of-mixtures (32.4 Msi for 28.4 volume-percent Pitch 100 Gr/Mg) and ultimate tensile strengths of better than 83 ksi. Failure analysis and fractography were then conducted to determine failure modes. Author

A84-29032* National Aeronautics and Space Administration. Lyndon B. Johnson Space Center, Houston, Tex.
THERMAL MANAGEMENT SYSTEM TECHNOLOGY DEVELOPMENT FOR SPACE STATION APPLICATIONS
J. G. RANKIN and P. F. MARSHALL (NASA, Johnson Space Center, Houston, TX) AIAA, SAE, ASME, AIChE, and ASMA, Intersociety Conference on Environmental Systems, 13th, San Francisco, CA, July 11-13, 1983. 14 p. refs
(SAE PAPER 831097)

A short discussion of the history to date of the NASA thermal management system technology development program is presented, and the current status of several ongoing studies and hardware demonstration tasks is reported. One element of technology that is required for long-life, high-power orbital platforms/stations that is being developed is heat rejection and a space-constructable radiator system. Aspects of this project include high-efficiency fin concepts, a heat pipe quick-disconnect device, high-capacity heat pipes, and an alternate interface heat exchanger design. In the area of heat acquisition and transport, developments in a pumped two-phase transport loop, a capillary pumped transport loop using the concept of thermal utility are reported. An example of a thermal management system concept is provided. J.N.

A84-29036
A CONTACT CONDUCTANCE INTERFACE FOR A SPACE CONSTRUCTABLE HEAT PIPE RADIATOR
J. A. OREN and M. L. FLEMING (Vought Corp., Dallas, TX) AIAA, SAE, ASME, AIChE, and ASMA, Intersociety Conference on Environmental Systems, 13th, San Francisco, CA, July 11-13, 1983. 11 p.
(SAE PAPER 831101)

The design, development, feasibility demonstration, and testing of a prototype heat exchanger device which will provide an interface with a spacecraft thermal control subsystem at a connectable/disconnectable joint is described. The approach taken involves pressurized clamping of a segmented cylindrical heat exchanger on the outside of a round heat pipe evaporator section, and is intended to provide a contact heat exchanger which could be connected or disconnected without breaking of fluid systems in the assembly/dissembly of radiator panels. The heat pipe radiators are 9 to 18 m in length and use a single high-capacity heat pipe attached to a fin 15 to 30 cm wide. In testing, thermal conductance across the interface of 8500 w/sq m-deg C and overall conductance of 4300 w/sq m-deg C were obtained. J.N.

A84-29067
THERMAL CONTROL OF THE TETHERED SATELLITE MODULE
G. BORRIELLO and G. PELLIS (Aeritalia S.p.A., Turin, Italy) AIAA, SAE, ASME, AIChE, and ASMA, Intersociety Conference on Environmental Systems, 13th, San Francisco, CA, July 11-13, 1983. 11 p.
(SAE PAPER 831138)

Thermal analytical modeling plays an important role in the design, development and evaluation of the Space Shuttle's Tethered Satellite System (TSS) module, which in accomodating a wide range of experiments and instruments requires variable thermal control features. The TSS design approach to thermal control encompasses external and internal coatings, control of thermally conductive paths, the use of multilayer insulation blankets, and electrical heaters. Standard thermal computer programs are used to evaluate spacecraft radiative exchange, quantify heat flux impingements on surfaces, and predict resulting temperature variations, at various Space Shuttle Orbiter orientations with respect to solar flux. O.C.

A84-29071
THE THERMAL DESIGN OF THE EUROPEAN COMPLEMENT OF FSLP
U. LAUX (ERNO Raumfahrttechnik GmbH, Bremen, West Germany) AIAA, SAE, ASME, AIChE, and ASMA, Intersociety Conference on Environmental Systems, 13th, San Francisco, CA, July 11-13, 1983. 11 p.
(SAE PAPER 831144)

Due to the unique requirements of the First Spacelab Mission, extensive analytical efforts have had to be made to determine instrument rack thermal characteristics. In the case of Space Shuttle Orbiter cargo bay-located payloads, such analytical studies can be less demanding provided that the instrumentation whose thermal control is in question employs the Shuttle's Freon-cooling loop and makes effective use of thermal insulation. In the case of complex experiment configurations, additional systems for the optimal control of human contact areas rather than heat rejection capabilities must be developed. It is noted that the thermal insulation practices developed for the European Bridge Assembly yield both higher thermal performance and greater integration flexibility. O.C.

A84-29076* United Technologies Corp., Windsor Locks, Conn.
REGENERABLE NON-VENTING THERMAL CONTROL SUBSYSTEM FOR EXTRAVEHICULAR ACTIVITY
G. J. ROEBELEN, JR., K. J. DRESSER, E. W. HODGSON, JR. (United Technologies Corp., Hamilton, Standard Div., Windsor Locks, CT), and C. LIN (NASA, Johnson Space Center, Houston, TX) AIAA, SAE, ASME, AIChE, and ASMA, Intersociety Conference on Environmental Systems, 13th, San Francisco, CA, July 11-13, 1983. 15 p.
(Contract NAS9-16609)
(SAE PAPER 831151)

Extravehicular Mobility Unit heat rejection requirements have been formulated for both Space Shuttle Orbiter and space station regenerable nonventing thermal sink (RNTS) applications, where the former involve nonventing extravehicular activity (EVA) missions and the latter both nonventing and regenerable EVA. The present conceptual study notes that while the exclusive use of thermal storage is suitable for the Space Shuttle mission, space station requirements are best satisfied by a hybrid system which combines thermal storage with radiator and heat pump. The Space Shuttle RNTS thermal control subsystem's thermal storage unit uses water as a phase change medium. It is noted that the same heat storage unit can satisfy the Space Shuttle and space station requirements. O.C.

N84-11200 Messerschmitt-Boelkow-Blohm G.m.b.H., Ottobrunn (West Germany). Betriebsbereich.
SPACECRAFT THERMAL CONTROL SELECTION FOR SEVEN YEARS OF LIFETIME IN SYNCHRONOUS ORBIT
L. PREUSS 1982 16 p Presented at 55th AGARD/SMP Panel Meeting/Specialists Meeting on Environ. Effects on Mater. for Space Appl., Toronto, 19-24 Sep. 1982
(MBB-UR-584-82-OE) Avail: Issuing Activity
Nonconductive and conductive flexible second surface mirrors (SSM) with interference filters on top for satellite use are presented. The SSM composition is analyzed and defined. The optimization procedure for the SSM is outlined. The qualification of the SSM on laboratory scale for synchronous orbit is demonstrated. Handling, application and performance specifications are given.
Author (ESA)

N84-15329*# National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.
NASA NEEDS AND TRENDS IN CRYOGENIC COOLING
A. SHERMAN *In its* Refrig. for for Cryogenic Sensors p 13-27 Dec. 1983 refs
Avail: NTIS HC A19/MF A01 CSCL 20L
Projected NASA needs in spaceborne cryogenic systems and recent results of NASA cryogenic cooling technology efforts in infrared astronomy, X-ray astronomy, gamma ray astronomy, liquid helium and space stations are discussed.
R.J.F.

N84-15426*# National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.
THERMAL ANALYSIS RESEARCH APPLICABLE TO SPACE STATION TECHNOLOGY NEEDS
H. M. ADELMAN Apr. 1983 53 p Presented at the Space State Technol. Workshop, Williamsburg, Va., 28-31 Mar. 1983
(NASA-TM-84658; NAS 1.15:84658) Avail: NTIS HC A04/MF A01 CSCL 20D
Thermal analysis, optimization, and software research and development at the NASA Langley Research Center which is applicable to analytical design calculations for space station structures are summarized. Topics discussed include integrated thermal-structural software, improved thermal radiation analysis, solution techniques for transient temperatures, unified thermal-structural finite elements, thermal structural sensitivity analysis and optimization, and concept and performance analysis for heat pipes.
Author

N84-15562# National Centre of Tribology, Risley (England). European Space Tribology Lab.
THERMAL CONDUCTANCE AND TORQUE OF THIN SECTION FOUR-POINT CONTACT BALL BEARINGS IN VACUUM
R. A. ROWNTREE and M. J. TODD Paris ESA Mar. 1983 57 p refs
(Contract ESTEC-4099/79/NL-PP(SC))
(ESA-ESTL-54; ESA-CR(P)-1772) Avail: NTIS HC A04/MF A01
Ball bearings for the L-SAT antenna pointing mechanism (APM) were tested in vacuum with external diameter clearance (i.e., free fit rings) and held in-situ with clamp rings. The influence of speed, temperature, internal preload, axial ring clamping force, lubricant and cage type was examined. As the inner race becomes warmer than the outer, the conductance increases linearly with the temperature difference, whereas the increase in torque is almost a square law relation. With a colder inner race, the bearing develops internal diametral clearance and thus gives low conductance and a small constant torque. Bearing torque and conductance are also shown to be dependent on axial clamping force, internal preload and lubricant quantity. Hysteresis effects of temperature on conductance and torque, and the contribution of the cage to the overall bearing torque are noted. By suitable selection of internal preload and clamping force, the design requirements for L-SAT APM bearings can be achieved.
Author (ESA)

N84-16509# Sandia Labs., Livermore, Calif. Systems Evaluation Div.
SODIUM HEAT TRANSFER SYSTEM MODELING
A. F. BAKER and M. E. FEWELL (Sandia Labs., Albuquerque, N. Mex.) 1983 6 p refs Presented at the ASME Winter Ann. Meeting, Boston, 13-18 Nov. 1983
(Contract DE-AC04-76DP-00789)
(DE84-002051; SAND-83-1631C; CONF-831111-9) Avail: NTIS HC A02/MF A01
The sodium heat transfer system of the international energy agency (IEA) small solar power systems (SSPS) central receiver system (CRS), which includes the heliostat field, receiver, hot and cold storage vessels, and sodium/water steam generator was modeled. The computer code SOLTES (simulator of large thermal energy systems), was used to model this system. The results from SOLTES are compared to measured data.
DOE

N84-16565*# Old Dominion Univ., Norfolk, Va. Dept. of Mechanical Engineering and Mechanics.
SELF-SHADOWING OF ORBITING TRUSSES Progress Report
J. MAHANEY and E. A. THORNTON Aug. 1983 48 p
(Contract NAG1-257)
(NASA-CR-173215; NAS 1.26:173215) Avail: NTIS HC A03/MF A01 CSCL 13I
The approach used to assess shadowing reductions on the heating of orbiting trusses involves determining the heating rates with slender member shadowing effects included and then obtaining the thermal response of the shadowed member. Steps taken to identify shadowers, find locations where shadowing occurs and calculate shadow intensity are listed. The finite element thermal structural analysis of cable stiffened space structure is delineated and the exact solution of the caternary problem is given. Typical cable surface heating rates are plotted. The structural analysis includes large deformation (nonlinear), thermal effect, and the pretension effect. Displacements and stresses are computed at different orbital positions for an orbit.
A.R.H.

N84-17222*# National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.
THERMAL ENERGY MANAGEMENT PROCESS EXPERIMENT
S. OLLENDORF *In* NASA. Langley Research Center STEP Expt. Requirements p 161-163 Jan. 1984
Avail: NTIS HC A15/MF A01 CSCL 22B
The thermal energy management processes experiment (TEMP) will demonstrate that through the use of two-phase flow technology, thermal systems can be significantly enhanced by increasing heat transport capabilities at reduced power consumption while operating within narrow temperature limits. It has been noted that such phenomena as excess fluid puddling, priming, stratification, and surface tension effects all tend to mask the performance of two-phase flow systems in a 1-g field. The flight experiment approach would be to attack the experiment to an appropriate mounting surface with a 15 to 20 meter effective length and provide a heat input and output station in the form of heaters and a radiator. Using environmental data, the size, location, and orientation of the experiment can be optimized. The approach would be to provide a self-contained panel and mount it to the STEP through a frame. A small electronics package would be developed to interface with the STEP avionics for command and data handling. During the flight, heaters on the evaporator will be exercised to determine performance. Flight data will be evaluated against the ground tests to determine any anomalous behavior.
M.G.

N84-18289*# Grumman Aerospace Corp., Bethpage, N.Y.
THERMAL CONTROL
B. HASLETT *In* NASA. Langley Research Center Space Station Technol., 1983 p 165-186 Feb. 1984
Avail: NTIS HC A09/MF A01 CSCL 22B
There are basically three key ingredients to the thermal control system for any large space platform or space station. These are heat rejection (from a centralized radiator or from body mounted radiators), heat acquisition (from payloads), and heat transport

(via a transport loop to the radiator). The echnical approach in the heat rejection area is to construct the radiator from individual elements so that it can be built on-orbit, is very insensitive to meteoroid and debris hazards, and is repairable. In the area of thermal acquisition and transport an added effort to better understand two phase flow in zero gravity by analysis and testing is suggested. Author

N84-18576*# National Aeronautics and Space Administration, Washington, D. C.
SECOND ALL-UNION SEMINAR ON HYDROMECHANICS AND HEAT-MASS TRANSFER IN WEIGHTLESSNESS. ABSTRACTS OF REPORTS: TABLE OF CONTENTS
G. Z. GERSHUNI and Y. M. ZHUKHOVITSKIY Jan. 1984 15 p refs Transl. into ENGLISH of conf. papers, 1981 p 176-186 Seminar held in Perm, USSR, 1981
(Contract NASW-3542)
(NASA-TM-77534; NAS 1.15:77534) Avail: NTIS HC A02/MF A01 CSCL 20D

Abstracts of reports are given which were presented at the Second All Union Seminar on Hydromechanics and Heat-Mass Transfer in Weightlessness. Topics inlcude: (1) features of crystallization of semiconductor materials under conditions of microacceleration; (2) experimental results of crystallization of solid solutions of CDTE-HGTE under conditions of weightlessness; (3) impurities in crystals cultivated under conditions of weightlessness; and (4) a numerical investigation of the distribution of impurities during guided crystallization of a melt. B.W.

N84-19396# European Space Agency, Paris (France).
ENVIRONMENTAL AND THERMAL CONTROL SYSTEMS FOR SPACE VEHICLES
T. D. GUYENNE, ed. and J. J. HUNT, ed. Dec. 1983 576 p refs Partly in FRENCH and ENGLISH Proc. of Intern. Symp., Toulouse, 4-7 Oct. 1983; sponsored by CNES and ESA Original contains color illustrations
(ESA-SP-200; ISSN-0379-6566) Avail: NTIS HC A25/MF A01; ESA, Paris FF 250, Member States, AU, CN and NO (+20% others)

Spacecraft thermal testing, thermal control technology, thermal control design, cryogenics, and thermal analysis were discussed. Environmental control systems for space stations and platforms, and in flight experience were considered.

N84-19398# Aeritalia S.p.A., Torino (Italy).
DEVELOPMENT OF A SPACECRAFT INFRARED TEST TECHNIQUE AS AN ALTERNATIVE TO SOLAR SIMULATION: FIRST STEPS ON L-SAT THERMAL MODEL
P. MESSIDORO, D. BOGGIATTO, M. PATACCIA, and P. BURATTI *In* ESA Environ. and Thermal Control Systems for Space Vehicles p 11-17 Dec. 1983 refs
Avail: NTIS HC A25/MF A01

The L-Sat satellite was used for an off-line investigation to develop an infrared test technique alternative to solar simulation, because of its large size and the presence of heat pipes on its north/south radiators. The infrared test set-up facility and test sequence; lamp characteristics; surface property measurements; flux calculation; flux measurement; power control system; lamp rig design; and test prediction and correlation are described. Improvements to the test technique are suggested. Author (ESA)

N84-19399# European Space Research and Technology Center, Noordwijk (Netherlands).
SPACECRAFT THERMAL BALANCE TESTING USING INFRARED LAMPS ON A DUMMY SPACECRAFT
G. B. T. TAN and J. B. WALKER *In* ESA Environ. and Thermal Control Systems for Space Vehicles p 19-25 Dec. 1983 refs
Avail: NTIS HC A25/MF A01

The use of tungsten lamp infrared sources placed in close proximity to a spacecraft undergoing thermal balance testing is discussed. The technique has economic advantages for thermal balance testing of spaceborne objects which are too large to fit into existing conventional solar simulation facilities. It was assessed by using a telecommunication satellite model with typical radiator faces. Comparison of the mathematical model and test model temperatures is considered acceptable, allowing for the difference between infrared and solar simulation. Author (ESA)

N84-19400# European Space Research and Technology Center, Noordwijk (Netherlands).
IRSIM: A PROGRAM FOR THE CALCULATION OF INFRARED FLUX INTENSITY INCIDENT ON A SPACECRAFT INSIDE A TEST CHAMBER
R. P. ROGERS *In* ESA Environ. and Thermal Control Systems for Space Vehicles p 27-37 Dec. 1983 refs
Avail: NTIS HC A25/MF A01

A computer program which calculates the infrared flux intensity received by a specimen in a test chamber is described. Illumination by an array of infrared lamps in thermal testing of spacecraft too large for conventional solar simulators is considered. The code is used to decide on a sensor/baffle/lamp arrangement at an early stage in the test process; and to help resolve discrepancies observed in the test measurements. The modelling of the NOSAT dummy spacecraft is described. Author (ESA)

N84-19401# European Space Agency, Paris (France).
THERMAL CYCLING TESTS IN SPACE ENVIRONMENT SIMULATION CHAMBERS [LES ESSAIS DE CYCLAGES THERMIQUES DANS LES CHAMBRES DE SIMULATION SPATIALE]
C. POUX (Intespace, Toulouse) *In its* Environ. and Thermal Control Systems for Space Vehicles p 39-42 Dec. 1983 In FRENCH
Avail: NTIS HC A25/MF A01

Thermal cycling/thermal vacuum test facilities to simulate space environments are described. Solar simulation at 1400 W/sqm is possible. Thermal cycling test temperatures can vary from 100 to 360 K. Thermal vacuum test temperatures between -60 and +55 C are achieved. Infrared tests using 500 W quartz lamps are carried out. The vacuum chambers allow a main satellite spherical body of 3 m diameter, or a deployed configuration of 6 m diameter, 7 m height, to be tested. Author (ESA)

N84-19402*# National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.
RECENT AND PLANNED DEVELOPMENTS AT THE GODDARD SPACE FLIGHT CENTER IN THERMAL CONTROL TECHNOLOGY
S. OLLENDORF *In* ESA Environ. and Thermal Control Systems for Space Vehicles p 45-51 Dec. 1983 refs
Avail: NTIS HC A25/MF A01

Thermal control technology for advanced spacecraft and space stations is presented. Results of proof of concept two phase laboratory devices indicate that large amounts of energy (1 to 2 kw) can be transported long distances (10 to 20 m) with very small temperature differences. An evolutionary test bed for advanced development of thermal technology, which provides data on components and systems for space station designs is described. Results of the STS-3 Thermal Canister Experiment show that the enclosure held simulated instruments to + or - 1 C over a wide range of thermal environments. Author (ESA)

N84-19405# Aeritalia S.p.A., Torino (Italy). Space Sector.
HEAT PIPES FOR THE L-SAT COMMUNICATIONS MODULE RADIATORS
M. PAPACCIA, V. PEROTTO, B. SESSIONS, and H. KREEB (Dornier-Werke G.m.b.H., Friedrichshafen, West Germany) *In* ESA Environ. and Thermal Control Systems for Space Vehicles p 67-74 Dec. 1983 refs
Avail: NTIS HC A25/MF A01

Constant conductance aluminum axial groove ammonia heat pipes for L-SAT 1 north/south radiators were developed. Twenty-four pipes on the south radiator and 38 on the north reject directly imposed heat loads of 600 W and 700 W, respectively. Pipe inner diameter is 5.0 mm, outer square dimension = 9.0

mm. Integral fins provide equipment mounting support and increased thermal efficiency. Pipe lengths range from 0.72 m to 1.238 m. The L-SAT honeycomb radiators offer up to 5.23 sqm radiating area each (2.1 x 2.58 m less the solar array drive mechanism). To establish the manufacturing techniques for the heat pipe radiators and to acquire confidence in the analytical modeling approach, a development model heat pipe radiator measuring 0.8 m x 1.6 m with ten 1.5 m long heat pipes was tested in a vacuum chamber. Author (ESA)

N84-19406# Royal Netherlands Aircraft Factories Fokker, Schiphol-Oost. Space Div.

A VARIABLE CONDUCTANCE HEAT PIPE (VCHP) RADIATOR SYSTEM FOR COMMUNICATIONS PAYLOADS

N. H. PENNINGS and C. J. SAVAGE (ESTEC, Noorwidjk, Netherlands) *In* ESA Environ. and Thermal Control Systems for Space Vehicles p 75-81 Dec. 1983 Sponsored by ESTEC
Avail: NTIS HC A25/MF A01

A thermal control system to support the development of a multibeam antenna array system for communication satellites is discussed. Trade-off shows that for the antenna power amplifiers a system using variable conductance heat pipes (VCHPs) is the optimum heat rejection system. The VCHP-concept is compared with louvers, phase change materials, feedback controlled heat pipes, and heaters. With passively controlled reservoirs and subject to a factor of 3 variation in the power dissipation, the VCHP concept features a temperature range of 10 to 50 C. The system is suitable for all spacecraft with remote dissipating and radiating elements. Author (ESA)

N84-19414# Aeritalia S.p.A., Torino (Italy).

THE THERMAL DESIGN OF L-SAT LARGE TELECOMMUNICATION SATELLITE

D. BOGGIATTO, E. COLIZZI, R. VENERI, and E. SACCHI *In* ESA Environ. and Thermal Control Systems for Space Vehicles p 149-159 Dec. 1983 refs Sponsored by ESA and British Aerospace Dynamics Group
Avail: NTIS HC A25/MF A01

The passive thermal control design of the L-SAT series of satellites is outlined. Multilayer insulation blankets, heaters, thermal doublers, paints, and thermal fillers/stand offs are supplemented by constant conductance heat pipes, electrically conductive coated second surface mirrors, and a multilayer insulation outer layer. The heat rejection philosophy is standard for a three axis stabilized geostationary satellite, with external appendages insulated from the spacecraft body. Author (ESA)

N84-19423# Institute of Space and Astronautical Science, Tokyo (Japan).

THERMOFLUIDYNAMICS OF HEAT PIPES

K. OSHIMA and M. MURAKAMI (Tsukuba University, Japan) *In* ESA Environ. and Thermal Control Systems for Space Vehicles p 231-234 Dec. 1983 refs
Avail: NTIS HC A25/MF A01

The operation of high heat flux heat pipes is analyzed using a thermodynamic phase diagram, and the gasdynamic heat pipe which uses the gasdynamic effect of the vapor flow for pumping up the liquid onto the evaporator is discussed. A space station thermal control system using the gasdynamic heat pipe is introduced. This system does not need any external force and is self-controlled. It ensures high system reliability as well as wide design flexibility. Author (ESA)

N84-19434# Aeritalia S.p.A., Torino (Italy). System Engineering-Space Sector.

DESIGN AND MANUFACTURING OF A HEAT REJECTION SYSTEM FOR ADVANCED THERMAL CONTROL

L. BUSSOLINO and J. P. BOUCHEZ (ESTEC, Noordwijk, Netherlands) *In* ESA Environ. and Thermal Control System for Space Vehicles p 329-335 Dec. 1983 refs
Avail: NTIS HC A25/MF A01

A Technology Demonstration Model (TDM) of a heat rejection system dedicated to advanced spacecraft and payload thermal control was manufactured. The TDM consists of radiator panels (1.2 x 1.85 m), Spacelab type piping, fluid loop servicer with pump package, thermal control valves (bypass and flow metering) and a microprocessor based electronic control unit. Studies leading to the definition of the TDM; the design and manufacturing activities of the components; and the test program are described. Author (ESA)

N84-19444# Aeritalia S.p.A., Torino (Italy). Space Sector.

THERMAL CONTROL OF TETHERED SATELLITE IN A VERY LOW ALTITUDE AERODYNAMIC MISSION

G. BORRIELLO, C. CHIARELLI, G. PELLIS, and F. AL-ASTRABADI *In* ESA Environ. and Thermal Control Systems for Space Vehicles p 407-416 Dec. 1983 refs
Avail: NTIS HC A25/MF A01

Aerodynamic heating rates that a very low altitude satellite (100 km) can experience were calculated. A theoretical analysis, evaluating Knudsen number for flow regimes from free molecular to transition, is presented. Although it is not possible to predict with high confidence level the heating rates in transition flow regimes, the analysis data can be used to facilitate theoretical development. Metallic and ceramic thermal shields to protect the satellite primary structure were investigated. Conventional design methods are proposed to control internal unit temperature. Author (ESA)

N84-19449# Lockheed Missiles and Space Co., Palo Alto, Calif.

EFFECTS OF COMBINED ULTRAVIOLET AND OXYGEN PLASMA ENVIRONMENT ON SPACECRAFT THERMAL CONTROL MATERIALS

M. MCCARGO, R. E. DAMMANN, J. C. ROBINSON, and R. J. MILLIGAN *In* ESA Environ. and Thermal Control Systems for Space Vehicles p 447-454 Dec. 1983 refs Sponsored by Lockheed Palo Alto Research Laboratory Directorate
Avail: NTIS HC A25/MF A01

A laboratory plasma reactor was built to study the effects on surface properties of materials flown in space shuttle cargo bays of the interaction of the surfaces with atomic oxygen in low Earth orbit. The apparatus, the effects of oxygen plasma plus ultraviolet radiation on thermal control materials, changes in optical properties, and rate of weight loss are described. Results show that UV effects are negligible in all cases, and that changes are due to the oxygen environment. Author (ESA)

N84-19454# Centre National d'Etudes Spatiales, Toulouse (France).

A MALTESE CROSS SHAPED MOBILE THERMAL CONTROL SHUTTER [VOLET MOBILE DE CONTROLE THERMIQUE DU TYPE CROIX DE MALTE]

I. ALET *In* ESA Environ. and Thermal Control Systems for Space Vehicles p 477-480 Dec. 1983 In FRENCH
Avail: NTIS HC A25/MF A01

The advantages of a Maltese cross shaped shutter over venetian blind type systems for satellite thermal control are described. It has low power consumption, is mechanically simple, and can be used against the Sun. Its low surface efficiency makes it unsuitable for geostationary telecommunication satellites, but presents no problems in low Earth orbit. Thermal, vibration, and shock tests demonstrate its robustness and reliability. Author (ESA)

N84-19458# European Space Research and Technology Center, Noordwijk (Netherlands).

THE LARGE SPACE SIMULATOR (LSS) AT ESA/ESTEC (A SUMMARY OF THE MAIN CHARACTERISTICS)

P. W. BRINKMANN *In* ESA Environ. and Thermal Control Systems for Space Vehicles p 501-503 Dec. 1983 refs
Avail: NTIS HC A25/MF A01

Parameters of ESA's Space Simulator for thermal balance tests on satellites and satellite equipment with large geometries are listed. A vertical main chamber and horizontal auxiliary chamber are interfaced by a 8 m dia nozzle. Main chamber and nozzle will be equipped with a shroud lining the complete chamber surface,

while the shroud elements in the auxiliary chamber have the form of light baffles. The collimation mirror is suspended from the rear stiffening ring of the auxiliary chamber. A spout provides the interface between the vacuum chamber and the lamp house. The lamp house contains 19 lamp modules, collection optics and transfer optics and provides a protective environment for all optical elements. The test articles can be mounted on a vibration-free support platform (eventually via a motion simulator) or suspended from support lugs in the upper part of the main chamber.
Author (ESA)

N84-19906# National Space Development Agency, Tokyo (Japan).
EVALUATION OF MODAL TESTING TECHNIQUES FOR SPACECRAFT STRUCTURES
K. SHIRAKI and H. MITSUMA *In* Shock and Vibration Inform. Center The Shock and Vibration Bull., part 3 p 161-170 May 1983 refs
Avail: SVIC, Code 5804, Naval Research Lab., Washington, D.C. 20375 CSCL 22B

A comparative study of modal testing techniques with a base classical sine sweep and random test methods based upon digital analysis techniques are compared by measuring transfer functions of a simple beam specimen. For the random test data, modal analyses were performed using two kinds of analyzers, for two steps of input levels, respectively. The modal parameters obtained by both analyzers were in good agreement. And the structural response nonlinear characteristics due to the input level change were investigated. An example of the application of these techniques to the development of the Engineering Test Satellite 3 is shown.
M.G.

N84-20622*# Vought Corp., Dallas, Tex.
FLEXIBLE RADIATOR THERMAL VACUUM TEST REPORT
J. A. OREN and C. W. HIXON 29 Oct. 1982 103 p refs
(Contract NAS9-14776)
(NASA-CR-171764; NAS 1.26:171764; REPT-2-32300/IR-03)
Avail: NTIS HC A06/MF A01 CSCL 22B

Two flexible, deployable/retraction radiators were designed and fabricated. The two radiator panels are distinguishable by their mission life design. One panel is designed with a 90 percent probability of withstanding the micrometeoroid environment of a low earth orbit for 30 days. This panel is designated the soft tube radiator after the PFA Teflon tubes which distribute the transport fluid over the panel. The second panel is designed with armored flow tubes to withstand the same micrometeoroid environment for 5 years. It is designated the hard tube radiator after its stainless steel flow tubes. The thermal performance of the radiators was tested under anticipated environmental conditions. The two deployment systems of the radiators were evaluated in a thermal vacuum environment.
S.L.

N84-20623*# Vought Corp., Dallas, Tex.
FLEXIBLE RADIATOR SYSTEM
J. A. OREN 30 Oct. 1982 82 p refs
(Contract NAS9-14776)
(NASA-CR-171765; NAS 1.26:171765; REPT-2-19200/3R-1195B)
Avail: NTIS HC A05/MF A01 CSCL 22B

The soft tube radiator subsystem is described including applicable system requirements, the design and limitations of the subsystem components, and the panel manufacturing method. The soft tube radiator subsystem is applicable to payloads requiring 1 to 12 kW of heat rejection for orbital lifetimes per mission of 30 days or less. The flexible radiator stowage volume required is about 60% and the system weight is about 40% of an equivalent heat rejection rigid panel. The cost should also be considerably less. The flexible radiator is particularly suited to shuttle orbiter sortie payloads and also whose mission lengths do not exceed the 30 day design life.
A.R.H.

N84-20624*# Vought Corp., Dallas, Tex.
FLEXIBLE RADIATOR SYSTEM: EXECUTIVE SUMMARY
J. R. OREN and R. L. COX 30 Oct. 1982 49 p
(Contract NAS9-14776)
(NASA-CR-171766; NAS 1.26:171766; REPT-2-19200/3R-1062B)
Avail: NTIS HC A03/MF A01 CSCL 22B

A full scale prototype flexible radiator panel was designed, built and tested. The panel, has approximately 173 sq ft of radiating area and is designed to reject 1.33 kW of heat to a 0 F sink with a 100 F fluid inlet. The panel is constructed from a flexible Teflon/silver mesh fin surrounding 1/8 inch Teflon tubes. The prototype panel is stowed on a 10 inch diameter by 4 foot wide drum. (It rolls up to a diameter of 17 inches when fully stowed). Deployment of the soft tube prototype is via two four inch diameter Kevlar/Mylar inflation tubes with flat springs incorporated in each tube. Nitrogen is normally used for the deployment with approximately 1 psi required. The springs retract the panels when the inflation tubes are deflated. Another method of deployment available for the soft tube flexible is a motor driven deployable boom. This eliminates the need for expendables when the panel area is varied during the mission for heat load control. The soft tube panel is designed for a 90% probability of no punctured tube in a 30 day mission. The acceptable working fluids for this soft tube flexible are Coolanol 15, Coolanol 20 and Glycol/water (a eutectic mixture).
S.L.

N84-21613# Consulenze Generali Roma (Italy).
COMPUTING THE RADIATION PRESSURE FORCES BY ADAPTING THERMAL DESIGN VERIFICATION SOFTWARES Final Report
C. ARDUINI *In its* Study on Syn. and Characterization of Large Space Systems, Phase 2. Part 2: Proposals for Additions, Modifications, and New Anal. Methods, Vol. 1 p 169-208 Dec. 1982
Avail: NTIS HC A16/MF A01

Formulas for computing radiation forces on large space structures are provided, and insertion of the formulas in thermal softwares is indicated. Radiation coming directly from the Sun or Earth, and direct reflection of this impinging radiation are considered. Except for thermal radiation, all cases can be covered by a single program run, and with a model limited to the spacecraft external surfaces. Formulas for general reflected flux distribution are generated. The formulas are specialized for diffuse, specular, and specular-diffuse reflection. Applications for Sun primary reflection are treated.
Author (ESA)

N84-21614# Consulenze Generali Roma (Italy).
SIMPLIFIED MODELS AND COMPUTATIONAL SCHEMES OF THE AERODYNAMIC LOAD
U. PONZI *In its* Study on Syn. and Characterization of Large Space Systems, Phase 2. Part 2: Proposals for Additions, Modifications and New Anal. Methods, Vol. 1 p 209-276 Dec. 1982 refs
Avail: NTIS HC A16/MF A01

A scheme for computing the aerodynamic load on large space structures during the preliminary design phase is outlined. The scheme is based on simplified interaction models able to reduce the aerodynamic aspect of the problem into a simple form with a reasonable accuracy; and the adaptation and/or use of existing softwares in order to solve the geometrical implications. The Lockheed orbital heat rate program, the Thermal Radiation Analysis System program, and the Simplified Shuttle Payload Thermal Analyzer are described.
Author (ESA)

N84-21616# Consulenze Generali Roma (Italy).
STUDY ON SYNTHESIS AND CHARACTERIZATION OF LARGE SPACE SYSTEMS, PHASE 2. PART 2: PROPOSALS FOR ADDITIONS, MODIFICATIONS AND NEW ANALYTICAL METHODS, VOLUME 2 Final Report
C. ANDUINI and U. PONZI Paris ESA Dec. 1982 368 p refs 5 Vol.
(Contract ESTEC-4348/80/NL-AK(SC))
(ESA-CR(P)-1779-VOL-4) Avail: NTIS HC A16/MF A01

Thermal design verification of large open truss structures of large spacecraft (the local approach and the shadow problem); computational savings in view factor evaluation by node prescreening; analytical formulations of the interactive structural thermal control problem (thermostructural self excitation); and design oriented control theories in continuous models are discussed.

N84-21617# Consulenze Generali Roma (Italy).
THERMAL DESIGN VERIFICATION OF THE LARGE OPEN TRUSS STRUCTURES. THE LOCAL APPROACH AND THE SHADOW PROBLEM Final Report
C. ARDUINI *In its* Study on Syn. and Characterization of Large Space Systems, Phase 2. Part 2: Proposals for Additions, Modifications and New Anal. Methods, Vol. 2 p 13-120 Dec. 1982 refs
Avail: NTIS HC A16/MF A01

For large space structure thermal design verification, an approximation which considers a single bay (or a module made by a finite number of bays) as isolated from the rest of the system (the "local" approach) was suggested. Conditions under which the approximation is acceptable; and expressing heat input to the isolated bay, while not considering all the complex shadow effects of the complete system, are discussed. Analysis shows that the local approach causes appreciable errors only at the boundaries, and considerably reduces computational loads. The method can also be applied when both trusses and finite bodies are present. For these systems an iterative scheme which solves in one step the system of the main bodies only (taking truss temperatures to be known) and in a successive step solves the truss, using the local approach (taking main body temperature as known) is proposed. Author (ESA)

N84-21618# Consulenze Generali Roma (Italy).
COMPUTATIONAL SAVINGS IN VIEW FACTOR EVALUATION ON MODE PRESCREENING Final Report
S. SGUBINI and C. ARDUINI *In its* Study on Syn. and Characterization of Large Space Systems, Phase 2. Part 2: Proposals for Additions, Modifications and New Anal. Methods, Vol. 2 p 121-170 Dec. 1982 refs
Avail: NTIS HC A16/MF A01

Criteria for reducing the number of view factors of each node with respect to the surroundings to the absolute minimum compatible with a prescribed accuracy for large space structures thermal design verification; and minimizing the number of elements required per node for a given accuracy are discussed. A multiple screening technique, using the Simplified Shuttle Payload Thermal Analyzer (SSPTA) program, is investigated. The SSPTA contains a mixed surface-contour integral type view factor routine. Additional surfaces can be screened out after the shadow check, if a substantial blockage is detected. Computation of view factors among the remaining nodes can be effected, after the appropriate number of elements in the node is selected, in agreement with the desired accuracy. It is shown that this procedure can drastically reduce the total number of elements in large systems, being equivalent, from the radiative point of view only, to a local approach, without however any arbitrary substructure isolation. Author (ESA)

N84-21619# Consulenze Generali Roma (Italy).
INTERACTIVE STRUCTURAL-THERMAL-CONTROL ANALYTICAL FORMULATIONS Final Report
C. ARDUINI *In its* Study on Syn. and Characterization of Large Space Systems, Phase 2. Part 2: Proposals for Additions, Modifications and New Anal. Methods, Vol. 2 p 171-368 Dec. 1982 refs
Avail: NTIS HC A16/MF A01

The suitability of analytic solutions for large space structure interactive thermal control dynamic problems was studied for the case of a beam subjected to the thermal environment of space, and possibly actively controlled by sensors and actuators. It is shown that the basic interactive equations can be constructed in a variety of conditions based on a menu of component terms derived from basic theories and limited special developments, such as a thermal theory of the beam. The approach is limited, however, to considering a fixed, generally simple, geometry, although the size can be increased by adding modes without changing the reduced size model. Author (ESA)

N84-21621# Consulenze Generali Roma (Italy).
ASSESSMENT OF THE EXISTING GROUND TEST TECHNOLOGY AND CONFRONTING WITH THE LARGE SPACE STRUCTURES (LSS) REQUIREMENTS. EXPERIMENTAL TECHNIQUES IN STRUCTURAL ANALYSIS
U. PONZI and A. AGNENI *In its* Study on Syn. and Characterization of Large Space Systems, Phase 2. Part 3: Expt. Design Verification Tech. te] p 13-103 Dec. 1982 refs
Avail: NTIS HC A19/MF A01

Static, dynamic and modal structural analysis of large space structures (LSS) on ground are discussed. Standard excitation tests, and the effect of the surrounding fluid in vibration are reviewed. For LSS ground testing, constraints due to the large size; to the peculiar physics of the problem; and originating from the Earth environment are the most important. These constraints act in general all together, so that the effect of one factor is exasperated by the presence of the remaining ones. The combination size-gravity is the most significant example. Size constraints are best tackled by partial model methods for static tests and reconstruction of the behavior of the entire system by modal synthesis for dynamic tests. Investigation of physics related constraints is severely limited by scarcity of data on large configurations. Earth environment effects can be assessed by comparing the effect, e.g., gravity with each experimental parameter. Author (ESA)

N84-21622# Consulenze Generali Roma (Italy).
ASSESSMENT OF THE EXISTING GROUND TEST TECHNOLOGY AND CONFRONTING WITH THE LARGE SPACE STRUCTURES (LSS) REQUIREMENTS. THERMAL TEST TECHNIQUES
U. PONZI *In its* Study on Syn. and Characterization of Large Space Systems, Phase 2. Part 3: Expt. Design Verification Tech. te] p 104-169 Dec. 1982 refs
Avail: NTIS HC A19/MF A01

Thermal balance and thermal cycle ground testing of large space structures is reviewed. Scale reduction is identified as the major problem. For the combined dynamical - radiation - thermal - structural problem, no length-scaling appears possible. For the combined radiation - thermal - structural problem (statistically distorting structures) slight length-scaling is possible. For uncoupled radiation - distortion, full length-scaling is possible. Simulation methods and facilities for solar radiation characteristics; albedo and Earth radiation; vacuum; heat sink; and spacecraft mounting are reviewed. Author (ESA)

N84-21626# Deutsche Forschungs- und Versuchsanstalt fuer Luft- und Raumfahrt, Goettingen (West Germany). Inst. fuer Aeroelastik.
DEVELOPMENT OF PROCEDURES FOR COMPONENT MODE SYNTHESIS Final Report
A. BERTRAM and P. CONRAD Paris ESA 15 Mar. 1983 163 p refs
(Contract ESTEC-4350/80/NL-PP; DFVLR-232-11; DFVLR-3-719-101)
(DFVLR-IB-232-82-C-09; ESA-CR(P)-1826) Avail: NTIS HC A08/MF A01

The requirements of a rational, cost effective component mode synthesis were established by performing modal coupling analyses on a spacecraft model composed of two modules with a highly redundant interface. Parameter studies defined criteria for the selection of the most suitable mode sets, the definition of boundary conditions, the number of modes and the accuracy of the mathematical mass model. Finite element models of the actual structure were used. The studies reveal the dynamic behavior of a structure with complicated interfaces, and enable optimum test boundary conditions to be defined. Author (ESA)

05

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.

A84-10956#
A METHODOLOGY TO INCLUDE STATIC AND KINETIC FRICTION EFFECTS IN SPACE SHUTTLE PAYLOAD TRANSIENT LOADS ANALYSIS
E. E. HENKEL, J. E. MISEL, and D. H. FREDERICK (Rockwell International Corp., Shuttle Integration and Satellite Systems Div., Downey, CA) IN: Shuttle Environment and Operations Meeting, Washington, DC, October 31-November 2, 1983, Collection of Technical Papers . New York, American Institute of Aeronautics and Astronautics, 1983, p. 171-177. refs
(AIAA PAPER 83-2654)

This paper presents a methodology that includes both static and kinetic friction effects for Space Shuttle payload transient loads. The methodology employs a residual flexibility correction to the normal modes of vibration. An alteration to the dynamic finite difference equations of motion is discussed which allows one to include friction effects at reasonable cost for large structural systems such as the Space Shuttle. Numerical results of an idealized and highly simplified structural transient response problem are included to demonstrate the completeness of the approach. The extension of the basic NASTRAN nonlinear methodology is presented through several stages of development to the point where constraint equations and residual flexibility effects are incorporated. It is shown how residual flexibilities improve the accuracy of the forced dynamic response for payloads mounted in the orbiter vehicle. Data are presented to demonstrate the possible impact of transient friction loads to the payload designer. Author

A84-11815#
TESTS AND PREDICTION OF COMPOSITE MATERIAL VISCOELASTIC BEHAVIOUR FOR LARGE SPACE STRUCTURE
L. B. CREMA, R. BARBONI, A. CASTELLANI (Roma, Universita, Rome, Italy), and I. PERONI International Astronautical Federation, International Astronautical Congress, 34th, Budapest, Hungary, Oct. 10-15, 1983. 13 p. refs
(IAF PAPER 83-418)

Experimental and analytical investigations of the damping behavior of glass-fiber and carbon-fiber reinforced composites are reported. Specimens 15 mm wide and 250, 300, or 400 mm long with 8 or 16 laminations and different laminate layups were subjected to flexure-modulus and flexural-strength tests at excitation frequencies of 5-350 Hz and temperatures of 25-120 C in an environmental chamber at 0.001 torr. The results are presented graphically. The frequency effect on the damping coefficient is found to be minimal, while a correlation between stiffness factors (due to layup sequences) and damping and a significant increase in damping above 90 C are observed. Glass-fiber damping coefficients are shown to be higher than those of carbon fibers overall. These results are in good agreement with numerical calculations based on classical laminate theory. An analysis of the bounds on the complex viscoelastic moduli based on the correspondence principle is presented, and the bounds calculated are compared to the measured values. T.K.

A84-11932
HARDWARE SIMULATION OF SPACECRAFT DYNAMICS AND CONTROL
K. REINEL (Deutsche Forschungs- und Versuchsanstalt fuer Luft- und Raumfahrt, Oberpfaffenhofen, West Germany) IN: World Congress on System Simulation and Scientific Computation, 10th, Montreal, Canada, August 8-13, 1982, Proceedings. Volume 3 . Montreal, International Association for Mathematics and Computers in Simulation, 1983, p. 210-212. refs

An overview is given of the hardware simulation activities of the spaceflight dynamics section at the German Space Operation Center. Two simulation methods for spacecraft attitude control hardware are discussed. Air-bearing simulation is used mainly for verifying the spacecraft dynamics and for identifying the mathematical model of actuators and torque generators. It is noted that disturbance torques in the laboratory and time-consuming adjustments of the platform limit the air-bearing simulation to small angle motion and preferably to tests that require the actuator hardware in the loop. The servo-driven motion simulator is controlled by computer and readily allows changes in the spacecraft configuration and the control system during the design and development phases. System tests of the attitude determination control are therefore performed to advantage on the three-axes motion simulator as soon as the actuators and the control torques can be modeled mathematically. Large angle motion is limited only by the freedom of the gimbal system. C.R.

A84-11933
ON MODELING AND SIMULATION OF THE DYNAMICS OF TETHER CONNECTED SATELLITE SYSTEMS
V. J. MODI (British Columbia, University, Vancouver, Canada), A. K. MISRA (McGill University, Montreal, Canada), and D. M. XU IN: World Congress on System Simulation and Scientific Computation, 10th, Montreal, Canada, August 8-13, 1982, Proceedings. Volume 3 . Montreal, International Association for Mathematics and Computers in Simulation, 1983, p. 217-219. refs

A general dynamical model for a system consisting of two satellites connected by a tether is presented. Three dimensional large rotational motion, longitudinal as well as transverse vibrations of the tether treated as a continuum, eccentricity of the orbit and aerodynamic drag in a rotating oblate atmosphere are taken into account. Equations of motion are obtained using a Lagrangian formulation. As the frequencies associated with rotational and vibrational motions differ by orders of magnitude, Gear's method is used for numerical integration. Attention is focused on the dynamics during retrieval of a subsatellite to the Shuttle and schemes for successful retrieval are suggested. Author

A84-11934
ATTITUDE CONTROL AND DYNAMICS OF THE SPACE OPERATIONS CENTER
G. C. MCGEE and A. M. ANDRONIKOU (Rockwell International Corp., Space Operations/Integration and Satellite Systems Div., Downey, CA) IN: World Congress on System Simulation and Scientific Computation, 10th, Montreal, Canada, August 8-13, 1982, Proceedings. Volume 3 . Montreal, International Association for Mathematics and Computers in Simulation, 1983, p. 222-224.

Attitude control of the Space Operations Center (SOC) when it is visited by the Shuttle orbiter has been studied in order to idenify the constraining requirements. A computer simulation of spacecraft disturbances was employed as an important element of the study, and time histories of control capabilities were developed. Results show that the propulsion and momentum storage requirements are achievable without undue spacecraft design impact if the prescribed approaches are used. Author

A84-11945
AGGREGATE MODELS FOR DISTRIBUTED PARAMETER SYSTEMS WITH APPLICATIONS TO FLEXIBLE AIR AND SPACECRAFT
T. L. JOHNSON (Bolt Beranek and Newman, Inc., Cambridge, MA) IN: World Congress on System Simulation and Scientific Computation, 10th, Montreal, Canada, August 8-13, 1982, Proceedings. Volume 3 . Montreal, International Association for Mathematics and Computers in Simulation, 1983, p. 365-367. refs

Even though the method of aggregation based on sensor and actuator influences presented here has been developed with a view to large space structure applications, it is of more general applicability. Unlike most aggregation methods, which attempt to preserve the plant dynamics, the proposed method first attempts to preserve input-output coupling; in this way, the order of the reduced model is related to the sum of the number of synthetic inputs and outputs, which is assumed to be much smaller than the order of the dynamics. Although general guidelines for controller design compatibility with the method are given, the aggregation method is not restricted to any particular control design algorithm. One important property is that the effect of model truncation can be precalculated independently of the feedback gains employed in the controller. Results are presented for general linear time-invariant multivariable systems, and a description is given of further results that can be obtained specifically for structural models. C.R.

A84-12483#
SATELLITE ATTITUDE DYNAMICS AND CONTROL IN THE PRESENCE OF ENVIRONMENTAL TORQUES - A BRIEF SURVEY
S. K. SHRIVASTAVA (British Columbia, University, Vancouver, Canada) and V. J. MODI (Indian Institute of Science, Bangalore, India) Journal of Guidance, Control, and Dynamics (ISSN 0731-5090), vol. 6, Nov.-Dec. 1983, p. 461-471. refs

Previously cited in issue 20, p. 3157, Accession no. A82-40002

A84-12488#
DYNAMICS AND CONTROL OF A DEFORMABLE GYROSTAT, UTILIZING CONTINUUM VEHICLE MODES
H. B. HABLANI (Rockwell International Corp., Seal Beach, CA) Journal of Guidance, Control, and Dynamics (ISSN 0731-5090), vol. 6, Nov.-Dec. 1983, p. 499-510. Research supported by the U.S. National Research Council. refs

The paper deals with dynamics of a specific gyroscopic flexible spacecraft and with synthesis of its controller. The infinite number of associated gyroscopic modes are shown to have alternately a precession parallel and antiparallel to the stored momentum. Dependence of mode shapes on the rotor's momentum is investigated. Identities based on the vehicle's momentum and inertia considerations are devised. The stochastic response analysis of the spacecraft subject to arbitrary excitation permits a 'modal cost analysis' of the vehicle. These developments show that, as rotor's momentum escalates, a larger number of modes are required to construct a truncated model having a prespecified accuracy. A controller is designed on the basis of the 'minimum error excitation' approach, which is found to be almost as effective as an optimal state feedback controller. The destabilizing influence of the truncated modes is exposed by utilizing the robustness inequalities available in the literature. Author

A84-12489#
TORQUE FROM SOLAR RADIATION PRESSURE GRADIENT DURING ECLIPSE
G. B. SINCARSIN and P. C. HUGHES (Toronto, University, Toronto, Canada) Journal of Guidance, Control, and Dynamics (ISSN 0731-5090), vol. 6, Nov.-Dec. 1983, p. 511-517. Sponsorship: Natural Sciences and Engineering Research Council of Canada. refs
(Contract NSERC-A-4183)

Previously cited in issue 20, p. 3159, Accession no. A82-40433

A84-13320
THE TOYSAT STRUCTURAL CONTROL EXPERIMENT
J. A. BREAKWELL (Lockheed Research Laboratories, Palo Alto, CA) and G. J. CHAMBERS (Lockheed Missiles and Space Co., Inc., Sunnyvale, CA) Journal of the Astronautical Sciences (ISSN 0021-9142), vol. 31, July-Sept. 1983, p. 441-454. Research supported by the Lockheed Independent Research and Development Program. refs

The hardware setup and experimental results of the Toysat structural control experiment are described in this paper. The experiment is designed to test theoretical analyses and hypotheses concerning the application of modern control methods to the control of a flexible structure. Linear-quadratic-Gaussian (LQG) optimal estimation and control algorithms are tested on the experimental hardware and shown to have desirable stability properties and reasonable robustness characteristics. Author

A84-13321
A HARDWARE DEMONSTRATION OF CONTROL FOR A FLEXIBLE OFFSET-FEED ANTENNA
R. D. BAULDRY, G. J. CHAMBERS, K. F. JOHANSEN, N. C. NGUYEN (Lockheed Missiles and Space Co., Inc., Sunnyvale, CA), J. A. BREAKWELL, and D. B. SCHAECHTER (Lockheed Research Laboratories, Palo Alto, CA) Journal of the Astronautical Sciences (ISSN 0021-9142), vol. 31, July-Sept. 1983, p. 455-470. Research supported by the Lockheed Independent Research and Development Program.

A hardware model of a flexible offset-feed antenna has been constructed in the laboratory in order to validate the applicability of modern control theory to the control of flexible structures involving realistic space hardware. In the model, principal control actuation is provided by a cluster of three control-moment gyros; sensing is provided by three rate-gyros, ten distributed accelerometers, and two laser attitude sensing devices. Optimal estimation algorithms and optimal control laws have been successfully implemented with an array processor to control this multi-input, multi-output, high-order system. The laboratory hardware, the dynamics of the antenna, and the control approach used are discussed in detail, and recent closed-loop control results are reported. V.L.

A84-15785
GEODETIC CONTROL OF THE REFLECTORS OF LARGE ANTENNAS [GEODEZICHESKII KONTROL' REFLEKTOROV BOL'SHIKH ANTENN]
G. A. TEREKHOVA Geodeziia i Kartografiia (ISSN 0016-7126), Sept. 1983, p. 12-17. In Russian. refs

Attention is given to the precise geodetic control and adjustment of large-antenna reflectors intended for radio astronomy and space communications. A number of control methods are examined, with attention given to hardware realizations, main characteristics, and practical applications. B.J.

A84-16885
INSTABILITY ANALYSIS OF SPACE TRUSSES
A. K. NOOR and J. M. PETERS (George Washington University, Hampton, VA) Computer Methods in Applied Mechanics and Engineering (ISSN 0045-7825), vol. 40, Oct. 1983, p. 199-218. refs

Reduction methods and computational procedures are presented for the instability analysis of space trusses with both geometric and material nonlinearities subjected to combined loads. A mixed formulation is used with the fundamental unknowns consisting of both the member forces and the joint displacements. The governing equations of the truss consist of the two sets of member constitutive relations and joint equilibrium equations. The vector of fundamental unknowns is expressed as a linear combination of a small number of path derivatives (derivatives of nodal displacements and member forces with respect to path parameters), and a Bubnov-Galerkin technique is used to approximate the governing equations by a small system of algebraic equations. The reduced equations are then used to determine the stability boundary and trace the nonlinear equilibrium paths. The potential of the proposed approach is discussed and its effectiveness is demonstrated by means of numerical examples of space trusses with combined geometric and material nonlinearities. The constitutive relations in these examples are assumed, for convenience, to be represented by Ramberg-Osgood polynomials. Author

A84-17355*# Jet Propulsion Lab., California Inst. of Tech., Pasadena.
SCIENCE PLATFORM AND ATTITUDE SUBSYSTEM IN-FLIGHT CALIBRATION FOR THE GALILEO SPACECRAFT
S. A. HAYATI and J. Y. LAI (California Institute of Technology, Jet Propulsion Laboratory, Pasadena, CA) (Guidance and Control Conference, Albuquerque, NM, August 19-21, 1981, Collection of Technical Papers, p. 500-512) Journal of Guidance, Control, and Dynamics (ISSN 0731-5090), vol. 7, Jan.-Feb. 1984, p. 29-35. NASA-supported research.

Previously cited in issue 21, p. 3640, Accession no. A81-44136

A84-17359#
SEMIAUTONOMOUS STATIONKEEPING OF GEOSYNCHRONOUS SATELLITES
C. C. CHAO (Aerospace Corp., Astrodynamics Dept., El Segundo, CA) Journal of Guidance, Control, and Dynamics (ISSN 0731-5090), vol. 7, Jan.-Feb. 1984, p. 57-61. Research sponsored by the Aerospace Corp. refs
(Contract F04701-82-C-0083)

Previously cited in issue 19, p. 2992, Accession no. A82-38883

A84-17361*# Jet Propulsion Lab., California Inst. of Tech., Pasadena.
DYNAMICS AND CONTROL OF A LARGE SPACE ANTENNA
S. J. WANG and J. M. CAMERON (California Institute of Technology, Jet Propulsion Laboratory, Control and Energy Conversion Div., Pasadena, CA) (Guidance and Control Conference, San Diego, CA, August 9-11, 1982, Collection of Technical Papers, p. 394-402) Journal of Guidance, Control, and Dynamics (ISSN 0731-5090), vol. 7, Jan.-Feb. 1984, p. 69-76. NASA-supported research. refs

Previously cited in issue 19, p. 2997, Accession no. A82-38967

A84-17369#
A FLEXIBLE STRUCTURE CONTROLLER DESIGN METHOD USING MODE RESIDUALIZATION AND OUTPUT FEEDBACK
J. A. BOSSI (Washington, University, Seattle, WA) and G. A. PRICE (Boeing Aerospace Co., Seattle, WA) (Guidance and Control Conference, San Diego, CA, August 9-11, 1982, Collection of Technical Papers, p. 388-393) Journal of Guidance, Control, and Dynamics (ISSN 0731-5090), vol. 7, Jan.-Feb. 1984, p. 125-127. refs

Previously cited in issue 19, p. 2997, Accession no. A82-38966

A84-17370#
COMMENTS ON 'DYNAMICS OF A SPACECRAFT DURING EXTENSION OF FLEXIBLE APPENDAGES'
M. S. JANKOVIC (Dome Petroleum, Ltd., Calgary, Alberta, Canada) Journal of Guidance, Control, and Dynamics (ISSN 0731-5090), vol. 7, Jan.-Feb. 1984, p. 128.

A84-17854#
ON THE DYNAMICS OF A SUBSATELLITE SYSTEM SUPPORTED BY TWO TETHERS
A. K. MISRA and G. S. DIAMOND (McGill University, Montreal, Canada) American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 22nd, Reno, NV, Jan. 9-12, 1984. 6 p.
(AIAA PAPER 84-0062)

The dynamics of a subsatellite system connected to a main orbiter by two extensible but massless tethers is studied. The points of attachment of these two tethers are offset from the centre of mass of the orbiter. Both constant length and retrieval cases are considered. Lagrangian formulation for constrained systems is used to derive the nonlinear equations of motion. These along with the constraint equations are solved numerically. It is noted that the rotational motion in the plane of the attachment points can be damped quite effectively using a simple control scheme. Comparisons are made with the single tether case. A two tether system has superior rotational behaviour, but seems to have disadvantages as far as longitudinal oscillations are concerned. Author

A84-17866#
CONTROL OF LARGE SPACE STRUCTURES
W. J. JASPER (Hughes Aircraft Co., Space and Communications Group, El Segundo, CA) American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 22nd, Reno, NV, Jan. 9-12, 1984. 5 p.
(AIAA PAPER 84-0081)

In the presence of disturbances, large flexible space structures will exhibit excessive vibration which, in the case of a space antenna, will degrade its pointing and focusing abilities. A velocity output feedback control system will augment damping to selected modes of vibration. The performance of the design derived from a reduced order model is degraded when evaluated on a higher order model. This paper addresses this problem, and discusses a way to minimize performance degradation due to unmodelled dynamics. A numerical example is then given. Author

A84-18060#
AEROELASTIC STABILITY AND RESPONSE OF FLEXIBLE TACTICAL WEAPONS
P. CRIMI (Avco Corp., Avco Systems Div., Wilmington, MA) American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 22nd, Reno, NV, Jan. 9-12, 1984. 9 p. refs
(AIAA PAPER 84-0392)

Static and dynamic aeroelastic characteristics of flexible tactical weapons are investigated analytically. Formulation of the static problem uses finite beam elements to model the vehicle and local linearization to represent the aerodynamic loading. Analyses of a representative configuration define the effects of bending stiffness, spin rate and dynamic pressure on divergence and static longitudinal stability. The dynamic problem is formulated in body-fixed coordinates using complex variables. Effects of velocity, spin rate and bending frequency on dynamic response and flutter are investigated. Author

A84-18168#
A DESIGN STRATEGY FOR MULTIPLE PAYLOAD POINTING FROM A THREE AXIS STABILIZED SPACECRAFT
J. R. VELMAN and W. L. BURKETT, JR. (Hughes Aircraft Co., Los Angeles, CA) American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 22nd, Reno, NV, Jan. 9-12, 1984. 8 p.
(AIAA PAPER 84-0566)

When multiple articulated payloads are carried on a spacecraft, each payload may have separate pointing performance requirements on agility, accuracy, and pointing stability. By using synergetic combinations of sensors and actuators, the controller design for each loop may be nearly decoupled from the remaining loop designs. The physical rational of the decoupling approach is given, and its power is demonstrated by the performance of a sample design. The example includes the effects of actuator imperfections and non-linearities, and many flexible modes. The approach provides a simple direct means of designing multivariable controllers tailored to mission requirements. Author

A84-19056* Rensselaer Polytechnic Inst., Troy, N. Y.
THE SPATIAL ORDER REDUCTION PROBLEM AND ITS EFFECT ON ADAPTIVE CONTROL OF DISTRIRBUTED PARAMETER SYSTEMS
M. J. BALAS (Rensselaer Polytechnic Institute, Troy, NY) IN: Conference on Decision and Control, 21st, Orlando, FL, December 8-10, 1982, Proceedings. Volume 1 . New York, Institute of Electrical and Electronics Engineers, 1982, p. 30-32. refs
(Contract NSF ECS-80-16173; NAG1-171)

A84-19118
MULTIVARIABLE DIRECT ADAPTIVE CONTROL FOR A GENERAL CLASS OF TIME-VARYING COMMANDS
I. BAR-KANA and H. KAUFMAN (Rensselaer Polytechnic Institute, Troy, NY) IN: Conference on Decision and Control, 21st, Orlando, FL, December 8-10, 1982, Proceedings. Volume 2 . New York, Institute of Electrical and Electronics Engineers, 1982, p. 750, 751. refs
(Contract NSF ECS-80-16173)

Direct multivariable model reference adaptive control (DMMRAC) procedures which are especially suitable for large scale structures (LSS) were in the past shown to be feasible provided that the input commands were constant. In this paper the feasibility of the MMRAC algorithms is extended to a large class of time-variable input commands. Author

A84-19127
A LARGE SPACE STRUCTURE BENCHMARK PROBLEM - ACOSS MODEL NO. 2
T. C. HENDERSON (Charles Stark Draper Labortory, Inc., Cambridge, MA) IN: Conference on Decision and Control, 21st, Orlando, FL, December 8-10, 1982, Proceedings. Volume 2 . New York, Institute of Electrical and Electronics Engineers, 1982, p. 905-908.

Attention is called to the need for a universal system model in order to assess the performance, sensitivity, and hardware requirements of the various active structural control methods being developed. The design of the model described here, ACOSS Model No. 2 (ACOSS denoting active control of large space structures), incorporates certain desired features into the overall system characteristics. The structural design is based on realistic sizes and weights, and the model has a simple unclassified optical system with associated performance measures and tolerances. It also has a set of disturbances that are typical of equipment vibration and attitude control. The model comprises two subsystems: an optical support structure and an equipment section. These are connected by springs at three points, allowing either passive or active vibration isolation. The optical support structure contains four optical surfaces that are assumed to be rigid and kinematically mounted on the structure. it is assumed that the equipment section takes the form of a rigid central section with two flexible solar panels cantilevered from it. C.R.

A84-19128
NUMBER CRUNCHING ON THE ACOSS MODEL NO. 2
R. GRAN and M. ROSSI (Grumman Aerospace Corp., Research and Development Center, Bethpage, NY) IN: Conference on Decision and Control, 21st, Orlando, FL, December 8-10, 1982, Proceedings. Volume 2 . New York, Institute of Electrical and Electronics Engineers, 1982, p. 909-911.

The spacecraft model called ACOSS Model Number 2 was used to develop a control system design for large space structures that have certain desirable characteristics. To achieve these characteristics, the control design approach used here is based on an optimal reduced order control design technique that explicitly computes the minimum of an expected quadratic cost function using a numerical search algorithm. The algorithm, developed by Rossi (1972), uses an explicit calculation of the gradient and Hessian tensors to guide a second order search. The algorithm and the 'number crunching' on the ACOSS model are both described. Author

A84-19675#
ATTITUDE STABILITY FOR THE YAW-WHEEL CLASS OF ORBITING GYROSTATS
P. C. HUGHES (Toronto, University, Toronto, Canada) Canadian Aeronautics and Space Journal (ISSN 0008-2821), vol. 29, Sept. 1983, p. 268-281. Research supported by the Natural Science and Engineering Research Council of Canada. refs

Motivated by the attitude stabilization of large, multibeam communcations satellites, the neoclassical problem of a rigid gyrostat in a circular orbit is considered. It is shown that the inclusion of a yaw wheel into the design can lead to a steady gyroscopic torque that is equal and opposite to the steady gravity-gradient external torque about the roll axis. This particular class of gyrostat equilibrium has not previously been studied in detail. Representative stability diagrams are presented which show that most (but not all) such equilibria are unstable. Author

A84-19728
PERIODIC OSCILLATIONS OF A GYROSTAT SATELLITE WITH RESPECT TO THE CENTERS OF MASS IN A CIRCULAR ORBIT [PERIODICHESKIE KOLEBANIIA SPUTNIKA-GIROSTATA OTNOSITEL'NO TSENTRA MASS NA KRUGOVOI ORBITE]
V. V. SAZONOV Kosmicheskie Issledovaniia (ISSN 0023-4206), vol. 21, Nov.-Dec. 1983, p. 838-850. In Russian. refs

The system of differential equations of motion of a gyrostat satellite with respect to the center of mass under the effect of gravity moment in circular orbit is considered. It is assumed that the intrinsic kinetic moment of the gyrostat is large and that the system contains a large parameter. A search is made for symmetric periodic solutions of this system, close to the periodic solutions of a degenerate system, obtained from the initial system when the large parameter is equal to infinity. The solutions are obtained in formal series in whole negative powers of the large parameter, and are analyzed numerically. B.J.

A84-20047#
DETERMINATION OF CRITICAL PARAMETERS IN LARGE FLEXIBLE SPACE STRUCTURES WITH UNCERTAIN MODAL DATA
R. K. YEDAVALLI (Stevens Institute of Technology, Hoboken, NJ) and R. E. SKELTON (Purdue University, West Lafayette, IN) ASME, Transactions, Journal of Dynamic Systems, Measurement, and Control (ISSN 0022-0434), vol. 105, Dec. 1983, p. 238-244. refs

This paper addresses the problem of control design for large flexible space structures with uncertain modal data. The concepts of modal cost analysis are applied to flexible space structures with these uncertain parameters: modal damping, modal frequencies, and mode shapes at actuator (sensor) locations. A quadratic function of displacements and displacement rates is used as a performance metric. In this case, it is possible to obtain explicit formulas for the cost contributions labeled 'modal costs' and 'parameter costs.' This type of cost decomposition analysis by which one can determine the significant modes and parameters can be useful in model reduction, parameter estimation, and structure redesign. The proposed technique is applied to the 'Purdue Model,' a generic model for a two-dimensional flexible structure. Author

A84-21237
VIBRATION CHARACTERISTICS OF SELF-EXPANDING STAYED COLUMNS FOR USE IN SPACE
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. 90, Sept. 22, 1983, p. 245-261. Research supported by the Science and Engineering Research Council. refs

Reference is made to the report by Belvin (1982) which presented experimental and theoretical results obtained at NASA for the free vibration of a stayed column. Exact theoretical results are given here, including natural frequencies and mode types not given in the NASA results. A substitute column method is employed to achieve economy and a much deeper understanding of the modes. An alternative design is proposed which implements recent developments in the design method and has a graphite epoxy core. The proposed design has the advantage that its stay dominated frequencies are higher than those for the NASA column. C.R.

A84-21285#
TRANSIENT DYNAMICS DURING THE ORBITER BASED DEPLOYMENT OF FLEXIBLE MEMBERS
V. J. MODI (British Columbia, University, Vancouver, Canada) and A. M. IBRAHIM American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 22nd, Reno, NV, Jan. 9-12, 1984. 11 p. refs
(AIAA PAPER 84-0061)

The paper presents a general formulation for studying librational dynamics of a large class of spacecraft during deployment of flexible members. It is applicable to a variety of mission ranging from deployment of antennas, booms and solar panels to manufacturing of trusses for space platforms using the Space Shuttle. The governing nonlinear, nonautonomous and coupled equations of motion are extremely difficult to solve even with the help of a computer, not to mention the cost involved. To get some appreciation as to the complex interactions between flexibility, deployment and attitude dynamics as well as to help pursue stability and control analysis, the equations are linearized about their nominal deflected equilibrium configuration. The procedure is applied to the Space Shuttle based deployment of plate-like members. Results suggest substantial influence of the inertia parameter, flexural rigidity of the appendages, orbit eccentricity, deployment velocity, initial conditions, etc. on the system response. This would indicate additional demand on the orbiter's control system during construction of space-platforms. Author

A84-24990#
ON THE NUMBER AND PLACEMENT OF ACTUATORS FOR INDEPENDENT MODAL SPACE CONTROL
R. E. LINDBERG, JR. (U.S. Navy, Naval Research Laboratory, Washington, DC) and R. W. LONGMAN (Columbia Un;iversity, New York, NY) Journal of Guidance, Control, and Dynamics (ISSN 0731-5090), vol. 7, Mar.-Apr. 1984, p. 215-221. refs

Previously cited in issue 19, p. 2994, Accession no. A82-38874

A84-24991*# RCA Astro-Electronics Div., Princeton, N. J.
A DEGREE OF CONTROLLABILITY DEFINITION - FUNDAMENTAL CONCEPTS AND APPLICATION TO MODAL SYSTEMS
C. N. VISWANATHAN (RCA, Astro-Electronics Div., Princeton, NJ), R. W. LONGMAN (Columbia University, New York, NY), and P. W. LIKINS (Lehigh University, Bethlehem, PA) Journal of Guidance, Control, and Dynamics (ISSN 0731-5090), vol. 7, Mar.-Apr. 1984, p. 222-230. refs
(Contract NAS8-32212)

Starting from basic physical considerations, this paper develops a concept of the degree of controllability of a control system, and then develops numerical methods to generate approximate values of the degree of controllability for any linear time-invariant system. In many problems, such as the control of future, very large, flexible spacecraft and certain chemical process control problems, the question of how to choose the number and locations of the control system actuators is an important one. The results obtained here offer the control system designer a tool which allows him to rank the effectiveness of alternative actuator distributions, and hence to choose the actuator locations on a rational basis. The degree of controllability is shown to take a particularly simple form when the dynamic equations of a satellite are in second-order modal form. The degree of controllability concept has still other fundamental uses - it allows one to study the system structural relations between the various inputs and outputs of a linear system, which has applications to decoupling and model reduction. Author

A84-24995#
IDENTIFICATION OF LARGE FLEXIBLE STRUCTURES MASS/STIFFNESS AND DAMPING FROM ON-ORBIT EXPERIMENTS
S. L. HENDRICKS, S. RAJARAM, M. P. KAMAT, and J. L. JUNKINS (Virginia Polytechnic Institute and State University, Blacksburg, VA) Journal of Guidance, Control, and Dynamics (ISSN 0731-5090), vol. 7, Mar.-Apr. 1984, p. 244, 245.

Previously cited in issue 19, p. 2993, Accession no. A82-38859

A84-25291#
EVOLUTION OF EUROPEAN TELECOMMUNICATION SATELLITE POINTING PERFORMANCE
N. BINGHAM, A. D. CRAIG, and L. FLOOK (British Aerospace PLC, Dynamics Group, Stevenage, Herts., England) IN: Communication Satellite Systems Conference, 10th, Orlando, FL, March 19-22, 1984, Technical Papers . New York, American Institute of Aeronautics and Astronautics, 1984, p. 336-344. refs
(AIAA PAPER 84-0725)

The pointing performance of a range of European communications satellite projects is reviewed. The main factors contributing to the overall beam pointing error are discussed, emphasizing the satellite attitude error. Attitude control concepts adopted for ESA satellites are addressed, discussing the reasons for the choices and describing the systems in terms of hardware and control algorithms. The discussion is limited to on-station modes. Finally, the improvement achievable in beam pointing by using an RF sensor/antenna-pointing mechanism control loop is considered. C.D.

A84-25496* Rensselaer Polytechnic Inst., Troy, N. Y.
SOME APPLICATIONS OF DIRECT ADAPTIVE CONTROL TO LARGE STRUCTURAL SYSTEMS
I. BAR-KANA and H. KAUFMAN (Rennselaer Polytechnic Institute, Troy, NY) IN: American Control Conference, San Francisco, CA, June 22-24, 1983, Proceedings. Volume 2 . New York, Institute of Electrical and Electronics Engineers, 1983, p. 573, 574.
(Contract NSF ECS-80-16173; NAG1-171)

Direct multivariable model reference adaptive control (DMMRAC) applications are considered with a representative example of a large structural system (LSS). Such applications have in the past been shown to be feasible for multivariable systems, provided that there exists a constant feedback gain matrix such that the resulting input-output transfer function is (simply) positive real. Author

A84-25516

CONTROLLABILITY AND OBSERVABILITY CRITERIA FOR MULTIVARIABLE LINEAR SECOND-ORDER MODELS

A. J. LAUB (Southern California, University, Los Angeles, CA) and W. F. ARNOLD (U.S. Naval Weapons Center, China Lake, CA) IN: American Control Conference, San Francisco, CA, June 22-24, 1983, Proceedings. Volume 3 . New York, Institute of Electrical and Electronics Engineers, 1983, p. 925, 926. refs

(Contract DAAG29-81-K-0131)

Criteria are discussed for the determination of controllability, stabilizability, observability, or detectability of linear second-order multivariable models of, for example, large space structures. An initial modal transformation is not required and the criteria are thus applicable to models with arbitrary damping coefficients. Moreover, the criteria are modal in the sense that some or all of the modes may be tested for controllability or observability. This aspect has advantages if not all the modes are known or easily computable. The criteria are further illustrated for a number of important special cases in a series of corollaries. Author

A84-25552* Jet Propulsion Lab., California Inst. of Tech., Pasadena.

USE OF ELECTROMAGNETIC MODELS IN THE OPTIMAL CONTROL OF LARGE SPACE ANTENNAS

F. MANSHADI and M. HAMIDI (California Institute of Technology, Jet Propulsion Laboratory, Pasadena, CA) IN: American Control Conference, San Francisco, CA, June 22-24, 1983, Proceedings. Volume 3 . New York, Institute of Electrical and Electronics Engineers, 1983, p. 1317-1323. NASA-supported research. refs

A general approach to the optimal control of large space antennas based on their RF/structural characteristics is described. The approach consists of defining a cost functional based on the degradation of the RF performance of the antenna and using the structural model as the dynamic system. The method is applied to the design of an optimal controller for a 55-m, wrap-rib offset-fed antenna. Simulation results show that control energy consumption is reduced to aproximately one third of the energy used to achieve the same RF performance with traditional control strategies. Author

A84-25586

NUMERICAL SOLUTION OF SEVERAL CLASSES OF NONLINEAR FLEXIBLE SHELL THEORY PROBLEMS [CHISLENNOE RESHENIE NEKOTORYKH KLASSOV NELINEINYKH ZADACH TEORII GIBKIKH OBOLOCHEK]

IA. M. GRIGORENKO (Akademiia Nauk Ukrainskoi SSR, Institut Mekhaniki, Kiev, Ukrainian SSR) Vychislitel'naia i Prikladnaia Matematika (ISSN 0321-4117), no. 50, 1983, p. 73-83. In Russian. refs

Approaches to the solution of nonlinear boundary-value problems describing the stress-strained state of several classes of thin flexible multilayered shells with orthotropic plies of variable thickness are presented. The solution of one-dimensional nonlinear boundary-value problems for deformations in the subcritical region is obtained by linearization, reduction to a system of nonlinear equations and a Cauchy problem, and solution continuation by parameter. A modification of the method of reduction to nonlinear equations and a Cauchy problem is used to solve one-dimensional problems of nonlinear deformation in supercritical regions. Two-dimensional problems of nonaxisymmetric deformation of shells of revolution with variable rigidity are considered. The results of solutions of nonlinear problems for axisymmetric deformations of conical and ellipsoidal shells and for asymmetric deformations of spherical shells are presented. J.N.

A84-26717

A SIMULATOR TO STUDY DYNAMIC INTERACTION OF THE SPACE SHUTTLE ON-ORBIT FLIGHT CONTROL SYSTEM WITH DEPLOYED FLEXIBLE PAYLOADS

S. S. DAVID and L. L. SACKETT (Charles Stark Draper Laboratory, Inc., Cambridge, MA) IN: Digital Avionics Systems Conference, 5th, Seattle, WA, October 31-November 3, 1983, Proceedings . New York, Institute of Electrical and Electronics Engineers, 1983, p. 5.3.1-5.3.9. refs

A series of studies was undertaken to investigate the effects of the Space Shuttle's on-orbit flight control system (FCS) dynamically interacting with the Orbiter and deployed flexible payloads. In order to support these studies, an existing digital simulator was modified to include elastic body effects and finite element modal parameters. The simulator provides a closed-loop simulation of the flight software interacting with detailed models of the Shuttle vehicle and flight environment. The simulator and the modifications implemented to support these studies are described. Assumptions, design considerations, features, and limitations are discussed. Recent studies, where dynamic interactions between the Orbiter/FCS and deployed payloads were examined, illustrate the use of the simulator's range of model fidelity and diagnostic capability. Author

A84-26845

STABILITY OF LARGE FLEXIBLE DAMPED SPACECRAFT MODELED AS ELASTIC CONTINUA

P. K. MAHARANA and S. K. SHRIVASTAVA (Indian Institute of Science, Bangalore, India) Acta Astronautica (ISSN 0094-5765), vol. 11, Feb. 1984, p. 103-109. refs

Vibrational stability of a large flexible, structurally damped spacecraft subject to large rigid body rotations is analyzed modeling the system as an elastic continuum. Using solution of rigid body attitude motion under torque free conditions and modal analysis, the vibrational equations are reduced to ordinary differential equations with time-varying coefficients. Stability analysis is carried out using Floquet theory and Sonin-Polya theorem. The cases of spinning and non-spinning spacecraft idealized as a flexible beam/plate undergoing simple structural vibration are analyzed in detail. The critical damping required for stabilizatioon is shown to be a function of the spacecraft's inertia radio and the level of disturbance. Author

A84-26977

MOTION OF A SYMMETRIC SATELLITE ABOUT THE CENTER OF MASS IN CIRCULAR ORBIT IN THE PRESENCE OF FLEXIBLE VISCOELASTIC RODS [DVIZHENIE SIMMETRICHNOGO SPUTNIKA VOKRUG TSENTRA MASS NA KRUGOVOI ORBITE PRI NALICHII GIBKIKH VIAZKOUPRUGIKH STERZHNEI]

N. E. BOLOTINA and V. G. VILKE Kosmicheskie Issledovaniia (ISSN 0023-4206), vol. 22, Jan.-Feb. 1984, p. 13-19. In Russian.

An averaging method in canonical variables is used to obtain approximate equations describing the evolution of the rotational motion of a symmetric satellite with two flexible viscoelastic rods. The solution obtained corresponds to the rotation of the satellite about the symmetry axis, which coincides with the normal to the orbit; since the satellite is symmetric, its angular velocity does not have to coincide with the orbital angular velocity. In the approximation considered, the rods remain rectilinear and there is no energy dissipation. B.J.

A84-27934*# Indian Inst. of Science, Bangalore.

CONTROL STRUCTURE INTERACTIONS IN LARGE SPACE STRUCTURES ANALYSIS USING ENERGY APPROACH

S. K. SHRIVASTAVA (Indian Institute of Science, Bangalore, India), R. C. RIED (NASA, Johnson Space Center, Structures and Mechanics Div., Houston, TX), and M. G. MANOHARAN Aeronautical Society of India, Journal (ISSN 0001-9267), vol. 35, May 1983, p. 59-67. Research supported by the U.S. National Research Council. refs

A simple energy approach to study the problem of control structure interactions in large space structures is presented. For the illustrative cases of free-free beam and free rectangular plate, the vibrational energy imparted during operation of constant and pulsed thrusters is found in a nondimensional form. Then based on a parametric study, suggestions are made on the choice of the thruster location and parameters to minimize the control structure interactions. Author

A84-29143#
ON TRANSIENT DYNAMICS AND STABILITY OF LARGE SPACE STRUCTURES
V. J. MODI (British Columbia, University, Vancouver, Canada) IN: U.S. National Congress of Applied Mechanics, 9th, Ithaca, NY, June 21-25, 1982, Proceedings . New York, American Society of Mechanical Engineers, 1982, p. 249-258. Sponsorship: Natural Sciences and Engineering Research Council of Canada. refs
(Contract NSERC-A-2181; NSERC-G-0662; NSERC-A-0967)

Results of a study aimed at assessing dynamical response and stability of orbiting spacecraft during deployment and/or retrieval of mass elements leading to time dependent inertias are presented. In particular two classes of problems are discussed: (1) flexible beam type appendages such as solar panels, antennas, preassembled trusses, etc., deploying from a space platform in an orbit; and (2) Space Shuttle-based tethered systems. The study suggests that with critical combinations of parameters the systems can become unstable; however, suitable control strategies are available which can restore stability. The analysis is relevant to construction of the proposed Space Operations Center (SOC), tethered rescue systems, retrieval of satellites for servicing, repositioning of space platform based telescopes, and similar situations involving interactions between transient inertias, flexibility, and system response. Author

A84-29145#
MULTIBODY DYNAMICS - ANALYSIS OF FLEXIBILITY EFFECTS
R. L. HUSTON (Cincinnati, University, Cincinnati, OH) IN: U.S. National Congress of Applied Mechanics, 9th, Ithaca, NY, June 21-25, 1982, Proceedings . New York, American Society of Mechanical Engineers, 1982, p. 265-271. refs
(Contract N00014-76-C-0139; NSF MEA-81-01110)
(AD-A132533)

This paper discusses flexibility effects in multibody systems. It presents a procedure for the efficient analysis of these effects in large systems containing many bodies. This procedure uses Kane's dynamical equations, Euler parameters, generalized speeds, relative coordinates, finite-segment modelling, and matrix-structural methods. It is a computer-oriented method with the governing equations written in algorithmic form. The procedure is applicable with multibody systems consisting of linked bodies in an 'open-tree' structure. It has specific applications with robots, flexible manipulators, antennae, and human body models. Author

A84-29471*# 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, 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. 17 p. refs

The problem of closed-loop control of maneuvers between two states for linear dynamical systems, subject to an arbitrarily specified terminal state, is considered. The feedback controller design is based on finite-time quadratic regulator theory. Closed-form expressions for the optimal control law are developed. Solutions are presented for both conventional and smoothed control profiles with fixed and/or free end condition problems. In the maneuvers using control-rate penalties, smooth profiles are generated throughout the maneuvers, in the sense that the initial condition jump discontinuities have been eliminated. Several examples involving large-angle maneuvers of a spacecraft are demonstrated. Results include control maneuvers from one state to another such as rest to rest and spin to rest, which effectively justify the solutions developed in this paper. Author

N84-10173*# Howard Univ., Washington, D. C.
THE DYNAMICS AND CONTROL OF LARGE FLEXIBLE SPACE STRUCTURES, 6 Final Report
P. M. BAINUM Sep. 1983 101 p refs
(Contract NSG-1414)
(NASA-CR-174450; NAS 1.26:174450) Avail: NTIS HC A06/MF A01 CSCL 22B

The controls analysis based on a truncated finite element model of the 122m. Hoop/Column Antenna System focuses on an analysis of the controllability as well as the synthesis of control laws. Graph theoretic techniques are employed to consider controllability for different combinations of number and locations of actuators. Control law synthesis is based on an application of the linear regulator theory as well as pole placement techniques. Placement of an actuator on the hoop can result in a noticeable improvement in the transient characteristics. The problem of orientation and shape control of an orbiting flexible beam, previously examined, is now extended to include the influence of solar radiation environmental forces. For extremely flexible thin structures modification of control laws may be required and techniques for accomplishing this are explained. Effects of environmental torques are also included in previously developed models of orbiting flexible thin platforms. B.W.

N84-11195# RAND Corp., Santa Monica, Calif.
THE FLEXURAL BEHAVIOR OF PACSAT (PASSIVE COMMUNICATION SATELLITE) IN ORBIT Interim Report
W. SOLLFREY Feb. 1983 131 p refs
(Contract MDA903-82-C-0068; ARPA ORDER 3584-7)
(AD-A131406; RAND/R-2936-ARPA; LC-83-570; ISBN-0-8330-0490-5) Avail: NTIS HC A07/MF A01 CSCL 22B

This report presents an analysis of the libration and vibration of a passive communications satellite known as PACSAT. It addresses the effects of various disturbing mechanical forces on verticality and straightness. Phenomena considered include orbital ellipticity, earth oblateness, solar and lunar gravity, radiation pressure, micrometeorial impacts, and thermal bending effects. The last two are the most important. It is concluded that the flexural misbehavior of PACSAT in orbit is such that it is most improbable that the present design (unsupported linear array) can perform its communications functions. Author (GRA)

N84-12222 Stanford Univ., Calif.
CONTROL OF FLEXIBLE SPACECRAFT BY OPTIMAL MODEL FOLLOWING Ph.D. Thesis
J. A. QUIRK 1983 244 p
Avail: Univ. Microfilms Order No. DA8307199

Spacecraft flexibility resulting from increased size and light-weight design techniques significantly increases the interaction between the structural bending modes and the vehicle control system. The subject of this thesis is the use of the unique properties of Optimal Model Following (OMF) to simplify the controller design process for flexible spacecraft. Model following controllers force the plant states to follow the dynamics of a model which incorporates the system performance specifications. OMF, model following using a linear quadratic cost function, trades off the degree of dynamics matching with the control effort utilized. As part of this thesis, an OMF controller design program was developed. OMF controllers were designed for three examples: altitude control of a flexible spacecraft, pointing of a camera package on a flexible appendage, and control of a spacecraft based on the Galileo vehicle. The performance characteristics of the OMF designs were compared to those of optimal controllers. Dissert. Abstr.

N84-12234*# National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, Ala.
SPACE STATION ATTITUDE CONTROL SYSTEM CONCEPT AND REQUIREMENTS
P. D. NICAISE *In* NASA. Langley Research Center Integrated Flywheel Technol., 1983 p 63-69 Dec. 1983 refs
Avail: NTIS HC A10/MF A01 CSCL 22B

There is currently no single Space Station configuration which is accepted as a baseline. However, the latest approach is toward symmetry in both geometry and mass distribution. This minimizes aerodynamic and gravity gradient torques. Solar arrays and radiators drive the configuration strongly. One axis of the solar arrays needs to be perpendicular to the orbit plane, and the geometric and principal axis should remain common along this axis to minimize secular torques. The need for both inertial and earth-fixed modes drives the structure of the Station toward a disk-like shape in the orbital plane. Author

N84-12235*# National Aeronautics and Space Administration. Lyndon B. Johnson Space Center, Houston, Tex.
THE BOEING FLYWHEEL STUDY
R. R. RICE *In* NASA. Langley Research Center Integrated Flywheel Technol., 1983 p 71-76 Dec. 1983 refs
Avail: NTIS HC A10/MF A01 CSCL 10C

The major features of the history of the Boeing flywheel were studied. The analysis of the regenerative fuel cell was started as an outgrowth of the original Boeing study of the Space Operations Center, and was completed in November 1982 with the publication of the final report number D180-27160-1. The current flywheel effort attempts to study the integrated flywheel using the same ground rules that were used on the fuel cell study. Author

N84-12236*# National Aeronautics and Space Administration. Lyndon B. Johnson Space Center, Houston, Tex.
SPACE STATION CONTROL REQUIREMENTS AND FLYWHEEL SYSTEM WEIGHTS FOR COMBINED MOMENTUM AND ENERGY STORAGE
F. M. ELAM *In* NASA. Langley Research Center Integrated Flywheel Technol., 1983 p 77-92 Dec. 1983 refs
Avail: NTIS HC A10/MF A01 CSCL 10C

The specifications of the flywheel system for momentum storage and vehicle torquing are somewhat dependent upon the attitude control requirements of the space station in orbit. As a ground rule, the flywheel system will be sized large enough to provide all attitude maneuvers, if practical, to avoid or minimize turning on the reaction control system (RCS). The RCS, whenever used, expels expensive mass and tends to contaminate optical surfaces of the vehicle. The vehicle rate and acceleration specifications of 0.10 deg/sec and 0.01 deg/square sec are tentative, and may be reduced if lesser values are more practical for flywheel design. For local vertical attitude hold, the average attitude error should be zero, and not the classical 1 degree, since control moment gyro (CMG) gimbal angles provide an exact reference feedback for gravity gradient momentum. Docking presents a problem for docking transients and attitude alignment which will require use of the RCS. Author

N84-12238*# National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, Ala.
IPACS ATTITUDE CONTROL TECHNOLOGY CONSIDERATIONS
L. BRANDON *In* NASA. Langley Research Center Integrated Flywheel Technol., 1983 p 99-104 Dec. 1983
Avail: NTIS HC A10/MF A01 CSCL 22B

Larger facilities or the Space Station and its evolutionary versions are considered for the control bandwidth which will evolve to lower values, probably in the 0.01 to 0.1 hertz range. An integrated power attitude control systems (IPACS) unit that incorporates conventional mechanical bearings to have a bandwidth of 4-10 hertz is expected. If the IPACS unit incorporates the advanced technology magnetic bearing, a bandwidth of 1.2 hertz is expected. It is found that for the Space Station or even the Space Platform, either of the above IPACS concepts are adequate. E.A.K.

N84-12243*# National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.
ADVANCED CONTROL AND POWER SYSTEM (ACAPS) TECHNOLOGY PROGRAM
C. R. KECKLER and N. J. GROOM *In its* Integrated Flywheel Technol., 1983 p 141-156 Dec. 1983 refs
Avail: NTIS HC A10/MF A01 CSCL 22B

The advanced control and power system (ACAPS) program is to establish the technology necessary to satisfy space station and related large space structures requirements for efficient, reliable, and cost effective energy storage and attitude control. Technology advances in the area of integrated flywheel systems capable of performing the dual functions of energy storage and attitude control are outlined. E.A.K.

N84-12245*# National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, Ala.
IPACS GUIDANCE NAVIGATION AND CONTROL SYSTEM CONSIDERATIONS AND TEST ACTIVITIES
H. J. BUCHANAN *In* NASA. Langley Research Center Integrated Flywheel Technol., 1983 p 165-168 Dec. 1983
Avail: NTIS HC A10/MF A01 CSCL 17G

The MSFC facility proposed for the Space Station Attitude Control Simulator which consists of a large three degree of freedom table driven by computer controlled hydraulic actuators designed to give high bandwidth and extremely fine control through large angles is outlined. The facility includes star and solar simulators providing collimated light with the spectral content and intensity typical of Earth orbit. E.A.K.

N84-13608*# National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.
STABILITY, VIBRATION AND PASSIVE DAMPING OF PARTIALLY RESTRAINED IMPERFECT COLUMNS
Z. RAZZAQ, R. T. VOLAND, H. G. BUSH, and M. M. MIKULAS, JR. Oct. 1983 38 p refs
(NASA-TM-85697; NAS 1.15:85697) Avail: NTIS HC A03/MF A01 CSCL 20K

A theoretical and experimental study of slender tubular columns for possible use in space structures is conducted in the presence of partial rotational end restraints. Explicit formulas are derived for computing the buckling load and the lowest natural frequency of perfectly straight uniform elastic members with rotational end restraints possessing linear moment-rotation characteristics. An exact solution in the form of a transcendental equation, and a numerical solution using second-order finite-differences are also presented. The presence of an initial imperfection is also incorporated into the numerical procedure. Vibration tests are conducted on an imperfect tubular steel member in the absence of an axial load. A damping concept consisting of a string-mass assembly is explored. Three passive damping configurations involving combinations of three lead shots were investigated. The three lead shot configurations provided considerably greater damping than the single lead shot. Author

N84-14235 California Univ., Los Angeles.
ACTIVE CONTROL OF LARGE FLEXIBLE SPACE STRUCTURES Ph.D. Thesis
M. K. MACKAY 1983 260 p
Avail: Univ. Microfilms Order No. DA8314665

The control of a large flexible space structure using a finite number of controls and observations is considered. The control problem is formulated as an optimal stochastic regulator. Various assumptions are made concerning the natural damping in the system. This leads to semigroup representations for the open loop system which are uniformly exponentially stable and compact, uniformly exponentially stable and noncompact, strongly stable, and unitary (no natural damping). New sufficient conditions are given for the existence of a solution to the control problem for the strongly stable and unitary cases. The solution to the control

problem is obtained in terms of the compensator, i.e., the optimal linear operator mapping the observations to the control. Both time domain and frequency domain representations for the compensator are given and its modal approximation is studied. The general theory is applied to a space structure modeled as a rigid central body with two flexible appendages (cantilevered beams).
Dissert. Abstr.

N84-14546# Virginia Polytechnic Inst. and State Univ., Blacksburg. Dept. of Aerospace and Ocean Engineering.
EXPERIMENTAL STUDY OF ACTIVE VIBRATION CONTROL Annual Report, 15 Mar. 1982 - 14 Mar. 1983
W. L. HALLAUER, JR. 15 Apr. 1983 11 p
(Contract AF-AFOSR-0217-82; AF PROJ. 2307)
(AD-A133818; AFOSR-83-0855TR) Avail: NTIS HCA02/MFA01 CSCL 20K

Control system hardware, including velocity sensors, force actuators, and analog circuitry, has been designed, fabricated, calibrated, and tested in operation. Active vibration control in the forms of direct-velocity-feedback control and modal-space control has been implemented on a dynamically uncomplicated beam-cable structure, and theorectical simulations of the structure-control dynamics have been completed. Either correlation between experiment and theory has been satisfactory, or the reasons for unsatisfactory correlation have become clear so that corrections can be made in the future. A dynamically complicated, variable-geometry plane grid structure intended for control experiments has been built and analyzed experimentally and theoretically for its modes of vibration. The initial versions of both the actual structure and its theorectical model was unsatisfactory in some respects, and necessary improvements are almost completed at this writing. Finally, the tasks of subcontractor HR Textron are almost completed. They consist of a study of the techniques known as component cost analysis and modal cost analysis and a preliminary study of issues involved in the testing of active vibration control systems of full-size satellite structures, most specifically whether testing should be conducted on the ground or in orbit.
Author (GRA)

N84-15181# TRW Space Technology Labs., Redondo Beach, Calif.
ACOSS FOURTEEN (ACTIVE CONTROL OF SPACE STRUCTURES) Final Technical Report, 23 Jun. 1981 - 30 Oct. 1982
R. J. BENHABIB, H. K. FLASHNER, and F. C. TUNG Mar. 1983 260 p
(Contract F30602-81-C-0194; DARPA ORDER 3654; AF PROJ. C654)
(AD-A133411; RADC-TR-83-51) Avail: NTIS HCA12/MFA01 CSCL 22B

ACOSS Fourteen is one of a series of studies for the development of a unified structural dynamics and control technology base to support future development of large space systems. The major emphasis in these studies in the past has been on generic control law development for active vibration suppression. The emphasis is now shifting towards hardware development and experimental verification of the technology. ACOSS Fourteen studies the definition, design and plan for an on-orbit, Shuttle-based Proof of Concept demonstration and stability enduring designs which extend previous designs and treat noncolocated actuator-sensor control systems, while remaining insensitive to modal truncation and inaccurate structural models.
Author (GRA)

N84-15182# Dornier-Werke G.m.b.H., Friedrichshafen (West Germany).
STUDY ON DAMPING REPRESENTATION RELATED TO SPACECRAFT STRUCTURAL DESIGN Final Report
E. HILBRANDT Paris ESA Feb. 1983 210 p refs
(Contract ESTEC-4435/80/NL-AK(SC))
(EMSB-18/83; ESA-CR(P)-1770) Avail: NTIS HC A10/MF A01

Damping representation models for spacecraft dynamic response analysis, and system damping prediction methods were analyzed. Results show that the only suitable damping model is the viscous damping model. For response analysis with adapted modal viscous damping values the response of a structure may be predicted with adequate accuracy if a derived coupling criteria is not violated. Otherwise the response should be predicted with a corrective method or the exact analysis with complex eigenmodes. Damping prediction methods for system damping from substructure damping are far more sensitive to the damping characteristics of the substructures than response analysis methods. Because of damping coupling effects nonproportional damping characteristics have to be incorporated in these system damping prediction methods. Damping estimation methods are not adequate for damping prediction; system identification must be applied. Differences between random and harmonic test methods are treated and system identification with random response data is discussed.
Author (ESA)

N84-15840 Rensselaer Polytechnic Inst., Troy, N. Y.
DIRECT MULTIVARIABLE MODEL REFERENCE ADAPTIVE CONTROL WITH APPLICATIONS TO LARGE STRUCTURAL SYSTEMS Ph.D. Thesis
I. BAR-KANA 1983 253 p
Avail: Univ. Microfilms Order No. DA8321179

The need for adaptive control of any system arises because of ignorance of the systems internal structure and critical parameter values, as well as changing control regimes. A large scale system is substantially more susceptible to these problems. Although considerable progress has been made in designing Model Reference adaptive controllers for unknown single input single output control systems, little progress has been made toward extension of these ideas to the multi-input multi-output (multivariable) case. Furthermore, most adaptive control procedures need the order of the (assumably unknown) controlled plant and use a reference model of the same order as the plant for implementation of the adaptive algorithm. Direct Multivariable Model Reference Adaptive Control (DMMRAC) procedures which do not require explicit parameter identification or a reference model of the same order as the plant seem to be especially attractive for the control of large structural systems. However, in the past they were shown to only be feasible for systems which satisfy the strictly positive realness condition.
Dissert. Abstr.

N84-16056*# Alabama Univ., Huntsville. Dept. of Aerospace Engineering.
FINITE ELEMENT ANALYSIS OF A DEPLOYABLE SPACE STRUCTURE
G. E. WEEKS *In its* Res. Rept.: 1983 NASA/ASEE Summer Faculty Fellowship Program 24 p Dec. 1983 refs
Avail: NTIS HC A99/MF A01 CSCL 20K

The dynamic characteristics of the Solar Array Flight Experiment (SAFE) structure during deployment and retraction are investigated. The SAFE structure consists of a deployable mast with an attached solar blanket designed with accordion type folds to permit packaging in a small volume. The planar form of the blanket geometry during deployment is maintained by a blanket tension/guidewire system. Structurally, the mast is modeled as an Euler beam column with inplane and out of plane bending and finite torsional stiffness. For out of plane motion, the blanket is modeled as a distributed mass uniformly supported by the three guidewires. For inplane motion the blanket displacements are assumed to vary linearly from the mast base to the mast tip. The mathematical model uses a virtual work formulation, required because the axial loading on the mast is nonconservative, combined with assumed beam modes to derive the differential equations of motion. Consideration of the time dependent boundary conditions results in an infinite set of ODE with time dependent coefficients. Finally, correlation of mast tip accelerations to mast base bending moments for specified modal motions are indicated.
M.G.

N84-16232# Instituto de Pesquisas Espaciais, Sao Jose dos Campos (Brazil).
SENSITIVITY ANALYSIS OF THE INFLUENCE OF THE FLEXIBILITY OF SOLAR PANELS ON THE ATTITUDE DYNAMICS OF ARTIFICIAL SATELLITES [ANALISE DE SENSITIVIDADE DA INFLUENCIA DA FLEXIBILIDADE DE APENDICES SOBRE A DINAMICA DA ATITUDE DE SATELITES ARTIFICIAIS]
D. L. FERREIRA, P. T. D. M. LOURENCAO, and O. M. NETO Jun. 1983 12 p refs In PORTUGUESE; ENGLISH summary Presented at the 7th Brazil. Mech. Eng. Conf., COBEM 83, Uberlandia, Minas Gerais, 13-16 Dec. 1983
(INPE-2763-PRE/337) Avail: NTIS HC A02/MF A01

The motion of a spin-stabilized satellite, having two flexible solar panels was studied. The equations of motion are attained using the Lagrangian formalism and the assumed modes method. The influence of the flexibility is studied using the eigenvalue and eigenvector sensitivity. The pole allocation technique is used to minimize the effects of elasticity on the rigid body motion.
Author

N84-16246*# Virginia Univ., Charlottesville. Dept. of Mechanical and Aerospace Engineering.
DIGITAL CONTROL SYSTEM FOR SPACE STRUCTURAL DAMPERS Semiannual Progress Report
J. K. HAVILAND Jan. 1984 27 p refs
(Contract NAG1-349)
(NASA-CR-175355; NAS 1.26:175355; UVA/52824/MAE84/101)
Avail: NTIS HC A03/MF A01 CSCL 22B

A recently developed concept for a damper was improved by adding a small taper to the proof-mass, and using a proximeter to determine position. Also, an experimental damper was built using a three-inch stroke in place of the standard one-inch stroke. The analog controller initially used was replaced by an independent digital controller slaved to a TRS-80 Model I computer, which also serves as a highly effective, low-cost development system. An overall system concept for the use of proof-mass dampers is presented.
A.R.H.

N84-16248*# Massachusetts Inst. of Tech., Cambridge. Dept. of Aeronautics and Astronautics.
RELIABILITY ISSUES IN ACTIVE CONTROL OF LARGE FLEXIBLE SPACE STRUCTURES Semiannual Status Report, 16 May - 15 Nov. 1983
W. E. VANDERVELDE 23 Nov. 1983 8 p
(Contract NAG1-126)
(NASA-CR-175341; NAS 1.26:175341) Avail: NTIS HC A02/MF A01 CSCL 22B

The unreliability of control system components was investigated in our attempt to deal with that problem. This matter is of concern in large space structure control because of the large number of components required to achieve specified performance in some situations, and the long operating period required between maintenance visits. The detection and isolation of component failures during system operation, and algorithms for reconfiguring control systems following detection and isolation of a failure were emphasized.
S.L.

N84-16249*# National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.
THERMALLY INDUCED SPIN RATE RIPPLE ON SPACECRAFT WITH LONG RADIAL APPENDAGES
J. V. FEDOR Aug. 1983 29 p refs
(NASA-TM-85058; NAS 1.15:85058) Avail: NTIS HC A03/MF A01 CSCL 22B

A thermally induced spin rate ripple hypothesis is proposed to explain the spin rate anomaly observed on ISEE-B. It involves the two radial 14.5 meter beryllium copper tape ribbons going in and out of the spacecraft hub shadow. A thermal lag time constant is applied to the thermally induced ribbon displacements which perturb the spin rate. It is inferred that the averaged thermally induced ribbon displacements are coupled to the ribbon angular motion. A possible exponential build up of the inplane motion of the ribbon which in turn causes the spin rate ripple, ultimately limited by damping in the ribbon and spacecraft is shown. It is indicated that qualitative increase in the oscillation period and the thermal lag is fundamental for the period increase. found that numerical parameter values required to agree with in orbit initial exponential build up are reasonable; those required for the ripple period are somewhat extreme.
E.A.K.

N84-17227*# Rockwell International Corp., Downey, Calif. Shuttle Integration and Satellite Systems Div.
A DEPLOYABLE STRUCTURE AND SOLAR ARRAY CONTROLS EXPERIMENT FOR STEP
T. S. NISHIMOTO *In* NASA. Langley Research Center STEP Expt. Requirements p 211-220 Jan. 1984
Avail: NTIS HC A15/MF A01 CSCL 22B

A candidate configuration for a controls experiment on the Space Technology Experiments Platform (STEP) is described. The elements of the experiment are the mast, the solar array, and an articulation module between the two. The characteristic dimensions are very compatible for integration on a pallet such a STEP's proposed configuration. The controls' objective would be the measurement of orbiter interaction as well as the system identification of the appendages. The flight experiment configuration would also provide a test bed for various active vibration controls concepts. The instrumentation being considered would measure accelerations, strains, displacements, and temperatures. The deployable mast has eight elements defining a structural bay. Uniaxial measurements would be required to define loads at a cross section of the structure. Displacements due to thermal distortion of the mast and the local state of the solar concentrator may be measured by an optical ranging technique from the orbiter aft flight deck.
M.G.

N84-17228*# National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.
VIBRATION ISOLATION TECHNOLOGY EXPERIMENT
C. R. KECKLER *In its* STEP Expt. Requirements p 221-230 Jan. 1984 refs
Avail: NTIS HC A15/MF A01 CSCL 22B

The objectives of the vibration isolation technology experiment are to demonstrate the viability of the magnetic suspension technology in providing the isolation of large structures elements from the external environment and to quantify the degree of isolation provided by this system. The approach proposed for this experiment is to mount a six-degrees-of-freedom magnetic bearing suspension system at the free end of a shuttle-attached flexible structure such as MAST. The disturbance generator, located on top of the isolation system, will be energized at selected and broadband frequencies to simulate a typical spacecraft vibration environment. Sensors located on the isolation system and the flexible structures element will be used to quantify the degree of isolation provided by this system.
M.G.

N84-17229*# National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.
INTEGRATED POWER/ATTITUDE CONTROL SYSTEM (IPACS) TECHNOLOGY EXPERIMENT
C. R. KECKLER *In its* STEP Expt. Requirements p 231-240 Jan. 1984 refs
Avail: NTIS HC A15/MF A01 CSCL 22B

An experiment is proposed that will perform the tasks associated with the control and energy storage/power generation functions attendant to space operations. It was shown in past studies that the integration of these functions into one system can result in significant weight, volume, and cost savings. The Integrated Power/Attitude Control System (IPACS) concept is discussed. During orbit day, power is derived from the solar cell arrays and, after appropriate conditioning, is used to operate the spacecraft subsystems, including the control system. In conventional approaches, a part of the collected solar energy is stored in a bank of batteries to permit operation of the vehicle's systems during orbit night. In the IPACS concept, the solar energy is stored in the spinning flywheels of the control system in the form of kinetic energy. During orbit night, the wheels are despun and, through the use of a wheel-shaft mounted generator, power is generated for the onboard subsystems. Operating these flywheels over a 50-percent speed variation permits the extraction of 75 percent of the stored energy while at the same time preserving 50 percent of the momentum capacity for control of the vehicle. Batteries can therefore be eliminated and significant weight and volume savings realized. R.J.F.

N84-17230*# General Electric Co., Philadelphia, Pa. Space Systems Div.
INVESTIGATION OF ARTICULATED PANEL DYNAMICS
C. V. STAHLE, JR. *In* NASA. Langley Research Center STEP Expt. Requirements p 241-255 Jan. 1984
Avail: NTIS HC A15/MF A01 CSCL 22B

An articulated panel dynamics experiment to evaluate present analysis and ground test methods as well as damping effectiveness is proposed. The experiment uses an existing panel design which was extensively analyzed and tested. These data provide a firm basis for evaluating the adequacy of panel analysis and ground test methodology. The key issues for future large space structure panel designs are addressed: the critical launch transient and vibroacoustic loading; the deployment analysis adequacy including air and gravitational effects; and the orbital resonant frequencies and mode shapes of deployed panel assemblies. By using an existing mature design that was thoroughly tested, the effort can focus on correlation of actual flight results with existing predictions. A second panel assembly incorporating passive damping is proposed to provide a direct measure of damped panel benefits that can be obtained. These benefits include: reduced launch loads and responses; and highly damped deployed modes. Existing space-qualified viscoelastic epoxy, in combination with composite materials or an alternate more effective damping material, will be used. R.J.F.

N84-17241# Institut National de Recherche d'Informatique et d'Automatique, Rocquencourt (France).
VALIDATION METHODS FOR MATHEMATICAL MODELS OF FLEXIBLE SATELLITE DYNAMICS Final Report [METHODES DE VALIDATION DES MODELES MATHEMATIQUES EN DYNAMIQUE DES SATELLITES NON RIGIDES]
C. A. DARMON Paris ESA 1983 303 p refs In FRENCH
(Contract ESTEC-2991/76/NL-AK(SC))
(ESA-CR(P)-1794) Avail: NTIS HC A14/MF A01

The linear equations of the dynamics of a rotating or three axis stabilized satellite are analyzed, using a second order Lagrange, a frequential, modal and a variable state model. Satellite sensor equations are solved. It is shown that satellite nonvibration modes are not observed by accelerometers and gyrometers. A fast Fourier transformation nonparametric method which identifies system order is presented. Parameter identification conditions for a second order model are established, and a maximum likelihood estimate algorithm for model parameters is described. An algorithm which identifies modal vectors and frequencies which intervene in the mode model as state variables, and second order model matrices for each observable mode is shown. Author (ESA)

N84-17251*# Smithsonian Astrophysical Observatory, Cambridge, Mass.
INVESTIGATION OF ELECTRODYNAMIC STABILIZATION AND CONTROL OF LONG ORBITING TETHERS Final Report, 13 Sep. 1982 - 12 Sep. 1983
G. COLOMBO (Padova Univ., Italy) and D. ARNOLD Jan. 1984 159 p refs
(Contract NAS8-35036)
(NASA-CR-170972; NAS 1.26:170972) Avail: NTIS HC A08/MF A01 CSCL 22B

The state-of-the-art in tether modelling among participants in the Tethered Satellite System (TSS) Program, the slack tether and its behavior, and certain advanced applications of the tether to problems in orbital mechanics are identified. The features and applications of the TSS software set are reviewed. Modelling the slack tether analytically with as many as 50 mass points and the application of this new model to a study of the behavior of a broken tether near the Shuttle are described. A reel control algorithm developed by SAO and examples of its use are described, including an example which also demonstrates the use of the tether in transferring a heavy payload from a low-orbiting Shuttle to a high circular orbit. Capture of a low-orbiting payload by a Space Station in high circular orbit is described. Energy transfer within a dumbbell-type spacecraft by cyclical reeling operations or gravitational effects on the natural elasticity of the connecting tether, it is shown, can circularize the orbit of the spacecraft. N.W.

N84-18262*# Virginia Polytechnic Inst. and State Univ., Blacksburg. Dept. of Engineering Science and Mechanics.
CONTROL OF LARGE FLEXIBLE SPACECRAFT BY THE INDEPENDENT MODAL-SPACE CONTROL METHOD Interim Report
L. MEIROVITCH and J. SHENAR Washington NASA Jan. 1984 212 p refs
(Contract NAG1-225)
(NASA-CR-3760; NAS 1.26:3760) Avail: NTIS HC A10/MF A01 CSCL 22B

The problem of control of a large-order flexible structure in the form of a plate-like lattice by the Independent Modal-Space Control (IMSC) method is presented. The equations of motion are first transformed to the modal space, thus obtaining internal (plant) decoupling of the system. Then, the control laws are designed in the modal space for each mode separately, so that the modal equations of motion are rendered externally (controller) decoupled. This complete decoupling applies both to rigid-body modes and elastic modes. The application of linear optimal control, in conjunction with a quadratic performance index, is first reviewed. A solution for high-order systems is proposed here by the IMSC method, whereby the problem is reduced to a number of modal minimum-fuel problems for the controlled modes. Author

N84-18281*# Lockheed Missiles and Space Co., Sunnyvale, Calif.
ATTITUDE, CONTROL AND STABILIZATION
B. G. MORAIS *In* NASA. Langley Research Center Space Station Technol., 1983 p 41-60 Feb. 1984
Avail: NTIS HC A09/MF A01 CSCL 22B

In the area of control, several problems can arise during the evolution of the space station. These incude: 1) the use of multiple or articulated flexible bodies; 2) the need for distributed cntrol for maneuvering and maintaining altitude; 3) hierarchical control to automate and manage control systems; 4) structual control (from the standpoint of appendage stamping; isolation, and possible figure control); 5) cntrol position and orientation for component modules during construction (an evolutionary requirement); 6) control during docking and undocking operations; and 7) the normal requirements for stablity and control during systems operations. In addition, there are a number of key technology concerns, such as significant landing modes which tend to be closely spaced and distributed widely, distributed sensors and actuators which are collecated, and the wide distribution of landing modes that must be reduced from a dimensional standpoint. Author

N84-18311# Draper (Charles Stark) Lab., Inc., Cambridge, Mass.
ACOSS ELEVEN (ACTIVE CONTROL OF SPACE STRUCTURES), VOLUME 1 Interim Report, Apr. - Nov. 1982
E. FOGEL, D. R. HEGG, H. MCCLAMROCH, and J. C. LIN Griffiss AFB, N.Y. RADC Jul. 1983 140 p 2 Vol.
(Contract F30602-81-C-0180; AF PROJ. C655)
(AD-A135675; CSDL-R-1598-VOL-1; RADC-TR-83-158-VOL-1)
Avail: NTIS HC A07/MF A01 CSCL 22A

This volume documents the progress made in four principal areas during this reporting period: (1) The difficulties encountered in the Large Space Structure (LSS) system identification were studied. Focusing on the high-resolution identification problem, a procedure for identifying lightly damped, closely spaced modes is derived; (2) Two approaches to the incorporation of actuator dynamics and the role of actuator transducers in LSS vibration control were explored; (3) A modal dashpot/modal spring control design is presented; and (4) A controlled experiment for the ACOSS design is proposed in which each principal element in the overall synthesis process is systematically examined. Author (GRA)

N84-18312# Draper (Charles Stark) Lab., Inc., Cambridge, Mass.
ACOSS ELEVEN (ACTIVE CONTROL OF SPACE STRUCTURES), VOLUME 2 Interim Report, Jun. - Nov. 1982
T. H. BROOKS and D. ANDING Griffiss AFB, N.Y. RADC Jul. 1983 148 p 2 Vol.
(Contract F30602-81-C-0180; AF PROJ. C655)
(AD-A135676; CSDL-R-1598-VOL-2; RADC-TR-83-158-VOL-2)
Avail: NTIS HC A07/MF A01 CSCL 22A

In analysis and simulation of Space-based Surveillance System Performance, a key variable is the scene/sensor interaction, under subcontract to CSDL, Photon Research Associates has developed a software package capable of generating and manipulating terrestrial scene data sets as a function of major surveillance system and mission parameters. This report documents the details of this simulation, called Genesis, which has now been incorporated into the Draper Integrated Simulations. Author (GRA)

N84-18313# Air Force Academy, Colo.
SCALE MODEL TESTING FOR CONTROL SYSTEM PARAMETERS OF LARGE STRUCTURES Final Report, Aug. 1982 - Aug. 1983
R. T. EVANS, B. J. SIMMONS, S. M. BROWN, D. A. ERCHINGER, and M. E. MATHEWS Oct. 1983 35 p
(Contract AF PROJ. 2308)
(AD-A135652; FJSRL-TR-83-0011) Avail: NTIS HC A03/MF A01 CSCL 22B

The premise is made that as an alternate to or enhancement to finite element analysis of a large complex structure, scale model tests can provide useful parameters for control system design. The objective is to minimize risks associated with expensive construction of large complex space structures by better predictions of the associated structural dynamics. This report covers construction of scale models, and comparison of scale model parameters to the full size structure. A comparison of the results obtained for three scale models yields general relationships that can be applied to future large complex structure development and to a conclusion that structural characteristics pertaining to control system parameters can be determined from scale model tests. GRA

N84-18987# California Univ., Los Angeles. Dept. of System Science.
RESEARCH ON BOUNDARY FEEDBACK AND CONTROL THEORIES, 1978 - 1983 Final Report, 2 Jan. 1982 - 31 Mar. 1983
A. V. BALAKRISHNAN Mar. 1983 16 p
(Contract AF-AFOSR-3550-78; AF PROJ. 2304)
(AD-A136531; AFOSR-83-1240TR) Avail: NTIS HC A02/MF A01 CSCL 12A

During the period of this grant, topics investigated included: nonlinear white noise theory; stabilization of distributed parameter systems by boundary feedback; system modeling and identification; control of flexible flight vehicles; random fields, filtering and estimation; control of randomly varying systems; and control of large space structures. Thirty technical papers were produced with titles including: active control of airfoils in unsteady aerodynamics; identification of aircraft parameters in turbulence with nonrational spectra; Aircraft performance modelling, theory and some preliminary results; and active control of large flexible space structures. GRA

N84-19383# Instituto de Pesquisas Espaciais, Sao Jose dos Campos (Brazil).
CAPTURE OF SATELLITE STABILIZED BY GRAVITY GRADIENT WITH A FLEXIBLE MAST DURING AND AFTER DEPLOYMENT [ANALISE DO PROBLEMA DE CAPTURA DE UM SATELITE ESTABILIZADO POR GRADIENTE DE GRAVIDADE COM MASTRO FLEXIVEL DURANTE E APOS A FASE DE ESTICAMENTO]
D. L. FERREIRA, P. T. D. M. LOURENCAO, and S. A. TAVARES May 1983 11 p refs In PORTUGUESE; ENGLISH summary Presented at the 7th Brazilian Congr. of Mech. Engr., COBEM 83, Uberlandia, Brazil, 13-16 Dec. 1983
(INPE-2749-PRE/325) Avail: NTIS HC A02/MF A01

The capture of the nominal equilibrium position of a gravity gradient stabilized satellite with flexible and extensible appendages is considered. The initial conditions, for which the capture is possible, are studied noting that there is a large variation in the parameters such as deployment velocity center of massa positions, etc. The objective is to evaluate the influence of the boom flexibility on the librational movement of the rigid body. The study is based on the Lagrangena formulation and on the method of assumed modes. Author

N84-19392*# Bendix Corp., Teterboro, N.J. Guidance Systems Div.
MODULAR DESIGN ATTITUDE CONTROL SYSTEM Final Report
F. D. CHICHESTER 24 Jan. 1984 71 p refs
(Contract NAS8-33979)
(NASA-CR-170996; NAS 1.26:170996) Avail: NTIS HC A04/MF A01 CSCL 22B

The problem of applying modular attitude control to a rigid body-flexible suspension model of a flexible spacecraft with some state variables inaccessible was addressed by developing a sequence of single axis models and generating a series of reduced state linear observers of minimum order to reconstruct those scalar state variables that were inaccessible. The specific single axis models treated consisted of two, three and four rigid bodies, respectively, interconnected by a flexible shaft passing through the mass centers of the bodies. Reduced state linear observers of all orders up to one less than the total number of scalar state variables were generated for each of the three single axis models cited. Author

N84-19394*# Avco Systems Div., Lowell, Mass.
MAINTENANCE AND OPERATIONAL ENHANCEMENT OF THE FLEXIBLE SPACECRAFT DYNAMICS PROGRAM Final Report
9 Sep. 1983 38 p refs
(Contract NAS5-27466)
(NASA-CR-175211; NAS 1.26:175211) Avail: NTIS HC A03/MF A01 CSCL 22B

The modifications and additions made to the Flexible Spacecraft Dynamics (FSD) Program under contract NAS5-27466 are described. The principal addition to the program was the capability to simulate a two axis gimble platform despin control system using the vibration damper degree of freedom for the azimuth gimble. The details of the modifications made to the FSD Program are presented. Modifications to existing subroutines are briefly described and a detailed description of new subroutines is given. In addition, the program variables in new labelled COMMON blocks are described in detail. New input symbols for the FSD Program are described. Author

N84-19464# Air Force Inst. of Tech., Wright-Patterson AFB, Ohio. School of Engineering.
DECENTRALIZED CONTROL OF A LARGE SPACE STRUCTURE USING DIRECT OUTPUT FEEDBACK M.S. Thesis
D. V. THYFAULT Dec. 1983 140 p
(AD-A136781; AFIT/GA/AA/83D-8) Avail: NTIS HC A07/MF A01 CSCL 12A

Direct output feedback control methods are used to develop a multiple-input multiple-output controller. The controller is then applied to the Charles Stark Draper Laboratory 2 (CSDL 2) model.

The CSDL 2 model is a sophisticated optical space structure representative of large flexible space structures. This model consists of 59 nodes and 23 lumped masses. The beam elements are fully connected and may support axial, transverse, and torsional deformations. NASTRAN is employed to generate modal approximations of the model as well as the mode shapes and frequencies of the resulting modes. Of the numerous modes available for the model, only the first 36 modes are utilized and implemented in the controller. The control problem is formulated in state space form and direct output feedback is implemented. The state is represented as modal amplitudes and rates. System outputs are obtained by rate sensors and control is applied by point force actuators. GRA

N84-19465# Air Force Inst. of Tech., Wright-Patterson AFB, Ohio. School of Engineering.
THE EFFECT OF MASS AND STIFFNESS CHANGES ON THE DAMPING FACTOR IN A LARGE SPACE STRUCTURE AS REPRESENTED BY THE CSDL 2 MODEL M.S. Thesis
D. E. OLSEN Dec. 1983 132 p
(AD-A136984; AFIT/GSO/AA/83D-2) Avail: NTIS HC A07/MF A01 CSCL 22B

This investigation was undertaken to determine the sensitivity of the damping factor in a large space structure (LSS) to small changes in nonstructural mass and structural element stiffness. Revision 3 of the ACOSS 2 model, developed by the Charles Stark Drapes Laboratory, Inc. (CSDL), was used as the model of the LSS. Various combinations of the mirror masses in this large space telescope were varied by up to 10%, selected structural elements were stiffened by increasing their cross-sectional areas by 10 and 50%, and, finally, two structural elements in the middle of the telescope were stiffened to represent the addition of a lumped mass located away from the control system sensors and actuators. A control system of 21 collocated sensors and actuators, positioned at the top and bottom of the telescope, was used in this analysis. The analysis was accomplished using NASTRAN for the finite element analysis, and, after selecting certain vibration modes for further study, the complex conjugate pairs used to determine the damping factors were calculated. The results indicate that the damping factors for the CSDL model are quite sensitive to small perturbations and that it is very difficult to predict the effect that a perturbation to the model will have on the damping factors. GRA

N84-19900# Concordia Univ., Montreal (Quebec). Dept. of Mechanical Engineering.
DYNAMIC BEHAVIOUR OF A SATELLITE ANTENNA STRUCTURE IN RANDOM VIBRATION ENVIRONMENT
V. K. JHA (SPAR Aerospace Ltd.), T. S. SANDAR, and R. B. BHAT *In* Shock and Vibration Inform. Center The Shock and Vibration Bull., part 3 p 91-103 May 1983 refs
Avail: SVIC, Code 5804, Naval Research Lab., Washington, D.C. 20375 CSCL 20K

Satellite antenna structures are often subjected to random excitations with power spectra densities varying in an arbitrary manner in the frequency domain. A mathematical model for effectively describing such excitations is proposed in order to compute the dynamic response of the antenna structure. The mathematical model of the excitation is developed analytically by enveloping the profile of the power spectral densities by linear segments of varying slopes. The validity of the proposed mathematical model is experimentally verified. The dynamic response of the satellite antenna structure is obtained using the proposed mathematical model for the excitation. The finite element program SPAR was used as the main frame for this dynamic response analysis. The eigenvalues and mode shapes along with displacements and stresses for the antenna structure subjected to random excitations encountered during normal operation are presented, employing the proposed mathematical model for the excitations. M.G.

N84-20625*# Bendix Corp., Teterboro, N.J. Guidance Systems Div.
EXHIBIT D MODULAR DESIGN ATTITUDE CONTROL SYSTEM STUDY Progress Report, Jan. - Feb. 1984
F. CHICHESTER Feb. 1984 69 p refs
(Contract NAS8-33979)
(NASA-CR-170993; NAS 1.26:170993) Avail: NTIS HC A04/MF A01 CSCL 22B

A dynamically equivalent four body approximation of the NASTRAN finite element model supplied for hybrid deployable truss to support the digital computer simulation of the ten body model of the flexible space platform that incorporates the four body truss model were investigated. Coefficients for sensitivity of state variables of the linearized model of the three axes rotational dynamics of the prototype flexible spacecraft were generated with respect to the model's parameters. Software changes required to accomodate addition of another rigid body to the five body model of the rotational dynamics of the prototype flexible spacecraft were evaluated. S.L.

N84-20627*# Howard Univ., Washington, D. C. Dept. of Mechanical Engineering.
ENVIRONMENTAL EFFECTS ON THE DYNAMICS AND CONTROL OF AN ORBITING LARGE FLEXIBLE ANTENNA SYSTEM
R. KRISHNA and P. M. BAINUM 1984 10 p refs Proposed for Presentation at the 35th Intern. Astronautical Congr., Lausanne, Switzerland, 7 - 13 Oct. 1984
(Contract NSG-1414)
(NASA-CR-175448; NAS 1.26:175448) Avail: NTIS HC A02/MF A01 CSCL 22B

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 effort in order to maintain shape and orientation, thermal deformations must be minimized in the preliminary design of the system. A.R.H.

N84-20880*# National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.
STATIC AND DYNAMIC STRUCTURAL-SENSITIVITY DERIVATIVE CALCULATIONS IN THE FINITE-ELEMENT-BASED ENGINEERING ANALYSIS LANGUAGE (EAL) SYSTEM
C. J. CAMARDA and H. M. ADELMAN Mar. 1984 80 p refs
(NASA-TM-85743; L-15659; NAS 1.15:85743) Avail: NTIS HC A05/MF A01 CSCL 20K

The implementation of static and dynamic structural-sensitivity derivative calculations in a general purpose, finite-element computer program denoted the Engineering Analysis Language (EAL) System is described. Derivatives are calculated with respect to structural parameters, specifically, member sectional properties including thicknesses, cross-sectional areas, and moments of inertia. Derivatives are obtained for displacements, stresses, vibration frequencies and mode shapes, and buckling loads and mode shapes. Three methods for calculating derivatives are implemented (analytical, semianalytical, and finite differences), and comparisons of computer time and accuracy are made. Results are presented for four examples: a swept wing, a box beam, a stiffened cylinder with a cutout, and a space radiometer-antenna truss. Author

N84-21172# Stevens Inst. of Tech., Hoboken, N. J. Dept. of Mechanical Engineering.
TIME DOMAIN ANALYSIS AND SYNTHESIS OF ROBUST CONTROLLERS FOR LARGE SCALE LQG (LINEAR QUADRATIC GAUSSIAN) REGULATORS Final Report, 1 Sep. 1982 - 31 Aug. 1983
R. K. YEDAVALLI, R. N. SHANBHAG, and J. IRUDAYASAMY 31 Aug. 1983 56 p
(Contract AF-83-0139; AF PROJ. 2304)
(AD-A137760; AFOSR-84-0040TR) Avail: NTIS HC A04/MF A01 CSCL 12A

The aspect of robustness for linear multivariable systems is analyzed in time domain. Both stability robustness and performance robustness are combinedly considered to meet stability and performance requirements. First a stability robustness condition in time domain (in terms of eigenvalues) is presented and examples are given which indicate that the proposed robustness condition is less conservative then the corresponding frequency domain condition as well as another recently proposed time domain condition, both given in terms of singular values. Next a technique is presented to further reduce the conservatism of the proposed condition. A design algorithm that incorporates both stability robustness and performance robustness into the design procedure suggested in the summer faculty program report, is modified with the help of new definitions of robustness indices. Computer software to implement the algorithm is presented along with simple examples to illustrate the concepts. Based on the experience gained by the minigrant research, areas of future research are recommended. Author (GRA)

N84-21604# European Space Agency, Paris (France).
DERIVATION AND COMBINATION OF IMPEDANCE MATRICES FOR FLEXIBLE SATELLITES
E. CRELLIN (ESTEC, Noorwidjk, Netherlands) and F. JANSSENS (ESTEC, Noorwidjk, Netherlands) Nov. 1983 107 p refs
(ESA-STR-209; ISSN-0379-4067) Avail: NTIS HC A06/MF A01

The concept of the impedance matrix of a dynamical system is presented as a tool for the study of the small vibrations about equilibrium of a satellite with flexible appendages (attitude dynamics). A method which avoids the derivation of the equations of motion of the global system and does not require discretization of the flexible appendage a priori is developed. The impedance of the global system enables the study of the attitude dynamics and it can be constructed, in a systematic way, from the subsystem impedances. Impedances for typical subsystems of spinning satellites are derived. The method of combination of the subsystem impedances is used to derive global system impedances for GEOS, ISPM, ISEE-B, ESRO-4 and IMP-J satellites. Author (ESA)

N84-21611# Consulenze Generali Roma (Italy).
STUDY ON SYNTHESIS AND CHARACTERIZATION OF LARGE SPACE SYSTEMS, PHASE 2. PART 2: PROPOSALS FOR ADDITIONS, MODIFICATIONS AND NEW ANALYTICAL METHODS, VOLUME 1 Final Report
C. ARDUINI and U. PONZI Paris ESA Dec. 1982 360 p refs 5 Vol.
(Contract ESTEC-4348/80/NL-AK(SC))
(ESA-CR(P)-1779-VOL-3) Avail: NTIS HC A16/MF A01

For large space structure design, solution of the dynamic problems of the periodic structures by cyclosymmetric technique is discussed. Computing radiation forces by adapting thermal design verification softwares is considered. Simplified models and computational schemes for the aerodynamic load are outlined. Finite element formulations for tensioned members are evaluated.

N84-21612# Consulenze Generali Roma (Italy).
THE SOLUTION OF THE DYNAMIC PROBLEM OF THE PERIODIC STRUCTURES BY CYCLOSYMMETRIC TECHNIQUE Final Report
C. ARDUINI *In its* Study on Syn. and Characterization of Large Space Systems, Phase 2. Part 2: Proposals for Additions, Modifications and New Anal. Methods, Vol. 1 p 13-168 Dec. 1982 refs
Avail: NTIS HC A16/MF A01

The cyclosymmetric approach is advocated for the large space structure eigenvalue problem. The method treats noncyclosymmetric systems as perturbations of a basic cyclosymmetric system. Noncyclosymmetry is assumed to reside in the boundary conditions only. The original set of equations is reduced to a formally cyclosymmetric system by including all the deviations in the load vector (F). All the unknowns are obtained as functions of F, but since F also depends on the unknowns, the solution is really a reformulation of the problem. System cyclosymmetry is estimated a posteriori by comparing its modal shapes to those of the cyclosymmetric boundary conditions. The method is particularly good for higher frequency modes, but also gives good results for frequencies as low as the fundamental, and for any number of bays. It can be applied to multisymmetric systems. Author (ESA)

06

ELECTRONICS

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

A84-10016#
SPACE STATION DATA MANAGEMENT - A SYSTEM EVOLVING FROM CHANGING REQUIREMENTS AND A DYNAMIC TECHNOLOGY BASE
W. C. MOSLEY (General Electric Co., Space Systems Div., Valley Forge, PA) IN: Computers in Aerospace Conference, 4th, Hartford, CT, October 24-26, 1983, Collection of Technical Papers . New York, American Institute of Aeronautics and Astronautics, 1983, p. 101-109.
(AIAA PAPER 83-2338)

An assessment is made of the data management system requirements, and consequent architectural properties, of a prospective Space Station data system.These requirements are shaped by such factors as an operational lifetime that will span several generations of technology, and the ability to accomodate evolutionary growth. The architectural features that must be emphasized include modularity, to achieve functional autonomy, flexibility of application, testability, transparency of technological modification, and standardization. It is noted that software verification and validation tools offer the greatest potential return on investment of any of the data management system technology areas in which accelerated development can be undertaken. Generally, it is judged that the technology base for the initial configuration of the Space Station data system is currently available. O.C.

A84-10025#
A VOICE INTERACTIVE SYSTEM FOR AIDING AND DOCUMENTATION OF SPACE-BASED TASKS
V. RILEY and R. VESTEWIG (Honeywell Systems and Research Center, Minneapolis, MN) IN: Computers in Aerospace Conference, 4th, Hartford, CT, October 24-26, 1983, Collection of Technical Papers . New York, American Institute of Aeronautics and Astronautics, 1983, p. 171-177.
(AIAA PAPER 83-2355)

The application of a voice-interactive maintenance-aiding device (VIMAD) to the performance assembly and maintenance tasks in space is considered. The problems presented by the complexity of the tasks to be performed, by the crew limitations of space missions, by the space environment in general, and by the further restrictions of extravehicular activities are reviewed. VIMAD has been developed for ground use and comprises a helmet-mounted, hand-held, or full-size portable display unit linked by RF or cable to a computer or microcomputer controlling the presentation of video or audio information. User command is by voice or portable keyboard, and the instructions and diagrams are stored on random-access video and audio disks. The modifications in software and hardware which might be needed to adapt VIMAD to space use are discussed, taking the need for task documentation into account, and the advantages and feasibility of a VIMAD-type system are demonstrated. T.K.

A84-10396#
EXPERIMENT DATA COMMUNICATIONS (48 MBIT/S) BETWEEN SPACELAB, THE SPACE SHUTTLE AND THE GROUND
R. J. SELG (ESA, Spacelab Sustaining Engineering Div., Cocoa Beach, FL) and G. A. WEIJERS (ESA, Spacelab Sustaining Engineering Div., Noordwijk, Netherlands) ESA Bulletin (ISSN 0376-4265), no. 35, Aug. 1983, p. 34-39.

Tests have been performed at Johnson Space Center in Houston to verify the end-to-end data-transmission performance of the NASA Space Transportation System's high-rate data downlink (48 Mbit/s) with the European Spacelab multiplexing and demultiplexing equipment to be used at the link's input and output. The aims of the tests were to check equipment compatibility and the overall performance of the link and to establish operational procedures and constraints in time for the first Spacelab flight. Author

A84-11816*# National Aeronautics and Space Administration, Washington, D. C.
HIGH CAPACITY POWER SYSTEMS FOR SPACE
J. P. MULLIN and J. H. AMBRUS (NASA, Space Energy Conversion Office, Washington, DC) International Astronautical Federation, International Astronautical Congress, 34th, Budapest, Hungary, Oct. 10-15, 1983. 5 p.
(IAF PAPER 83-421)

Candidate high-power supply systems for future space missions are discussed. Solar cells, particularly made from GaAs materials, are projected to be amenable large arrays that will have a 10 yr lifetime with a 15 percent efficiency at the end. Concentrator arrays using GaAs cells could furnish over 200 W/sq m with 100 suns irradiance. Different battery systems, other than the present low-power NiCd storage systems, will be required, and could be either fuel cell systems or NiH2 batteries. The flywheel also offers promise, especially if integrated within the attitude control system. Solar thermal systems are also possible, featuring SiGe thermocouples, or boron alloys or rare earth calcogenides in thermoelectric generators or thermionic converters equipped with alkali metal elements. Mechanical systems, notably the Brayton cycle engine, offer multihundredwatt performance and higher, with at least 3.5 yr lifetimes. Experimentation is still needed to characterize the power supply interaction with the spacecraft environment and to design efficient and long-lasting radiators if heat engines are implemented. M.S.K.

A84-11817#
PHOTOVOLTAIC SOLAR ARRAYS LEADING TO A CANDIDATE SPACE POWER SYSTEM IN THE REGIME BEYOND 100 KW
W. WESTPHAL and J. RATH (Telefunken AG, Wedel, West Germany) International Astronautical Federation, International Astronautical Congress, 34th, Budapest, Hungary, Oct. 10-15, 1983. 27 p.
(IAF PAPER 83-422)

Design and technology considerations for a solar array power supply for the manned space station are discussed. The system would provide up to 100 kW peak and 40 kW continuous if batteries are provided. Currently unanswered problems are the interactions between the array and the station or platform, expansion to 260 kW output, stowage in the Shuttle for launch, and the deployment scenario. Choices will be made between concentrator and panel configurations, the structural materials, and the concentrator designs. Modular units are favored if retraction of the array is not a factor. It is noted that the solar array is preferred to nuclear turboelectric configurations for the 100 kW space station power supply. M.S.K.

A84-11823#
MANAGEMENT OF THE RADIOLINK OF THE SOLAR SAIL SPACECRAFT BY RADIO-AMATEURS
J. Y. PRADO, A. PERRET, and J. VILLAEYS (Union pour la Promotion de la Propulsion Photonique, Venerque, Haute-Garonne, France) International Astronautical Federation, International Astronautical Congress, 34th, Budapest, Hungary, Oct. 10-15, 1983. 4 p.
(IAF PAPER 83-447)

The progress of the technical studies being performed as a prelude to the construction of solar sail vehicles for a race to the moon is assessed. The designs of the sail are guided by the necessity of making them very large and very light, as well as of reflective materials. Attention is being given to the optimized control of the sails in order to configure the trajectory and gain or lose speed as needed. The manufacture and launch of a solar sail is projected to cost $2.5-5 million, and is planned to reach operation by 1986-87. The sails will be constructed of aluminized plastic films a few microns thick. Three sails can be launched in three separate modules in the lower part of the Ariane 3 or 4 fairing and placed in near-GEO by a kick motor. Ground control will guide the unfurling of the sails, which will be equipped to telemeter attitude data. Each sail will weigh about 170 kg, and commands will be issued at amateur radio wavelengths. M.S.K.

A84-13521#
EVALUATION OF BUS IMPEDANCE ON THE SPOT MULTIMISSION PLATFORM
A. CAPEL (ESA, Earth Observation Programme Office, Toulouse, France) and A. BARNABA (Centre National d'Etudes Spatiales, Toulouse, France) ESA Journal (ISSN 0379-2285), vol. 7, no. 3, 1983, p. 277-298. refs

A numerical model for the performance of a boost-type regulator for solar-array voltage regulation through shunting excess energy into dissipative elements or shorting the array strings is presented. Equations and variable waveforms which define static operation are described and a dynamic model is configured using the current-injection principle. The resulting small-signal equivalent model is tested against operation of a breadboard model and verified, and further confirmed in comparison with the unit in the SPOT power system. Note is taken of the bus impedance in the three boost sections of the SPOT power circuitry. Attention is also given to the effect of batteries wired in parallel to the user load. M.S.K.

A84-15623
NTC '82; NATIONAL TELESYSTEMS CONFERENCE, GALVESTON, TX, NOVEMBER 7-10, 1982, CONFERENCE RECORD
Conference sponsored by the Institute of Electrical and Electronics Engineers. New York, Institute of Electrical and Electronics Engineers, Inc., 1982, 515 p.

Topics of interest in the aerospace and electronic systems fields, such as space communications and digital avionics, are explored. Attention is given to digital avionic analysis and design, and to 30/20 GHz technology advances. Land mobile satellite system design concepts and technologies are discussed, as are communications, microwaves, and tracking systems for space, launch vehicles for communications satellites, and civil and military applications of the GPS. Optical communications potentialities, theory, and technologies are examined, and consideration is devoted to robotics, image coding advances, and advanced concepts in communications. The DBS system is described, together with computer simulations of telecommunication systems, remote sensing systems, and linearization of satellite communication. Offshore communications are investigated, as are optical processing of RF signals, communications and tracking for the Shuttle, and potential design and performance features of a space station. M.S.K.

A84-15639*# National Aeronautics and Space Administration. Lyndon B. Johnson Space Center, Houston, Tex.

SPACE STATION COMMUNICATIONS AND TRACKING EQUIPMENT MANAGEMENT/CONTROL SYSTEM

M. H. KAPELL and J. W. SEYL (NASA, Johnson Space Center, Houston, TX) IN: NTC '82; National Telesystems Conference, Galveston, TX, November 7-10, 1982, Conference Record . New York, Institute of Electrical and Electronics Engineers, Inc., 1982, p. B2.1.1-B2.1.8.

Design details of a communications and tracking (C and T) local area network and the distribution system requirements for the prospective space station are described. The hardware will be constructed of LRUs, including those for baseband, RF, and antenna subsystems. It is noted that the C and T equipment must be routed throughout the station to accommodate growth of the station. Configurations of the C and T modules will therefore be dependent on the function of the space station module where they are located. A block diagram is provided of a sample C and T hardware distribution configuration. A topology and protocol will be needed to accommodate new terminals, wide bandwidths, bidirectional message transmission, and distributed functioning. Consideration will be given to collisions occurring in the data transmission channels. M.S.K.

A84-15640* National Aeronautics and Space Administration. Lyndon B. Johnson Space Center, Houston, Tex.

COMMUNICATIONS, TRACKING, AND DOCKING ON THE SPACE STATION

H. O. ERWIN (NASA, Johnson Space Center, Houston, TX), M. H. CODEN, and F. W. SCHOLL (Codenoll Technology Corp., New York, NY) IN: NTC '82; National Telesystems Conference, Galveston, TX; November 7-10, 1982, Conference Record . New York, Institute of Electrical and Electronics Engineers, Inc., 1982, p. B2.2.1-B2.2.5.

Many of the communications, tracking, and docking functions on a large manned orbiting Space Station - one that is modular and made of metal - will have to be performed by optical systems out of necessity. This paper discusses four practical approaches to accomplishing Space Station functions using optical communications technology. It also provides the results of preliminary experiments involved in the design of particular systems. Major operational factors considered in each system design include: (a) electromagnetic interference problems, (b) data bandwidth requirements, (c) zero-gravity operations, (d) free-space operations, (e) data security, and (f) modular expansion of the Space Station structure. The technologies discussed are the following: (a) local infrared communications, (b) optical tracking and docking techniques, (c) long distance free space optical communications, and (d) local area optical networks. Author

A84-15641

MULTIBEAM PHASED ARRAYS - APPLICATION TO SOC/FREE-FLYER COMMUNICATION SYSTEM

J. S. RICE and J. H. OTT (Novar Electronics Corp., Barberton, OH) IN: NTC '82; National Telesystems Conference, Galveston, TX, November 7-10, 1982, Conference Record . New York, Institute of Electrical and Electronics Engineers, Inc., 1982, p. B2.3.1-B2.3.5.

Features of a multibeam design for control and communications between a NASA space station and up to 10 free-flying platforms are described. Performance demands permit high gain narrow beams at long range and low gain wide beams at short range. Interferometric phase control would form the transmit and receive beams based on measurements made by the free-flyers using reference signals beamed from no more than three locations on the space station's phased array. Nonlinear polarization is expected, and multiple antennas will be included on the station to prevent signal blocking. Calculations for the phased array are presented, and monolithic phased array technology is noted to fail to meet a need for multiaccess capabilities. M.S.K.

A84-15642*# National Aeronautics and Space Administration. Lyndon B. Johnson Space Center, Houston, Tex.

APPLICATION OF BEAM POWER TECHNOLOGY TO A SPACE STATION

G. D. ARNDT and J. H. SUDDATH (NASA, Johnson Space Center, Houston, TX) IN: NTC '82; National Telesystems Conference, Galveston, TX, November 7-10, 1982, Conference Record . New York, Institute of Electrical and Electronics Engineers, Inc., 1982, p. B2.4.1-B2.4.5. refs

The feasibility and performance parameters for beam microwave power supplies from a space station to nearby orbiting satellites are examined. A 5.8 GHz transmission frequency is found suitable for beaming 1-10 kW over a distance of 1-10 km. The antenna could have a 15 m diameter, a 64 kW output, provide uniform illumination, and have a retrodirective phase control system. A LEO to ground demonstration project is described, involving power levels of 0.0025 mW/sq cm and yielding 202 W at a 100 x 100 m rectenna. M.S.K.

A84-15643* Lockheed Engineering and Management Services Co., Inc., Houston, Tex.

A COMMUNICATIONS SYSTEM CONCEPTUAL DESIGN FOR A LOW EARTH ORBITING MANNED SPACE STATION

K. TU (Lockheed Engineering and Management Services Co., Inc., Houston, TX), W. E. TEASDALE, and R. J. ZIMMERMAN (NASA, Johnson Space Center, Houston, TX) IN: NTC '82; National Telesystems Conference, Galveston, TX, November 7-10, 1982, Conference Record . New York, Institute of Electrical and Electronics Engineers, Inc., 1982, p. B2.5.1-B2.5.19.

The results of a NASA study on the design of the communications system for a space station RF communications system are reported. The system requirements, ground rules, and assumptions are detailed, together with the overall configuration, the relay satellite links, and the forward and return links. The operational modes are surveyed for voice and data transmission performances, as well as links to unmanned orbital transfer vehicles. Tradeoff studies are yet to be performed for system growth, video data compression, multiaccess communications, optical or conventional functioning, and the necessary antenna systems. M.S.K.

A84-15671

AUTONOMOUS NAVIGATION OF GEOSYNCHRONOUS SATELLITES USING THE NAVSTAR GLOBAL POSITIONING SYSTEM

P. JORGENSEN (Aerospace Corp. El Segundo, CA) IN: NTC'82; National Telesystems Conference, Galveston, TX, November 7-10, 1982, Conference Record . New York, Institute of Electrical and Electronics Engineers, Inc., 1982, p. D2.3.1-D2.3.6.

Special problems arise in connection with the navigation of geosynchronous satellites using the Navstar/Global Positioning System (GPS). A user's set on a geosynchronous satellite, unlike the near earth user, can never perform the required measurements to four GPS satellites simultaneously. The present investigation is concerned with the consequences of this situation for the navigation of the geosynchronous satellites. It s found that despite the limited visibility of Navstar/GPS satellites to user satellites at geosynchrous altitude, GPS can provide autonomous navigation of geosynchronous satellites with an accuracy of the order of 100 m. G.R.

A84-17743
NARROW MULTIBEAM SATELLITE GROUND STATION ANTENNA EMPLOYING A LINEAR ARRAY WITH A GEOSYNCHRONOUS ARC COVERAGE OF 60 DEG. II - ANTENNA DESIGN
M. J. GANS and N. AMITAY (Bell Radio Research Laboratory, Holmdel, NJ) IEEE Transactions on Antennas and Propagation (ISSN 0018-926X), vol. AP-31, Nov. 1983, p. 966-972. refs

A dually polarized narrow (less than 0.5 deg) beam antenna which provides a geosynchronous arc coverage of 60 deg is proposed and analyzed. To track the geosynchronous arc accurately, the properly oriented antenna produces a conically scanned beam by means of a linear array of feed horns with bias ccut apertures illuminating a pair of parabolic cylinder reflectors in an imaging arrangement. This design, with reduced size array and singly curved reflectors, is relatively simple to construct. Calculations for a 0.35 deg beamwidth Ku band earth station antenna show a 0.05 deg pointing accuracy with scan loss due to aberrations less than 1 dB and little pattern degradation throughout the scan region. For multiple beam capability, a Rotman lens is proposed and analyzed as a means of exciting the feed array. It allows communication with multiple satellites spaced as close as 1 deg. Author

A84-18025*# Systems Science and Software, La Jolla, Calif.
PLASMA SHEATH STRUCTURE SURROUNDING A LARGE POWERED SPACECRAFT
M. J. MANDELL, G. A. JONGEWARD, and I. KATZ (System, Science and Software, La Jolla, CA) American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 22nd, Reno, NV, Jan. 9-12, 1984. 5 p. refs
(Contract NAS3-23058)
(AIAA PAPER 84-0329)

Various factors determining the floating potential of a highly biased (about 4-kV) spacecraft in low earth orbit are discussed. While the common rule of thumb (90 percent negative; 10 percent positive) is usually a good guide, different biasing and grounding patterns can lead to high positive potentials. The NASCAP/LEO code can be used to predict spacecraft floating potential for complex three-dimensional spacecraft. Author

A84-18394*# National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, Ala.
A PROGRAMMABLE POWER PROCESSOR FOR HIGH POWER SPACE APPLICATIONS
J. R. LANIER, JR., J. R. GRAVES, R. E. KAPUSTKA, and J. R. BUSH, JR. (NASA, Marshall Space Flight Center, Huntsville, AL) IN: PESC '82; Annual Power Electronics Specialists Conference, 13th, Cambridge, MA, June 14-17, 1982, Record . New York, Institute of Electrical and Electronics Engineers, 1982, p. 331-340. refs

A Programmable Power Processor (P3) has been developed for application in future large space power systems. The P3 is capable of operation over a wide range of input voltage (26 to 375 Vdc) and output voltage (24 to 180 Vdc). The peak output power capability is 18 kW (180 V at 100 A). The output characteristics of the P3 can be programmed to any voltage and/or current level within the limits of the processor and may be controlled as a function of internal or external parameters. Seven breadboard P3s and one 'flight-type' engineering model P3 have been built and tested both individually and in electrical power systems. The programmable feature allows the P3 to be used in a variety of applications by changing the output characteristics. Test results, including efficiency at various input/output combinations, transient response, and output impedance, are presented. Author

A84-19169
SAMPLED DATA CONTROL OF LARGE SPACE STRUCTURES USING CONSTANT GAIN VELOCITY FEEDBACK - A NEGATIVE VIEW
N. H. MCCLAMROCH (Michigan, University, Ann Arbor, MI) IN: Conference on Decision and Control, 21st, Orlando, FL, December 8-10, 1982, Proceedings. Volume 3 . New York, Institute of Electrical and Electronics Engineers, 1982, p. 1279, 1280.

A framework is developed for sampled data control of large space structures, in terms of discrete time recursive equations in second order form. This framework is used to analyze the simplest control scheme where the loop is closed using constant gain output velocity feedback. It is shown that the closed loop is stable if the feedback gain is positive definite and not too large, and if the output velocity feedback is properly specified. Properties of such a stabilizing controller establish the advantage of analog control of the form considered. Author

A84-20583
POTENTIAL OF MINICOMPUTER-ARRAY PROCESSOR SYSTEM FOR NONLINEAR FINITE-ELEMENT ANALYSIS
G. A. STROHKORB and A. K. NOOR (George Washington University, Hampton, VA) Computers and Structures (ISSN 0045-7949), vol. 18, no. 4, 1984, p. 703-718. refs

The potential of using a minicomputer/array-processor system for the efficient solution of large-scale, nonlinear, finite-element problems is studied. A Prime 750 is used as the host computer, and a software simulator residing on the Prime is employed to assess the performance of the Floating Point Systems AP-120B array processor. Major hardware characteristics of the system such as virtual memory and parallel and pipeline processing are reviewed, and the interplay between various hardware components is examined. Effective use of the minicomputer/array-processor system for nonlinear analysis requires the following: (1) proper selection of the computational procedure and the capability to vectorize the numerical algorithms; (2) reduction of input-output operations; and (3) overlapping host and array-processor operations. A detailed discussion is given of techniques to accomplish each of these tasks. Two benchmark problems with 1715 and 3230 degrees of freedom, respectively, are selected to measure the anticipated gain in speed obtained by using the proposed algorithms on the array processor. Previously announced in STAR as N83-27259 S.L.

A84-20647
IMPROVED ORBIT UTILIZATION USING AUXILIARY FEEDS IN EXISTING EARTH TERMINALS
J. ARNBAK, M. H. A. J. HERBEN, and R. A. C. M. VAN SPAENDONK (Eindhoven, Technische Hogeschool, Eindhoven, Netherlands) Space Communication and Broadcasting (ISSN 0167-9368), vol. 1, Dec. 1983, p. 405-416. refs

While geostationary orbit crowding has begun to restrict further development of the satellite communications bands, and the investment in existing earth terminals discourages antenna replacements for the achievement of lower sidelobe envelopes, the E-W stationkeeping tolerance was suffciently tightened in 1979 to make feasible the coordination of two potentially interfering satellite networks through specific sidelobe reductions at the appropriate earth terminals. This may be achieved by a simple retrofit of these terminals which are found to constrain orbit occupancy. Attention is presently given to the state of interferometric sidelobe suppression by auxillary feeds in double-reflector antenna systems, in view of feed geometry, orbital spacing between satellites, required excitation levels, and system bandwidth. O.C.

A84-20709
DIELECTRIC CHARGING IN SPACE - GROUND TEST DATA AND MODEL VERIFICATION
V. W. PINE, B. L. BEERS, and S. T. IVES (Beers Associates, Inc., Reston, VA) (IEEE, U.S. Defense Nuclear Agency, NASA, et al., Annual Conference on Nuclear and Space Radiation Effects, Gatlinburg, TN, July 18-21, 1983) IEEE Transactions on Nuclear Science (ISSN 0018-9499), vol. NS-30, Dec. 1983, p. 4290-4295. refs

A computational model of the charging of dielectrics by electron irradiation has been verified by comparison with ground-based test data. Recent improvements to the model are described briefly. Model calculations are compared with a variety of ground-based test data. The test data span a range of electron energies, from a few keV to beyond 1 MeV. Several experimental configurations are examined. Agreement between computational and experimental results is good. Author

A84-22958* Jet Propulsion Lab., California Inst. of Tech., Pasadena.
NEW DIRECTIONS IN SOLAR ARRAY DEVELOPMENT
J. SCOTT-MONCK (California Institute of Technology, Jet Propulsion Laboratory, Pasadena, CA) IN: Photovoltaic Specialists Conference, 16th, San Diego, CA, September 27-30, 1982, Conference Record . New York, Institute of Electrical and Electronics Engineers, 1982, p. 7-12. NASA-supported research. refs

A broad overview is presented of current and near-term solar array technology that could be suitable for space use. Particular consideration is given to such advanced concepts as high power arrays, concentrator arrays, and ultrathin solar cell arrays. It is concluded that if such ambitious concepts as geosynchronous space platforms, orbital space stations, and alternate forms of propulsion are realized, the type of new technology described in this paper may find acceptance for space. B.J.

A84-22959
TECHNOLOGY COMPONENTS OF SOLAR ARRAYS FOR SPACE PLATFORMS
K. BOGUS (ESA, European Space Research and Technology Centre, Noordwijk, Netherlands) IN: Photovoltaic Specialists Conference, 16th, San Diego, CA, September 27-30, 1982, Conference Record . New York, Institute of Electrical and Electronics Engineers, 1982, p. 13-20. refs

It is noted that the European Space Photovoltaics Program responds to the near-future needs of space platform missions. The chosen approach is characterized by emphasis on silicon-cell optimization, development of long-life contact systems, and commonality for different applications. Space platform concepts in the framework of the European space program are categorized into four classes containing near-term missions and follow-up generations: retrievable LEO platforms; long-life LEO platforms for earth observation and astronomy; power module systems; and geostationary telecommunication platforms. The requirements on the solar array subsystem in each of these classes are identified, leading to a definition of PV technology development requirements. Current space PV technology activities in Europe which respond to these requirements are discussed, and future space platform applications are examined. B.J.

A84-22961* Lockheed Missiles and Space Co., Sunnyvale, Calif.
SOLAR ARRAY SHUTTLE FLIGHT EXPERIMENT - HARDWARE DEVELOPMENT AND TESTING
R. V. ELMS (Lockheed Missiles and Space Co., Inc., Sunnyvale, CA), H. C. HILL, and L. E. YOUNG (NASA, Marshall Space Flight Center, Huntsville, AL) IN: Photovoltaic Specialists Conference, 16th, San Diego, CA, September 27-30, 1982, Conference Record . New York, Institute of Electrical and Electronics Engineers, 1982, p. 25-30.
(Contract NAS8-31352)

This paper reports on the fabrication and ground testing of (a) a large area, light-weight, flexible substrate developmental solar array wing that has been built for NASA-MSFC and of (b) the supporting structure and data acquisition system (DAS) which, with the wing, will be flown in the Shuttle as an experiment in 1984. The experiment will verify the dynamics, thermodynamic, and electrical performance predictions of the array wing and will demonstrate the structural capability of the array wing for Orbiter launch and re-entry environments. The experiment hardware verification program was designed to minimize costs and risk of experiment performance degradation while maintaining Shuttle and crew safety. The previous full-scale wing hardware tests included an extension mast water table test and wing testing for random vibration, thermal vacuum, and acoustic environments. The results of these tests were used to define wing design modifications and to scope the test program for the experiment hardware. Author

A84-22962
TECHNICAL ASPECTS OF THE INTELSAT V SOLAR ARRAY
H. E. POLLARD and W. R. BARON (Ford Aerospace and Communications Corp., Palo Alto, CA) IN: Photovoltaic Specialists Conference, 16th, San Diego, CA, September 27-30, 1982, Conference Record . New York, Institute of Electrical and Electronics Engineers, 1982, p. 31-35.

The Intelsat V solar array is the largest rigid solar array used for a commercial communication satellite. This paper describes salient technology applications of the electrical design, development and manufacture of the Intelsat V solar array. The circuits including cells, interconnects and wiring are being assembled using solderless welding techniques; the first solar array of this size to do so. Special welding process controls are described including monitor of electrical pulse, resistance and head pressure which provide the quality control to assure satisfactory welds. With the extensive use of solderless cells, various techniques were employed to ensure humidity resistance. The use of the Scanning Auger Microprobe as well as X-ray fluorescence for Palladium measurements are summarized. The electrical and environmental test program for the project is reviewed. Author

A84-22963* Lockheed Missiles and Space Co., Sunnyvale, Calif.
NEW COMPONENT DEVELOPMENT FOR MULTI-100 KW LOW-COST SOLAR ARRAY APPLICATIONS
G. J. PACK and J. A. MANN (Lockheed Missiles and Space Co., Inc., Sunnyvale, CA) IN: Photovoltaic Specialists Conference, 16th, San Diego, CA, September 27-30, 1982, Conference Record . New York, Institute of Electrical and Electronics Engineers, 1982, p. 36-38. Research supported by the Lockheed Missiles and Space Co.
(Contract NAS8-32981)

Studies of the cost and performance of flexible arrays have shown that the most dramatic reductions in the $/Watt figure of merit are achieved by increasing performance. An examination of those properties that contribute to array performance indicated areas where radical changes in current design practice and philosophy would result in significant cost and performance impacts. To take advantage of the predicted cost reductions, modules were fabricated and tested that had ultra-thin superstrates as a load carrying member and large area dielectric wraparound (DWA), gridded back surface and copper contacted solar cells. Author

A84-22979* Applied Solar Energy Corp., City of Industry, Calif.
LARGE AREA, LOW COST SPACE SOLAR CELLS
J. KUKULKA and P. A. ILES (Applied Solar Energy Corp., City of Industry, CA) IN: Photovoltaic Specialists Conference, 16th, San Diego, CA, September 27-30, 1982, Conference Record . New York, Institute of Electrical and Electronics Engineers, 1982, p. 146-149.
(Contract NAS9-16440)

This paper describes cost effective production-ready space solar cells which can meet the requirements for use on the Space Shuttle and other large space missions. Actual yield and performance data for these cells, as well as cost comparisons between these and standard space cells are included. Author

A84-22982
MECHANICAL WRAPAROUND CONTACTED CELL FOR LOW COST SPACE ARRAYS
N. MARDESICH, D. JOSLIN, and D. MICHAELS (Spectrolab, Inc., Sylmar, CA) IN: Photovoltaic Specialists Conference, 16th, San Diego, CA, September 27-30, 1982, Conference Record . New York, Institute of Electrical and Electronics Engineers, 1982, p. 160-163.

The paper presents the advantages, performance, reliability and cost of a mechanical wraparound contact on a large area solar cell. The wraparound contact consists of a silver ribbon laminated to the metallization on the back of a solar cell with an insulating acrylic-Kapton-acrylic sandwich and wrapped around the edge to the N+ metallization and welded. The wraparound contact can increase the cell cost by approximately 20 percent, which must be offset by the panel assembly savings. Author

A84-22997#
PREDICTION OF SOLAR CELL PERFORMANCE IN SPACE
R. L. STATLER and D. H. WALKER (U.S. Navy, Naval Research Laboratory, Washington, DC) IN: Photovoltaic Specialists Conference, 16th, San Diego, CA, September 27-30, 1982, Conference Record . New York, Institute of Electrical and Electronics Engineers, 1982, p. 301-306. Navy-supported research.

Predicting solar array performance with a high degree of accuracy is of critical importance to the success of space missions. This calculation is influenced by a large number of variables and parameters. Consequently, the accurate prediction becomes very difficult and safety margins must be assigned because of unknown factors relating to incomplete description of the behavior of the materials and components in the solar array. This paper discusses two factors which are important in such predictions. The first is a description of the gradual deterioration of the optical transmissivity of the coverglass and its adhesive layer, using data derived from the solar cell experiment on the Naval Research Laboratory NTS-2 satellite. The magnitude of this effect is shown through the interpretation of satellite data. The second factor is temperature enhanced radiation damage which was observed during radiation experiments at low dose rates on silicon solar cells. The observed radiation damage is shown to be strongly dependent on the temperature of the silicon cells during irradiation. The magnitude of this effect is shown in its influence on the interpretation of satellite data. Author

A84-25306#
MSAT MOBILE COMMUNICATION DEMONSTRATION SATELLITE SYSTEM AND BUS TRADEOFF CONSIDERATIONS
R. D. CASWELL (Department of Communications, Communications Research Centre, Ottawa, Canada) and A. M. KIDD (Spar Aerospace, Ltd., Montreal, Canada) IN: Communication Satellite Systems Conference, 10th, Orlando, FL, March 19-22, 1984, Technical Papers . New York, American Institute of Aeronautics and Astronautics, 1984, p. 450-458. refs
(AIAA PAPER 84-0751)

A84-26516#
RADIATION CHARACTERISTICS OF ARRAY ANTENNAS WITH DISTURBED APERTURE COVERAGE [STRAHLUNGSCHARAKTERISTIK VON ARRAY-ANTENNEN MIT GESTOERTER APERTURBELEGUNG]
E. FLOERY and W. RIEDLER (Graz, Technische Universitaet, Graz, Austria) (International Union of Radio Science and Nachrichtentechnische Gesellschaft, Gemeinsame Tagung, Kleinheubach, West Germany, Oct. 3-7, 1983) Kleinheubacher Berichte (ISSN 0343-5725), vol. 27, 1984, p. 243-252. In German. Research supported by the Fonds zur Foerderung der wissenschaftlichen Forschung. refs

A numerical simulation of the effect of disturbances in the ideal aperture coverage of phased array antennas on the radiation geometry is presented. The microwave radiation energy distribution in the near-earth region provides an important criterion for determining the energy threshold value of ionospheric modification and for fixing error tolerances. The simulation method is based on discretizing the aperture so that the geometric form and the energy distribution of the sending antenna can assume arbitrary profiles. C.D.

A84-28067
CHARACTERISTICS OF THE MICROPROCESSOR IMPLEMENTATION OF ALGORITHMS FOR THE PROCESSING OF RADIO SIGNALS AND NOISE IN LARGE ANTENNA ARRAYS [OSOBENNOSTI MIKROPROTSESSORNOI REALIZATSII ALGORITMOV OBRABOTKI RADIOSIGNALOV I POMEKH V BOL'SHIKH ANTENNYKH RESHETKAKH]
V. V. POPOVSKII and E. I. GLUSHANKOV Radioelektronika (ISSN 0021-3470), vol. 27, March 1984, p. 51-53. In Russian. refs

A84-29861
TELECOMMUNICATION SYSTEMS FOR LARGE-SCALE SPACE MANUFACTURING ACTIVITY
D. OLMSTEAD (Stanford University, Stanford, CA) and M. A. ROTHBLATT (Schnader, Harrison, Segal and Lewis, Washington, DC) IN: Space manufacturing 1983; Proceedings of the Sixth Conference, Princeton, NJ, May 9-12, 1983 . San Diego, CA, Univelt, Inc., 1983, p. 157-175.
(AAS PAPER 83-216)

Telecommunication systems for large-scale manufacturing activity are analyzed in terms of probable requirements, available frequency resources and desired network architecture. Separate analysis is provided for space manufacturing activity in earth orbit and in deep space. The paper suggests various design alternatives for meeting dispersed space communications requirements and considers interface options with terrestrial networks. The paper recommends adoption of a TDMA-based architecture and suggests spectrum allocation priorities for intersatellite and space operation radio services. Author

N84-12233*# National Aeronautics and Space Administration. Lyndon B. Johnson Space Center, Houston, Tex.
SPACE STATION ENERGY SIZING
R. R. RICE *In* NASA. Langley Research Center Integrated Flywheel Technol., 1983 p 57-62 Dec. 1983
Avail: NTIS HC A10/MF A01 CSCL 22B

A general schematic for a space station power system is described. The major items of interest in the power system are the solar array, transfer devices, energy storage, and conversion equipment. Each item will have losses associated with it and must be utilized in any sizing study, and can be used as a checklist for itemizing the various system components. Author

N84-12246*# National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.
ASSESSMENT OF POTENTIAL FOR BATTERIES IN SPACE APPLICATIONS
F. E. FORD *In* NASA. Langley Research Center Integrated Flywheel Technol., 1983 p 171-174 Dec. 1983
Avail: NTIS HC A10/MF A01 CSCL 10C

Different battery technologies for energy storage in space missions were examined. One of the best ways of the possibilities of high energy density batteries were determined by looking at more conventional batteries (i.e., lead-acid, nickel-cadmium, nickel-hydrogen, etc.). The theoretical specific energy density for state of the art batteries and the usable energy density for a reasonable life expectancy are outlined. The most mature of these couples is lead acid, which achieves nearly 20% of its theoretical capacity. The nickel-cadmium couple, has matured to where the active capacity is 17% of its theoretical capacity. The achievements are used to measure the practicality of more advanced batteries and to estimate what is needed for future high power space systems. E.A.K.

N84-12634*# TRW Space Technology Labs., Redondo Beach, Calif. Power Sources Engineering Dept.
STUDY OF MULTI-KILOWATT SOLAR ARRAYS FOR EARTH ORBIT APPLICATIONS Final Report, 19 Nov. 1980 - 30 Jun. 1983
R. E. PATTERSON 15 Oct. 1983 200 p refs
(Contract NAS8-34131)
(NASA-CR-170939; NAS 1.26:170939; REPT-38172-6001-UE-00)
Avail: NTIS HC A09/MF A01 CSCL 10A

A miniaturized Cassegrainian concentrator (MCC) solar array concept is being developed with the objective of significantly reducing the recurring cost of multikilowatt solar arrays. The desired cost reduction is obtained as a result of using very small high efficiency solar cells in conjuction with low cost optics. The MCC single element concept incident slar radiation is reflected rom a primary parabolic reflector to a secondary hyperbolic reflector and finally to a 4 millimeter diameter solar cell. A light catcher cone is used to improve off axis performance. The solar cell is mounted to a heat fin. An element is approximately 13 millimeters thick which permits efficient launch stowage of the concentrator system panels without complex optical component deployments or retractions. The MCC elements are packed in bays within graphite epoxy frames and are electrically connected into appropriate series-parallel circuits. A MCC sngle element with a 21 sq cm entrance aperture and a 20 efficient, 0.25 sq cm gallium arsenide solar cell has the same power output as 30 sq cm of 11-percent efficiency (at 68 C) silicon solar cells. S.C.L.

N84-12653# Istituto di Ricerca e Tecnologia per lo Studio del Plasma Nello Spazio, Frascati (Italy).
ORBITING WIRE AS A DYNAMO: AUXILIARY POWER POSSIBILITIES FOR SPACE PLATFORMS
G. MASTRANTONIO Mar. 1983 12 p refs Sponsored by CNR
(IFSI-83-3) Avail: NTIS HC A02/MF A01

A technique to short circuit the electric field set up by the Earth's magnetic field in an orbiting metal wire, so that energy can be extracted is described. Useful powers of 3 kw for wire length 1 km, 4 mm in diameter and for external load equal to the wire resistance are predicted. By varying the wire length as well as its cross-section low-voltage, high current (and vice-versa) needs can be met. Author (ESA)

N84-14394# General Research Corp., Santa Barbara, Calif.
RF SYSTEMS IN SPACE. VOLUME 2: SPACE-BASED RADAR ANALYSES Final Technical Report
A. V. MRSTIK, D. BESTE, R. J. BARTEK, and P. M. PAZICK Griffiss AFB, N.Y. RADC Apr. 1983 213 p
(Contract F30602-81-C-0119; AF PROJ. 4506)
(AD-A133735; RADC-TR-83-91-VOL-2) Avail: NTIS HCA10/MFA01 CSCL 17I

The main objective of this effort was to develop a computer based analytical capability for simulating the RF performance of large space-based radar (SBR) systems. The model is capable of simulating corporate and space fed aperture. The model also can simulate multibeam feeds, cluster/point feeds, corporate feed and various aperture distributions. The simulation is capable of accepting Draper Labs structural data and antenna current data from Atlantic Research Corporation's (ARC) First Approximation Methods (FAM) and Higher Approximation Methods (HAM) models. In addition there is a routine to input various apertures surface distortions which causes the elements in the arrays to be displaced from the ideal location on a planar lattice. There were analyses looking at calibration/compensation techniques for large aperture space radars. Passive, space fed lens SBR designs were investigated. The survivability of an SBR system was analyzed. The design of ground based SBR validation experiments for large aperture SBR concepts were investigated. SBR designs were investigated for ground target detection. GRA

N84-14395# General Research Corp., Santa Barbara, Calif.
RF SYSTEMS IN SPACE. VOLUME 1: SPACE ANTENNAS FREQUENCY (SARF) SIMULATION Final Technical Report
A. C. LUDWIG, J. R. FREEMAN, and J. D. CAPP Griffiss AFB, N.Y. RADC Apr. 1983 253 p
(Contract F30602-81-C-0119; AF PROJ. 4506)
(AD-A133734; RADC-TR-83-91-VOL-1) Avail: NTIS HCA12/MFA01 CSCL 17I

The main objective of this effort was to develop a computer based analytical capability for simulating the RF performance of large space-based radar (SBR) systems. The model is capable of simulating corporate and space fed aperture. The model also can simulate multibeam feeds, cluster/point feeds, corporate feed and various aperture distributions. The simulation is capable of accepting Draper Labs structural data and antenna current data from Atlantic Research Corporation's (ARC) First Approximation Methods (FAM) and Higher Approximation Methods (HAM) models. In addition there is a routine to input various apertures surface distortions which causes the elements in the array to be displaced from the ideal location on a planar lattice. These were analyses looking at calibration/compensation techniques for large aperture space radars. Passive, space fed lens SBR designs were investigated. The survivability of an SBR system was analyzed. The design of ground based SBR validation experiments for large aperture SBR concepts were investigated. SBR designs were investigated for ground target detection. GRA

N84-14761# Dornier-Werke G.m.b.H., Friedrichshafen (West Germany).
MODERN SOFTWARE DEVELOPMENT TOOLS IN SPACE PROJECTS ON THE EXAMPLE OF A SPACELAB EXPERIMENT
O. NEFF, R. SCHMIDT, and H. J. SCHNEIDER *In* ESA Software Eng. p 257-259 Aug. 1983
Avail: NTIS HC A13/MF A01

The life cycle of the software for a Spacelab experiment is outlined. Typical software requirements for spacecraft experiments, and software development tools used in this project are presented. The program design language; the real time language PEARL for programming; and a powerful debugging system, which can also be used for test and operation of the complete experiment are described. An implementation of the compiler and real time operating system, resulting in very efficient object code is demonstrated. Author (ESA)

N84-15386# Fondazione Ugo Bordoni, Rome (Italy).
THE SMALL TRANSMITTER RECEIVER STATIONS IN THE SIRIO EXPERIMENT [LE PICCOLE STAZIONI RICETRASMITTENTI NELL'ESPERIMENTO SIRIO]
P. LOMBARDI, P. MIGLIORINI, and E. SAGGESE (Telespazio S.p.A.) Oct. 1982 12 p In ITALIAN Submitted for publication
(FUB-50-1982) Avail: NTIS HC A02/MF A01

Experiments related to the utilization of 3m antenna transmitter receiver stations are discussed. The stations can transmit or receive via the Sirio satellite either 64 k bit/sec or 2.048 Mbit/sec data rates from or to similar stations or large antenna (17m) stations. System operation was tested using large antenna transmitters and small antenna receivers. With clear sky conditions a 0.0000001 error rate is feasible. The influence of rain events with alternations of the order on up to 12 dB is discussed. Author (ESA)

N84-15970 Colorado State Univ., Fort Collins.
CURRENT COLLECTION FROM THE SPACE PLASMA THROUGH DEFECTS IN HIGH VOLTAGE SOLAR ARRAY INSULATION Ph.D. Thesis
R. P. STILLWELL 1983 129 p
Avail: Univ. Microfilms Order No. DA8317838

For spacecraft operation in the near earth environment, solar cell arrays constitute the major source of reliable long-term power. Optimization of mass and power efficiency results in a general requirement for high voltage solar arrays. The space plasma environment, though, can result in large currents being collected

by exposed solar cells. The solution of a protective covering of transparent insulation is not a complete solution, inasmuch as defects in the insulation result in anomalously large currents being collected through the defects. Tests simulating the electron collection from small defects in an insulation have shown that there are two major collection modes. The first mode involves current enhancement by means of a surface phenomenon involving the surrounding insulator. In the second mode the current collecton is enhanced by vaporization and ionization of the insulator material, in addition to the surface enhancement of the first mode.
Dissert. Abstr.

N84-16247*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
RADIATING DIPOLE MODEL OF INTERFERENCE INDUCED IN SPACECRAFT CIRCUITRY BY SURFACE DISCHARGES
R. N. METZ (Colby College) Jan. 1984 7 p refs
(NASA-TP-2240; E-1775; NAS 1.60:2240) Avail: NTIS HC A02/MF A01 CSCL 22B

Spacecraft in geosynchronous orbit can be charged electrically to high voltages by interaction with the space plasma. Differential charging of spacecraft surfaces leads to arc and blowoff discharging. The discharges are thought to upset interior, computer-level circuitry. In addition to capacitive or electrostatic effects, significant inductive and less significant radiative effects of these discharges exist and can be modeled in a dipole approximation. Flight measurements suggest source frequencies of 5 to 50 MHz. Laboratory tests indicate source current strengths of several amperes. Electrical and magnetic fields at distances of many centimeters from such sources can be as large as tens of volts per meter and meter squared, respectively. Estimates of field attenuation by spacecraft walls and structures suggest that interior fields may be appreciable if electromagnetic shielding is much thinner than about 0.025 mm (1 mil). Pickup of such fields by wires and cables interconnecting circuit components could be a source of interference signals of several volts amplitude. Author

N84-17224*# General Dynamics Corp., San Diego, Calif.
PHOTOVOLTAIC CONCENTRATOR POINTING DYNAMICS AND PLASMA INTERACTION STUDY
T. G. STERN *In* NASA. Langley Research Center STEP Expt. Requirements p 177-184 Jan. 1984
Avail: NTIS HC A15/MF A01 CSCL 20I

The objectives of this experiment are to use the Space Technology Experiments Platform (STEP) system to demonstrate the viability of concentrator photovoltaic arrays by: (1) configuring a deployable mast on the STEP pallet with concentrator mass models and some active photovoltaic modules; (2) measuring the array pointing dynamics under normal rotation as well as disturbance conditions; (3) performing an array plasma interaction experiment to determine the steady-state plasma losses under various voltage conditions; and (4) providing active distributed control of the support truss to determine the improvement in dynamic response. Experiment approach and test control and instrumentation are described. M.G.

N84-17235*# National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.
ADAPTIVE MICROWAVE REFLECTOR
J. W. GOSLEE *In its* STEP Expt. Requirements p 325-331 Jan. 1984 refs
Avail: NTIS HC A15/MF A01 CSCL 20N

As an interim step in going to the 100-meter reflector that was evaluated, a 5-meter reflector is proposed to test the electrostatic concept under space conditions. Some of the issues which require the space environment for evaluation are the following questions: Can deployment of a box ring structure with a thin film reflector attached be manually deployed? In the absence of humidity, can a 0.3-mil aluminized Kapton film reflector be formed by the electrostatic process suitable for antenna applications? Can the photogrammetric process be used to evaluate the reflector surface with pictures taken from the payload handling station? Can the space charging effect be evaluated with the 5-meter reflector attached to the Shuttle? Does the outgassing of moisture from 0.3-mil Kapton film affect its reflector capability? A box ring truss support structure and an automatic sequence deployment system are discussed. R.J.F.

N84-17236*# National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.
MICROWAVE REFLECTOR CHARACTERIZATION USING SIMPLE INSTRUMENTS IN EVA
J. W. GOSLEE *In its* STEP Expt. Requirements p 333-338 Jan. 1984
Avail: NTIS HC A15/MF A01 CSCL 20N

An antenna with rigid panels which can be measured under ground conditions, carried to space in a packaged condition, deployed into a form similar to the Earth-measured one, measured under space conditions, restowed, and brought back to Earth so that the original measurements can be verified is the type being proposed for this experiment. The antenna chosen will be measured under ground conditions, carried aloft, deployed into its antenna shape, lifted by the remote manipulator system to a position where it can be sighted by two astronauts at the two theodolites, and held there until the surface characterization can be completed. An alternate method would be to use photogrammetry and take pictures of the surface from the payload handling station. After the surface characterization is completed, the antenna will be folded and restowed into the Shuttle bay for return to Earth. The surface characterization will be repeated on Earth after its return for verification both of the original measurement taken on Earth and the measurement taken in space. R.J.F.

N84-17254# Aerospace Corp., Los Angeles, Calif.
A REVIEW OF SCATHA SATELLITE RESULTS: CHARGING AND DISCHARGING
J. F. FENNELL, H. C. KOONS, M. S. LEUNG, and P. F. MIZERA *In* ESA Spacecraft/Plasma Interactions and their Influence on Field and Particle Meas. p 3-11 Nov. 1983 refs
(Contract AF-F04701-82-C-0083)
Avail: NTIS HC A10/MF A01

Results from the SCATHA satellite charging monitors and discharge detectors are summarized. The data show that surface charging, near synchronous altitudes, occurs preferentially in the midnight to local morning sectors. Evidence for bulk charging by energetic electrons is also observed. Material charging data show that there is a marked increase in bulk conductivity of solar-illuminated Kapton with exposure time in the space vacuum. Teflon accumulates a permanent charge which slowly increases with time. A quartz cloth material charges to higher than expected levels. Statistical analysis of the surface charging and the resultant discharges and noise generation shows a close association with each other. Discharges are ascribed to possible bulk charging. The signal amplitudes of the discharges are discussed and the temporal character of the discharge signal is shown.
Author (ESA)

N84-17269*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
THE ROLE OF POTENTIAL BARRIER FORMATION IN SPACECRAFT CHARGING
C. K. PURVIS *In* ESA Spacecraft/Plasma Interactions and their Influence on Field and Particle Meas. p 115-124 Nov. 1983 refs Previously announced as N83-35005
Avail: NTIS HC A10/MF A01 CSCL 22B

The role of potential barrier formation in spacecraft charging at geosynchronous orbit is discussed. Sudden dramatic shifts in structure potential at eclipse entry and exit, and in response to injections of hot plasma during eclipse do not indicate the magnitude of differential charging. All daylight charging and some long-term eclipse charging is barrier dominated. Shaded or low yield surfaces charge negatively, forming vacuum potential barriers which suppress emission of photoelectrons and secondary electrons, causing the spacecraft to charge negatively. This process, which is configuration and material dependent, limits the magnitude of insulator-negative differential charging to values substantially lower than supposed, and allows the possibility of insulator-positive differential charging. Discharges are less energetic and more localized than supposed. If the spacecraft changes its potential when electrons are emitted in a discharge, then when the structure is driven positive, electron emission should cease. Author (ESA)

N84-17431*# LinCom Corp., Los Angeles, Calif.
USER MANUAL OF THE CATSS SYSTEM (VERSION 1.0) COMMUNICATION ANALYSIS TOOL FOR SPACE STATION Interim Report
C. S. TSANG, Y. T. SU, and W. C. LINDSEY Nov. 1983 45 p
(Contract NAS9-16868)
(NASA-CR-171728; NAS 1.26:171728; TR-1183-8314) Avail: NTIS HC A03/MF A01 CSCL 17B

The Communication Analysis Tool for the Space Station (CATSS) is a FORTRAN language software package capable of predicting the communications links performance for the Space Station (SS) communication and tracking (C & T) system. An interactive software package was currently developed to run on the DEC/VAX computers. The CATSS models and evaluates the various C & T links of the SS, which includes the modulation schemes such as Binary-Phase-Shift-Keying (BPSK), BPSK with Direct Sequence Spread Spectrum (PN/BPSK), and M-ary Frequency-Shift-Keying with Frequency Hopping (FH/MFSK). Optical Space Communication link is also included. CATSS is a C & T system engineering tool used to predict and analyze the system performance for different link environment. Identification of system weaknesses is achieved through evaluation of performance with varying system parameters. System tradeoff for different values of system parameters are made based on the performance prediction. Author

N84-17436*# Old Dominion Univ., Norfolk, Va. Dept. of Electrical Engineering.
AIRBORNE ANTENNA PATTERN CALCULATIONS Final Report, 1 Nov. 1982 - 31 Oct. 1983
A. B. BAGHERIAN and R. R. MIELKE Dec. 1983 106 p refs
(Contract NSG-1655)
(NASA-CR-173284; NAS 1.26:173284) Avail: NTIS HC A06/MF A01 CSCL 20N

Use of calculation program START and modeling program P 3D to produce radiation patterns of antennas mounted on a space station is discussed. Basic components of two space stations in the early design stage are simulated and radiation patterns for antennas mounted on the modules are presented. Author

N84-17931# Air Force Inst. of Tech., Wright-Patterson AFB, Ohio.
SELECTION OF NOISY SENSORS AND ACTUATORS FOR REGULATION OF LINEAR SYSTEMS Ph.D. Thesis
M. L. DELORENZO Aug. 1983 254 p
(AD-A135442; AFIT/CI/NR-83-59D) Avail: NTIS HC A12/MF A01 CSCL 12A

This research has developed and tested an algorithm which aids the controls engineer in placing sensors and actuators in a linear system to best achieve a set of variance specifications on the outputs and inputs of the system. The term best achieve has been defined to be the sensor and actuator configuration which enables a controller to do either of the following: Meet the input specifications while minimizing a sum of output variances normalized by their specification (i.e. input-constrained solution), or meet the output specifications while minimizing a sum of input variances normalized by their specification (i.e., output-constrained solution). The approach taken to solve this sensor and actuator selection (SAS) problem was to use LQG (Linear Quadratic Gaussian) theory to specify a structure for the controller, and then develop an algorithm (SASLQG) that places sensors and actuators in this controller structure to achieve either the input-constrained or output-constrained solution. The main advantage of this approach is the mathematical ease which LQG theory addresses variance constraints, and the main disadvantage is that there may be other controller structures which do better. GRA

N84-18458# Contraves Corp., Zurich (Switzerland). Dept. EKR.
SPACE TELESCOPE: SOLAR ARRAY PRIMARY DEVELOPMENT MECHANISM
A. VEIT and D. CHANDLER *In* ESA First European Space Mech. and Tribology Symp. p 27-34 Dec. 1983
Avail: NTIS HC A10/MF A01

A Primary Deployment Mechanism (PDM) powered by redundant stepper motors was developed for the primary deploy and stow operations of the Space Telescope solar array. The mechanism locks the array boom in the deployed position and releases the boom at the end of mission for restowing before capture and Earth return via space shuttle. Due to a continual growth in the design load of the PDM, the system exhibited instabilities. A redesign introduced a planetary gear train between the motors and the primary lever arms. This results in a very stable system, allowing for increase in system load if required. Three flight models were successfully tested. Acceptance testing, besides ambient operational tests, included vibration and thermal vacuum tests with operational testing being included in the thermal vacuum environment. Author (ESA)

N84-18532# National Telecommunications and Information Administration, Annapolis, Md.
ASSESSMENT OF SATELLITE POWER FLUX-DENSITY LIMITS IN THE 2025-2300 MHZ FREQUENCY RANGE, PART 1
A. FARRAR Oct. 1983 67 p refs
(PB84-129402; NTIA/REPT-83-135) Avail: NTIS HC A04/MF A01 CSCL 17B

An assessment of the line-of-sight (LOS) power flux-density (pfd) limits for satellites operating in the 2025-2300 MHz frequency range was conducted. Two computer models were used in the analysis. Modifications to these models were suggested in order to enhance their accuracy in the evaluation of the pfd limits in this and other shared bands. Distinctions were made between the satellites in geostationary satellite orbit and those in nongeostationary orbits. Two different sets of limits were calculated, one for the satellites in the geostationary satellite orbit and the other for the satellites in nongeostationary satellite orbits. These limits were calculated using the technical characteristics of equipment in the 2025-2300 MHz frequency range. The preliminary calculations using the existing computer models indicate that the pfd limits for the satellites operating in this frequency range may be relaxed. GRA

N84-19382*# National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.
SPACELAB DATA PROCESSING FACILITY
1983 27 p refs Original document contains color illustrations
(NASA-TM-85556; NAS 1.15:85556) Avail: NTIS HC A03/MF A01 CSCL 14B

The Spacelab Data Processing Facility (SDPF) processes, monitors, and accounts for the payload data from Spacelab and other Shuttle missions and forwards relevant data to various user facilities worldwide. The SLDPF is divided into the Spacelab Input Processing System (SIPS) and the Spacelab Output Processing System (SOPS). The SIPS division demultiplexes, synchronizes, time tags, quality checks, accounts for the data, and formats the data onto tapes. The SOPS division further edits, blocks, formats, and records the data on tape for shipment to users. User experiments must conform to the Spacelab's onboard High Rate Multiplexer (HRM) format for maximum process ability. Audio, analog, instrumentation, high density, experiment data, input/output data, quality control and accounting, and experimental channel tapes along with a variety of spacelab ancillary tapes are provided to the user by SLDPF. M.A.C.

N84-19463# Air Force Geophysics Lab., Hanscom AFB, Mass.
SHEATH IONIZATION MODEL OF BEAM EMISSIONS FROM LARGE SPACECRAFTS
S. T. LAI, H. A. COHEN, K. H. BHAVNANI (Radex, Inc.), and M. F. TAUTZ (Radex, Inc.) 30 Dec. 1983 14 p Presented at the Spacecraft Environ. Interactions Technol. Conf., Colorado Springs, 4-6 Oct. 1983
(Contract AF PROJ. 7661)
(AD-A137181; AFGL-TR-83-0331) Avail: NTIS HC A02/MF A01 CSCL 22A

An analytical model of the charging of a spacecraft emitting electron and ion beams has been applied to the case of large spacecraft. In this model, ionization occurs in the sheath due to the return current. Charge neutralization of spherical space charge flow is examined by solving analytical equations numerically. Parametric studies of potential large spacecraft are performed. As in the case of small spacecraft, the ions created in the sheath by the returning current play a large role in determining spacecraft potential. Author (GRA)

N84-21781# Mission Research Corp., Santa Barbara, Calif.
THE EFFECTS OF APERTURE ANTENNAS AFTER SIGNAL PROPAGATION THROUGH ANISOTROPIC IONIZED MEDIA
D. L. KNEPP 1 Mar. 1983 76 p
(Contract DNA001-81-C-0006; S99-QAXH)
(AD-A138286; AD-E301332; MRC-R-744; DNA-TR-81-254) Avail: NTIS HC A05/MF A01 CSCL 20N

Because of the large ranges involved, a space based search and track radar requires a large aperture antenna to increase the energy collected and to create a narrow beam for accurate angle measurements and for resistance to localized jammers. This report gives the effects of such an antenna on measurements of received power, decorrelation time (or distance), mean time delay, time delay jitter and coherence bandwidth after propagation of the radar signal through a strongly disturbed transionospheric propagation channel. It is shown that aperture averaging can reduce observed signal power, increase observed decorrelation time and can be a significant factor in reducing the time delay jitter observed at the antenna output. As part of this analysis an analytic solution is obtained for the two-position, two-frequency mutual coherence function for spherical wave propagation in the strong scatter limit. Transmitter and receiver are located in free-space on opposite sides of a thick slab containing anisotropic electron density irregularities that are elongated in the direction parallel to the magnetic field. The orientation of the magnetic result is used to determine the effect of an antenna aperture as a function of geometry relative to the magnetic field. GRA

07

ADVANCED MATERIALS

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

A84-10949*# Monsanto Research Corp., St. Louis, Mo.
EROSION OF MYLAR AND PROTECTION BY THIN METAL FILMS
P. FRAUNDORF (Monsanto Research Center, St. Louis, Mo), D. LINDSTROM, S. SANDFORD, P. SWAN, R. WALKER, E. ZINNER (Washington University, St. Louis, MO), and N. PAILER (Max-Planck-Institut fuer Kernphysik, Heidelberg, West Germany) IN: Shuttle Environment and Operations Meeting, Washington, DC, October 31-November 2, 1983, Collection of Technical Papers . New York, American Institute of Aeronautics and Astronautics, 1983, p. 131-137. refs
(Contract NAGW-122)
(AIAA PAPER 83-2636)

Mylar strips, 2.5 microns thick, uncoated and coated with 50A, 100A and 200A of Al, Pd, and Au/Pd were exposed on STS-5 in order to measure the erosion of mylar and to test means of protecting thin plastic foils commonly used for space experiments in low earth orbit. Analysis by optical microscopy, SEM and STEM investigation, EDX measurements, FTIR spectroscopy and weight loss measurements showed that while up to 75 percent of the uncoated mylar was eroded during exposure, thin coatings of the above metals can protect mylar for integrated oxygen-fluxes of at least 10 to the 21st atoms/sq cm. Author

A84-17108
NEW FABRIC STRUCTURES OF CARBON FIBER
A. NISHIMURA, N. UEDA, and H. S. MATSUDA (Toray Industries, Inc., Otsu, Shiga, Japan) IN: Materials and processes - Continuing innovations; Proceedings of the Twenty-eighth National SAMPE Symposium and Exhibition, Anaheim, CA, April 12-14, 1983 . Azusa, CA, Society for the Advancement of Material and Process Engineering, 1983, p. 71-88.

Carbon fiber fabric has been increasingly used as a reinforcing intermediate material in the fields of aircraft and aerospace materials that require high performance; and is becoming one of the basic reinforcing materials for composites. A drawback of conventional fabric, however, is in lower transfer ratio of the properties to those of the composites. This is a result of carbon fiber bend (crimp), caused by the alternate crossing of warp and weft yarns which induce stress concentration. In order to solve the problem, a new fabric structure, that is, bi-directional noncrimp carbo fiber fabrics have been developed. In this paper, attention is given to test results obtained from extensive studies of noncrimp fabrics; that is, optimum design of fabric construction and effect of the construction to mechanical properties. The carbon fiber investigated includes the newly developed high strain type having more than 1.7 percent ultimate strain. Author

A84-17120
FIELD REPAIR OF GRAPHITE EPOXY SKIN PANELS ON THE SPACESHIP COLUMBIA
W. A. HENRY (Rockwell International Corp., Space Transportation and Systems Group, Downey, CA) IN: Materials and processes - Continuing innovations; Proceedings of the Twenty-eighth National SAMPE Symposium and Exhibition, Anaheim, CA, April 12-14, 1983 . Azusa, CA, Society for the Advancement of Material and Process Engineering, 1983, p. 249-257.

Prior to and during the first four test flights of the spaceship Columbia, structural deficiencies as well as flight damages to the aft propulsion subsystem orbital maneuvering and reaction control subsystems pods graphite epoxy (G/ep) skin panels were strengthened and repaired with beefup straps and doublers bonded in place at Kennedy Space Center. This is a delineation of the structural modifications and double repairs made on these skin panels. It includes a discussion of failure causes and descriptions, inspections, development of bonding techniques and procedures, installation of beefups and repair doublers, and bonding procedure modifications resulting from problems encountered in the field. It highlights the evolution of the procedure from that developed in the laboratory to modifications made in the field to eliminate problems encountered during field installation of beefups and repairs. The beefup and repair procedures developed in the laboratory and modified in the field prior to and during the early flights of Columbia have become the standard procedures for all OMS/RCS pod field repairs. Author

A84-17151
ADVANCED COMPOSITE ANTENNA REFLECTORS FOR COMMUNICATIONS SATELLITES
R. N. GOUNDER, C. F. SHU, and B. D. JACOBS (RCA, Astro Electronics Div., Princeton, NJ) IN: Materials and processes - Continuing innovations; Proceedings of the Twenty-eighth National SAMPE Symposium and Exhibition, Anaheim, CA, April 12-14, 1983 . Azusa, CA, Society for the Advancement of Material and Process Engineering, 1983, p. 678-686.

This paper discusses advanced composites applications to communications antenna reflectors used on RCA-built satellites. Various types of reflector systems and their specific materials and structures requirements are reviewed. The mechanical design, analysis, and test results for the different types of advanced composite reflectors are presented. The specific problems associated with deployable, frequency-reuse, gridded Kevlar reflectors and large, deployable, high-frequency graphite reflectors are discussed in greater detail. Novel design concepts for the control of thermal distortions in deployable, composite reflectors are presented. Author

A84-17174
USING THE OUTGASSING TEST TO SCREEN MATERIALS FOR CONTAMINATION POTENTIAL
R. MOSS (Ford Aerospace and Communications Corp., Western Development Laboratories Div., Palo Alto, CA) IN: Materials and processes - Continuing innovations; Proceedings of the Twenty-eighth National SAMPE Symposium and Exhibition, Anaheim, CA, April 12-14, 1983 . Azusa, CA, Society for the Advancement of Material and Process Engineering, 1983, p. 1045-1056. refs

The standard outgassing test method, ASTM E-595, and the apparatus used are described, and results of internal and round robin inter-laboratory tests are reviewed. It is shown that the ASTM E-595 outgassing test is an accurate, reproducible method for screening organic materials for contamination. Normal acceptance levels of 1.0 percent TML and 0.10 percent VCM are realistic for the initial screening of materials. More than 90 percent of materials can be expected to clearly pass or fail the 1.0 and 0.10 percent limits. Round robin tests confirm that different laboratories testing the same material can expect the same accept/reject results. The test is not operator sensitive. V.L.

A84-17200
CRACKED INNER LAYER FOIL IN HIGH-DENSITY MULTILAYER PRINTED WIRING BOARDS
G. R. PAUL (McDonnell Douglas Astronautics Co., Huntington Beach, CA) IN: Materials and processes - Continuing innovations; Proceedings of the Twenty-eighth National SAMPE Symposium and Exhibition, Anaheim, CA, April 12-14, 1983 . Azusa, CA, Society for the Advancement of Material and Process Engineering, 1983, p. 1399-1405. refs

A study has been undertaken to establish why foil cracks occur at the internal foil planes of multilayer boards (MLBs) fabricated with standard 1- and 2-oz electrodeposited (ED) copper foil. The foil cracking was observed during the testing of high-density MLBs and following the thermal stress requirements similar to MIL-P-55110C, but at 500 F. Metallographic analysis indicated that layers one and two and/or nine and ten of a typical 10-layer MLB were most susceptible to thermal shock damage. Test panels were fabricated using standard ED clad material for comparison to laminate with high-temperature elongation (HTE) copper foil. The test panels were subjected to process variations throughout the stages of fabrication to determine the failure mechanism. Author

A84-17768
MATERIALS AND CONSTRUCTION TECHNIQUES FOR LARGE SPACECRAFT STRUCTURES [WERKSTOFFE UND BAUWEISEN GROSSER RAUMFAHRTSTRUKTUREN]
W. HARTUNG (Deutsche Forschungs- und Versuchsanstalt fuer Luft- und Raumfahrt, Institut fuer Strukturmechanik, Brunswick, West Germany) DFVLR-Nachrichten (ISSN 0011-4901), vol. 40, Nov. 1983, p. 26-29. In German.

The current status of DFVLR research on CFRP materials and designs for large structures (such as a communications platform) to be built from modular subassemblies in orbit is reviewed. The pilot studies assume a platform lifetime of 10-20 yr and use slender, thin-walled profiled bars as primary construction elements. Thermal cyclic tests show that epoxide-resin CFRP elements maintain tensile strength at 80 percent or better after 3480 cycles but suffer some loss of stiffness. Exposure during 27 h to an electron-radiation dose greater than that predicted for the platform lifetime produces no detrimental effect on CFRP performance. Overall, the applicability of CFRP to these structures has been confirmed. Since the structural designs themselves cannot be effectively tested on earth, modal survey tests using new software (incorporating phase-resonance and phase-separation phenomena) and mathematical simulations of the larger structures are being developed. T.K.

A84-18159#
REACTIONS OF HIGH VELOCITY ATOMIC OXYGEN WITH CARBON
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, 22nd, Reno, NV, Jan. 9-12, 1984. 6 p. Research supported by the Aerospace Corp. refs
(AIAA PAPER 84-0549)

A spacecraft in low earth orbit experiences bombardment by fast oxygen atoms by virtue of its own orbital velocity. Direct, dramatic observations on the Space Shuttle, as well as indirect evidence from a number of Space Division and NASA spacecraft, have revealed some of the effects which this bombardment can produce. The high velocity at which atoms strike surfaces on orbit has resulted in gas-solid chemistry not observed in the thermal interactions of oxygen atoms with surfaces and has apparently accelerated the rates of some more familiar processes. The phenomenology of oxygen atom collisions with surfaces is completely unstudied at these high collision velocities (2-8 km/sec). This paper discusses the reactions between oxygen atoms and carbon films at collision velocities of 3.5 km/sec. It is found that there is no apparent translational energy enhancement of reaction probability at this collision velocity. Results are compared to on-orbit rates. Author

A84-19912*# National Aeronautics and Space Administration. Lyndon B. Johnson Space Center, Houston, Tex.
LOW EARTH ORBIT ATOMIC OXYGEN EFFECTS ON SURFACES
L. J. LEGER, J. T. VISENTINE, and J. F. KUMINECZ (NASA, Johnson Space Center, Houston, TX) American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 22nd, Reno, NV, Jan. 9-12, 1984. 9 p. refs
(AIAA PAPER 84-0548)

Significant effects have been observed on surfaces in the Shuttle Orbiter payload bay and on some experiments due to exposure to the LEO environment. These effects, which are predominantly manifested as surface recession and therefore mass loss, appear to arise from oxidation from exposure to atomic oxygen, the major LEO component. Rates of interaction were measured on two experiments for a large group of materials and specifically for thin organic films, and are in the range of 2-3 x 10 to the 24th cu cm/atom. These rates are large enough to present significant problems for solar arrays which use similar thin films for solar-cell support. Author

A84-20682* Jet Propulsion Lab., California Inst. of Tech., Pasadena.
SIMULATED SPACE RADIATION EFFECTS ON DIELECTRICS AND COATINGS
F. L. BOUQUET, A. PHILLIPS (California Institute of Technology, Jet Propulsion Laboratory, Pasadena, CA), and D. A. RUSSELL (Boeing Radiation Effects Laboratory, Seattle, WA) (IEEE, U.S. Defense Nuclear Agency, NASA, et al., Annual Conference on Nuclear and Space Radiation Effects, Gatlinburg, TN, July 18-21, 1983) IEEE Transactions on Nuclear Science (ISSN 0018-9499), vol. NS-30, Dec. 1983, p. 4090-4093. NASA-supported research. refs

Simulation tests of space radiation have been performed for specific organic and inorganic materials. The test results for fifteen materials exposed to protons and five exposed to electrons are presented. Author

A84-21775
THE EFFECT OF PRESSURE AND TEMPERATURE ON TIME-DEPENDENT CHANGES IN GRAPHITE/EPOXY COMPOSITES BELOW THE GLASS TRANSITION
J. MIJOVIC and R. C. LIANG (New York, Polytechnic Institute, Brooklyn, NY) Polymer Engineering and Science (ISSN 0032-3888), vol. 24, no. 1, Jan. 1984, p. 57-66. refs
(Contract NSF MEA-81-20211)

Effects of pressure and temperature on time-dependent changes in physical/mechanical properties of graphite/epoxy composites were investigated. Samples were cut from the eight-ply-thick laminates of commercially used composites, post-cured, and then quenched to environments of various temperature and pressure. Time-dependent changes in their properties were analyzed by thermal and thermomechanical (dynamic mechanical) measurements. An increase in the glass-transition temperature was found to occur as a function of time. The rate of this process was enhanced by an increase in temperature and/or a decrease in pressure. An explanation was offered in terms of types and mechanisms of molecular events that occur in the glassy state. Time-dependent decrease in free volume (and enthalpy) takes place but is not the sole mechanism responsible for the observed increase in T(g). After a certain period of time (which depends on T and P of the environment), additional crosslinking appears to take place. Author

A84-24501
FRACTURE MECHANICS OF CERAMICS. VOLUME 5 - SURFACE FLAWS, STATISTICS, AND MICROCRACKING
R. C. BRADT, ED. (Pennsylvania State University, University Park, PA), A. G. EVANS, ED. (California, University, Berkeley, CA), D. P. H. HASSELMAN, ED. (Virginia Polytechnic Institute and State University, Blacksburg, VA), and F. F. LANGE, ED. (Rockwell International Science Center, Thousand Oaks, CA) New York, Plenum Press, 1983, 706 p.

Among the topics discussed are interface crack extension with friction, the indentation fracture toughness of brittle materials with Palmquist cracks, the surface and subsurface fracture of alpha-SiC single crystals, brittle material deformation and cracking during high temperature scratching, ceramic material reliability assessment, a probabilistic framework for structural design, the measurement and implications of the stress corrosion limit, a universal materials function for subcritical crack extension, and the fracture of piezoelectric materials. Also discussed are the fracture statistics of multiple flaw distributions, reliability improvements for hot pressed silicon nitride, ceramic microcracking mechanisms, statistical aspects of grain boundary cracking in ceramics and rocks, the fracture behavior of glass matrix/glass particle composites, and limitations and challenges found in the application of fracture mechanics to ceramics. O.C.

A84-24508
ASSESSMENT OF RELIABILITY OF CERAMIC MATERIALS
J. E. RITTER, JR. (Massachusetts, University, Amherst, MA) IN: Fracture mechanics of ceramics. Volume 5 - Surface flaws, statistics, and microcracking . New York, Plenum Press, 1983, p. 227-251. refs

The reliability analysis of ceramic components must take into account the variability and time-dependency of strength. The techniques and concepts of fracture mechanics can be used for purposes of design to estimate the allowable stress and expected lifetime of a component in service. This is accomplished by estimating the initial crack size in the material and the time required for the crack to grow from its initial size to a final critical size. The application of fracture mechanics theory appropriate for carrying out a reliability analysis is reviewed and successful applications of this theory are discussed. Limitations of the theory and methods for overcoming these limitations are then presented. Author

A84-28242
SIC-REINFORCED-ALUMINUM ALLOYS FOR AEROSPACE APPLICATIONS
B. J. MACLEAN and M. S. MISRA (Martin Marietta Aerospace, Denver, CO) IN: Mechanical behavior of metal-matrix composites; Proceedings of the Symposium, Dallas, TX, February 16-18, 1982 . Warrendale, PA, The Metallurgical Society of AIME, 1983, p. 301-320.

The aluminum alloys 6061 and 2024, reinforced with SiC whiskers or particulates, were tested for tensile, fatigue, impact toughness, and thermal expansion properties. Substantial improvements in modulus, strength, and fatigue resistance were observed when compared to the metal-matrix composite's wrought alloy counterpart. Depending on the degree of hot-working, elastic moduli on the order of 18 x 10 to the 6th psi (124 GPa) are possible with tensile strengths of greater than 70,000 psi (480 MPa). Enhanced strength and stiffness evolve at the expense of elongation and impact toughness. Microstructure and fractography reveal the relation between reinforcement/matrix homogeneity and isotropy of properties. The coefficient of thermal expansion is seen to decrease from a nominal value of 13 x 10 to the -6th in./in. F to 8 x 10 to the -6th in./in. F. Author

A84-28458* Jet Propulsion Lab., California Inst. of Tech., Pasadena.
EVALUATION OF SPACECRAFT MATERIALS AND PROCESSES FOR OPTICAL DEGRADATION POTENTIAL
T. ODONNELL (California Institute of Technology, Jet Propulsion Laboratory, Applied Mechanics Technology Section, Pasadena, CA) IN: Spacecraft contamination environment; Proceedings of the Meeting, Arlington, VA, May 4-6, 1982 . Bellingham, WA, SPIE - The International Society for Optical Engineering, 1983, p. 65-71. refs
(Contract JPL-955426)

A Wide Field Planetary Camera instrument with wide wavelength sensitive Charged Coupled Device detectors has been designed and built for employment in space. The contamination potential of the spacecraft hardware is determined by the outgassing characteristics of the selected materials and the effect of the performed processing procedures. An investigation was conducted to provide for more selective material screening with respect to contamination potential and to develop an optical effects data base. In the investigation, a series of thermogravimetric, residual gas, Micro-Volatile Condensible Material (VCM), and Vacuum Optical Degradation tests were performed. The results of the Micro-VCM testing of four epoxy adhesive systems are presented in tables. G.R.

A84-28553* Jet Propulsion Lab., California Inst. of Tech., Pasadena.
ELECTRICALLY CONDUCTIVE BLACK OPTICAL PAINT
M. M. BIRNBAUM, E. C. METZLER, and E. L. CLELAND (California Institute of Technology, Jet Propulsion Laboratory, Pasadena, CA) IN: Scattering in optical materials; Proceedings of the Meeting, San Diego, CA, August 25-27, 1982 . Bellingham, WA, SPIE - The International Society for Optical Engineering, 1983, p. 60-70. NASA-supported research. refs

An electrically conductive flat black paint has been developed for use on the Galileo spacecraft which will orbit Jupiter in the late 1980s. The paint, designed for equipment operating in high-energy radiation fields, has multipurpose functions. Its electrical conductivity keeps differential charging of the spacecraft external surfaces and equipment to a minimum, preventing the buildup of electrostatic fields and arcing. Its flat black aspect minimizes the effects of stray light and unwanted reflectances, when used in optical instruments and on sunshades. Its blackness is suitable, also, for thermal control, when the paint is put on spacecraft surfaces. The paint has good adherence properties, as measured by tape tests, when applied properly to a surface. The electrically conductive paint which was developed has the following characteristics: an electrical resistivity of 5 x 10 to the 7th ohms per square; a visual light total reflectance of approximately 5 percent; an infrared reflectance of 0.13 measured over a spectrum from 10 to the (-5.5) power to 0.001 meter; a solar absorptivity, alpha-s, of 0.93, and a thermal emissivity, epsilon, of 0.87, resulting in an alpha-s/epsilon of 1.07. The formula for making the paint and the process for applying it are described. Author

A84-28900
EFFECT OF TEMPERATURE, MOISTURE AND RADIATION EXPOSURES ON COMPOSITE MECHANICAL PROPERTIES
V. F. MAZZIO (General Electric Co., Space Div., Valley Forge, PA) and G. HUBER (Cincinnati Testing Laboratories, Inc., Cincinnati, OH) SAMPE Journal (ISSN 0091-1062), vol. 20, Mar.-Apr. 1984, p. 14, 15, 18 (4 ff.).
(Contract F33615-79-C-5114)

A program was conducted to determine the effects of electron beam radiation, moisture, and temperature exposure on the mechanical properties of advanced composites. The composite systems evaluated were three graphite/epoxy materials (P-75-S/CE339, GY70/X30, and T300/934) and one Kevlar/epoxy system (Kevlar 49/5209). The environmental conditions evaluated were three levels of radiation exposure (between 3 x 10 to the 8th and 3 x 10 to the 9th rads), moisture saturation at 90 percent R.H. and 160 F, and combined moisture and space environmental exposure. High and low dose rate exposure of PS75-S/CE339 resulted in improved properties due to postcuring effects. Kevlar 49/5209 showed no apparent effects from radiation when compared with baseline properties. P75-S/CE339 tensile specimens exposed to combined moisture and space environment and tested at elevated temperature showed a decrease in modulus and strength; Kevlar 49/5209 showed a slight reduction in tensile properties. V.L.

A84-29101#
A VARIATIONAL THEOREM FOR THE VISCOELASTODYNAMIC ANALYSIS OF HIGH-SPEED LINKAGE MACHINERY FABRICATED FROM COMPOSITE MATERIALS
B. S. THOMPSON (Michigan State University, East Lansing, MI) and C. K. SUNG American Society of Mechanical Engineers, Design and Production Engineering Technical Conference, Dearborn, MI, Sept. 11-14, 1983. 7 p. refs
(Contract NSF MEA-82-16777)
(ASME PAPER 83-DET-6)

The dynamic analysis of high-speed linkage machinery fabricated from viscoelastic composite materials requires the construction of appropriate equations of motion and boundary conditions for the members of the mechanism. In order to establish these equations, a variational theorem is presented herein by considering the motion of a continuum having dynamic viscoelastic deformations superimposed on a general rigid-body motion. The theorem is written in the Stieltjes convolution notation, and variations in displacement, velocity, stress and strain yield the appropriate characteristic equations. A finite element analysis based on the theorem is presented for flexible four bar linkages constructed from graphite-epoxy laminates, and the results are compared with experimental data. Author

A84-29565#
HIGHER TEMPERATURE COMPOSITE JOINTS SURVIVE ELIMINATION TESTS
V. WIGOTSKY Aerospace America (ISSN 0740-722X), vol. 22, Feb. 1984, p. 32, 35.

Design and preliminary test results for four types of graphite/polyimide joints for aerospace vehicles are discussed. Different designs of joints made from Celion 3000 and 6000/PMR-15 graphite in a polyimide matrix over a polyimide/fiberglass honeycomb core were subjected to temperatures ranging from -250 to 600 F to reveal information about laminate net tension strength, the relative worth of separately bonded or cocured doublers, and the importance of bonding attachment angles to the joint. In static tests it was discovered that one bolted design type had cover failures outside the joint area at an average of 97 percent of the design load; T-shape, and L-shape design types met or exceeded design requirements; and a sandwiched, straight joint design type was dropped because of difficulties in bonding its parts together. Diagrams are presented which describe the different design types in detail. I.H.

A84-29572#
GRAPHITE/POLYIMIDE JOINTS EXTEND TEMPERATURE LIMITS
V. WIGOTSKY Aerospace America (ISSN 0740-722X), vol. 22, March 1984, p. 29-31.

After extensive testing, an American aerospace company has found four graphite/polyimide joint designs for which the 350 F temperature limit of epoxy-matrix could be raised to 550 F. The bonded and bolted joints are designed for loads encountered by control surfaces of advanced aerospace vehicles. However, there are certain problems because static and fatigue testing revealed a wide variation in failure loads and modes among different specimens. The reasons for these variations are discussed, taking into account deficiencies in gripping of the test specimen, the shelf life of resin, and the role of the nadic ester. G.R.

N84-11220*# National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.
SURFACE ANALYSIS OF GRAPHITE FIBER REINFORCED POLYIMIDE COMPOSITES
D. L. MESSICK (Virginia Polytechnic Inst. and State Univ., Blacksburg), D. J. PROGAR, and J. P. WIGHTMAN Oct. 1983 21 p refs Presented at the 15th Natl. SAMPE Tech. Conf., Cincinnati, 4-6 Oct. 1983
(Contract NAG1-248)
(NASA-TM-85700; NAS 1.15:85700) Avail: NTIS HC A02/MF A01 CSCL 11D

Several techniques have been used to establish the effect of different surface pretreatments on graphite-polyimide composites. Composites were prepared from Celion 6000 graphite fibers and the polyimide LARC-160. Pretreatments included mechanical abrasion, chemical etching and light irradiation. Scanning electron microscopy (SEM) and X-ray photoelectron spectroscopy (XPS) were used in the analysis. Contact angle of five different liquids of varying surface tensions were measured on the composites. SEM results showed polymer-rich peaks and polymer-poor valleys conforming to the pattern of the release cloth used durng fabrication. Mechanically treated and light irradiated samples showed varying degrees of polymer peak removal, with some degradation down to the graphite fibers. Minimal changes in surface topography were observed on concentrations of surface fluorine even after pretreatment. The light irradiation pretreatment was most effective at reducing surface fluorine concentrations whereas chemical pretreatment was the least effective. Critical surface tensions correlated directly with the surface fluorine to carbon ratios as calculated from XPS. Author

N84-11595*# Martin Marietta Corp., Denver, Colo.
EVALUATION AND PREDICTION OF LONG-TERM ENVIRONMENTAL EFFECTS OF NONMETALLIC MATERIALS, SECOND PHASE Final Report
Sep. 1983 46 p refs
(Contract NAS8-33578)
(NASA-CR-170915; NAS 1.26:170915; MCR-83-643) Avail: NTIS HC A03/MF A01 CSCL 13B

Changes in the functional properties of a number of nonmetallic materials were evaluated experimentally as a function of simulated space environments and to use such data to develop models for accelerated test methods useful for predicting such behavioral changes. The effects of changed particle irradiations on candidate space materials are evaluated. N.W.

N84-16037*# Mississippi State Univ., State College. Dept. of Chemical Engineering.
AN EVALUATION OF TECHROLL SEAL FLEXIBLE JOINT MATERIAL
W. B. HALL *In* Alabama Univ. Res. Rept.: 1983 NASA/ASEE Summer Faculty Fellowship Program 18 p Dec. 1983
Avail: NTIS HC A99/MF A01 CSCL 11A

This study evaluated the materials utilized in the flexible joint for possible failure modes. Studies undertaken included effect of temperature on the strength of the system, effect of fatigue on the strength of the system, thermogravimetric analysis, thermochemical analysis, differential scanning calorimeter analysis, dynamic mechanical analysis, and peel test. These studies indicate that if the joint failed due to a materials deficiency, the most likely mode was excessive temperature in the joint. In addition, the joint material is susceptible to fatigue damage which could have been a contributing factor. B.W.

N84-17217*# Dayton Univ., Ohio. Research Inst.
THE EFFECTS OF THE SPACE ENVIRONMENT ON DAMPING MATERIALS AND DAMPING DESIGNS ON FLEXIBLE STRUCTURES
M. F. KLUESENER *In* NASA. Langley Research Center STEP Expt. Requirements p 79-102 Jan. 1984 refs
Avail: NTIS HC A15/MF A01 CSCL 20K

The effects of space environments on damping materials and damping designs on flexible structures were investigated. The following items were examined: damping of flexible spacecraft appendages; composite loss factor (n sub s) vs. time in high vacuum for damped test beams and damping of flexible structures. The STEP experiments show inherent damping of flexible structures in space effective possible damping design configurations for space structures, effects of passively damped components on the system loss factor of flexible structures and the effect of space environment on properties of damping materials. E.A.K.

N84-17253# European Space Agency, Paris (France).
SPACECRAFT/PLASMA INTERACTIONS AND THEIR INFLUENCE ON FIELD AND PARTICLE MEASUREMENTS
A. PEDERSEN, ed., D. GUYENNE, ed., and J. HUNT, ed. Nov. 1983 217 p refs Proc. of 17th ESLAB Symp., Noordwijk, Netherlands, 13-16 Sep. 1983
(ESA-SP-198; ISSN-0379-6566) Avail: NTIS HC A10/MF A01; ESA, Paris FF 140 Member States, AU, CN and NO (+20% others)

The effect of spacecraft-plasma interactions on plasma and electric field measurements was discussed, using results from Voyager, SCATHA, ISEE, and GEOS satellite missions, and space shuttle flights. Spacecraft charging and impact ionization during Halley's comet flyby missions were considered. Means of controlling spacecraft surface potentials were examined.

N84-17293*# Rensselaer Polytechnic Inst., Troy, N. Y.
COMPOSITE STRUCTURAL MATERIALS Semiannual Progress Report, 30 Apr. - 30 Sep. 1983
G. S. ANSELL, R. G. LOEWY, and S. E. WIBERLEY Dec. 1983 190 p
(Contract NGL-33-018-003)
(NASA-CR-173259; NAS 1.26:173259; SAPR-45) Avail: NTIS HC A09/MF A01 CSCL 11D

Progress and plans are reported for investigations of: (1) the mechanical properties of high performance carbon fibers; (2) fatigue in composite materials; (3) moisture and temperature effects on the mechanical properties of graphite-epoxy laminates; (4) the theory of inhomogeneous swelling in epoxy resin; (5) numerical studies of the micromechanics of composite fracture; (6) free edge failures of composite laminates; (7) analysis of unbalanced laminates; (8) compact lug design; (9) quantification of Saint-Venant's principles for a general prismatic member; (10) variation of resin properties through the thickness of cured samples; and (11) the wing fuselage ensemble of the RP-1 and RP-2 sailplanes. A.R.H.

N84-18416# Erno Raumfahrttechnik G.m.b.H., Bremen (West Germany). Structures Dept.
INTEGRITY CONTROL OF CARBON FIBER REINFORCED PLASTICS STRUCTURAL ELEMENTS, PHASE 1 REPORT
W. H. PAUL and D. WAGNER Paris ESA 8 Apr. 1983 342 p refs
(Contract ESA-4442/80/NL-AK(SC))
(TB-TS-11-01/82-A; ESA-CR(P)-1778) Avail: NTIS HC A15/MF A01

An integrity control program for CFRP structural elements, to avoid catastrophic failures due to propagation of defects and imperfections inherent in FRPs is established. Based upon the experience with fracture control of elements made from homogeneous materials, the control logic applicable to safety relevant elements is determined and consequences in application through all project phases are considered. Problems in defining adequate acceptance/rejection criteria for quality assurance are identified, given the difficulties in determination of local inter and intra laminary stresses at notches and defects. The phenomenological approach to relate damage propagation under operational conditions to initial gross stresses cannot describe the real process: cracking, especially delamination, results in a significant change of stresses in individual layers. A tranfer matrix analytical method is proposed. Author (ESA)

N84-21290*# Perkin-Elmer Corp., Danbury, Conn. Space Science Div.
OPTICAL COATING IN SPACE Final Report
A. N. BUNNER 27 Oct. 1983 83 p refs
(Contract NASW-3753)
(NASA-CR-175441; NAS 1.26:175441; ER-591; REPT-2983-81)
Avail: NTIS HC A05/MF A01 CSCL 20F

A technological appraisal of the steps required to approach the goal of in-situ optical coating, cleaning and re-coating the optical elements of a remote telescope in space is reported. Emphasis is placed on the high ultraviolet throughput that a telescope using bare aluminum mirrors would offer. A preliminary design is suggested for an Orbital Coating Laboratory to answer basic technical questions. Author

N84-21675# Fulmer Research Inst. Ltd., Stoke Poges (England).
REVIEW REPORT OF THE THIRD YEAR'S ACTIVITIES ON THE STUDY SURVEY OF ADVANCED MATERIALS
D. P. BASHFORD Paris ESA 14 Sep. 1983 12 p
(Contract ESA-4389/80/NL-AK(SC))
(R878; ESA-CR(P)-1838) Avail: NTIS HC A02/MF A01

Mechanical test methods applicable to carbon fiber reinforced plastics (CFRP) were investigated. Moisture absorption and residual stresses in CFRP were studied. Epoxy resins suitable for space structure applications as matrices for fiber reinforced composites were examined. Author (ESA)

08

ASSEMBLY CONCEPTS

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

A83-44602

CANADARM AND THE SPACE SHUTTLE

B. A. AIKENHEAD (National Aeronautical Establishment, Ottawa, Canada), R. G. DANIELL, and F. M. DAVIS (SPAR Aerospace, Ltd., Toronto, Canada) Journal of Vacuum Science and Technology A (ISSN 0734-2101), vol. 1, Apr.-June 1983, pt. 1, p. 126-132. Research supported by the National Research Council of Canada.

The remote manipulator system designed for the Space Shuttle is discussed. The system requirements and environment are summarized, and the manipulator arm assembly and its installation in the Orbiter, the joint assemblies, the end effector, and the wrist roll joint are discussed. The system uses brushless dc servomotors to drive the six joints and the end effector in a variety of control modes which provide both manual and automatic control of the arm functions. Allowances made for the vacuum environment are addressed, and proof of compliance with requirements is considered. C.D.

A84-10070*# National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.

A SYSTEM FOR INTELLIGENT TELEOPERATION RESEARCH

N. E. ORLANDO (NASA, Langley Research Center, Hampton, VA) American Institute of Aeronautics and Astronautics, Computers in Aerospace Conference, 4th, Hartford, CT, Oct. 24-26, 1983. 7 p. refs

(AIAA PAPER 83-2376)

The Automation Technology Branch of NASA Langley Research Center is developing a research capability in the field of artificial intelligence, particularly as applicable in teleoperator/robotics development for remote space operations. As a testbed for experimentation in these areas, a system concept has been developed and is being implemented. This system termed DAISIE (Distributed Artificially Intelligent System for Interacting with the Environment), interfaces the key processes of perception, reasoning, and manipulation by linking hardware sensors and manipulators to a modular artificial intelligence (AI) software system in a hierarchical control structure. Verification experiments have been performed: one experiment used a blocksworld database and planner embedded in the DAISIE system to intelligently manipulate a simple physical environment; the other experiment implemented a joint-space collision avoidance algorithm. Continued system development is planned. Author

A84-11935

SIMULATION OF THE MOTION OF A SHUTTLE-ATTACHED FLEXIBLE MANIPULATOR ARM

R. A. MILLER, W. R. GRAHAM, and F. R. VIGNERON (Department of Communications, Ottawa, Canada) IN: World Congress on System Simulation and Scientific Computation, 10th, Montreal, Canada, August 8-13, 1982, Proceedings. Volume 3 . Montreal, International Association for Mathematics and Computers in Simulation, 1983, p. 225-227.

An overview of the Shuttle's Remote Manipulator Control System is presented, followed by a description of a two-joint, two-link model of the arm used to study its flexible behavior. Two methods of modelling link flexibility are formulated. Non real-time and real-time simulations are described, and conclusions regarding the arm's flexible behavior and the simulation methodology are presented. Author

A84-15667* Lockheed Engineering and Management Services Co., Inc., Houston, Tex.

KNOWLEDGE BASED SYSTEMS FOR INTELLIGENT ROBOTICS

N. S. RAJARAM (Lockheed Engineering and Management Services Co., Inc., Houston, TX) IN: NTC '82; National Telesystems Conference, Galveston, TX, November 7-10, 1982, Conference Record . New York, Institute of Electrical and Electronics Engineers, Inc., 1982, p. D1.1.1-D1.1.4. refs

(Contract NAS9-15800)

It is pointed out that the construction of large space platforms, such as space stations, has to be carried out in the outer space environment. As it is extremely expensive to support human workers in space for large periods, the only feasible solution appears to be related to the development and deployment of highly capable robots for most of the tasks. Robots for space applications will have to possess characteristics which are very different from those needed by robots in industry. The present investigation is concerned with the needs of space robotics and the technologies which can be of assistance to meet these needs, giving particular attention to knowledge bases. 'Intelligent' robots are required for the solution of arising problems. The collection of facts and rules needed for accomplishing such solutions form the 'knowledge base' of the system. G.R.

A84-21486

THE SHUTTLE REMOTE MANIPULATOR SYSTEM: CANADARM - A ROBOT ARM IN SPACE

C. G. J. WAGNER-BARTAK (Spar Aerospace, Ltd., Mississauga, Ontario, Canada) (United Nations, Symposium on Solar Energy from Space, Vienna, Austria, Aug. 9-21, 1982) Space Solar Power Review (ISSN 0191-9067), vol. 4, no. 1-2, 1983, p. 131-142.

The diversity of automated tasks required by the Space Shuttle has prompted critical consideration of both artificial intelligence and the man/machine relationship, resulting in the development of the Shuttle's Remote Manipulator System (RMS). This system provides interactive computer and human control, so that either can possess executive system management. For the 'astroworker', the RMS constitutes a dextrous cybernetic system that electronically and mechanically increases physical strength, sensory perception, and dimensions of reach. It is the first generation of space-based robotic manipulators that will eventually become the workhorses of space-based industrialization. Attention is given to the development status of the RMS, as well as the extrapolation of its technology to future orbital robotics for manufacturing, auxiliary power source deployment, and platform construction in solar power conversion projects. O.C.

A84-22336#

REMOTE MANIPULATORS IN SPACE

P. S. MATTHEWS, B. R. HILL (Spar Aerospace, Ltd., Remote Manipulator Systems Div., Toronto, Canada), and C. G. WAGNER-BARTAK IN: Manufacturing in space; Proceedings of the Winter Annual Meeting, Boston, MA, November 13-18, 1983 . New York, American Society of Mechanical Engineers, 1983, p. 101-112.

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

A84-22337#

AUTOMATION, ROBOTICS, AND MACHINE INTELLIGENCE SYSTEMS (ARAMIS) IN SPACE MANUFACTURING

D. G. STUART (MIT, Cambridge, MA) IN: Manufacturing in space; Proceedings of the Winter Annual Meeting, Boston, MA, November 13-18, 1983 . New York, American Society of Mechanical Engineers, 1983, p. 113-126. refs

Two studies are reviewed, one on the design of a space manufacturing facility (SMF), and the other on automation, robotics, and machine intelligence systems (ARAMIS) for space applications. The overall design of the SMF is described, as well as examples of space-specific production processes and equipment. A systematic method to evaluate ARAMIS options for tasks in space is presented. Promising ARAMIS options are described for mechanical actuation tasks, monitoring and control tasks, decision and planning tasks, and fault diagnosis and handling tasks.

Author

A84-25484* Honeywell, Inc., Clearwater, Fla.

MANIPULATOR INTERACTIVE DESIGN WITH INTERCONNECTED FLEXIBLE ELEMENTS

R. P. SINGH (Honeywell, Inc., Clearwater, FL) and P. W. LIKINS (Lehigh University, Bethlehem, PA) IN: American Control Conference, San Francisco, CA, June 22-24, 1983, Proceedings. Volume 2 . New York, Institute of Electrical and Electronics Engineers, 1983, p. 505-512. NASA-sponsored research. refs

This paper describes the development of an analysis tool for the interactive design of control systems for manipulators and similar electro-mechanical systems amenable to representation as structures in a topological chain. The chain consists of a series of elastic bodies subject to small deformations and arbitrary displacements. The bodies are connected by hinges which permit kinematic constraints, control, or relative motion with six degrees of freedom. The equations of motion for the chain configuration are derived via Kane's method, extended for application to interconnected flexible bodies with time-varying boundary conditions. A corresponding set of modal coordinates has been selected. The motion equations are imbedded within a simulation that transforms the vector-dyadic equations into scalar form for numerical integration. The simulation also includes a linear, time-invariant controler specified in transfer function format and a set of sensors and actuators that interface between the structure and controller. The simulation is driven by an interactive set-up program resulting in an easy-to-use analysis tool. Author

A84-25531

DYNAMICS OF NONRIGID ARTICULATED ROBOT LINKAGES

R. P. JUDD and D. R. FALKENBURG (Oakland University, Rochester, MI) IN: American Control Conference, San Francisco, CA, June 22-24, 1983, Proceedings. Volume 3 . New York, Institute of Electrical and Electronics Engineers, 1983, p. 1045-1049. refs

This paper presents the kinematic and dynamic analysis of an n-link manipulator with flexible members. The deformation of a link from its rigid body position is modeled by a homogeneous transformation. The dynamic equations are obtained using an Euler-Lagrange formulation. These equations are compared to those describing a rigid link mechanism. Author

A84-25828

STUDY OF ARTIFICIAL INTELLIGENCE TECHNIQUES - REALIZATION OF A HIGHLY AUTONOMOUS EXPERIMENTAL ROBOT SYSTEM [CONTRIBUTION AL'ETUDE DE TECHNIQUES D'INTELLIGENCE ARTIFICIELLE - REALISATION D'UN SYSTEME ROBOTIQUE EXPERIMENTAL AGRANDE AUTONOMIE]

A. LANUSSE Toulouse III, Universite, Docteur-Ingenieur Thesis, 1983, 179 p. In French. refs

Artificial intelligence research is conducted to develop a robotized assembly system capable of implementing short or long production series with small variations. A flexible multirobot multisensor assembly cell is defined and realized. Integration of software programs effects the development of the NNS system. The methodology can easily be transferred to more complex problems in the future. The applications of artificial intelligence techniques in diagnosis and treatment of robot system failures are examined, including decision systems, production systems, and logical-proof systems. Finally, existing plan-synthesis methods are examined in detail and an algorithm that generalizes the NOAH system is proposed. C.M.

A84-28523* National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.

NASA RESEARCH IN TELEOPERATION AND ROBOTICS

A. J. MEINTEL, JR. (NASA, Langley Research Center, Automation Technology Branch, Hampton, VA) and R. L. LARSEN (NASA, Computer Science and Electronics Office, Washington, DC) IN: Robotics and industrial inspection; Proceedings of the Meeting, San Diego, CA, August 24-27, 1982 . Bellingham, WA, SPIE - The International Society for Optical Engineering, 1983, p. 22-30. refs

Increased automation is necessary in future NASA missions. Drivers for automation include constrained funding and physical resources as well as mission capabilities not achievable through conventional means. The application of emerging technology in manipulators and machine intelligence will enable the development of robotic devices remotely commanded by human operators to increase man's productivity in space. The Office of Aeronautics and Space Technology (OAST) has established a program for research in teleoperation and robotics. The program's near-term focus is a Remote Orbital Servicing System (ROSS). The longer range goals include: (1) basic research in autonomous operations, (2) human factors research on the man-machine interface to remote systems, and (3) system integration and analysis of advanced concepts. This paper reviews the current NASA research and technology and considers future work needed to meet the OAST goals. Author

A84-28541

APPLICATION OF LASER INTERFEROMETRY TO ROBOTICS

R. H. ANDERSON, C. W. GILLARD, and C.-C. HUANG (Lockheed Missiles and Space Co., Inc., Space Systems Div., Sunnyvale, CA) IN: Robotics and industrial inspection; Proceedings of the Meeting, San Diego, CA, August 24-27, 1982 . Bellingham, WA, SPIE - The International Society for Optical Engineering, 1983, p. 207-213. refs

The application of a two-color CO_2 laser system and a HeNe phase modulated system to the positioning and control of robots is discussed. The CO_2 laser system has a 0.03 micron precision for aligning optical elements, and the HeNe phase modulated system has a 25 micron precision for measuring and controlling large antennas. If incorporated into robotics, laser metrology would permit unsophisticated robots (unaffected by temperature or stress) to perform high-precision work. The recommended primary distance measuring system for robotics is the multichannel interferometer in addition to a modulated subcarrier for absolute distance measurement updates. Other recommendations include beam relay by stationary and tracking mirrors, and a retroreflector target attached to the robot as close as possible to the tool. C.M.

A84-44183*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.

ON MODELING DILUTION JET FLOWFIELDS

J. D. HOLDEMAN (NASA, Lewis Research Center, Cleveland, OH) and R. SRINIVASAN (Garrett Turbine Engine Co., Phoenix, AZ) AIAA, SAE, and ASME, Joint Propulsion Conference, 20th, Cincinnati, OH, June 11-13, 1984. 13 p. Previously announced in STAR as N84-25713. refs

(AIAA PAPER 84-1379)

This paper compares temperature field measurements from selected experiments on a single row, and opposed rows, of jets injected into a ducted crossflow with profiles calculated using an empirical model based on assumed vertical profile similarity and superposition, and distributions calculated with a 3-D elliptic code using a standard K-E turbulence model. The empirical model predictions are very good within the range of the generating experiments, and the numerical model results, although exhibiting too little mixing, correctly describe the effects of the principal flow and geometric variables. Author

N84-10582*# Massachusetts Inst. of Tech., Cambridge. Space Systems Lab.
SPACE APPLICATIONS OF AUTOMATION, ROBOTICS AND MACHINE INTELLIGENCE SYSTEMS (ARAMIS). VOLUME 3, PHASE 2: EXECUTIVE SUMMARY Final Report
D. L. AKIN, M. L. MINSKY, E. D. THIEL, and C. R. KURTZMAN Washington NASA Oct. 1983 42 p refs
(Contract NAS8-34381)
(NASA-CR-3736; NAS 1.26:3736; SSL-32-83-VOL-3-PHASE-2)
Avail: NTIS HC A03/MF A01 CSCL 05H

The field of telepresence is defined, and overviews of those capabilities that are now available, and those that will be required to support a NASA telepresence effort are provided. Investigation of NASA's plans and goals with regard to telepresence, extensive literature search for materials relating to relevant technologies, a description of these technologies and their state of the art, and projections for advances in these technologies are included. Several space projects are examined in detail to determine what capabilities are required of a telepresence system in order to accomplish various tasks, such as servicing and assembly. The key operational and technological areas are identified, conclusions and recommendations are made for further research, and an example developmental program leading to an operational telepresence servicer is presented. Author

N84-10583*# Massachusetts Inst. of Tech., Cambridge. Space Systems Lab.
SPACE APPLICATIONS OF AUTOMATION, ROBOTICS AND MACHINE INTELLIGENCE SYSTEMS (ARAMIS), PHASE 2. VOLUME 1: TELEPRESENCE TECHNOLOGY BASE DEVELOPMENT Final Report
D. L. AKIN, M. L. MINSKY, E. D. THIEL, and C. R. KURTZMAN Oct. 1983 106 p refs
(Contract NAS8-34381)
(NASA-CR-3734; NAS 1.26:3734; SSL-30-83) Avail: NTIS HC A06/MF A01 CSCL 05H

The field of telepresence is defined, and overviews of those capabilities that are now available, and those that will be required to support a NASA telepresence effort are provided. Investigation of NASA's plans and goals with regard to telepresence, extensive literature search for materials relating to relevant technologies, a description of these technologies and their state of the art, and projections for advances in these technologies over the next decade are included. Several space projects are examined in detail to determine what capabilities are required of a telepresence system in order to accomplish various tasks, such as servicing and assembly. The key operational and technological areas are identified, conclusions and recommendations are made for further research, and an example developmental program is presented, leading to an operational telepresence servicer. Author

N84-10584*# Massachusetts Inst. of Tech., Cambridge. Space Systems Lab.
SPACE APPLICATIONS OF AUTOMATION, ROBOTICS AND MACHINE INTELLIGENCE SYSTEMS (ARAMIS), PHASE 2. VOLUME 2: TELEPRESENCE PROJECT APPLICATIONS Final Report
D. L. AKIN, M. L. MINSKY, E. D. THIEL, and C. R. KURTZMAN Washington NASA Oct. 1983 116 p refs
(Contract NAS8-34381)
(NASA-CR-3735; NAS 1.26:3735; SSL-31-83) Avail: NTIS HC A06/MF A01 CSCL 05H

The field of telepresence is defined and overviews of those capabilities that are now available, and those that will be required to support a NASA telepresence effort are provided. Investigation of NASA' plans and goals with regard to telepresence, extensive literature search for materials relating to relevant technologies, a description of these technologies and their state of the art, and projections for advances in these technologies over the next decade are included. Author

N84-11761*# National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, Ala.
SELF-LOCKING TELESCOPING MANIPULATOR ARM Patent Application
M. F. NESMITH, inventor (to NASA) 30 Sep. 1983 14 p
(NASA-CASE-MFS-25906-1; US-PATENT-APPL-SN-537757)
Avail: NTIS HC A02/MF A01 CSCL 05H

A telescoping manipulator arm and pivotable finger assembly are disclosed. The telescoping arm assembly includes a generally T-shaped arm having three outwardly extending fingers guided on the grooved roller guides to compensate for environmental variations. The pivotable finger assembly includes four pivoting fingers. Arcuate teeth are formed on the ends of the fingers. A rack having teeth on four sides meshes with each one of the fingers. One surface of the rack includes teeth along its entire surface which mesh with teeth of the finger. The teeth at the remote end of the rack engage teeth of a gear wheel. NASA

N84-13208*# Essex Corp., Huntsville, Ala.
ANALYSIS OF LARGE SPACE STRUCTURES ASSEMBLY: MAN/MACHINE ASSEMBLY ANALYSIS Final Report
Washington NASA Dec. 1983 172 p refs
(Contract NAS8-32989)
(NASA-CR-3751; NAS 1.26:3751; H-83-03) Avail: NTIS HC A08/MF A01 CSCL 22A

Procedures for analyzing large space structures assembly via three primary modes: manual, remote and automated are outlined. Data bases on each of the assembly modes and a general data base on the shuttle capabilities to support structures assembly are presented. Task element times and structure assembly component costs are given to provide a basis for determining the comparative economics of assembly alternatives. The lessons learned from simulations of space structures assembly are detailed. Author

N84-16250*# National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.
SYNCHRONOUSLY DEPLOYABLE TRUSS STRUCTURE Patent Application
H. G. BUSH, M. M. MIKULAS, JR., and R. E. WALLSOM, inventors (to NASA) (Kentron International, Inc., Hampton, Va.) 30 Nov. 1983 15 p
(NASA-CASE-LAR-13117-1; US-PATENT-APPL-SN-556512)
Avail: NTIS HC A02/MF A01 CSCL 22B

A collapsible-expandable truss structure is disclosed which includes two space surface truss layers with an attached core layer. The surface truss layers are composed of several linear struts arranged in multiple triangular configurations. Each linear strut is hinged at its center and hingedly connected at each end to a nodular joint. A passive spring serves as the expansion force to move the folded struts from a stowed collapsed position to a deployed operative final truss configuration. A damper controls the rate of spring expansion for synchronized deployment of the truss as the folded configuration is released for deployment by restraint belts that synchronously extend under the control of motor driven spools. NASA

N84-16807# Naval Academy, Annapolis, Md. Dept. of Weapons and Systems Engineering.
STABILITY ENHANCEMENT OF A FLEXIBLE ROBOT MANIPULATOR Final Report, 1982 - 1983
T. D. LOOKE 24 Jun. 1983 115 p
(AD-A134185; USNA-TSPR-126) Avail: NTIS HC A06/MF A01 CSCL 12A

A computer software programming technique was developed to compensate a highly oscillatory robot system controlled by a bang-bang input. The assumptions that the system was linear and had lumped parameter characteristics allowed a fifth order, simplified dynamic model to be derived. Analysis using frequency response methods led to further simplification of the model to a third order system. Based on the third order model, a technique was developed which would compensate the system with a form of deadbeat control. Simulation of the model driven by the compensated bang-bang input verified the deadbeat response. The technique was implemented on an 8080-based microcomputer system which controlled the input. Actual system response to the compensated input was observed to be essentially free of the undesirable oscillatory motions, thus yielding an apparently rigid system. Author (GRA)

N84-17219*# National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.
ERECTABLE BEAM EXPERIMENT
W. L. HEARD, JR. *In its* STEP Expt. Requirements p 121-134 Jan. 1984
Avail: NTIS HC A15/MF A01 CSCL 22B

The erectable beam applicability to the MAST/STEP experiment is summarized. High manual assembly rates were demonstrated in neutral buoyancy tests and it is suggested that use of an erectable beam would eliminate extension/retraction complexity associated with deployable beams. The erectable beam assembly aid is easily adaptable to general truss configurations and structural appendages could be accommodated with the use of actuators. The ACCESS flight experiment precedes MAST by 2 to 3 years and will provide mature, space proven assembly/disassembly technology on which to base the MAST experiment. E.A.K.

N84-20175*# Stanford Univ., Calif.
PRECISE CONTROL OF FLEXIBLE MANIPULATORS Semiannual Progress Report
R. H. CANNON, JR. Mar. 1984 36 p refs
(Contract NAG1-322)
(NASA-CR-175389; NAS 1.26:175389) Avail: NTIS HC A03/MF A01 CSCL 05H

Experimental apparatus were developed for physically testing control systems for pointing flexible structures, such as limber spacecraft, for the case that control actuators cannot be collocated with sensors. Structural damping ratios are less than 0.003, each basic configuration of sensor/actuator noncollocation is available, and inertias can be halved or doubled abruptly during control maneuvers, thereby imposing, in particular, a sudden reversal in the plant's pole-zero sequence. First experimental results are presented, including stable control with both collocation and noncollocation. Author

N84-20316# Carnegie-Mellon Univ., Pittsburgh, Pa. Robotics Inst.
RECURSIVE LAGRANGIAN DYNAMICS OF FLEXIBLE MANIPULATOR ARMS VIA TRANSFORMATION MATRICES Interim Technical Report
W. J. BOOK Dec. 1983 28 p
(AD-A137345; CMU-RI-TR-83-23) Avail: NTIS HC A03/MF A01 CSCL 12A

Improving the performance of most engineering systems requires the ability to model the system's behavior with improved accuracy. The evolution of the mechanical arm from teleoperator and crane to present day industrial and space robots and large space manipulators is no exception. Initial simple kinematic and dynamic models are no longer adequate to improve performance in the most critical applications. Both the mechanical system and control system require improved models for design simulation. Proposed new control algorithms require dynamic models for control calculation. Planning and programming activities as well as man-in-the-loop simulation also require accurate models of the arms. Accuracy is usually acquired at some cost. The application of mechanical arms to economically sensitive endeavors in industry and space also gives incentive to improve the efficiency of the formulation and simulation of dynamic models. Control algorithms and man-in-the-loop simulation require real time calculation of dynamic behavior. Formulation of the dynamics in an easy to understand conceptual approach is also important if maximum use of the results is to be obtained. The nonlinear equations of motion for flexible manipulator arms consisting of rotary joints connecting two flexible links are developed. Kinematics of both the rotary joint motion and the link deformation are described by 4x4 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 4x4 matrix operations ready for programming. Author (GRA)

N84-20626*# National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.
CONSTRUCTION CONCEPT FOR ERECTING AN OFFSET-FED ANTENNA
M. D. RHODES Mar. 1984 20 p refs
(NASA-TM-85774; NAS 1.15:85774) Avail: NTIS HC A02/MF A01 CSCL 22B

A design concept for the construction of an offset-fed antenna is discussed. Antennas of this type are of interest for space applications because the configuration eliminates the effects of feed and feed-support blockage. The proposed construction concept is developed around the assembly of a stiff truss substructure by pressure-suited astronauts operating in extravehicular activity (EVA) assisted by a mobile platform that moves along the structure to position the astronauts at joint locations where they can latch members in place. Construction can be accomplished from the shuttle cargo bay in the course of a normal flight or from a space station platform. The concepts demonstrates the versatility of machine assisted manned assembly and is only one of many potential applications. Author

N84-20857*# Massachusetts Inst. of Tech., Cambridge. Dept. of Ocean Engineering.
FEASIBILITY OF REMOTELY MANIPULATED WELDING IN SPACE. A STEP IN THE DEVELOPMENT OF NOVEL JOINING TECHNOLOGIES Final Report
K. MASUBUCHI, J. E. AGAPAKIS, A. DEBICCARI, and C. VONALT Sep. 1983 260 p refs
(Contract NASW-3740)
(NASA-CR-175437; NAS 1.26:175437) Avail: NTIS HC A12/MF A01 CSCL 13I

In order to establish permanent human presence in space technologies of constructing and repairing space stations and other space structures must be developed. Most construction jobs are performed on earth and the fabricated modules will then be delivered to space by the Space Shuttle. Only limited final assembly jobs, which are primarily mechanical fastening, will be performed on site in space. Such fabrication plans, however, limit the designs of these structures, because each module must fit inside the transport vehicle and must withstand launching stresses which are considerably high. Large-scale utilization of space necessitates more extensive construction work on site. Furthermore, continuous operations of space stations and other structures require maintenance and repairs of structural components as well as of tools and equipment on these space structures. Metal joining technologies, and especially high-quality welding, in space need developing. Author

09

PROPULSION

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

A84-13397#

A PARAMETRIC STUDY OF SPACE TRANSFER-PROPULSION STAGES

V. R. LARSON, P. E. COFFMAN (Rockwell International Corp., Rocketdyne Div., Canoga Park, CA), A. FABRIZI, and G. BAIOCCHI (BPD Difesa-Spazio, Colleferro, Italy) International Astronautical Federation, International Astronautical Congress, 34th, Budapest, Hungary, Oct. 10-15, 1983. 44 p. Research supported by the European Space Agency, Rockwell International Corp., and Universitadi Roma.
(IAF PAPER 83-401)

Surveys of commercial spacecraft activities and future geosynchronous earth orbit (GEO) satellite requirements suggest that a spacecraft propulsion system that provides the perigee burn for a broad range of future commercial satellites would have an excellent market potential. The efforts in this direction reported here followed two approaches. The first concentrated on the feasibility and the payload capabilities that could be provided by an upper propulsion system assembled essentially from off-the-shelf components and subsystems. The second approach considers the benefits that could be achieved by using major subsystems specifically tailored for the application. The results obtained thus far indicate that attractive UPS configurations can be defined with either approach. C.R.

A84-16116

A FUTURE SOLAR ORBITAL TRANSFER VEHICLE CONCEPT

C. F. GARTRELL (General Research Corp., McLean, VA) IEEE Transactions on Aerospace and Electronic Systems (ISSN 0018-9251), vol. AES-19, Sept. 1983, p. 704-710. refs

The limiting payload performance of any transfer vehicle is determined by the exhaust velocity of the propellant and the mass characteristics of the transfer vehicle. The theoretical specific impulse limit of liquid oxygen/liquid hydrogen systems is about 560 s, while specific impulses obtained in practice are about 460 s. However, a much greater value for the specific impulse can be produced by making use of the direct heating of low atomic number gases. It is pointed out that in the innerplanet environment the sun offers a convenient source of thermal energy. The present investigation is concerned with a solar orbital transfer vehicle (SOTV) which utilizes a 100 m diameter concentrator system to provide the approximately 10 MW of thermal power needed to obtain a nominal thrust level of 2780 N. G.R.

A84-18141*# National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.

VERTICAL ASCENT FROM EARTH TO GEOSYNCHRONOUS ORBIT

J. A. MARTIN (NASA, Langley Research Center, Space Systems Div., Hampton, VA) American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 22nd, Reno, NV, Jan. 9-12, 1984. 11 p. refs
(AIAA PAPER 84-0509)

The concept of ascending vertically from the equator on earth to the point in geosynchronous orbit directly above was investigated. The gravity losses were found to be so great that vertical ascent is not practical with only chemical-rocket propulsion. With laser propulsion, propellant requirements with vertical ascent are reduced and might allow the use of single-stage vehicles from earth to geosynchronous orbit. Combined or composite chemical and laser propulsion is shown to be useful. A gravity ladder suspended from geosynchronous orbit part of the distance to earth is shown to reduce the vehicle propulsion requirements. Author

A84-21484

TRANSPORTATION - OPTIONS AND HIGH PAYOFF CHOICES

M. W. HUNTER, II (Lockheed Missiles and Space Co., Inc., Palo Alto, CA) (United Nations, Symposium on Solar Energy from Space, Vienna, Austria, Aug. 9-21, 1982) Space Solar Power Review (ISSN 0191-9067), vol. 4, no. 1-2, 1983, p. 99-117. refs

In recent years, nonrocket ideas have proliferated. Various electromagnetic acceleration schemes, energy transfer by laser from power stations to accelerating vehicles, and momentum transfer devices consisting of structures of vast proportions have been suggested. It is a complex array of possibilities, many of which potentially apply from low earth orbit to interstellar propulsion. This paper relies on the simple relations between energy and momentum which are fundamental to the various possible space propulsion systems. Energy transmission by new techniques, such as a laser power station, and the various limitations on its conversion to momentum are covered. Momentum storage and direct momentum transfer are also treated. Author

A84-21485

AN ELECTRIC PROPULSION TRANSPORTATION SYSTEM FROM LOW-EARTH ORBIT TO GEOSTATIONARY ORBIT UTILIZING BEAMED MICROWAVE POWER

W. C. BROWN (Raytheon Co., Microwave Power Transmission Dept., Waltham, MA) and P. E. GLASER (Arthur D. Little, Inc., Cambridge, MA) (United Nations, Symposium on Solar Energy from Space, Vienna, Austria, Aug. 9-21, 1982) Space Solar Power Review (ISSN 0191-9067), vol. 4, no. 1-2, 1983, p. 119-129. refs

An electric propulsion transportation system from low-earth orbit to geostationary orbit that is based upon microwave power transmission technology derived from studies of the Solar Power Satellite is described. The ion engines in the transportation vehicle are supplied with d.c. electrical power that is obtained from a microwave rectenna on the vehicle that collects and rectifies power from a microwave beam originating from a transmitter located on the earth near its equator. As the transportation vehicle passes over the transmitter on each revolution, it receives power first at low duty cycle and then rapidly at longer duty cycle as it gains in altitude. The paper contains estimates of transit times from low-earth orbit to geostationary orbit and estimates of transportation costs for a typical scenario. These estimates indicate acceptable transit times to geostationary orbit and costs that are much less than existing chemical propulsion methods. Author

A84-22980* Spire Corp., Bedford, Mass.

LARGE AREA SPACE SOLAR CELL ASSEMBLIES

M. J. NOWLAN and M. B. SPITZER (Spire Corp., Bedford, MA) IN: Photovoltaic Specialists Conference, 16th, San Diego, CA, September 27-30, 1982, Conference Record . New York, Institute of Electrical and Electronics Engineers, 1982, p. 150-155. refs
(Contract NAS3-22236)

Results of the development of a 34.3 sq cm space solar cell and integral glass cover are presented. Average AM(0) cell efficiency is 14 percent. The cell design includes a high performance back surface reflector yielding a thermal alpha of approximately 0.66. A novel process is described which integrates cell fabrication and encapsulation thereby achieving a reduction of encapsulation cost. Test results indicate the potential of this new technology. Author

A84-24980#

HIGHLY EFFICIENT, VERY LOW-THRUST TRANSFER TO GEOSYNCHRONOUS ORBIT - EXACT AND APPROXIMATE SOLUTIONS

D. C. REDDING Journal of Guidance, Control, and Dynamics (ISSN 0731-5090), vol. 7, Mar.-Apr. 1984, p. 141-147.

Previously cited in issue 19, p. 2988, Accession no. A83-39400

A84-24981#
OPTIMAL LOW-THRUST TRANSFERS TO SYNCHRONOUS ORBIT
J. V. BREAKWELL (Stanford University, Stanford, CA) and D. C. REDDING Journal of Guidance, Control, and Dynamics (ISSN 0731-5090), vol. 7, Mar.-Apr. 1984, p. 148-155. refs

The general problem of circle-to-circle transfer is examined for chemical rocket spacecraft, following Lawden's 'primer vector' theory. Impulsive and near-impulsive transfers are analyzed to predict initial conditions for low-thrust transfers. A computer solution of the low-thrust problem is described. Results are presented for the low earth orbit to geosynchronous orbit case, showing behavior of the optimal thrust direction, and developing transfer efficiency figures for a range of acceleration limits. Both fixed-thrust and fixed-acceleration propulsion systems are considered. The effect of multiple burns is discussed. Robbins's approximation for gravity loss is shown to be good for a large class of maneuvers. Author

A84-25292#
A STANDARDIZED PROPULSION MODULE FOR FUTURE COMMUNICATIONS SATELLITES IN THE 2000 TO 3000 KG CLASS
H. KELLERMEIER, D. E. KOELLE (Messerschmitt-Boelkow-Blohm GmbH, Ottobrunn, West Germany), and R. BARBERA (ESA, European Space Research and Technology Centre, Noordwijk, Netherlands) IN: Communication Satellite Systems Conference, 10th, Orlando, FL, March 19-22, 1984, Technical Papers . New York, American Institute of Aeronautics and Astronautics, 1984, p. 345-353.
(AIAA PAPER 84-0727)

Applications of a propulsion module in the 2500 kg range are examined. Propulsion module technology in Europe is reviewed and the goals of the Orbital Propulsion Module Study conducted for ESA in 1983 are outlined. Propulsion systems investigated by the study for three types of missions are compared: (1) the GEO insertion of an AR 44 L payload, (2) the GTO-GEO transfer of a Shuttle-launched spacecraft of three tons maximum, and (3) the LEO raising of a three-to-five ton spacecraft from the 300 km Shuttle orbit to some 1000 km with a moderate plane change. Four major propulsion system alternatives are compared to each other in terms of GEO payload and mission cost: a satellite-integrated unified system, an attached unified propulsion module, a separable propulsion module, and an autonomous propulsion vehicle/stage. A conceptual definition of two different propulsion modules resulting from the study is presented and discussed. C.D.

A84-25293#
UTILIZATION OF ELECTRIC PROPULSION FOR COMMUNICATION SATELLITES
PH. SAINT-AUBERT (Matra SA, Toulouse, France), D. VALENTIAN (SocieteEuropeenne de Propulsion, Vernon, Eure, France), and W. BERRY (ESA, European Space Research and Technology Centre, Noordwijk, Netherlands) IN: Communication Satellite Systems Conference, 10th, Orlando, FL, March 19-22, 1984, Technical Papers . New York, American Institute of Aeronautics and Astronautics, 1984, p. 354-364. refs
(AIAA PAPER 84-0729)

The advantages and drawbacks of utilizing an electric propulsion system for the station-keeping of future telecommunication satellites are reviewed and analyzed. Two propulsion systems presently under development in Europe are used as reference systems: The FEEP concept, where liquid caesium is ionized under the field emission principle, and the RIT 10 concept, where the ionization depends on radio frequency excitation of a gas. A mission analysis is presented, and the optimization of the propulsion system parameters using a solar array alone or combining an array with on-board batteries, is discussed. C.D.

A84-25294#
WHY DON'T WE USE ION PROPULSION?
R. SPERBER (GTE Satellite Corp., Stamford, CT) IN: Communication Satellite Systems Conference, 10th, Orlando, FL, March 19-22, 1984, Technical Papers . New York, American Institute of Aeronautics and Astronautics, 1984, p. 365-375. refs
(AIAA PAPER 84-0730)

Ion propulsion systems are compared with conventional catalytic and electrically augmented hydrazine systems and the potential for incorporation of ion propulsion into today's Delta spacecraft is discussed. Battery-powered ion propulsion systems tend to be more massive than electrically augmented hydrazine systems because of the large fixed masses of additional batteries required. Solar array power appears to be preferable for ion-propelled spacecraft. For commercial use, ion propulsion will have to satisfy technical problems with respect to life, contamination, RF noise, and integration of the system into real spacecraft. Technical and political approaches to these problems are suggested. C.D.

A84-25344
INTERSTELLAR SOLAR SAILING - CONSIDERATION OF REAL AND PROJECTED SAIL MATERIALS
G. L. MATLOFF (Pratt Institute, Brooklyn, NY) British Interplanetary Society, Journal (Interstellar Studies) (ISSN 0007-084X), vol. 37, March 1984, p. 135-141. refs

The relevant theory of real partially transmitting films is developed. Interstellar missions using 'real' beryllium and aluminium solar sails 5-30 nm thick are investigated, as is a mission using a projected 10 nm composite sail. Analysis indicates that optimized performance projections for these sails do not vary appreciably from previous calculations for an idealized 90 percent reflective sail with an area/mass thickness of 6 x 0.00001 kg/m sq and an emissivity of 0.5. Substantial performance improvement is possible if a perforated sail is used in place of a hyper-thin, flat, metallic or composite sheet. The theory of two types of optical filters that might be relevant in the consideration of perforated solar sails, although not entirely adequate in the visual spectral region, is reviewed and discussed. Author

A84-27443#
ROUNDTRIP INTERSTELLAR TRAVEL USING LASER-PUSHED LIGHTSAILS
R. L. FORWARD (Hughes Research Laboratories, Malibu, CA) Journal of Spacecraft and Rockets (ISSN 0022-4560), vol. 21, Mar.-Apr. 1984, p. 187-195. refs

Design concepts for large lightsail spacecraft powered by solar-pumped lasers and capable of high-speed interstellar travel are proposed. Major components of the systems include circular thin-Al-film sails (optimum thickness about 16 nm for 650-nm radiation), powerful solar-driven CW-laser arrays with a 1000-km diameter in earth or solar orbit, and 1000-km-diameter Fresnel zone lenses to focus the laser beam. A fly-by mission to Alpha Centauri (with a 65-GW laser system, a 3.6-km-diameter sail, a maximum speed of 0.11 c, and a travel time of about 40 yr), a one-way rendezvous mission to Alpha Cen (7.2 TW, 100 km, 0.21 c, 36 yr; deceleration phase 26 TW, 30 km, 5 yr), and a manned return mission to Epsilon Eridani (43 PW, 1000 km, 0.5 c, 51 yr earth time or 46 yr crew-aging time, including 5 yr for exploration) are described and illustrated with drawings. T.K.

A84-29869
MAKING THE HIGH FRONTIER HIGHLY VISIBLE WITH A SOLAR SAIL RACE TO THE MOON
G. PIGNOLET (Centre National d'Etudes Spatiales; Union pour la Promotion de la Propulsion Photonique, Toulouse, France) IN: Space manufacturing 1983; Proceedings of the Sixth Conference, Princeton, NJ, May 9-12, 1983 . San Diego, CA, Univelt, Inc., 1983, p. 249-257. refs
(AAS PAPER 83-226)

It is felt that for too many people space and the possibilities it offers remain too remote. It is difficult for the public to distinguish between science fiction and potential reality. What makes the difference is experience, sensory experience, and this is related directly to the structure of the human brain. It is thought that a race to the moon between several small solar sails could attract the attention to the reality of space. The sails would remain visible from the surface of the earth and could provide sustained interest for the world-wide public. The costs of such a race are also discussed. C.R.

N84-11206*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
RESISTOJET PROPULSION FOR LARGE SPACECRAFT SYSTEMS
M. J. MIRTICH 1982 32 p refs Presented at the 16th Intern. Elec. Propulsion Conf., New Orleans, 17-19 Nov. 1982; sponsored by AIAA, the Japan Soc. for Aeron. and Space Sci., and Deutsche Gesselschaft fur Luft-und Raumfarhrt
(NASA-TM-83489; E-1813; NAS 1.15:83489) Avail: NTIS HC A03/MF A01 CSCL 21H

Resistojet propulsion systems have characteristics that are ideally suited for the on-orbit and primary propulsion requirements of large spacecraft systems. These characteristics which offer advantages over other forms of propulsion are reviewed and presented. The feasibility of resistojets were demonstrated in space whereas only a limited number of ground life tests were performed. The major technology issues associated with these ground tests are evaluated. The past performance of resistojets is summarized and, looks into the present day technology status is reviewed. The material criteria, along with possible concepts, needed to attain high performance resistojets are presented. S.L.

N84-12226*# Boeing Aerospace Co., Seattle, Wash.
STUDY OF AUXILIARY PROPULSION REQUIREMENTS FOR LARGE SPACE SYSTEMS. VOLUME 1: EXECUTIVE SUMMARY
W. W. SMITH and G. W. MACHLES Sep. 1983 22 p
(Contract NAS3-23248)
(NASA-CR-168193-VOL-1; NAS 1.26:168193-VOL-1; D180-27728-1) Avail: NTIS HC A02/MF A01 CSCL 21H

An insight into auxiliary propulsion systems (APS) requirements for large space systems (LSS) launchable by a single shuttle is presented. In an effort to scope the APS requirements for LSS, a set of generic LSSs were defined. For each generic LSS class a specific structural configuration, representative of that most likely to serve the needs of the 1980's and 1990's was defined. The environmental disturbance forces and torques which would be acting on each specific structural configuration in LEO and GEO orbits were then determined. Auxiliary propulsion requirements were determined as a function of: generic class specific configuration, size and openness of structure, orbit, angle of orientation, correction frequency, duty cycle, number and location of thrusters and direction of thrusters and APS/LSS interactions. The results of this analysis were used to define the APS characteristics of: (1) number and distribution of thrusters, (2) thruster modulation, (3) thrust level, (4) mission energy requirements, (5) total APS mass component breakdown, and (6) state of the art adequacy/deficiency. S.L.

N84-13218*# Boeing Aerospace Co., Seattle, Wash.
STUDY OF AUXILIARY PROPULSION REQUIREMENTS FOR LARGE SPACE SYSTEMS, VOLUME 2 Final Report
W. W. SMITH and G. W. MACHLES Sep. 1983 305 p refs
(Contract NAS3-23248)
(NASA-CR-168193-VOL-2; NAS 1.26:168193-VOL-2; D180-27728-2) Avail: NTIS HC A14/MF A01 CSCL 21H

A range of single shuttle launched large space systems were identified and characterized including a NASTRAN and loading dynamics analysis. The disturbance environment, characterization of thrust level and APS mass requirements, and a study of APS/LSS interactions were analyzed. State-of-the-art capabilities for chemical and ion propulsion were compared with the generated propulsion requirements to assess the state-of-the-art limitations and benefits of enhancing current technology. Author

N84-19474# Air Force Inst. of Tech., Wright-Patterson AFB, Ohio. School of Engineering.
DISCONTINUOUS LOW THRUST ORBIT TRANSFER M.S. Thesis
J. R. CASS, JR. Dec. 1983 64 p
(AD-A136908; AFIT/GA/AA/83D-1) Avail: NTIS HC A04/MF A01 CSCL 21C

This paper examines the use of discontinuous low thrust for orbital transfers between two non-coplanar, circular orbits. The vehicle is assumed to be a solar-powered, ion rocket that cannot operate when it is within the Earth's shadow. Two timescales are used to derive a minimum fuel trajectory. The fast timescale solution maximizes a change in inclination when given a change in semi-major axis for a single orbit. The slow timescale solution combines fast timescale results to obtain the minimum fuel trajectory. Results are presented for three specific transfers requiring varying amounts of shadow penetration. It is shown that the fuel penalty caused by discontinuous thrust is small. However, there can be a moderate increase in total trip time if the time within the shadow is large. Author (GRA)

10

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.

A84-10024*# National Aeronautics and Space Administration, Washington, D. C.
SPACE STATION AUTONOMY REQUIREMENTS
J. L. ANDERSON (NASA, Washington, DC) IN: Computers in Aerospace Conference, 4th, Hartford, CT, October 24-26, 1983, Collection of Technical Papers . New York, American Institute of Aeronautics and Astronautics, 1983, p. 164-170.
(AIAA PAPER 83-2352)

Several concepts of autonomy have emerged from space station technology and mission studies. Unifying these concepts is important to enabling the needs for and requirements of autonomous systems for a space station to be explored. One purpose of autonomy related to a space station is to offload routine, demonstrated, precisely specifiable tasks and functions from humans to machines in order to increase habitability, increase human-machine system productivity, or to decrease operational costs. Defining incremental roles, functions, and technical capabilities for autonomy leads to identification of computing systems technologies needed to enable various degrees of autonomy. Author

A84-10066*# National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.
DATA SYSTEM ARCHITECTURE CONSIDERATIONS FOR A SPACE STATION
E. B. CONNELL (NASA, Goddard Space Flight Center, Data Systems Technology Office, Greenbelt, MD) IN: Computers in Aerospace Conference, 4th, Hartford, CT, October 24-26, 1983, Collection of Technical Papers . New York, American Institute of Aeronautics and Astronautics, 1983, p. 472-477.
(AIAA PAPER 83-2346)

The functions that a space station could serve are outlined and details of the data systems requirements are discussed. The data system design will be guided by an overall space systems plan, and will feature distributed, layered architecture, user friendliness, hierarchical control, technology transparency, standard interfaces, and automated engineering tools. The station would begin with a limited core capability and evolve to serve functions defined thereafter. The automation of the engineering tools will be necessary to permit an optimized, minimized crew to control all functions of the space station, while at the same time freeing the crew from being actively involved in maintaining the nominal life support functions of the equipment. One major criterion is that the software must be error free, while another is adaptibility to changing space station configurations and demands. M.S.K.

A84-10883
SPACE APPLICATIONS AT THE CROSSROADS; PROCEEDINGS OF THE TWENTY-FIRST GODDARD MEMORIAL SYMPOSIUM, GREENBELT, MD, MARCH 24, 25, 1983
J. H. MCELROY, ED. and E. L. HEACOCK, ED. (NOAA, Washington, DC) Symposium sponsored by AAS, AIAA, American Society for Aerospace Education, et al. San Diego, CA, Univelt, Inc. (Science and Technology Series. Volume 55), 1983, 308 p.
NASA's accomplishments in space exploration in the quarter century since NASA was formed are reviewed and the directions that could be taken in the near future are examined. The increases in spacefaring capabilities that were gained in the interval covering the Mercury program to near-operational status for the STS are discussed, as are the historical, current, and future NASA aeronautical research programs. Comparisons are made between the data available from the multispectral scanner and the thematic mapper on board Landsat-4, particularly for land cover/use applications. Attention is given to promising avenues for new classification schemes for the enhanced spectral range of the thematic mapper. D.H.K.

A84-10965*# National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, Ala.
LAUNCH PROCESSING FOR SPACELAB 1
R. O. MCBRAYER (NASA, Marshall Space Flight Center, Huntsville, AL) IN: Shuttle Environment and Operations Meeting, Washington, DC, October 31-November 2, 1983, Collection of Technical Papers . New York, American Institute of Aeronautics and Astronautics, 1983, p. 228-233.
(AIAA PAPER 83-2622)
The final integration of Spacelab payloads with the Shuttle is described. Attention is given to launch processing planning, schedules, quality control, and problem reports and configuration maintenance. Also covered are the integration and checkout of individual and combined experiments, mounting the end cones, attachment of the transfer tunnel, and inclusion of an extra experiments pallet. The entire Spacelab module was subjected to a full systems simulation before deliverance to the Orbiter bay. Modular parts that were transferred from building-to-building were placed in sealed containers filled with a purged atmosphere during transport. M.S.K.

A84-11719#
SPACE LOGISTICS
D. S. EDGECOMBE, C. O. COOGAN, and R. R. TESTER (Battelle Columbus Laboratories, Columbus, OH) International Astronautical Federation, International Astronautical Congress, 34th, Budapest, Hungary, Oct. 10-15, 1983. 9 p.
(IAF PAPER 83-24)
Features of logistics for space missions are discussed with an eye to existing trends and possible improvements. The thrust of space programs is shifting from exploration to exploitation of near-earth space, either through expansion of existing satellite capabilities or construction of a series of space stations. Payload dimensions and operating equipment are moving toward standardization, in proven electronic components and in size to fit the Shuttle bay. Space stations and on-orbit servicing by the Orbiter would extend the lifetimes of satellites while also encouraging greater standardization of parts. A need then arises to stockpile parts which may be subject to obsolescence because the assemby lines will have closed. The defense systems practice of front-end logistics analysis assimilates factors which impinge on the desired degree of readiness and the ability to sustain operations over a long time period. All components are analyzed for their criticality and reliability to identify the logistics areas which are feasible to alter, particularly for characterizing the parts and materials which must be available in storage from the beginning, a project such as a space station. M.S.K.

A84-11722#
ESA SPACE STATION ACTIVITIES
J. COLLET and G. PETERS (ESA, Directorate of Space Transportation Systems, Paris, France) International Astronautical Federation, International Astronautical Congress, 34th, Budapest, Hungary, Oct. 10-15, 1983. 9 p. refs
(IAF PAPER 83-30)
Current ESA space-station planning is surveyed, focusing on the studies comprising the Long-Term Space-Transportation Preparatory Programme. The present Spacelab, Ariane-2, 3, and 4, and European Retrievable Carrier (Eureca) projects are reviewed, and the need for a European launch capability beyond Ariane-4, a European space infrastructure, and continued cooperation with NASA is defined. User needs in the life sciences, material sciences, space science, remote sensing, communications, and industry are described. Proposed ESA contributions to space-station design include Spacelab-based habitation, logistics, and laboratory modules; Eureca-based solar arrays and heat-pipe radiators; and new designs for an orbital maneuvering vehicle (modular and integrated versions are illustrated). The prospects for ESA/NASA cooperation in the space-station project are considered in terms of political, economic, and technological factors. D.G.

A84-11723#
OVERVIEW OF SPACE STATION OPERATIONS
W. C. SCHNEIDER (Computer Sciences Corp., Falls Church, VA) and J. H. DISHER International Astronautical Federation, International Astronautical Congress, 34th, Budapest, Hungary, Oct. 10-15, 1983. 7 p.
(IAF PAPER 83-38)
Current planning and development for space-station operations in the 1990's are summarized. The system elements (habitat, power/utility module, multiple-docking/berthing module, logistics module, discipline-oriented modules, teleoperator maneuvering system, remote manipulation system, and ground support) and capabilities (experiments, satellite service, upper-stage basing and servicing, structural fabrication or assembly, and operation of tethered satellites) are characterized. It is shown that a station in a 450-km, 28.5-deg-inclined circular orbit with crew exchange and resupply every 90-120 days could fulfill these requirements with an initial crew of 6-8 and mature-phase crew of 20-24. Launch and support by the Space Shuttle are assumed. Consideration is given to data-management, mission-control, and operational safety factors. The findings are illustrated with tables and graphs. D.G.

A84-11727#
EUROPEAN UTILISATION ASPECTS FOR A SPACE STATION
W. LEY and H. SAX (Deutsche Forschungs- und Versuchsanstalt fuer Luft- und Raumfahrt, Cologne, West Germany) International Astronautical Federation, International Astronautical Congress, 34th, Budapest, Hungary, Oct. 10-15, 1983. 8 p. Research supported by the European Space Agency.
(IAF PAPER 83-54)
The results of an ESA study on the payloads and benefits of European participation in a NASA space station are reported. Analyses and questionnaires were prepared of mission candidates in material sciences and processes, life sciences, space science applications and technology, and new space utilization fields. European hardware contributions to a space station were projected as logistics, hangar, and experiments modules, as well as retrievable free-flying platforms that would carry material sciences, biology, space sciences, and earth observation instrumentation. The usefulness of a manned presence for the space-based materials, life sciences, and space technologies is concluded valid, especially with regard to operations on a space station. The space station would be, in fact, a complement to present unmanned European space missions, and the human presence is essential for constructing and maintaining larger, more complex apparatus in space. M.S.K.

A84-11728#

SPACE STATION - A CANADIAN PERSPECTIVE

K. H. DOETSCH (National Aeronautical Establishment, Ottawa, Canada) International Astronautical Federation, International Astronautical Congress, 34th, Budapest, Hungary, Oct. 10-15, 1983. 16 p.

(IAF PAPER 83-55)

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

A84-11737#

AN OVERVIEW OF THE INSTITUTIONAL AND REGULATORY ASPECTS AND THEIR IMPACT ON SYSTEM DESIGN

F. M. GALANTE (Eutelsat, Paris, France) International Astronautical Federation, International Astronautical Congress, 34th, Budapest, Hungary, Oct. 10-15, 1983. 11 p.

(IAF PAPER 83-82)

Attention is given to international regulations that are applicable to geostationary orbit use by fixed satellite service systems, with a view to the means currently available for the reduction of potential interference to acceptable levels through a system-coordination process. This coordination process may result in either a reduction of the capacity of the planned system, or in a reduction of service quality. It is noted that if the interference environment is taken into consideration at the time of a given system's planning, rather than at the coordination stage, it may be possible to achieve a system optimization that will reduce the negative economic impact of coordination. O.C.

A84-11739#

COMMERCIAL COMMUNICATIONS SATELLITE MARKET AND TECHNOLOGY IN THE 90'S

R. T. FILEP (Communications 21 Corp., Redondo Beach, CA) International Astronautical Federation, International Astronautical Congress, 34th, Budapest, Hungary, Oct. 10-15, 1983. 6 p. refs

(IAF PAPER 83-86)

A description is presented of a user requirement study which was conducted during the fall of 1982 to determine possible commercial communications missions for a low-earth orbit space station under consideration for the 1990s. The study included a review of the literature on large space structures for communications. The survey returns were grouped into four categories, taking into account missions relating to testing, space communications technology, scientific research priorities and suggestions for cost savings in space, and communications traffic growth. In discussions regarding the space station, of considerable interest to many of the participants was the concept of the space station as a 'service station-in-the-sky'. Some interest was expressed in a low-earth orbit communications satellite. G.R.

A84-11753#

UTILISATION OF THE EUROPEAN RETRIEVAL CARRIER EURECA FOR LIFE SCIENCE RESEARCH

G. SEIBERT (ESA, Paris, France) International Astronautical Federation, International Astronautical Congress, 34th, Budapest, Hungary, Oct. 10-15, 1983, IAF Paper 83-169. 9 p.

The design features, mission profiles, and functions of the EURECA free flying platform, to be launched from the Orbiter into a 500 km orbit, then return for retrieval at a later date, are described. The 2.2 m spacecraft will weigh about 3.5 tons, feature a 400 N thruster and propellant sufficient for a 400 m/sec velocity change, and interface with the Orbiter RMS arm. The missions will support biology, exobiology, and materials processing experiments. The first mission will carry a protein crystallization experiment to provide protein crystals for X ray diffraction studies, botany experiments to determine the effect of gravity on plant growth, an experiment to determine the long-term effect of space radiation on biological materials, and the protection afforded biological materials by shielding equipment. The EURECA platform will maintain orbit for six months before lowering orbit for a passive capture by the Orbiter. M.S.K.

A84-11773#

THE FAIRCHILD LEASECRAFT SYSTEM - A COMMERCIALLY-OPERATED PLATFORM FOR SCIENCE AND BUSINESS IN SPACE

B. RAAB (Fairchild Space Co., Germantown, MD) International Astronautical Federation, International Astronautical Congress, 34th, Budapest, Hungary, Oct. 10-15, 1983. 10 p.

(IAF PAPER 83-232)

Design features and mission profiles for the Leasecraft free-flying platforms are described. The Leasecraft would use multimission modular spacecraft (MMS) configured for launch by the Shuttle, transfer to 28.5 deg polar sunsynchronous inclination orbits, and return for later retrieval with the RMS arm, changeout and replacement of the payload, and return to the sunsynchronous orbit. The Leasecraft would have two optional solar power panels, an attitude control subsystem, a special function module, and a TDRSS antenna, as well as a propulsion subsystem that would also be refueled during Orbiter rendezvous. Payloads would be categorized as primary or secondary, with the former claiming priority on the spacecraft attitude, mission modes, and revisit intervals. An example of a primary mission would be the Advanced X-ray Astrophysics Facility, while secondary paylods could include materials processing experiments and search and rescue transponders. Primary services are expected to cost $2-4 million/month, while secondary services run $0.5-1 million/month. M.S.K.

A84-11779#

NATURAL SELECTION OF STELLAR CIVILIZATIONS BY THE LIMITS OF GROWTH

M. D. PAPAGIANNIS (Boston University, Boston, MA) International Astronautical Federation, International Astronautical Congress, 34th, Budapest, Hungary, Oct. 10-15, 1983. 9 p. refs

(IAF PAPER 83-272)

Evolution occurs in any system that possesses degrees of freedom to allow the appearance of new entities and constraints to select a few of them to become part of the system which in this manner continues to evolve. The limits of growth in a finite system, which will be imposed on all stellar civilizations by the colossal distances that separate the stars, will become the constraint that will affect the natural selection of these civilizations. Those that will manage to overcome their innate tendencies toward continuous material growth and replace them with non-material goals will be the only ones to survive this crisis. As a result the entire galaxy in a cosmically short period will become populated by stable, highly ethical and spiritual civilizations. Author

A84-11787#

ANALYTICAL MODEL OF THE EVOLUTION OF ORBIT PARAMETERS OF A QUASI GEOSTATIONARY SATELLITE

P. LEGENDRE (Centre National d'Etudes Spatiales, Toulouse, France) International Astronautical Federation, International Astronautical Congress, 34th, Budapest, Hungary, Oct. 10-15, 1983. 9 p. refs

(IAF PAPER 83-316)

The MASQ analytical model describing the evolution of the orbit parameters of a geostationary satellite maintained within a narrow window (0.1 deg) in longitude and latitude is examined. The method used in developing the model involves expanding the perturbation functions in adapted orbit parameters and incorporating them in the Lagrange equations. The model is a secular evolution model with sums of periodical terms; the periods are extensively variable and come under four different categories. The model is shown to be sufficiently accurate to maintain geostationary satellites in station and requires less computational effort than numerical methods. V.L.

A84-11938* Jet Propulsion Lab., California Inst. of Tech., Pasadena.

SIMULATION OF THE GALILEO SPACECRAFT AXIAL - DELTA-V ALGORITHM

J. M. LONGUSKI (California Institute of Technology, Jet Propulsion Laboratory, Guidance and Control Section, Pasadena, CA) IN: World Congress on System Simulation and Scientific Computation, 10th, Montreal, Canada, August 8-13, 1982, Proceedings. Volume 3 . Montreal, International Association for Mathematics and Computers in Simulation, 1983, p. 236-238. refs
(Contract NAS7-100)

Preliminary results are presented from the analysis of the Galileo spacecraft axial delta-V algorithm. The Galileo spacecraft is a dual spin interplanetary spacecraft which will study the four Galilean moons of Jupiter as well as the Jovian environment and atmosphere. In order to achieve orbit about Jupiter and accurately deliver the probe to the planet's upper atmosphere, the Galileo spacecraft must be capable of performing many trajectory corrections or delta-V maneuvers. Twelve 10 Newton thrusters and one 400 Newton engine are utilized for this purpose. There are many maneuver modes and control algorithms available to the spacecraft. In this paper only the analysis of the axial delta-V algorithm will be discussed. The analysis consists of two parts: an analytic study and a simulation study. The analytic results are based on rigid body dynamics, while the simulation includes the first order effect of the flexible magnetometer boom and nutation damper. The simulation utilizes a program developed at JPL which allows flexible body effects to be simulated by modeling a collection of rigid bodies attached together by hinges, springs and dampers. In this preliminary study of the Galileo only two rigid bodies were used in the simulation, but many more can and will be used in the final tests. In this analysis, the algorithm appears to be working correctly and the analytic and simulation results agree very well. Author

A84-13376#

THE SPACELAB TEST PROGRAM

J. K. VON DER LIPPE (Messerschmitt-Boelkow-Blohm GmbH; Raumfahrttechnik GmbH, Bremen, West Germany) AIAA, AHS, IES, SETP, SFTE, and DGLR, Flight Testing Conference, 2nd, Las Vegas, NV, Nov. 16-18, 1983. 12 p.
(AIAA PAPER 83-2685)

The design features, program organization, and tests of the Spacelab are described. Spacelab provides a shirtsleeve environment for LEO missions lasting up to 30 days. The design is modular and can accommodate up to three pallets as well as the pressurized vessel, with all components staying mounted in the Orbiter bay. ESA provides design, development, and manufacturing, as well as the instrument pointing system, the first flight payload package, and post-delivery support until after the second flight. NASA will purchase a second Spacelab, supply verification instrumentation for the hardware during the first two flights, and will construct the Spacelab tunnel. The final product was constructed after complete testing of subsystem component, and no environmental testing was performed on a complete system. Actual full system tests covered the initial power-up, interfaces, EM compatibility, noise, off-gassing, leaks, mass properties, and software. M.S.K.

A84-13901#

SPACELAB'S DEVELOPMENT

M. BIGNIER (ESA, Paris, France) ESA Bulletin (ISSN 0376-4265), no. 36, Nov. 1983, p. 6-11.

Significant events in the international cooperation between ESA members and NASA in the development of Spacelab are outlined. The agreement to develop Spacelab in Europe was formalized in a MOU between NASA and ESRO in 1972, and was followed by configuration studies in both Europe and the U.S. It was decided in 1973 that ESA would build the hardware and turn it over to NASA, which would fly Spacelab on the Shuttle and buy a second Spacelab manned module. Once delivered, all responsibility for Spacelab would be transferred to NASA. A total of 10 European countries participated in the design, construction, and testing, performed by a project team of 100 engineers and 40 industrial companies. Design reviews were performed until 1981, in concert with hardware development of both Spacelab and pallets. The Eureca free-flying platform is being developed as a follow-on project, and studies are being conducted for activities in the future, such as participation in a space station. M.S.K.

A84-14586* Jet Propulsion Lab., California Inst. of Tech., Pasadena.

LARGE DEPLOYABLE REFLECTOR (LDR) - A CONCEPT FOR AN ORBITING SUBMILLIMETER-INFRARED TELESCOPE FOR THE 1990S

P. N. SWANSON, S. GULKIS, T. B. H. KULPER (California Institute of Technology, Jet Propulsion Laboratory, Pasadena, CA), and M. KIYA (NASA, Ames Research Center, Moffett Field, CA) Optical Engineering (ISSN 0091-3286), vol. 22, Nov.-Dec. 1983, p. 725-731. NASA-supported research. refs

The history and background of the Large Deployable Reflector (LDR) are reviewed. The results of the June 1982 Asilomar (CA) workshop are incorporated into the LDR science objectives and telescope concept. The areas where the LDR may have the greatest scientific impact are in the study of star formation and planetary systems in the own and nearby galaxies and in cosmological studies of the structure and evolution of the early universe. The observational requirements for these and other scientific studies give rise to a set of telescope functional requirements. These, in turn, are satisfied by an LDR configuration which is a Cassegrain design with a 20 m diameter, actively controlled, segmented, primary reflector, diffraction limited at a wavelength of 30 to 50 microns. Technical challenges in the LDR development include construction of high tolerance mirror segments, surface figure measurement, figure control, vibration control, pointing, cryogenics, and coherent detectors. Project status and future plans for the LDR are discussed. Author

A84-14764

SPACEFLIGHT TO 2000 - INTERAVIA LOOKS FORWARD FROM THE PRESENT

C. BULLOCH Interavia (ISSN 0020-5168), vol. 38, Nov. 1983, p. 1185-1192.

NASA and ESA space missions and technologies to the year 2000 are discussed, together with economic and political factors impinging on the space activities. International cooperation is essential for projects costing upwards of $10 billion, with one driving force being that nations must participate in space programs or lose any technological competitiveness they could generate internally due to the cutting edge qualities of space technologies. Telecommunications will continually expand, with the STS remaining the largest booster vehicle. ESA may develop a launcher for LEO applications, and use a lifting body first stage. Improved durability is planned for the Shuttle main engines, as are thrust augmentation and ceramic-lined chambers. Over 100 missions have been identified for a space station, and a range of orbit transfer vehicles is being developed for a variety of applications. One spin-off from space programs will be advances in computer technology because of current data rates from remote sensing satellites, the need for a high level of artificial intelligence on a space station, and remotely controlled devices such as free-flying repair platforms. D.H.K.

A84-15092
MISSION TO MARS - THE CASE FOR A SETTLEMENT
C. STOKER (Colorado, University, Boulder, CO) and C. P. MCKAY Technology Review (ISSN 0040-1692), vol. 86, Nov.-Dec. 1983, p. 27-30, 35-37.

Scenarios and motivations for exploration, settlement, and exploitation of Mars are explored. Mars has an atmosphere that contains enough oxygen to extract breathing gases, and the soil is mineralogically rich in elements suitable for the manufacture of construction materials, fuels, and soil for growing plants. The location of Mars also serves as a gateway to the asteroids, which may be mined for raw materials. The Martian moons, Deimos and Phobos, are candidates for the development of asteroid mining techniques. The water supply on Mars consists of a 0.3 percent atmospheric concentration, the polar caps, and the potential for a deeply penetrating permafrost that extends to the lower latitudes. NASA has a design for a Mars mapper satellite that could locate the ground-frost areas of the entire planet. Ion-drive and solar-sail propulsive systems could provide power for the trip to Mars after the spacecraft have been assembled in earth orbit. The round-trip journey, plus landing, experimentation, and exploration, would last more than 2.5 yr. A larger data base is still needed to predict the health effects of the long journey in microgravity, isolation, and in exposure to occasional solar flare radiation. M.S.K.

A84-15161
MAN IN SPACE - AN OVERVIEW
O. G. GAZENKO (Ministerstvo Zdravookhraneniia SSSR, Institut Mediko-Biologicheskikh Problem, Moscow, USSR) Aviation, Space, and Environmental Medicine (ISSN 0095-0562), vol. 54, Section II, Dec. 1983, p. S3-S5.

The effects of the space environment on humans are reviewed in the light of 22 years of experience, and the implications for future space-colonized projects are considered. The primary factors discussed are cosmic radiation and weightlessness. While operations near the earth are shown to expose crew members to only minimal amounts of radiation, interplanetary voyages will involve exposure to relativistic androns which could affect vital brain centers. Weightlessness brings numerous complications related to changes in the afferent nervous system, the cardiovascular system, and the loading of the musculoskeletal system which could well induce evolutionary changes in space colonists ('El Greco-type' humans in solar-system colonies or new species of the Homo genus in Galactic colonies). The risk factors for current spacecraft crew members are shown to be comparable to those encountered by test pilots or professional boxers. T.K.

A84-15189#
GLOBAL IMPLICATIONS OF SPACE ACTIVITIES: AN AIAA/ASPEN INSTITUTE ASSESSMENT
New York, American Institute of Aeronautics and Astronautics, 1983, 7 p.

The impact of space technology on six areas of global impact was assessed by the AIAA and representatives of government, industry, and educational organizations in June 1983. Attention was given to percussions that would be felt in science, third world participation in space applications, space station policy, military activities, remote sensing, and technology transfer. Recommendations were developed that included continuance of the NASA Advanced Communications Technology program, facilitating an open-door policy for remote-sensing data, governmental sponsorship of meetings between representatives of space-faring nations, encouragement of international participation by scientists in the planning stages of a space station, and efforts by the U.S. to benefit from the technologies of other countries in planning future space stations. Continued open dissemination of nonclassified technological literature in the U.S. is also advised, as are increased efforts to negotiate weapons bans for space, separation of military and civilian space activities, and persevering attention to the needs of developing countries in space policy. M.S.K.

A84-15321
FINANCING LARGE SPACE PROJECTS [LE FINANCEMENT DES GRANDS PROJETS SPATIAUX]
M. E. LEVY (Paris, Banque Nationale, Paris, France) IN: Management of large space projects; Course on Space Technology, Toulouse, France, May 3-14, 1982, Proceedings . Toulouse, Cepadues-Editions, 1983, p. 609-623. In French.

The arrangement possible for financing large space projects are explored, together with various projects which can be undertaken. The scale of financing is noted to be on the order already experienced with petroleum, nuclear, natural gas production and utilization facilities, the Airbus program, and international gas pipelines. The projects depend on volume, time to operatinal status, the novelty, international aspect, and the risks. Participants in the venture comprise the promoter, the financiers, the public authorities, and the clients. Financing plans include normal credit channels, taking into account the associated risks and necessary advances for capitalization, loans, credit-leasing arrangements, and through concessions. Proposed and operational projects for which the financing is necessary include the Ariane, the SPOT satellite, Spacelab, DBS satellites, and astronomical satellites. M.S.K.

A84-15381
DEVELOPING THE SPACE FRONTIER; PROCEEDINGS OF THE TWENTY-NINTH ANNUAL CONFERENCE, HOUSTON, TX, OCTOBER 25-27, 1982
A. NAUMANN, ED. and G. ALEXANDER, ED. (Lockheed Engineering and Management Services Co., Inc., Houston, TX) Conference sponsored by the American Astronautical Society and American Institute of Aeronautics and Astronautics. San Diego, CA, Univelt, Inc. , 1983, 434 p.

Projects which are planned, under development, in design, or are being carried out as parts of the U.S. space program are discussed. Factors influencing the articulation of a U.S. space policy are examined from political, military, scientific, NASA, and civilian viewpoints. Private sector participation in space activities is explored in terms of remote sensing, the development of low-cost spacecraft, and cooperative agreements among companies to fund space ventures. The implementation of government space development programs by government agencies is described, together with financial and business participation in space. Areas requiring technological advance to commence space construction are delineated, covering propulsion, power sources, commercial needs, and data management systems. Economic, political, and social impediments and supports for space activities are assessed, as is progress in utilization and expansion of the capabilities of the STS. Finally, the suitability of the Shuttle as a base for development of the space frontier is examined. No individual items are abstracted in this volume M.S.K.

A84-17026
COLLOQUIUM ON THE LAW OF OUTER SPACE, 25TH, PARIS, FRANCE, SEPTEMBER 27-OCTOBER 2, 1982, PROCEEDINGS
Colloquium sponsored by the International Astronautical Federation. New York, American Institute of Aeronautics and Astronautics, 1983, 352 p.

International law aspects of outer space are addressed. The topics considered include: legal aspects of protection of the earth and outer space environment, legal aspects of the peaceful use of outer space in the light of Article IV of the 1967 Outer Space Treaty, determination of applicable law to living and working in outer space, and legal aspects of direct broadcast satellites. C.D.

A84-17054#
JURISPRUDENTIAL PHILOSOPHIES OF THE ART OF LIVING IN SPACE THE TRANSNATIONAL IMPERATIVE
P. M. STERNS and L. I. TENNEN IN: Colloquium on the Law of Outer Space, 25th, Paris, France, September 27-October 2, 1982, Proceedings . New York, American Institute of Aeronautics and Astronautics, 1983, p. 187-202. refs
(IAF PAPER 82-IISL-38)

The parameters to be considered in determining the law applicable to living and working in space are examined. In addition, traditional jurisprudential philosophies are analyzed in terms of their rationale and policy considerations in the context of a space settlement. It is demonstrated that a jurisprudential philosophy which transcends national legal structures will be necessary for the continued existence of a space settlement. Such a philosophy will promote the interests and policies of all the participants in a space settlement, in times of dispute as well as in times of peaceful coexistence. V.L.

A84-17057#
DETERMINATION OF APPLICABLE LAW TO LIVING AND WORKING IN OUTER SPACE
L. FEKETE IN: Colloquium on the Law of Outer Space, 25th, Paris, France, September 27-October 2, 1982, Proceedings . New York, American Institute of Aeronautics and Astronautics, 1983, p. 221, 222. refs
(IAF PAPER 82-IISL-44)

The international space law as it applies to national and international space crews is discussed. The subjects of space law are always states and never physical persons. States are obliged to see to it that their nationals conduct space activities in accordance with international law. Space stations are under the jurisdiction of the state on whose registry the station is launched into outer space. The law of the jurisdictional state applies to the crew. Where the crew is an international one, the various states participating in the undertaking may agree between themselves as to the applicable law. C.D.

A84-17058#
DETERMINATION OF APPLICABLE LAW TO LIVING AND WORKING IN SPACE
H. DESAUSSURE (Akron, University, Akron, OH) and P. HAANAPPEL (McGill University, Montreal, Canada) IN: Colloquium on the Law of Outer Space, 25th, Paris, France, September 27-October 2, 1982, Proceedings . New York, American Institute of Aeronautics and Astronautics, 1983, p. 223-228. refs
(IAF PAPER 82-IISL-45)

The existing body of international space law does not contain a comprehensive set of rules dealing with living and working in outer space. In developing such a set of rules the international legal community can either follow a substantive law approach or a conflicts approach. This paper will deal with two recent developments in U.S. domestic law which are relevant to the subject of living and working in space; first, a U.S. District Court decision on property and privacy law as affected by remote sensing from the airspace; secondly, U.S. legislation giving U.S. courts criminal jurisdiction over launched spacecraft and personnel on board. Both developments will be discussed and put into an international context. Author

A84-17074#
THE SOLAR POWER SATELLITE - A PROGRAMME FOR DEVELOPMENT AID
R. C. MEINER IN: Colloquium on the Law of Outer Space, 25th, Paris, France, September 27-October 2, 1982, Proceedings . New York, American Institute of Aeronautics and Astronautics, 1983, p. 343-346.

It is pointed out that there are essentially four types of foreign aid. These types include the transfer of knowledge, the transfer of materials, the transfer of funds, and the provision of preferential agreements. A great number of studies have been conducted to assess the pros and cons of a Solar Power Satellite System (SPSS). According to many, the most difficult problems which have to be solved in connection with such a project are related to environmental, societal, political, and institutional aspects. The present investigation is concerned with the initiation of a gradual, phased approach toward a Solar Power Satellite (SPS). Phase I of such an approach would involve the set-up of an organization and the allocation of studies. The building of photovoltaic farms and of an SPS pilot project would occur during the second phase, while development and deployment of a full SPSS would take place during the third phase. The developments are to be financed under foreign aid. G.R.

A84-17075#
ENERGY FROM SPACE - LEGAL IMPLICATIONS OF THE USE OF THE GEOSTATIONARY ORBIT
S. GOROVE IN: Colloquium of the Law of Outer Space, 25th, Paris, France, September 27-October 2, 1982, Proceedings . New York, American Institute of Aeronautics and Astronautics, 1983, p. 347-349.

The provisions of international and treaty law governing the use of geostationary orbits (GEO) and the communications spectrum associated with them are reviewed. The questions raised are considered especially important in the light of plans for solar-power satellites in GEO. The claims of national sovereignty over portions of the GEO by equatorial nations in the Bogota Declaration of 1976 have been rejected, and the Outer Space Treaty of 1967 provides for free exploration and use of space. The frequency-assignment resolutions of the successive WARC meetings (1971, 1973, 1977, and 1979) on space telecommunications have also concerned themselves with GEO, and call for 'equitable access' to GEO 'in practice'. Such provisions are interpreted to mean that nations can demand access to GEO slots or communications channels only when they possess the technical capability to use them; no 'sharing in the benefits' (as stipulated in the Moon Agreement) is required. The need for more carefully defined criteria and the establishment of priorities for future GEO use is stressed. T.K.

A84-17076#
CONSEQUENCES OF TRANSMISSION OF SOLAR ENERGY FROM OUTER SPACE
A. A. COCCA IN: Colloquium on the Law of Outer Space, 25th, Paris, France, September 27-October 2, 1982, Proceedings . New York, American Institute of Aeronautics and Astronautics, 1983, p. 351-353.

The possible physical effects of MW, laser, or mirror-type SPS transmissions and their legal implications are considered. The bioeffects of the transmitted radiation and the atmospheric effects of transmission and of launcher-effluent injection (heating and ionospheric depletion) are examined, and the political aspects of receiver siting (near the equator for GEO solar systems) are indicated. The occupation of large portions of the MW band for SPS transmission and more generalized detrimental effects of SPS on space and terrestrial communications systems are explored, and the provisions of the Space Treaty, the Liability Convention, and (proposed) WARC Radio Regulations are discussed. Since no specific regulations on the use of solar energy have been adopted, a set of twelve basic tenets is proposed. The definition of solar energy and the GEO as nonappropriable parts of the 'common heritage of mankind' and the establishment of international organs (including a compulsory tribunal) to enforce the liability of SPS operators for ensuing damages and the fair sharing of soar resources are urged. T.K.

A84-17077#
LEGAL ASPECTS OF SOLAR POWER SATELLITES IMPACT ON THE ENVIRONMENT
I. H. PH. DIEDERIKS-VERSCHOOR IN: Colloquium on the Law of Outer Space, 25th, Paris, France, September 27-October 2, 1982, Proceedings . New York, American Institute of Aeronautics and Astronautics, 1983, p. 355-363. refs

There are three sources of the impact. The first has to do with the terrestrial operations connected with the construction of the launching site, the space vehicles, the satellites themselves, and the receiving installations. The second concerns the transport operations of the space vehicles carrying the satellites, and the third the transmission of the solar energy back to earth. The overall impact will comprise the biological effects of electromagnetic radiation, the atmospheric effects of radiation and launch effluents, and the environmental effects of land requirements and the siting of launch facilities and ground-based energy receivers. The rules of space law that form the legal framework for this situation are set forth. A rudimentary foundation for protection of the environment does exist, thanks mainly to the Space treaty of 1967. The absence in current space law of any rule making it mandatory for states to act in such a way as to preclude any possibility of contaminating the environment is decried. C.R.

A84-17762
THE GERMAN SPACELAB MISSION D1 [DIE DEUTSCHE SPACELAB-MISSION D1]
N. KIEHNE and H. STEIMLE (Deutsche Forschungs- und Versuchsanstalt fuer Luft- und Raumfahrt, Cologne, West Germany) DFVLR-Nachrichten (ISSN 0011-4901), vol. 40, Nov. 1983, p. 2-4. In German.

The goals, planning, and organization of the 7-day German Spacelab mission (D1) planned (in cooperation with NASA and ESA) for mid-1985 are reviewed, with a focus on the roles played by the DFVLR. The scientific payload components are listed in a table, and the biomedical, materials-science and processing, communications, and navigation experiments are characterized. DFVLR is responsible for choosing the experiments to be performed, developing and building the apparatus, integration of the payload in the FRG, operational control of the mission, and management of the program. Preparations are underway for the training of the ground personnel and the mission and payload specialists with a Spacelab simulator, and for staging operations in cooperation with NASA to facilitate the integration of the D1 payload into the STS. DFVLR project management is under the supervision of a joint committee comprising both DFVLR and the FRG Science and Technology Ministry. A block diagram of the organizational structure is provided. T.K.

A84-17763
OPERATIONAL PLANNING, SIMULATION, AND PERFORMANCE OF THE GERMAN SPACELAB MISSION D1 [OPERATIONELLE PLANUNG, SIMULATION UND AUSFUEHRUNG DER DEUTSCHEN SPACELAB-MISSION D1]
H. J. PANITZ (Deutsche Forschungs- und Versuchsanstalt fuer Luft- und Raumfahrt, Cologne, West Germany) DFVLR-Nachrichten (ISSN 0011-4901), vol. 40, Nov. 1983, p. 5-10. In German.

The current status of DFVLR preparations and planning for the 7-day German Spacelab mission (D1) planned for June, 1985, is reviewed, emphasizing operational rather than hardware aspects. The development of crew activity plans and operating procedures for the 100 scientific experiments, the selection and training of the two mission specialists and two payload specialists (using the Spacelab simulator being completed at Cologne), and the organization of the ground-support and communications systems are discussed. Drawings, block diagrams, and a sample activity plan are included. T.K.

A84-19850
SPACE STATIONS - A KEY TO SOCIO-ECONOMIC BENEFITS FROM SPACE?
J. M. LOGSDON Earth-Oriented Applications of Space Technology (ISSN 0277-4488), vol. 3, no. 3-4, 1983, p. 219-225. refs

The way that the idea for a space station has evolved is traced. It was first proposed as a means for preparing for manned planetary exploration. By 1966, however, it was concluded that such a station would be used instead for broadbased research and development programs in science and technology. In the latter part of the 1970s there was again a change, with the station now seen as an operations center for constructing and maintaining space systems. Research was no longer to be the primary goal. At the present time, however, research is again being put forward as the rationale. It is believed that if the goals and benefits of the station are specified too precisely, there may be insufficient interest and support. The project should be approached as a long-term investment, one that will enable the U.S. to continue making progress in space. It is also believed that the efforts that the Soviet Union is making in this area should serve as an impetus to U.S. efforts. C.R.

A84-21344
PROJECT SPACE STATION - PLANS FOR A PERMANENT MANNED SPACE CENTER
B. OLEARY (Science Applications, Inc., Pasadena, CA) Harrisburg, PA, Stackpole Books, 1983, 174 p. refs

Plans and possibilities for a U.S. space station are discussed, and some visions of the human role in space at the turn of the century are presented. The Soviet role in space, the militarization of space, the building of a space station from tinkermodules, and the use of space stations for industry, communications, and space travel are addressed. The possibility of mining precious metals in asteroids is considered. Space station architecture, the construction of factories and hotels in space, commerce and homesteading in space, and space careers are discussed. C.D.

A84-21476
ENERGY FROM SPACE; PROCEEDINGS OF THE SYMPOSIUM ON SOLAR ENERGY FROM SPACE, VIENNA, AUSTRIA, AUGUST 9-21, 1982
J. W. FREEMAN, ED. (Rice University, Houston, TX) Symposium sponsored by the United Nations. Space Solar Power Review (ISSN 0191-9067), vol. 4, no. 1-2, 1983, 192 p.

Aspects of solar power generation in space are considered. The subjects discussed include: a vision of future energy from space; solar power satellite concept for utilization of energy from space; the institutional challenge of solar power satellites; system study of the solar power satellite concept; market potential and possible limitations for satellite solar power stations; financing a solar power satellite project; and European questions related to satellite power systems. Also addressed are: options and high payoff choices for transportation; an electric propulsion transportation system from low-earth orbit to geostationary orbit utilizing beamed microwave power; the Canadarm robot arm of the Shuttle Remote Manipulator System; an early experimental solar power satellite; power economical considerations for the integration of terrestrial and extraterrestrial solar generators into existing power generation stations; and space solar power in perspective. C.D.

A84-21477
ENERGY FROM SPACE - A VISION OF THE FUTURE
P. JANKOWITSCH (Austrian National Assembly Parliament, Vienna, Austria) (United Nations, Symposium on Solar Energy from Space, Vienna, Austria, Aug. 9-21, 1982) Space Solar Power Review (ISSN 0191-9067), vol. 4, no. 1-2, 1983, p. 3-10.

The SPS is one of the most promising nonpolluting power generation options which could contribute to meeting global energy demands in the 21st century. With proper organization and foresight, the nations of the world may one day collaborate in establishing a satellite solar power system to resolve their energy needs. Intelsat and Inmarsat have emerged to provide exciting examples of the feasibility of such international efforts. The implications of SPS deployment are international in scope. An SPS would use outer space and radio frequency spectrum resources that are within the international domain. SPS would be subject to the present legal regime governing activities in outer space which encompasses two international organizations and three treaties. Author

A84-21478
EVOLUTION OF THE SOLAR POWER SATELLITE CONCEPT - THE UTILIZATION OF ENERGY FROM SPACE
P. E. GLASER (Arthur D. Little, Inc., Cambridge, MA) (United Nations, Symposium on Solar Energy from Space, Vienna, Austria, Aug. 9-21, 1982) Space Solar Power Review (ISSN 0191-9067), vol. 4, no. 1-2, 1983, p. 11-21. refs

The utilization of the inexhaustible resources available in space is discussed with emphasis on solar energy conversion in orbit for use on earth. The rationale for the solar power satellite (SPS) as a potential global energy supply option is presented, and the evolution of this concept since 1968 is traced. Alternative concepts for obtaining energy from space are also reviewed. The factors favoring the development of the SPS are highlighted, including projected dramatic increases in global electrical generating capacity. Environmental impacts and societal effects with emphasis on international participation in an SPS program are considered and the SPS is compared with alternative energy conversion methods. The international implications of the SPS are underlined and the common interests of both developed and developing nations in the development of the SPS as a 21st century option are recognized. The steps towards implementation of the SPS option are outlined in the context of achieving the inevitable transition to renewable sources of energy. Author

A84-21479
SOLAR POWER SATELLITES - THE INSTITUTIONAL CHALLENGE
J. M. LOGSDON (George Washington University, Washington, DC) (United Nations, Symposium on Solar Energy from Space, Vienna, Austria, Aug. 9-21, 1982) Space Solar Power Review (ISSN 0191-9067), vol. 4, no. 1-2, 1983, p. 23-29.

The tasks of designing, financing, developing, and operating a solar power satellite (SPS) system would be as much organizational and institutional in character as they are technical and economic. The institutional character of a proposed SPS would be an issue of interest to almost all countries of the world, because the supply of large quantities of baseload of electricity by the SPS would have global political and economic impact. This investigation has the objective to provide some information regarding questions of organization and management of such a SPS, giving attention to the point that similar (although far from identical) institutional challenges have been solved. Thus, the International Telecommunications Satellite Organization (Intelsat) is discussed as an example. The reasons for the success of Intelsat are considered along with the limits to the Intelsat model, and the global context for SPS development. G.R.

A84-21480* National Aeronautics and Space Administration. Lyndon B. Johnson Space Center, Houston, Tex.
A SYSTEM STUDY OF THE SOLAR POWER SATELLITE CONCEPT
R. O. PILAND (NASA, Johnson Space Center, Houston, TX) (United Nations, Symposium on Solar Energy from Space, Vienna, Austria, Aug. 9-21, 1982) Space Solar Power Review (ISSN 0191-9067), vol. 4, no. 1-2, 1983, p. 35-47.

The paper summarizes a system study of the solar power satellite (SPS) concept which was conducted in the 1977-1980 time period. The system study was sponsored by the U.S. Department of Energy and the National Aeronautics and Space Administration as part of an SPS Concept Development and Evaluation Program. A reference system, developed during the study is described. The reference system was subsequently used as a basis for environmental, economic, and societal assessments. The reference system was recognized as probably not being an optimized approach. A number of alternate approaches which were studied in less depth are also described. The paper concludes with a number of observations regarding the SPS concept, and the pertinence of ongoing space technology, development, and flight programs to various aspects of the concept. Author

A84-21481
MARKET POTENTIAL AND POSSIBLE LIMITATIONS FOR SATELLITE SOLAR POWER STATIONS
M. J. CLAVERIE and A. P. DUPAS (CNRS, Paris, France) (United Nations, Symposium on Solar Energy from Space, Vienna, Austria, Aug. 9-21, 1982) Space Solar Power Review (ISSN 0191-9067), vol. 4, no. 1-2, 1983, p. 49-59. refs

A84-21482
FINANCING A SOLAR POWER SATELLITE PROJECT
C. A. S. FAWCETT (Morgan Grenfell and Co., Ltd., London, England) (United Nations, Symposium on Solar Energy from Space, Vienna, Austria, Aug. 9-21, 1982) Space Solar Power Review (ISSN 0191-9067), vol. 4, no. 1-2, 1983, p. 71-77.

It is pointed out that the solar power satellite project constitutes a unique financial challenge because is represents the first attempt to exploit extraterrestrial sources commercially. This project is to make electricity available to all nations from sources which are outside the claim of any nation. This transnational character of the project and, in addition, the magnitude of the project costs, point to the desirability and the need for international funding. A technique known as 'project financing' has been developed in the world's financial community specifically for the purpose of funding such very large ventures. Attention is given to details of project financing, the completion risk, the completion agreement, the economic risk (technological risk), aspects of equity, questions regarding the debt, and the United Nations revolving fund for natural resources exploration. G.R.

A84-21483
EUROPEAN QUESTIONS RELATED TO SATELITE POWER SYSTEMS
D. KASSING (ESA, European Space Research and Technology Centre, Noordwijk, Netherlands) (United Nations, Symposium on Solar Energy from Space, Vienna, Austria, Aug. 9-21, 1982) Space Solar Power Review (ISSN 0191-9067), vol. 4, no. 1-2, 1983, p. 87-97. refs

A number of problems which have been identified in recent European studies related to satellite power systems are addressed. Based on energy demand and supply projections for Europe, developed by the International Institute for Applied Systems Analysis, the potential of power satellites in a future energy mix is discussed. A few major constraints are presented which may restrict power transmission to European receiving sites, e.g., orbital limitations, siting problems of the ground station, and economic and institutional issues. Conceptual designs for the structure of ground receiving stations located offshore near the European coastlines are described. Author

A84-21487
SPACE STATION - AN EARLY EXPERIMENTAL SOLAR POWER SATELLITE
M. NAGATOMO (Tokyo University, Tokyo, Japan) (United Nations, Symposium on Solar Energy from Space, Vienna, Austria, Aug. 9-21, 1982) Space Solar Power Review (ISSN 0191-9067), vol. 4, no. 1-2, 1983, p. 143-154. refs

The Solar Power Satellite (SPS) is a typical macroengineering problem encompassing technical, social, and economic problems with many potential solutions, among which choices must be made. The 'macrophasing' project management concept presently introduced features a central facility for each of the several phases which will serve as an experimental facility, demonstrating milestone achievements for each of the major SPS development problems. The first phase will feature an orbital space station that is to be built within one decade. This dedicated space station may, after furnishing valuable construction and operational experience, be used in turn as the construction platform for the larger (subscale) models of the prospective SPS which constitute the second phase. The third and last phase will emphasize economic evaluation of the system. O.C.

A84-21488
POWER-ECONOMICAL CONSIDERATIONS FOR THE INTEGRATION OF TERRESTRIAL AND EXTRATERRESTRIAL SOLAR GENERATORS INTO EXISTING POWER GENERATION SYSTEMS
I. B. STOY (Rheinisch-Westfaelisches Elektrizitaetswerk AG, Essen, West Germany) (United Nations, Symposium on Solar Energy from Space, Vienna, Austria, Aug. 9-21, 1982) Space Solar Power Review (ISSN 0191-9067), vol. 4, no. 1-2, 1983, p. 155-167.

A84-21489
SPACE SOLAR POWER IN PERSPECTIVE
G. R. WOODCOCK (Boeing Aerospace Co., Seattle, WA) (United Nations, Symposium on Solar Energy from Space, Vienna, Austria, Aug. 9-21, 1982) Space Solar Power Review (ISSN 0191-9067), vol. 4, no. 1-2, 1983, p. 169-181. refs

When the solar power satellite (SPS) concept was introduced in 1968, it quickly became regarded as a fanciful idea which would not work. The claims made by early critics were mainly related to the assumed inefficiency of microwave power transmission, the problems concerning the construction and control of the required large space structures, the astronomical cost of space transportation, and the energy needed for delivery of the SPS to orbit. However, a number of studies and developments occurring at the time the criticisms were being leveled and afterwards showed that many of the claims made by the critics were not true. The present investigation synopsizes current knowledge of the SPS concept and reviews new circumstances not considered in evaluations conducted in 1980 and 1981. The technical challenges are examined along with environmental issues, the 'reference system' created by DOE-NASA studies, cost issues, new developments, and needs for further research. G.R.

A84-21497
MANNED PLANETARY MISSIONS?
R. C. PARKINSON (British Aerospace PLC, Dynamics Group, Stevenage, Herts., England) Spaceflight (ISSN 0038-6340), vol. 26, Feb. 1984, p. 50-52.

Manned planetary missions, mistakenly criticized as glamour projects, are shown to be more effective, more attractive and less costly than unmanned missions; NASA is shown to outspend ESA in both project types. The complexity of a manned mission increases its information capturing ability and eliminates the need for multiple unmanned missions. Manned space activities will reduce costs with the proposed manned Space Station, which would serve as a transportation node to geosynchronous flight. The reusable Orbit Transfer Vehicle with large payload capability would move spacecraft to high orbit while decreasing the overall launching cost to approximately $11 million per ton. In conclusion manned missions (e.g., to Mars and Jupiter) in coordination with robots to maximize data collection are suggested. C.M.

A84-21499
MANKIND'S INTERSTELLAR FUTURE
A. R. MARTIN Spaceflight (ISSN 0038-6340), vol. 26, Feb. 1984, p. 76-79.

Results of a questionnaire, based on the Delphi method, and dealing with space predictions are presented. The results project mankind as a stellar civilization by the end of the 21st century. The questionnaires, answered by 15 individuals connected with space aspects, provide median dates and interquartile ranges for 11 space missions including the first manned mission to the Jupiter system (2029), the use of solar system natural resources (2040), and the mission colonization of an extrasolar planet (2260). A scenario forecast depicts humans as having landed on Phobos and Deimos by 2005 and the establishment of L-5 colonies by 2075. C.M.

A84-21720
SPACE 1991
D. VELUPILLAI Flight International (ISSN 0015-3710), vol. 125, Jan. 21, 1984, p. 163-165.

NASA's plans for a space station by 1991 are discussed. The space station, with a 500-km-high circular orbit inclined at 28.5 deg, is to be continuously manned, a staging post to higher orbits, a satellite service center, and a platform for science and industry. It will comprise several repairable and evolvable modules and unmanned independent platforms, will have a 60 kW power capability, and will possess an open-loop life-support system for its rotating crew of six to eight people. An eventual self-sufficient colony is intended. Differences from the Space Shuttle will be the station's electronic pilotage and distributed computer architecture with microprocessors controlling each task. Initial cost is estimated at $8,000 million spread over five years. Industry contracts are to be awarded for preliminary design of major elements, and international cooperation is indicated. C.M.

A84-22327
MANUFACTURING IN SPACE; PROCEEDINGS OF THE WINTER ANNUAL MEETING, BOSTON, MA, NOVEMBER 13-18, 1983
L. KOPS, ED. (McGill University, Montreal, Canada) Meeting sponsored by the American Society of Mechanical Engineers. New York, American Society of Mechanical Engineers (Production Engineering Symposia Series. PED Volume 11), 1983, 223 p.

Processes, facilities, and issues related to manufacturing in outer space are addressed. The subjects discussed include: NASA, European, and Japanese projects on materials processing in space; gravitational effects in dendritic growth; space research impact on semiconductor crystal growth technology; simulation prior to space manufacturing; hardware for materials processing in space; containerless science and technologies; a low orbit satellite manufacturing facility; remote manipulators in space; automation, robotics, and machine intelligence systems in space manufacturing. Also considered are: manufacturing space systems in space; electrophoresis operations in space; rationale for commercial activities in space; Space Shuttle, private enterprise, and intellectual properties in space manufacturing; manufacturers' liability for space products; economics and profitability of space manufacturing; and international cooperation and competition in materials processing in space. C.D.

A84-22338#
MANUFACTURING SPACE SYSTEMS IN SPACE
G. R. WOODOOCK (Boeing, Kent Space Center, Kent, WA) IN: Manufacturing in space; Proceedings of the Winter Annual Meeting, Boston, MA, November 13-18, 1983 . New York, American Society of Mechanical Engineers, 1983, p. 127-137.

It is pointed out that the strongest motivator for developing the initial steps in space manufacturing technology is the opportunity afforded by the Space Shuttle to repair or maintain spacecraft in low earth orbit. The steps that will be followed in the repair of the Solar Max spacecraft are outlined. Even though this is a repair rather than a manufacturing mission, the steps to be carried out are similar to those that could be used for manufacturing in space. The use of EVA astronauts to simplify deployment mechanism design is then discussed, noting that the astronauts can readily remove launch retention fixtures, unfold a deployable device, and install braces or pip-pins to place and lock an appendage into its mission-operational position. This can eliminate complex electromechanical drives and sequencers and, in many instances, provide a much stiffer structure in the process. A description is then given of the manufacturing processes foreseen for the space station. C.R.

A84-22341*# National Aeronautics and Space Administration, Washington, D. C.

SPACE SHUTTLE, PRIVATE ENTERPRISE AND INTELLECTUAL PROPERTIES IN THE CONTEXT OF SPACE MANUFACTURING

S. N. HOSENBALL and R. F. KEMPF (NASA, Washington, DC) IN: Manufacturing in space; Proceedings of the Winter Annual Meeting, Boston, MA, November 13-18, 1983 . New York, American Society of Mechanical Engineers, 1983, p. 149-160.

It is a national policy to make the capabilities of the Space Transportat ion System available to a wide range of potential users. This includes its availability as a space manufacturing facility for commercial activities, which may be carried out on a reimbursable basis or as a joint endeavor with NASA, but with substantial private investment. In any high risk, long lead-time research and development activity directed towards commercialization, the protection afforded the results of the research and development under the laws relating to intellectual property rights may provide an important incentive for private investment. The paper reviews NASA's policies and practices for the protection of privately-established intellectual property rights involved in STS use, with particular emphasis on reimbursable launch agreements and joint endeavor agreements. Author

A84-22862#

A CYLINDRICAL NEAR-FIELD TEST FACILITY FOR LARGE SATELLITE ANTENNAS

C.-P. FISCHER (Messerschmitt-Boelkow-Blohm GmbH, Munich, West Germany) European Microwave Conference, 13th, Nuernberg, West Germany, Sept. 5-9, 1983, Paper. 6 p. refs (MBB-UR-628-83-OE)

Recent developments in satellite antenna technology have the objective to achieve a more economical frequency spectrum utilization for improved communication capacity. The approach utilized in the implementation of this objective involves the employment of a narrow antenna beamwidth and frequency reuse. Large reflectors will be needed along with high frequencies (up to 40 GHz presently), low side lobe levels, excellent polarization purity, and high beam pointing accuracy. Spacecraft antennas will be implemented as deployable reflector antennas with multifeed systems and antenna fine pointing mechanism built with carbon-fiber-reinforced plastic structures. Suitable approaches for testing the antennas are discussed. It is found that near-field testing provides major advantages over far-field testing in the considered case. Attention is given to the principles of cylindrical near-field testing, the required instrumentation and the software, and test results. G.R.

A84-23440* Chicago Univ., Ill.

PYROELECTRIC MATERIALS AS ELECTRONIC PULSE DETECTORS OF ULTRAHEAVY NUCLEI

J. A. SIMPSON and A. J. TUZZOLINO (Chicago, University, Chicago, IL) Physical Review Letters (ISSN 0031-9007), vol. 52, Feb. 20, 1984, p. 601-604. refs (Contract NGL-14-001-006; NGL-14-001-258)

The design and testing of ultraheavy-nucleus pulse detectors based on pyroelectric materials are reported, extending the preliminary findings of Tuzzolino (1983) and Simpson and Tuzzolino (1983). Uranium-ion beams of about 240 MeV/u are detected by a 39.5-micron-thick Si detector, degraded to about 175 MeV/u by Al absorbers, and then strike 700-micron-thick polyvinylidene fluoride or 1000-micron-thick $LiTaO_3$ pyroelectric samples. Both detector systems are connected to a coincidence circuit via charge-sensitive preamplifiers, shaping amplifiers with 30-microsec effective time constants, and electronic discriminators. Sample spectra are shown, and the pulse heights measured are found to agree with theoretical calculations to within a factor of about 2. The response of the pyroelectric materials is found to be unaffected by exposure to about 10 Mrad of 2-7-MeV/u heavy ion radiation. With further study and improvement of the detection sensitivity, devices of this type could be applied to large-area space measurements of low ultraheavy-ion fluxes. T.K.

A84-24626*

SPACE STATION: POLICY, PLANNING AND UTILIZATION; PROCEEDINGS OF THE SYMPOSIUM, ARLINGTON, VA, JULY 18-20, 1983

M. GERARD, ED. and P. W. EDWARDS, ED. (American Institute of Aeronautics and Astronautics, New York, NY) Symposium sponsored by the American Institute of Aeronautics and Astronautics and NASA. New York, American Institute of Aeronautics and Astronautics , 1983, 221 p.

The design, technology, and applications of the proposed Space Station (SS) are examined in contributions and discussions from the AIAA/NASA Symposium on the Space Station held on July 18-20, 1983. The role of man in space, the history of SS concepts, and the requirements of scientists, engineers, and commercial users are reviewed. Discussion is included on military space activities; the Solar Maximum Repair Mission; the role of the SS in earth sciences, life sciences, astronomy and astrophysics, and solar physics; pharmaceutical manufacturing on the SS, satellite and platform maintenance and repair from the SS; international utilization of the SS; SS architectures and user concerns; the SS as an element of the total space-system architecture; productivity on an evolutionary SS, SS information and communications systems; and environmental-control and life-support systems for the SS. T.K.

A84-24627*# National Aeronautics and Space Administration. Lyndon B. Johnson Space Center, Houston, Tex.

THE ROLE OF MAN IN SPACE

J. R. LOUSMA (NASA, Johnson Space Center, Houston, TX) IN: Space station: Policy, planning and utilization; Proceedings of the Symposium, Arlington, VA, July 18-20, 1983 . New York, American Institute of Aeronautics and Astronautics, 1983, p. 7-13.

The roles played by astronauts in space missions are discussed using illustrations from the Spacelab and STS experience, and the implications for the proposed space station are considered. Man's ability to perform successfully for relatively long periods in space is demonstrated, and capabilities in manipulation, EVA, equipment repair and compensation for equipment failure, earth observation, astronomy of sun and stars, and laboratory experimentation are characterized and illustrated with photographs. Space station activities planned include repairs (like that of the Solar Maximum Satellite), maintenance (of the Space Telescope), and construction and involve the use of a manned maneuvering unit, a teleoperator maneuvering system, and/or a manned or unmanned OTV. T.K.

A84-24629#

USE OF SPACE STATION FOR SCIENCE

T. M. DONAHUE (National Academy of Sciences, Washington, DC) IN: Space station: Policy, planning and utilization; Proceedings of the Symposium, Arlington, VA, July 18-20, 1983 . New York, American Institute of Aeronautics and Astronautics, 1983, p. 33-35.

Scientific goals for the next 15 years in astronomy and astrophysics, earth sciences, planetary exploration, and solar and space physics are surveyed; the requirements of space missions to attain them are listed; and the ability of the proposed space station to fulfill the requirements is analyzed. The need for GEO, deep-space, high-inclination-orbit, and free-flyer capabilities in addition to a manned station in LEO at 28.5-deg inclination is identified: the manned station would serve primarily to service, launch, or even construct unmanned science vehicles which could serve the scientific needs better than experiments forcefully adapted to the station itself. T.K.

A84-24631#

THE ROLE OF SPACE STATION IN EARTH SCIENCES

L. R. GREENWOOD (Fairchild Space Co., Germantown, MD) IN: Space station: Policy, planning and utilization; Proceedings of the Symposium, Arlington, VA, July 18-20, 1983 . New York, American Institute of Aeronautics and Astronautics, 1983, p. 66-72. refs

Space-station or space-platform characteristics and technologies required or desirable for future research in upper-atmosphere studies, global atmospheric chemistry, meteorology, and climatology are examined, summarizing the findings of a summer (1982) study by the Earth's Environment Panel of the National Research Council Space Applications Board. Capabilities discussed include deployment of large numbers of sensors, high-inclination-orbit options, frequent recalibration and intercalibration with satellites, introduction of new or larger lidar and microwave observatories, and repair and maintenance of instruments and cooled detectors. Earth-science missions are found to require only intermittent manned presence for maintenance and calibration or for construction of large platforms for transfer to GEO. T.K.

A84-24632#
ROLE OF A SPACE STATION IN PHARMACEUTICAL MANUFACTURING
J. T. ROSE (McDonnell Douglas Astronautics Co., St. Louis, MO) IN: Space station: Policy, planning and utilization; Proceedings of the Symposium, Arlington, VA, July 18-20, 1983 . New York, American Institute of Aeronautics and Astronautics, 1983, p. 79-84.

The impact of the proposed space station on the commercial manufacture of pharmaceuticals is discussed, with a focus on the prototype program (using electrophoresis) being developed by McDonnell Douglas in cooperation with the Ortho Pharmaceutical Corporation and NASA. The commercial organization of the program is outlined, and the successful production tests carried out with the STS are briefly described and illustrated with photographs and drawings. First test flight of a production-scale prototype is planned for 1985, to be followed by an unmanned-free-flyer program and/or manned production on the space station. The economic advantages of the manned mode are seen in ease of maintenance, lower transportation costs (raw materials and products only rather than whole vehicles or modules), and more rapid development of new products. T.K.

A84-24635#
NATIONAL SECURITY IMPLICATIONS OF A U.S. SPACE STATION
C. W. COOK (USAF, Washington, DC) IN: Space Station: Policy, planning and utilization; Proceedings of the Symposium, Arlington, VA, July 18-20, 1983 . New York, American Institute of Aeronautics and Astronautics, 1983, p. 145-157.

The use of the proposed space station for military missions is discussed. The current military role in space is characterized (unmanned communications and surveillance satellites), the DOD manned programs of the past are reviewed, and current projects in cooperation with NASA (manned-spaceflight-engineer program, space test program, and space biotechnology program) are examined. While DOD interest in further research on man's roles and capabilities in space remains high, and while the potential of a space station (e.g., for repairing or maintaining unmanned satellites on orbit) will continue to receive close attention, no military missions requiring a manned space station or justifying DOD financing have been identified. A more evolutionary approach using an extended STS and perhaps a space-based TMS is favored. T.K.

A84-24636#
SPACE STATION COMMUNICATIONS
C. L. CUCCIA (Ford Aerospace and Communications Corp., Palo Alto, CA) IN: Space station: Policy, planning and utilization; Proceedings of the Symposium, Arlington, VA, July 18-20, 1983 . New York, American Institute of Aeronautics and Astronautics, 1983, p. 182-188.

A concise history of the various types of communications that have been used in low-earth-orbit vehicles and form the basis of the various types of communications and communication requirements that can be realized in space-station developments over the next decade is presented. The Space Shuttle can be assumed to be a prototype space station in the tradition of Apollo and Spacelab. Shuttle operations require earth-to-ground support communications, EVA communications, internal communications, and communications to and from other spacecraft (TDRS) and free-flying vehicles for experiments (SPAS-01). These basic communication requirements will expand to the point where the man-computer alliance in the space station will transform the station into a space communications and computer center capable of providing data processing and storage in association with ground-based distributed processing along the growing terrestrial ISDN global digital highway. The space station will also provide unique means to obtain data and information from one part of the earth or space and transport them to another point on earth. Author

A84-24637#
ENVIRONMENTAL CONTROL AND LIFE SUPPORT (ECLS) DESIGN OPTIMIZATION APPROACH
H. F. BROSE (United Technologies Corp., Hamilton Standard Div., Windsor Locks, CT) IN: Space station: Policy, planning and utilization; Proceedings of the Symposium, Arlington, VA, July 18-20, 1983 . New York, American Institute of Aeronautics and Astronautics, 1983, p. 189-194.

The design of environmental-control and life-support (ECLS) systems for the proposed space station is discussed. Design constraints imposed by the overall station concept include crew size and tour of duty, evolutionary vs. integral development, power concept, orbit-keeping and ACS concept, and EVA requirements. The design process involves selecting the station scenario or range of scenarios to be realized, setting the ECLS standards, reviewing concepts capable of meeting these standards, performing payback analysis, and selecting the technologies using specific criteria. Basic, intermediate, and growth versions of a station ECLS system are presented in block diagrams and characterized. A flexible design approach applicable to different scenarios is recommended. T.K.

A84-25251
COMMUNICATION SATELLITE SYSTEMS CONFERENCE, 10TH, ORLANDO, FL, MARCH 19-22, 1984, TECHNICAL PAPERS
Conference sponsored by the American Institute of Aeronautics and Astronautics. New York, American Institute of Aeronautics and Astronautics, 1984, 753 p.

Topics are discussed which are related to satellite communications in Latin America, the efficient use of the geostationary orbit, spacecraft antennas, direct broadcast systems, communication networks, earth stations, Ka-band systems and hardware, mobile systems, launch system developments, and satellite evaluation and test. Other subjects considered are concerned with Direct Broadcast Satellite (DBS) home terminals, regional and international systems, geostationary platforms and clusters, signal processing systems and technology, domestic systems, propagation effects, advanced spacecraft bus technology, military systems, systems availability and cost, and transponder components, taking into account low power devices and power amplifiers. Attention is given to a low cost communications satellite for developing countries, approaches for optimizing communications satellite reliability, and digital technologies and systems for geostationary orbit satellites. G.R.

A84-25253#
REDUCED DOMESTIC SATELLITE ORBIT SPACING
G. L. SHARP (Federal Communications Commission, Washington, DC) IN: Communication Satellite Systems Conference, 10th, Orlando, FL, March 19-22, 1984, Technical Papers . New York, American Institute of Aeronautics and Astronautics, 1984, p. 7-17. refs
(AIAA PAPER 84-0652)

The demand for services provided by communications satellites in geostationary orbit is growing, and problems arise with respect to the required increase in capacity. One approach for providing such an increase involves the employment of more satellites operating at smaller orbital spacings. The present investigation is concerned with the results of technical studies conducted by the Federal Communications Commission (FCC) to determine the feasibility of reducing orbital spacings between U.S. 'domestic fixed satellites' (domsats). Attention is given to details regarding the usable orbital arc, an adjacent satellite interference model, antenna sidelobe patterns, a single entry analysis, a 4/6 GHz aggregate analysis, results for the 4/6 GHz bands, results for the 12/14 GHz bands, data services, voice services, video reception, and high power spot beams. G.R.

A84-25254#
TIME PHASED INTRODUCTION OF ADVANCED TECHNOLOGIES - ITS IMPACT ON ORBIT/SPECTRUM CONSERVATION
D. TONG (Hughes Aircraft Co., El Segundo, CA) IN: Communication Satellite Systems Conference, 10th, Orlando, FL, March 19-22, 1984, Technical Papers . New York, American Institute of Aeronautics and Astronautics, 1984, p. 18-26. refs
(AIAA PAPER 84-0653)

It is pointed out that technical factors influence both the number of spacecraft which can occupy the geostationary orbit with acceptable interference, and the amount of traffic which each spacecraft can carry. These factors are not static, but in a state of continuous evolution. It is suggested that the most practical procedure would involve the introduction of new technical standards in stages over an extended period of time. The present investigation has the objective to examine some of the foreseen improvements in spacecraft and transmission technologies. Orbit conservation technologies are considered, taking into account spacecraft antenna improvements, earth station antenna improvements, and transponder technologies. Attention is given to telephony and record traffic-analog, telephony and record traffic-digital, analog television, and digital television. It is found that a number of techniques exist which can significantly increase the capacity of the geostationary orbit. G.R.

A84-25281#
GEO SPACE PLATFORM ECONOMICS - IMPACT OF CONCEPT, SIZE, LAUNCH MODE AND LIFETIME
D. E. KOELLE (Messerschmitt-Boelkow-Blohm GmbH; ERNO Raumfahrttechnik GmbH, Ottobrunn, West Germany) IN: Communication Satellite Systems Conference, 10th, Orlando, FL, March 19-22, 1984, Technical Papers . New York, American Institute of Aeronautics and Astronautics, 1984, p. 241-248. refs
(AIAA PAPER 84-0704)

The design of GEO communications platforms is examined from an economic perspective. The historical and projected growth of satellite services and spacecraft mass and capability is traced, and the concepts proposed for large conventional satellites, platforms with integrated transfer propulsion, modular platform assemblies, and large man-tended stations with service and repair are reviewed. Spacecraft and launch costs are evaluated, taking the impact of design lifetime into account. A decrease in per-channel space-segment costs is predicted for larger satellites and platforms. Graphs and tables of the numerical results and drawings of proposed systems are included. T.K.

A84-25304#
DIGITAL TECHNOLOGIES AND SYSTEMS FOR GEOSTATIONARY ORBIT SATELLITES
R. PETERS (International Telecommunications Satellite Organization, Washington, DC), R. RIEGER, and A. STANLEY (Messerschmitt-Boelkow-Blohm GmbH, Munich, West Germany) IN: Communication Satellite Systems Conference, 10th, Orlando, FL, March 19-22, 1984, Technical Papers . New York, American Institute of Aeronautics and Astronautics, 1984, p. 432-439. refs
(AIAA PAPER 84-0749)

Power consumption, speed, and radiation resistance of bipolar and CMOS technologies are reviewed for their suitability for use in geosynchronous orbit satellites. Results of Intelsat sponsored radiation tests on five complete microprocessor systems, plus RAMs and PROMs, representing several different bipolar and CMOS techniques, are discussed with other recent test data. Radiation hardened CMOS devices proved quite radiation resistant, had low power consumption and very low soft error rates, making them well suited for satellite applications. Finally, future trends of integrated circuits, including speed, power consumption and reliability are analyzed. Author

A84-25309#
THE SPACE VAN AND ITS POTENTIAL IMPACT ON THE DESIGN OF COMMUNICATIONS SATELLITES
L. CORMIER (TranSpace, Inc., Washington, DC) IN: Communication Satellite Systems Conference, 10th, Orlando, FL, March 19-22, 1984, Technical Papers . New York, American Institute of Aeronautics and Astronautics, 1984, p. 476-481.
(AIAA 84-0758)

This paper outlines the impact that much lower transportation costs might have on the design of communications satellites. The first portion of the paper describes a launch vehicle, the 'Space Van,' which is fully reusable and promises to reduce transportation costs to synchronous orbit by a factor of between two and ten or more, depending upon the total tonnage transported. Such a reduction in transportation costs should be a powerful stimulus to new approaches to the design of communications satellites. The paper concludes with an outline of some concepts for these new design approaches. Author

A84-25318#
COMPUTER TOOLS FOR OPTIMIZING ORBIT USE
T. MIZUNO, Y. ITO, and T. MURATANI (Kokusai Denshin Denwa Co., Ltd., Research and Development Laboratories, Tokyo, Japan) IN: Communication Satellite Systems Conference, 10th, Orlando, FL, March 19-22, 1984, Technical Papers . New York, American Institute of Aeronautics and Astronautics, 1984, p. 549-557.
(AIAA PAPER 84-0651)

The ORBIT-II orbit-spacing-optimization program for GEO communications satellites is characterized and demonstrated. The problems inherent in current orbit-management (OM) techniques are discussed; the methods proposed to improve OM are surveyed (earth and satellite antenna characteristics, positioning flexibility, transmission efficiency, and interference criteria); and the possible administrative (WARC) approaches to OM are reviewed. The ORBIT-II program represents a tool capable of optimizing both positions and beam patterns, with world-map visualization of the results. Sample problems involving both a priori planning and the phased introduction of orbit-conservation measures and including as many as 94 satellites are calculated, and maps and tables of service-arc constraints are shown. D.G.

A84-25319*# National Aeronautics and Space Administration, Washington, D. C.
LESSONS LEARNED DURING THE FIRST YEAR OF THE TDRSS
R. O. ALLER and L. M. ROBINSON (NASA, Washington, DC) IN: Communication Satellite Systems Conference, 10th, Orlando, FL, March 19-22, 1984, Technical Papers . New York, American Institute of Aeronautics and Astronautics, 1984, p. 558-564.
(AIAA PAPER 84-0687)

The Tracking and Data Relay Satellite System (TDRSS) is the National Aeronautics and Space Administration's (NASA) newest capability for tracking and communicating with NASA's low-earth orbiting scientific and operational satellites. This support will eventually be provided through three identical satellites in geosynchronous orbit. They will relay data through a single ground station located in New Mexico. This paper discusses both the overall TDRSS concept and NASA's experience to date with the first of the three relay satellites on station. Author

A84-25327#

DEVELOPMENT TRENDS IN EUROPE ON SATELLITE CLUSTERS AND GEOSTATIONARY PLATFORMS

U. RENNER (ESA, Communication Satellites Dept., Noordwijk, Netherlands) and J. NAUCK (ERNO Raumfahrttechnik GmbH, Bremen, West Germany) IN: Communication Satellite Systems Conference, 10th, Orlando, FL, March 19-22, 1984, Technical Papers . New York, American Institute of Aeronautics and Astronautics, 1984, p. 622-628. refs

(AIAA PAPER 84-0703)

ESA development programs for advanced GEO communications satellites or platforms are surveyed. The ongoing concentration of space-communications traffic in the European region is evaluated, and a gradual transition from the current Eutalsat deployment (one 9-channel satellite in each of three orbital positions) to a configuration combining string-of-pearls clusters of medium-size (18-channel) national satellites and large international platforms is predicted. The technology of clustering and platform assembly in space, including TV observation of neighbor satellites, rendezvous, and mechanical docking in LEO and/or GEO, is discussed. Various proposed vehicles and configurations are illustrated with drawings, and the ESA efforts currently underway or planned (e.g., in-orbit experiments using EURECA) are characterized. D.G.

A84-28576

SYSTEMS CONSIDERATIONS IN MOSAIC FOCAL PLANES

K. P. WHITE, III (Aerospace Corp., Los Angeles, CA) IN: Advanced remote sensing; Proceedings of the Meeting, San Diego, CA, August 26, 27, 1982 . Bellingham, WA, SPIE - The International Society for Optical Engineering, 1983, p. 68-74. refs

Two key reasons for pursuing the development of mosaic focal planes are reviewed and it is shown that rapid frame repetition rate is the only requirement that can be solved no other way than through mosaic focal planes. With the view that spaceborne mosaic focal plane sensors are necessarily 'smart sensors' requiring a lot of onboard processing just to function, it is pointed out that various artificial intelligence techniques may be the most appropriate to incorporate in the data processing. Finally, a novel mosaic focal plane design is proposed, termed a virtual mosaic focal plane, in response to other system constraints. Author

A84-28579

COORDINATE TRANSFORMATION ASSEMBLY

C.-C. HUANG and J. BARNEY (Lockheed Missiles and Space Co., Inc., Space Systems Div., Sunnyvale, CA) IN: Advanced remote sensing; Proceedings of the Meeting, San Diego, CA, August 26, 27, 1982 . Bellingham, WA, SPIE - The International Society for Optical Engineering, 1983, p. 88-97.

The coordinate transformation assembly (CTA) is a noncontact electrooptical device conceived to link the angular coordinates between two remote platforms to a high degree of accuracy. The CTA is, therefore, highly desirable in cases in which the coordinates of one point have to be relayed around corners or over a number of obstacles to another point. It has been demonstrated that the CTA can be employed to measure slight angular shifts in the position of structures such as those inherent in the cargo of large spacecraft. The theoretical basis of CTA operation is discussed, taking into account the roll coordinate, and pitch and yaw coordinates. Attention is given to the transmitter and receiver used in a laboratory setup. G.R.

A84-28975#

WITH THE SPACE SHUTTLE TOWARDS SPACE INDUSTRIALIZATION [MIT DER RAUMFAEHRE 'SPACE SHUTTLE' ZUR WELTRAUM-INDUSTRIALISIERUNG]

J. VON PUTTKAMER IN: Annual report of the Frankfurt Physics Union during the period Jan. 1, 1980 to Dec. 31, 1980, the 155th year of the Union (Jahresbericht des physikalischen Vereins zu Frankfurt am Main fuer die Zeit vom 1.1.1980 bis zum 31.12.1980, 155. Vereinsjahr). Frankfurt am Main, Physikalischer Verein, 1982, p. 47-67. In German.

The space transportation vehicle, 'Space Shuttle', introduces an entirely new era for astronautics. The new era is concerned with the operational, almost routinewise, utilization of the cosmic environment for humanity. The key to this development is the lowering of transportation costs by making use of a space transportation system which is more economical than the one-way launch vehicles of the past. Space industrialization can provide access to the new world of space and utilize it for the common good of mankind. Attention is given to details regarding the Space Transportation System and plans for its utilization, the usable characteristics of outer space, the aims of space industrialization, products 'Made in Space', solar energy made available for terrestrial applications with the aid of geostationary satellites, and the 'humanization' of space. G.R.

A84-29063* Case Western Reserve Univ., Cleveland, Ohio.

GRAVITATIONAL BIOLOGY ON THE SPACE STATION

J. R. KEEFE (Case Western Reserve University, Cleveland, OH) and A. D. KRIKORIAN (New York, State University, Stony Brook, NY) AIAA, SAE, ASME, AIChE, and ASMA, Intersociety Conference on Environmental Systems, 13th, San Francisco, CA, July 11-13, 1983. 25 p. NASA-supported research. refs

(SAE PAPER 831133)

The current status of gravitational biology is summarized, future areas of required basic research in earth-based and spaceflight projects are presented, and potential applications of gravitational biology on a space station are demonstrated. Topics covered include vertebrate reproduction, prenatal/postnatal development, a review of plant space experiments, the facilities needed for growing plants, gravimorphogenesis, thigmomorphogenesis, centrifuges, maintaining a vivarium, tissue culture, and artificial human organ generation. It is proposed that space stations carrying out these types of long-term research be called the National Space Research Facility. C.M.

A84-29126

U.S. NATIONAL CONGRESS OF APPLIED MECHANICS, 9TH, CORNELL UNIVERSITY, ITHACA, NY, JUNE 21-25, 1982, PROCEEDINGS

Congress supported by NSF, U.S. Navy, U.S. Army, et al. New York, American Society of Mechanical Engineers, 1982, 526 p.

Various topics in applied mathematics are addressed. The subjects discussed include: two-phase flow, nonlinear fracture mechanics, tribology, interfacial fluid mechanics, mechanical behavior of composite materials, large motions of systems containing flexible bodies, geophysical fluid dynamics, structural reliability and damage assessment, electromagnetoelastic interactions, flows in materials processing, qualitative theory of dynamical systems, and mechanics of energy technology. C.D.

A84-29656#

THE RESIDUAL GRAVITATIONAL FIELD OF ORBITAL SPACE STATIONS [UEBER DAS RESTSCHWEREFELD IN ORBITALEN RAUMSTATIONEN]

W. KNABE (ERNO Raumfahrttechnik GmbH, Bremen, West Germany) Deutsche Gesellschaft fuer Luft- und Raumfahrt, Jahrestagung, Munich, West Germany, Oct. 17-19, 1983. 16 p. In German. refs

(DGLR PAPER 83-089)

The gravitational field within an orbiting space station and its influence on freely moving bodies in the station are investigated analytically. The field is shown to have a tensorial character, and this finding is extended by analogy from Newtonian to modern gravitational theory. The station is thus characterized as a freely falling inertial laboratory. Current gradiometric techniques for measuring the residual field are reviewed, and an alternative method theoretically applicable at near-zero gravity is proposed. T.K.

A84-29657#

MICROGRAVITY CONDITIONS ON ORBITAL PLATFORMS [MIKROGRAVITATIONS-BEDINGUNGEN ORBITALER PLATTFORMEN]

D. EILERS (ERNO Raumfahrttechnik GmbH, Bremen, West Germany) Deutsche Gesellschaft fuer Luft- und Raumfahrt, Jahrestagung, Munich, West Germany, Oct. 17-19, 1983. 20 p. In German. ESA-sponsored research. refs

(DGLR PAPER 83-90)

The design of orbital platforms to provide undisturbed microgravity environments for experiments and manufacturing processes is discussed, with a focus on the European Retrievable Carrier (Eureca), a platform carrying a wide variety of payloads for a 6-month mission in a 500-km orbit (with release and retrieval by the STS at 300 km). The microgravity requirements of the Eureca experiments are analyzed, and limits of 0.00001 g in the 0.01-1-Hz frequency range, from 0.00001 to 0.001 g in the 1-100-Hz range, and about 0.001 Hz at higher frequencies are proposed. The verification methods currently employed in the Eureca design process are characterized and illustrated. The natural phenomena affecting the microgravity environment (primarily residual atmosphere and gravitational gradients) and the effects of the platform systems (AOCS, thermal circulation, power supply, and data processing) and payloads are evaluated, and the allowable contributions of the subsystems to the microgravity 'budget' are presented in a table. T.K.

A84-29658#

THE ATTITUDE AND ORBIT CONTROL SYSTEM FOR EURECA [DAS BAHN- UND LAGEREGELUNGSSYSTEM FUER EURECA]

G. LIPPNER and H. BAUER (Dornier System GmbH, Friedrichshafen, West Germany) Deutsche Gesellschaft fuer Luft- und Raumfahrt, Jahrestagung, Munich, West Germany, Oct. 17-19, 1983. 6 p. In German.

(DGLR PAPER 83-091)

The development of an AOCS for the European Retrievable Carrier (Eureca) is reported.. The AOCS is designed to perform the transfer maneuver to a 500-km orbit after Eureca is released from the cargo bay of the STS, maintain attitude and orbit during the operational phase (about 6 months for the first flight), and return Eureca to the STS orbit for retrieval. Major components include sun and earth sensors; accelerometer; gyros; magnetic, N2, and hydrazine positioning systems (the latter for orbit transfer); and control electronics. The AOCS design is modular, using the modular attitude control system (MACS) bus to insure flexibility for future Eureca modifications. The development of the AOCS enters the C/D phase in June, 1984, with delivery of the first flight unit for system integration planned for April, 1986. Drawings, flow charts, block diagrams, and tables of hardware parameters are provided. T.K.

A84-29852* Jet Propulsion Lab., California Inst. of Tech., Pasadena.

SPACE MANUFACTURING 1983; PROCEEDINGS OF THE SIXTH CONFERENCE, PRINCETON UNIVERSITY, PRINCETON, NJ, MAY 9-12, 1983

J. D. BURKE, ED. (California Institute of Technology, Jet Propulsion Laboratory, Pasadena, CA) and A. S. WHITT, ED. (Space Studies Institute, Princeton, NJ) Conference sponsored by Princeton University, American Astronautical Society, and Space Studies Institute. San Diego, CA, Univelt, Inc. , 1983, 495 p.

General topics are biomedical and social sciences, space stations and habitats, space manufacturing, international and legal considerations, materials resources and processing, accelerators and asteroids, and space economics. Among the papers presented, consideration is given to the evolution of man as an explorer; whether people, robots, or hybrids should operate a space station; electrophoresis experiments in space; the emerging government regulation of American space entrepeneurs; the extraction and purification of iron-group and precious metals from asteroidal feedstocks; the construction, testing, and design comparison to computer simulation fo the Mass-Driver III; and the international competition in commercial aerospace markets. C.M.

A84-29854

PROBABLE MISSIONS AND TRANSPORTATION SCENARIOS TO USE REGENERATIVE LIFE SUPPORT SYSTEMS

T. VINOPAL, E. GUSTAN, and R. OLSON (Boeing Aerospace Corp., Seattle, WA) IN: Space manufacturing 1983; Proceedings of the Sixth Conference, Princeton, NJ, May 9-12, 1983 . San Diego, CA, Univelt, Inc., 1983, p. 27-43. refs

(AAS PAPER 83-201)

Six missions that could benefit from a controlled ecological life support system type system are described along with their transportation and cost analyses: the Leo Low Inclination, the Leo High Inclination, the 6 X GEO, the Lunar Base, the Asteroid Base, and the Mars Surface Exploration. Each transportation analysis consists of a trajectory analysis to determine the travel route, and a vehicle analysis to determine the most efficient rocket or group of rockets for the mission. Life support systems discussed involve three materials supply methods: (1) storing materials on board at launch time for the entire mission, (2) periodically resupplying materials via a transportation vehicle, and (3) supplying all essential materials through waste recycling. Finally, cost estimates are provided for each mission on a per kilogram basis. C.M.

A84-29855

SPACE STATIONS - THE NEXT STEP IN SPACE?

J. M. LOGSDON IN: Space manufacturing 1983; Proceedings of the Sixth Conference, Princeton, NJ, May 9-12, 1983 . San Diego, CA, Univelt, Inc., 1983, p. 45-57. refs

(AAS PAPER 83-202)

This paper explores the question of whether a space station is the appropriate next major step in the U.S. space program. It briefly traces past space station proposals, then reviews the kind of forces affecting a possible decision within the next few years to proceed with a space station. The station is viewed as an investment opportunity which makes best sense if the United States is likely to pursue an active space program in coming decades. Author

A84-29856

UNDERSTANDING SPACE SETTLEMENTS AS HUMAN SYSTEMS

F. WHITE (Human Systems, Inc., Newton, MA) IN: Space manufacturing 1983; Proceedings of the Sixth Conference, Princeton, NJ, May 9-12, 1983 . San Diego, CA, Univelt, Inc., 1983, p. 59-84. refs

(AAS PAPER 83-204)

A unified approach to the development of space settlements is discussed using as a framework Human Systems Theory. Human systems as general systems are examined, and it is illustrated that the human mind, interacting with its environment, conceives of physical technologies to serve a need within the human system. The importance of human technologies interface and the development of a vision or purpose are demonstrated by three examples of companies that became successful human systems. In addition, pitfalls of North American colonies at Jamestown, Plymouth, and Massachusetts Bay are examined to alert space settlement planners. It is maintained that a successful human system requires a vision that supports the dynamic balance of the physical, conceptual, and spiritual technologies of that system. Finally, a proposal for a research program designed to generate more knowledge about human systems for space applications is proposed. C.M.

A84-29857

A PROGRAM TO DEVELOP EFFICIENT MANNED OPERATIONS IN SPACE

R. KLINE (Grumman Aerospace Corp., Bethpage, NY) IN: Space manufacturing 1983; Proceedings of the Sixth Conference, Princeton, NJ, May 9-12, 1983 . San Diego, CA, Univelt, Inc., 1983, p. 107-118.

(AAS PAPER 83-207)

The evolutionary development of man's activities in space is reviewed, and a program which combines man and machine for expanding on-orbit operations is discussed. The space station and its general mission areas are covered: a National Space Test Facility, a Transportation Harbor, Satellite Servicing, and an Observatory. It is noted that as space missions change, the astronaut's tasks will expand to include tests set-up, data reduction, stage assembly, fueling operations, service, and repair. The man-machine interface will change simultaneously with developments in robotics, artificial intelligence, and telepresence. Also examined are future manned and unmanned space stations in geosynchronous and hi-energy orbits. It is recommended that to use man efficiently in space, Shuttle Orbiter flights be used to develop space operational equipment, as well as demonstrate the equipment's applications to commercial, scientific, and defense communities. C.M.

A84-29865
MAJOR CONCERNS OF PRIVATE ENTERPRISE REGARDING RECENT DEVELOPMENTS IN SPACE LAW
S. GOROVE (Mississippi, University, University, MS) IN: Space manufacturing 1983; Proceedings of the Sixth Conference, Princeton, NJ, May 9-12, 1983 . San Diego, CA, Univelt, Inc., 1983, p. 199-208. refs
(AAS PAPER 83-221)
This presentation starts out by recalling one of the early concerns of private enterprise regarding the legitimacy of its activities in outer space. The discussion moves on to a consideration of some of the major concerns that have arisen in view of recent developments in space law. Among them are: (1) unresolved issues pertaining to the use of the geostationary orbit; (2) similar issues regarding the exploitation of the moon and other celestial bodies; (3) concerns about the international implications of direct television broadcasting by satellites; (4) misgivings about the adequacy of legal protection against damage, harm or interference which may occur in outer space; and, finally, (5) concerns about the state of governmental regulatory procedures. Author

A84-29866* National Aeronautics and Space Administration, Washington, D. C.
INTERNATIONAL ASPECTS OF COMMERCIAL SPACE ACTIVITIES
K. S. PEDERSEN (NASA, International Affairs Div., Washington, DC) IN: Space manufacturing 1983; Proceedings of the Sixth Conference, Princeton, NJ, May 9-12, 1983 . San Diego, CA, Univelt, Inc., 1983, p. 209-217.
(AAS PAPER 83-222)
Attention is given to problems in international cooperation that will arise if NASA proceeds with a Space Station. The rise in space budgets in many countries is cited as an indication of the growing importance being placed on space activities. It is also pointed out that these nations are emphasizing areas which hold promise for eventual commercial payoff. Developing countries are also paying greater attention to space. As part of the European Space Agency's development program, it is underwriting the development of up to six multiuser facilities dedicated to microgravity research; these include furnaces and thermostats for processing metallurgical samples and for crystal growth and botanical investigations. Competition from Europe is seen as a spur to efficiency. Attention is also given to the question whether international cooperation will interfere with research carried out by the US for military purposes. C.R.

A84-29868
A LEGAL CHARTER FOR NON-GOVERNMENTAL SPACE INDUSTRIALIZATION
M. A. ROTHBLATT (Schnader, Harrison, Segal and Lewis, Washington, DC) IN: Space manufacturing 1983; Proceedings of the Sixth Conference, Princeton, NJ, May 9-12, 1983 . San Diego, CA, Univelt, Inc., 1983, p. 229-247. refs
(AAS PAPER 83-225)
Maximum and minimum legal bounds for the exercise of state supervision and authorization of nongovernmental activity in outer space are specified. Legal limits are given in both international and United States law. It is shown that both existing United States law and current regulation theory mandate a minimum exercise of state supervision and authorization for a defined class of space industrialiation activities and that they specify supervisory and control responsibilities. This class of activity, together with the supervisory and control responsibilities, is outlined. Statutory language is suggested pursuant to which firms will receive legal charters to engage in a broad class of space development activity. On the basis of existing space law treaties and other fundamental principles of international law, it is shown that state exercise of supervision and authorization may range from state operation of all space activity to state responsibility for all space activity. C.R.

A84-29883
INTERNATIONAL COMPETITION IN COMMERCIAL AEROSPACE MARKETS
A. M. DEERING (Johnson and Higgins, New York, NY) and W. A. GOOD (Earth Space Transport Systems Corp., New York, NY) IN: Space manufacturing 1983; Proceedings of the Sixth Conference, Princeton, NJ, May 9-12, 1983 . San Diego, CA, Univelt, Inc., 1983, p. 421-430. refs
(AAS PAPER 83-244)
The U.S. has not approached the subject of space commerce in a way which takes the best advantage of its competitive free enterprise system. Many lessons can be learned by closely examining the relationship between government and entrepreneurs in the early days of air commerce. A review of recent international trends in commercial space technology shows that the U.S. is not maintaining the technological leadership to which it is committed due to a suboptimal government/industry relationship vis a vis other industrialized nations. Author

N84-10174*# Martin Marietta Corp., Denver, Colo.
MOLECULAR CONTAMINATION MATH MODEL SUPPORT Final Report
R. WELLS 30 Sep. 1983 97 p refs
(Contract NAS8-34945)
(NASA-CR-170899; NAS 1.26:170899; MCR-83-640) Avail: NTIS HC A05/MF A01 CSCL 22B
The operation and features of a preprocessor for the Shuttle/Payload Contamination Evaluation Program Version 2) are described. A preliminary preprocessor for SPACE 2 is developed. Further refinements and enhancements of the preprocessor to insure complete user friendly operation, are recommended. N.W.

N84-10179# Applied Physics Lab., Johns Hopkins Univ., Laurel, Md.
LARGE SPACE INSTRUMENTATION TO MEASURE THE INTERACTION BETWEEN SPACE STRUCTURES AND THE ENVIRONMENT Final Report, 1 Oct. 1981 - 30 Sep. 1982
C. I. MENG Dec. 1982 21 p
(Contract MIPR-FY7121-82-00007; AF PROJ. 7661)
(AD-A129990; AFGL-TR-83-0059) Avail: NTIS HC A02/MF A01 CSCL 14B
The major effort at the Applied Physics Laboratory of the Johns Hopkins University while participating in the Air Force Geophysics Laboratory's planning of the polar orbiting space shuttle payload definition is to provide necessary information on the polar region space environment and suggestions on the various measurements of the interaction between the space structure and the environment. During the first phase, the effort was concentrated on the polar region space environment, and results of the investigation were presented to the first meeting of the IMPS Definition Phase at JPL. During the second phase of the program, the major effort was on the investigation of possible instrumentation to perform measurements of the interaction between space structures and the environment. Four measurements and their instrumentation were conceived and suggested to the IMPS Definition Team. These are summarized here. Author (GRA)

N84-12228*# National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.
INTEGRATED FLYWHEEL TECHNOLOGY, 1983
C. R. KECKLER, ed., G. E. RODRIGUEZ, ed. (NASA. Goddard Space Flight Center), and N. J. GROOM, ed. Washington Dec. 1983 205 p refs Workshop held in Greenbelt, Md., 2-3 Aug. 1983
(NASA-CP-2290; L-15707; NAS 1.55:2290) Avail: NTIS HC A10/MF A01 CSCL 10C

Topics of discussion included: technology assessment of the integrated flywheel systems, potential of system concepts, identification of critical areas needing development and, to scope and define an appropriate program for coordinated activity.

N84-14752# CAP Sogeti Logiciel, Toulouse (France). Space Branch.
SOFTWARE PRODUCTION IN A LARGE SPACE PROJECT: THE SPOT MISSION CENTER
V. T. KHANG *In* ESA Software Eng. p 185-190 Aug. 1983 refs
Avail: NTIS HC A13/MF A01

The MULTIPRO software workbench used to manage the software production of a team of up to 20 engineers on the SPOT (French satellite) is described. The software runs on CDC Cybers or the SEMS Solaris 16. Software tools were developed for the firmware of the terminals, a librarian and a document generator. A detailed analysis language, not part of the workbench, is used on the Cyber as required by quality assurance. Author (ESA)

N84-16075*# National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, Ala.
SIGNIFICANT SCIENTIFIC AND TECHNICAL RESULTS AT MARSHAL SPACE FLIGHT CENTER Annual Report for 1983
Nov. 1983 83 p refs
(NASA-TM-82562; NAS 1.15:82562) Avail: NTIS HC A05/MF A01 CSCL 05B

Research programs in atmospheric science, materials processing in space, and space sciences as well as technology programs in space power, materials processes, and space structures are discussed. Author

N84-16097*# Essex Corp., Huntsville, Ala.
SPACE TELESCOPE Final Report
E. C. PRUETT, K. B. ROBERTSON, C. N. VANVALKENBURG, and W. REED 13 Sep. 1983 34 p
(Contract NAS8-33272)
(NASA-CR-170948; NAS 1.26:170948; H-83-06) Avail: NTIS HC A03/MF A01 CSCL 03A

Space telescope drawings, mockup drawings, space support equipment, and Spacelab experiment hardware are discussed. N.W.

N84-16242*# National Aeronautics and Space Administration. John F. Kennedy Space Center, Cocoa Beach, Fla.
STS-9: ORBITAL WORKSHOP SPACELAB TO FLY ON NINTH SHUTTLE MISSION
Oct. 1983 8 p
(NASA-TM-85497; KSC-231-83; NAS 1.15:85497) Avail: NTIS HC A02/MF A01 CSCL 22A

The first non-astronants are discussed. Spacelab is described. Spacelab objectives, Spacelab 1 investigations, atmospheric physics and Earth observations, space plasma physics, solar physics and astronomy, material sciences and technology development, and life sciences are discussed. N.W.

N84-16420*# National Aeronautics and Space Administration, Washington, D. C.
THE US SPACE STATION: POTENTIAL BASE FOR A SPACEBORNE MICROWAVE FACILITY
D. MCCONNELL *In* JPL Spaceborne Imaging Radar Symp. p 144-156 1 Jul. 1983
Avail: NTIS HC A08/MF A01 CSCL 22B

Concepts for a U.S. space station were studied to achieve the full potential of the Space Shuttle and to provide a more permanent presence in space. The space station study is summarized in the following questions: Given a space station in orbit in the 1990's, how should it best be used to achieve science and applications objectives important at that time? To achieve those objectives, of what elements should the station be comprised and how should the elements be configured and equipped. These questions are addressed. E.A.K.

N84-16677# Technische Univ., Darmstadt (West Germany). Inst. of Physical Geodesy.
GEODETIC ASPECTS OF ESA PROJECTS, STUDIES AND INVESTIGATIONS
E. GROTEN *In* Technische Univ. Geodesy and Global Geodyn. p 429-438 1982 refs
Avail: NTIS HC A02/MF A01

Some of the various ESA projects which are of basic interest to the advancement of modern geodesy are considered. Besides projects also studies and investigations sponsored by ESA or carried out in ESA-offices and at ESA-facilities are mentioned. References are given where more detailed information can be found. Author

N84-16991*# Iowa Univ., Iowa City. Dept. of Physics and Astronomy.
INTERPRETATION OF STS-3/PLASMA DIAGNOSTICS PACKAGE RESULTS IN TERMS OF LARGE SPACE STRUCTURE PLASMA INTERACTIONS Semiannual Technical Progress Report, 10 Jul. 1983 - 25 Jan. 1984
W. S. KURTH 27 Jan. 1984 19 p
(Contract NAG3-449)
(NASA-CR-173266; NAS 1.26:173266) Avail: NTIS HC A02/MF A01 CSCL 20I

The Plasma Diagnostics Package, which was flown aboard STS-3 recorded various chemical releases from the Orbiter. Changes in the plasma environment were observed to occur during Flash Evaporator System (FES) releases, water dumps and maneuvering thruster operations. During flash evaporator operations, broadband Orbiter-generated electro-static noise is enhanced and plasma density irregularity (delta n/N) is observed to increase by as much as 4 times and is strongly peaked below 6 Hz. In the case of water dumps, background electrostatic noise is enhanced or suppressed depending on frequency and Delta N/N is also seen to increase by as much as 4 times. Various changes in the plasma environment are effected by primary and vernier thruster operations. In addition, thruster activity stimulates electrostatic noise with a spectrum which is most intense at frequencies below 10 kHz. Author

N84-17050# La Jolla Inst., Calif.
IDENTIFICATION OF NEW POTENTIAL SCIENTIFIC AND TECHNOLOGY AREAS FOR DOD APPLICATION. SUMMARY OF ACTIVITIES Final Technical Report, 2 Aug. 1982 - 2 Aug. 1983
2 Aug. 1983 301 p
(Contract MDA903-82-C-0376; ARPA ORDER 3710)
(AD-A134372; LJI-LJ-83-252) Avail: NTIS HC A14/MF A01 CSCL 05A

Document reports on highlights of this year's program, including laser propagation in the atmosphere, laser beam clean-up in Raman amplifiers, X-ray laser research, utilization of the external tanks of the Space Shuttle, and the Status of Solid State materials suitable for high power lasers. GRA

N84-17223*# Department of Communications, Ottawa (Ontario). Space Technology and Applications Branch.
CANADIAN ATTITUDE SENSING EXPERIMENTAL PACKAGE (CASEP)
A. H. REYNAUD *In* NASA. Langley Research Center STEP Expt. Requirements p 165-176 Jan. 1984 refs
Avail: NTIS HC A15/MF A01 CSCL 22B

The Canadian Attitude Sensing Experiment Package (CASEP) was designed to demonstrate and verify the operation of an attitude sensing subsystem prior to committing its use on an operational mission. Data telemetry/recording requirements, power and physical requirements, and mission requirements of the experiment package are defined. M.G.

N84-18315# European Space Agency, Paris (France).
SPACELAB DATA BOOK
N. LONGDON, comp. and J. HUNT, ed. Sep. 1983 127 p
Original contains color illustrations
(ESA-BR-14; ISSN-0250-1589) Avail: NTIS HC A02/MF A01

The Spacelab program is outlined. Crew training, functions, and accommodation are described. Safety factors; accommodation for experiments; structural design; the Igloo; command and data management subsystem; electrical power distribution; environment control; and the transfer tunnel are described. Ground operations; ground support; mission operations; and possible developments are outlined. Author (ESA)

N84-19371*# Stanford Telecommunications, Inc., McLean, Va.
STUDY OF A TRACKING AND DATA ACQUISITION SYSTEM FOR THE 1990'S. VOLUME 3: TDAS COMMUNICATION MISSION MODEL Draft Final Report
T. MCCREARY 31 May 1983 122 p refs Prepared in cooperation with Space Communications Co., Gaithersburg, Md.
(Contract NAS5-26546)
(NASA-CR-175195; NAS 1.26:175195; STI/E-TR-25066-VOL-3)
Avail: NTIS HC A06/MF A01 CSCL 22A

A parametric description of the communication channels required between the user spacecraft to be supported and the user ground data systems is developed. Scenarios of mission models, which reflect a range of free flyers vs space platform usage as well as levels of NASA activity and potential support for military missions, and potential channel requirements which identify: (1) bounds on TDAS forward and return link data communication demand, and (2) the additional demand for providing navigation/tracking support are covered. Author

N84-19429# Dornier-Werke G.m.b.H., Friedrichshafen (West Germany).
THE COMPLEMENTARY ROLES OF EXISTING AND ADVANCED ENVIRONMENTAL, THERMAL CONTROL AND LIFE SUPPORT TECHNOLOGY FOR SPACE STATIONS
A. I. SKOOG and H. F. BROSE (Hamilton Standard, Windsor Locks, Conn.) *In* ESA Environ. and Thermal Control Systems for Space Vehicles p 281-288 Dec. 1983 refs
Avail: NTIS HC A25/MF A01

The role of existing technology, especially Shuttle and Spacelab equipment, and the evolution to incorporation of advanced hardware in a closed loop environmental thermal control and life support (ETCLS) system are discussed. Analyses of regenerative and closed loop systems performed during Space Operations Center, Manned Space Platform, Space Station and Spacelab programs are reviewed. Cabin atmosphere, hygiene, water management, and galley requirements are considered. It is concluded that a considerable amount of existing ETCLS equipment can be used for space stations. Author (ESA)

N84-20605*# Engineering and Economics Research, Inc., Vienna, Va.
AN ATTACHED PAYLOAD OPERATIONS CENTER (APOC) AT THE GODDARD SPACE FLIGHT CENTER (GSFC), VOLUME 1 Final Report
7 Dec. 1983 101 p 2 Vol.
(Contract NAS5-26962)
(NASA-CR-175160; NAS 1.26:175160) Avail: NTIS HC A06/MF A01 CSCL 14B

A management overview of the Attached Payload Operations Center (APOC) functional requirements and design are presented. The rationale for developing the APOC concept and the assumptions utilized are presented. A summary of the concept complete with major functional areas and associated data flows is provided. The attributes of this concept are formalized and the necessary resources needed for its development and operation presented. S.L.

N84-20613# Committee on Commerce, Science, and Transportation (U. S. Senate).
CIVIL SPACE STATION
Washington GPO 1984 91 p refs Hearing before the Subcomm. on Sci., Technol. and Space of the Comm. on Com., Sci. and Transportation, 98th Congr., 1st Sess., 15 Nov. 1983
(S-REPT-98-523; GPO-29-426) Avail: Subcommittee on Science, Technology and Space

How present uses of space can be extended and how other capabilities can be developed that have a unique applicability to a permanent presence in space are issues explored. Existing alternatives for accomplishing the nation's objectives in space are examined and the advantages and disadvantages of each are considered. Private sector involvement, the possibility of international cooperation, and the functions and concepts for a mixture of manned and unmanned elements are discussed. A.R.H.

N84-20617*# Lockheed Aircraft Corp., Burbank, Calif.
ON-ORBIT SPACECRAFT/STAGE SERVICING DURING STS LIFE CYCLE Final Report
27 Jan. 1984 140 p refs
(Contract NAS9-15800)
(NASA-CR-171775; NAS 1.26:171775; LMSC-D931673) Avail: NTIS HC A07/MF A01 CSCL 22B

A comprehensive and repesentative set of shuttle payloads was identified for shuttle and space station servicing missions. The classes of servicing functions were determined and the general servicing support required for the set of referenced spacecraft was allocated. A candidtate strawman space station was depicted from a synthesis of space station concepts derived from NASA space station architecture studies done by eight contractors. The shuttle servicing hardware and kits were identified and their applicability in transitioning servicing capability to the space station was evaluated. A.R.H.

N84-21145# Massachusetts Inst. of Tech., Cambridge.
IMPLEMENTATION OF MACLISP ON A LARGE ADDRESS SPACE COMPUTER Final Report
J. MOSES 21 Dec. 1983 4 p
(Contract DE-AC02-79ER-10357)
(DE84-005042; DOE/ER-10357/1) Avail: NTIS HC A02/MF A01

This is a belated final report on the implementation of NIL - the New Implementation of LISP. Work on this project began in 1978 and is still continuing. The original timetable for the project - two years - slipped badly. Over four years were used to get a working version ready for distribution. At this point over 130 copies of the NIL System were distributed and many of the users find it superior to all available alternatives on the DEC VAX. In that sense the project was quite successful. DOE

N84-21437*# Terra-Mar, Mountain View, Calif.
ALTERNATIVE STRATEGIES FOR SPACE STATION FINANCING
D. C. WALKLET and A. T. HEENAN 1 Sep. 1983 33 p refs
(Contract NASW-3750)
(NASA-CR-175412; NAS 1.26:175412) Avail: NTIS HC A03/MF A01 CSCL 05C

The attributes of the proposed space station program are oriented toward research activities and technologies which generate long term benefits for mankind. Unless such technologies are deemed of national interest and thus are government funded, they must stand on their own in the market place. Therefore, the objectives of a United States space station should be based on commercial criteria; otherwise, such a project attracts no long term funding. There is encouraging evidence that some potential space station activities should generate revenues from shuttle related projects within the decade. Materials processing concepts as well as remote sensing indicate substantial potential. Futhermore, the economics and thus the commercial feasibility of such projects will be improved by the operating efficiencies available with an ongoing space station program. B.G.

N84-21440# Committee on Appropriations (U. S. Senate).
DEPARTMENT OF HOUSING AND URBAN DEVELOPMENT-INDEPENDENT AGENCIES APPROPRIATIONS FOR 1984: NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
In its Dept. of Housing and Urban Develop., and Certain Independent Agencies Appropriations, 1984, Pt. 2 p 1133-1387 1984
Avail: Comm. on Appropriations

Research and development activities in the areas of space transportation systems, space stations, space scence, technology utilization, aeronautical research and technology, space research, energy technology, space tracking and data systems and construction of facilities are summarized. Achievements of the past year were also summarized. B.G.

N84-21441# Committee on Science and Technology (U. S. House).
AUTHORIZING APPROPRIATIONS TO THE NATIONAL AERONAUTICS AND SPACE ADMINISTRATION FOR FISCAL YEAR 1985
Washington GPO 1984 222 p Presented in accompaniment to H.R. 5154 to the Comm. on Sci. and Technol., 98th Congr., 2d Sess., 21 Mar. 1984
(H-REPT-98-629; GPO-31-451) Avail: US Capitol, House Document Room

The Committee on Science and Technology recommends passage of the funding appropriations bill to NASA for research and development, space flight, control and data communications, construction of facilities, and program management. Principal areas of activity in space transportation capability relate to Spacelab, high altitude satellite orbit placement, payload operations, and advanced programs study and evaluation. The completion of the fleet of shuttle orbiters along with mission preparation and control contribute to the fulfillment of the Space Transportation System. The advanced systems program performs studies and aids development of improved capabilities in tracking and data systems for new missions and to improve cost effectiveness and reliability for overall support of the spaceflight missions. The research and program management appropriation funds the performance and management of research, technology, and test activities at NASA installations along with the planning, and support of contractor research and development in aeronautical and space research. M.A.C.

N84-21442# Committee on Science and Technology (U. S. House).
REVIEW OF THE NATIONAL AERONAUTICS AND SPACE ACT OF 1958
Washington GPO 1984 410 p Hearings before the Subcomm. on Space Sci. and Appl. of the Comm. on Sci. and Technol., 98th Congr., 1st Sess., 18, 19, 25, 26 Oct. 1983
(GPO-28-915) Avail: Subcommittee on Space Science and Applications

Whether the policy objectives contained in the National Aeronautics and Space Act of 1958 adequately reflect the direction and scope of NASA's future is explored including whether NASA's ability to keep pace with changes in the space program is in any way limited by the agency's charter. Major trends which are significantly changing the nature of the civilian space program discussed include space commercialization, increased emphasis on national security, and international cooperation and competition. A.R.H.

N84-21443# Committee on Commerce, Science, and Transportation (U. S. Senate).
NATIONAL AERONAUTICS AND SPACE ADMINISTRATION AUTHORIZATION ACT, 1985
Washington GPO 1984 21 p H.R. 5154 enacted into law by the 92nd Congr., 2d Sess., 28 Mar. 1984
Avail: US Capitol, House Document Room

Appropriations to the National Aeronautics and Space Administration for research and development, space flight, control and data communications, construction of facilities, and research and program management, and for other purposes are authorized. The provisions of the bill are presented. S.L.

N84-21444# Committee on Science and Technology (U. S. House).
NATIONAL AERONAUTICS AND SPACE ADMINISTRATION AUTHORIZATION ACT, 1985
Washington GPO 1984 22 p A bill, H.R. 5154, referred to the Comm. on Sci. and Technol., 98th Congr., 2d Sess., 15 Mar. 1984
(H-REPT-98-629) Avail: US Capitol, House Document Room

Appropriations are authorized to the National Aeronautics and Space Administratin for research and development, space flight, control and data communications, construction of facilities, and research and program management, and for other purposes. The provisions of the bill are presented. S.L.

N84-21590# European Space Agency, Paris (France).
INTRODUCTION TO GEOSTATIONARY ORBITS
E. M. SOOP (ESOC, Darmstadt, West Germany) and W. R. BURKE, ed. Nov. 1983 148 p refs
(ESA-SP-1053; ISSN-0379-6566) Avail: NTIS HC A07/MF A01

The laws governing spacecraft motion in geostationary orbit, and the orders of magnitude of perturbing effects on the orbit are discussed. Orbital maneuvers, perturbed orbits, in orbit control, eclipse effects, stationkeeping, and orbit determination are introduced. Author (ESA)

N84-21592*# Rockwell International Corp., Downey, Calif. Space Operations Center.
SHUTTLE INTERACTION STUDY Quarterly Review
3 Sep. 1980 86 p
(Contract NAS9-16153)
(NASA-CR-173400; NAS 1.26:173400; PD80-55; QR-1) Avail: NTIS HC A05/MF A01 CSCL 14B

The role of the Space Operations Center (SOC) as it effects the missions of the space shuttle was analyzed. Graphic representation of space shuttle docking procedures with attention to the docking module was presented. Other topics included extravehicular activity options, space station evaluation, space logistics of the SOC, equipment interfacing, and SOC buildup scenarios. M.A.C.

N84-21593*# Rockwell International Corp., Downey, Calif. Space Operations Center.
SHUTTER INTERACTION STUDY EXTENSION Monthly Progress Report, 6 Oct. - 6 Nov. 1981
Oct. 1981 14 p
(Contract NAS9-16153)
(NASA-CR-173401; NAS 1.26:173401; MPR-3) Avail: NTIS HC A02/MF A01 CSCL 14B

Plans for space shuttle missions as they effect the Space Operation Center (SOC) were examined. Shuttle fleet utilization, traffic analysis, SOC assembly operations, SOC propellant storage, and flight support facilities were studied with cost estimates, and completion schedules included. M.A.C.

N84-21594*# Rockwell International Corp., Downey, Calif. Space Operations Center.
SHUTTLE INTERACTION STUDY EXTENSION Final Review
Feb. 1982 257 p
(Contract NAS9-16153)
(NASA-CR-173398; NAS 1.26:173398; PD82-1A) Avail: NTIS HC A12/MF A01 CSCL 14B

The following areas of Space Shuttle technology were discussed: variable altitude strategy, spacecraft servicing, propellant storage, orbiter plume impingement, space based design, mating (docking and berthing), shuttle fleet utilization, and mission/traffic model. B.G.

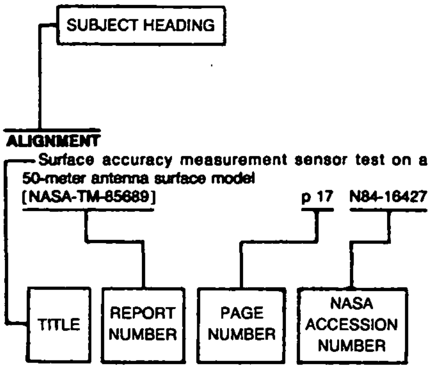
N84-21595*# Rockwell International Corp., Downey, Calif. Space Operations Center.
SHUTTER INTERACTION STUDY Monthly Progress Report, 19 Sep. - 24 Oct. 1980
Oct. 1980 68 p
(Contract NAS9-16153)
(NASA-CR-173402; NAS 1.26:173402; MPR-3) Avail: NTIS HC A04/MF A01 CSCL 14B

The deployment, transport, and exchange procedures for the SOC logistics module and for logistics modules/cradles envisioned to support both the flight support facilities operation and the space construction operation were developed. The use of a holding and positioning aid device was determined to be the most desirable arrangement for the parking/holding of the modules during this exchange operation. The capability/feasibility of transporting eight crew members in the orbiter to and from the SOC was analyzed. Two arrangements were defined for this operation: (1) with the airlock in the orbiter cabin, and (2) with no airlock in the cabin. Author

N84-21596*# Rockwell International Corp., Downey, Calif. Space Operations/Integration and Satellite Systems Div.
SHUTTLE INTERACTION STUDY EXTENSION Midterm Review
15 Oct. 1981 160 p
(Contract NAS9-16153)
(NASA-CR-173403; NAS 1.26:173403; PD81-20A) Avail: NTIS HC A08/MF A01 CSCL 14B

The implications of using the Shuttle with the SOC were analyzed, including constraints that the Shuttle places upon the SOC design. All the considerations involved in the use of the shuttle as a part of the SOC concept were identified. Author

Typical Subject Index Listing



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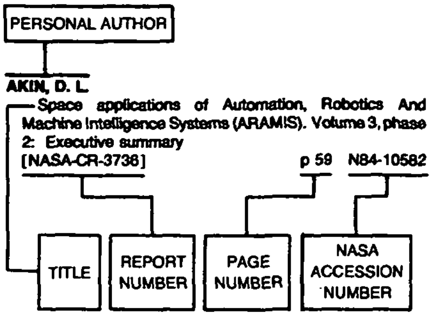
PERSONAL AUTHOR INDEX

Typical Personal Author Index Listing



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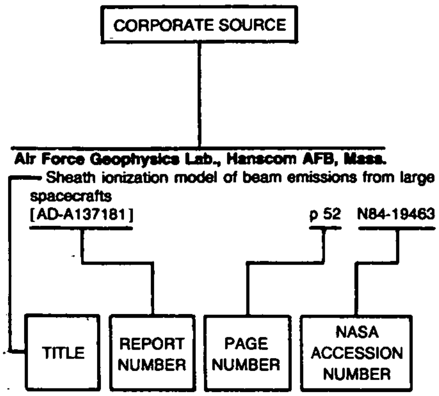
CORPORATE SOURCE INDEX

Typical Corporate Source Index Listing



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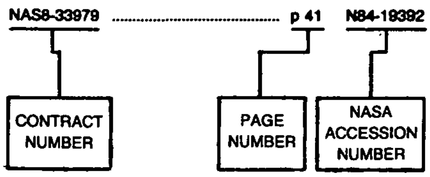

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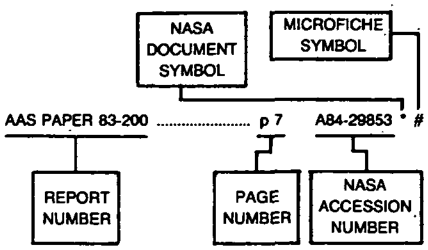

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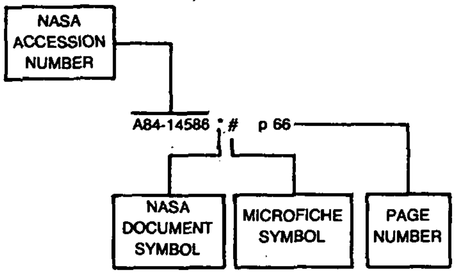

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1. Report No. NASA SP-7046 (11)	2. Government Accession No.	3. Recipient's Catalog No.
4. Title and Subtitle TECHNOLOGY FOR LARGE SPACE SYSTEMS A Bibliography with Indexes		5. Report Date January 1985 6. Performing Organization Code
7. Author(s)		8. Performing Organization Report No.
9. Performing Organization Name and Address National Aeronautics and Space Administration Washington, D.C. 20546		10. Work Unit No. 11. Contract or Grant No.
12. Sponsoring Agency Name and Address		13. Type of Report and Period Covered 14. Sponsoring Agency Code

15. Supplementary Notes

Report prepared, in part, by personnel in the Space Technology Flight Experiments Office and the Technical Library Branch, Hampton, Virginia.

16. Abstract

This bibliography lists 539 reports, articles and other documents introduced into the NASA scientific and technical information system between January 1, 1984 and December 31, 1984. Its purpose is to provide helpful information to the researcher, manager, and designer in technology development and mission design in the area of Large Space System Technology. Subject matter is grouped according to system, interactive analysis and design, structural and thermal analysis and design, structural concepts and control systems, electronics, advanced materials, assembly concepts, propulsion, and solar power satellite systems.

17. Key Words (Suggested by Author(s)) Large Space Systems Large Space Structures Large Space Antenna	18. Distribution Statement Unclassified - Unlimited

19. Security Classif. (of this report)	20. Security Classif. (of this page)	21. No. of Pages	22. Price*
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